# Corporate influence and the academic computer science discipline. [4: CMU, computer architecture and real estate]

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**abstract** Prosopographical work on the four major centers for computer research in the United States has now been conducted, resulting in big questions about the independence of, so called, computer science.

## Introduction

Buildings named "Gates", chairs called "Cadence", succursal in Qatar, deep ties to corporations, Intel and soon Facebook: Here is the modern university of the early 21st century.

But, Carnegie - the founder - was not content with merely naming a professorship or an entire department or even a whole residential college after himself, he went further than anyone with a university... A biographer reports the following, (Carnegie who had some literary aspirations often wrote grandiose texts e.g. his draft letter of departure from Business),

> '*During the long summer months spent at Skibo in this first year of his retirement, [he] had ample time to consider how best to disperse his vast surplus of wealth, upon which he had hardly as yet made a dent. For someone who had written so extensively and preached so eloquently as he on the duties of the man of wealth, it is rather surprising that he faced this task better armed with platitudes* (...)'

CMU is betting on two fields in computer science : AI and Robotics, and Cloud computing. Considering the circumstances in which this science takes place, constantly torn between academic ideals that feel as distant as fairy tales and the everyday necessities as well as practical opportunities and lucrative benefits available far and wide to computer scientists, the idea that this research is conducted in the interest of the great majority can be seriously doubted.

**abbreviations**

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CS     = Computer Science
ECE    = Electrical And Computer Engineering
ML     = Machine Learning
Pr.    = Professor
Univ.  = University
Ass.   = Assistant
Assoc. = Associate
Aff.   = Affiliated
Fac.   = Faculty
Dpt.   = Department
Dir.   = Director
Ma.    = Masters
Und.   = Undergraduate
Prog.  = Program/s
Em.    = Emeritus
f.     = fellowship
aw.    = award
F      = Facebook
MS     = Microsoft
AMZ    = Amazon
GM     = General Motors
fo.    = founder, implied company
con.   = consultant etc.
M      = Million, implied USD
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| | academic rank, position | corporate funding | | corporate employment, ties | PhD |
|---|---|---|---|---|---|
| Aldrich, Jonathan | Professor | F, Ethereum Foundation | x | Sequent Computer Systems; fo. | Washingt |
| Andersen, David | Professor | MS f. | x | Google Brain; Intel[con]; BrdgAI[fo] | MIT |
| Balcan, Nina | Pr. ['Cadence Design Systems'] | G, AMZ[AWS ML] aw; Raytheon f | x | MS | Carnegie |
| Blelloch, Guy | Professor | | x | Intel "*Affiliated Faculty*" [+ Lombardy real estate] | MIT |
| Blum, Manuel | Univ. Pr. ['Bruce Nelson'], Em. | | | | MIT |
| Brookes, Stephen | Professor | | | | Oxford |
| Brumley, David | Professor; Affiliated Faculty | | x | Stanford 'computer security officer'; ForAllSecure ['CEO'] | Carnegie |
| Bryant, Randy | University Professor Emeritus | IBM aw. | x | IBM, HP 'and other companies' [con] | MIT |
| Cervesato, Iliano | Teaching Professor | | x | ITT Industries; Deductive Solutions[fo] | Torino |
| Cortina, Thomas | Assoc. Dean for Und. Prog.; Teaching Pr. | G ['CS4HS'] | x | IBM | Polytech |
| Dannenberg, Roger | Professor Emeritus | | | | Carnegie |
| Eckhardt, Dave | Teaching Professor | | | | Carnegie |
| Erdmann, Michael | Professor, CS and Robotics | | | | MIT |
| Faloutsos, Christos | Professor | G(>1.5M),Boeing(200K),IBM.. | x | Intel "*Affiliated Faculty*" | Toronto |
| Forlizzi, Jodi | Pr., Assoc. Dean for Diversity, Equity And Inclusion; Aff. Fac. | G, MS, GM [+'US Military'] | x | Pratter.us ['healthcare startup', fo.] | Carnegie |
| Frieze, Alan | University Professor; Aff. Fac. | IBM aw. | x | | London |
| Ganger, Greg | Professor | | x | Intel "*Affiliated Faculty*" | Michigan |
| Garlan, David | Pr.; Assoc. Dean for Ma. Prog.; Aff. Fac. | IBM aw. | x | Tektronix, Inc. | Carnegie |
| Gibbons, Phillip | Professor | F, Intel, Oracle | x | AT&T, Lucent, Intel, HP, DEC | Berkeley |
| Gibson, Garth | Consulting Professor | | x | Panasas Inc. [fo] | Berkeley |
| Gligor, Virgil | Professor, Affiliated Faculty | [NSA-NIST aw.] | x | Burroughs, IBM [con.], SAP | Berkeley |
| Gupta, Anupam | Professor | | x | Lucent | Berkeley |
| Harchol-Balter, Mor | Professor [Bruce Nelson] | G, MS, IBM aw., F f. | | | Berkeley |
| Harper, Robert | Professor | | | | Cornell |
| Hodgins, Jessica | Allen Newell Univ. Pr. of CS And Robotics | Packard f. | x | F, Disney | Carnegie |
| Kanade, Takeo | U.A. Helen Whitaker Univ. Pr. | | | | Kyoto |
| Lee, Tai-Sing | Professor | | | | MIT,Har |
| Mackey, John | Teaching Professor | | | | Hawaii |
| Mason, Matthew | Professor, CS and Robotics | | x | IBM | MIT |
| Maxion, Roy | Research Professor | | | | Colorado |
| Mitchell, Tom | Aff. Fac., E. Fredkin Univ. Pr., Faculty Founders Univ. Pr. | | x | Squirrel AI ['Chief AI Scientist'] | Stanford |
| Mowry, Todd | Professor | | x | Intel, silicon Graphics; IBM [con.] | Stanford |
| O'Donnell, Ryan | Professor | MS | x | MS | MIT |
| O'Hallaron, David | Pr. of CS and ECE, Dir. of CS Ma. Prog. | AMZ, Intel['cloud'],IBM | x | Intel ['Director'], GE | Virginia |
| Pfenning, Frank | Professor | | | | Carnegie |
| Platzer, André | Professor | | | | Oldenbu |
| Pollard, Nancy | Professor | | | | MIT |
| Ravi, R. | Professor; Affiliated Faculty | | | | Brown |
| Reddy, Raj | Moza Bint Nasser Univ. Pr.; Aff. Fac. | Honda | x | IBM | Stanford |
| Rosenfeld, Roni | Aff. Fac.; Dpt. Head, ML Dpt.; Pr. | | x | G, DNS Capital, Ignite Venture Partners [con.] | Carnegie |
| Rudich, Steven | Professor | | | | Berkeley |
| Sakr, Majd | Teaching Professor | | x | NEC | Pittsburg |
| Sandholm, Tuomas | Angel Jordan Univ. Pr. of CS | 55M 'venture capital raiser'+22M | x | G,Baidu[con.]; CombineNet,Optimized Markets,Strategy Robot[military][fo] | Amherst |
| Satyanarayanan, Mahadev | Carnegie Group Professor of CS | | x | "*Intel Affiliate researcher*" | Carnegie |
| Schwartz, Russell | Professor | | x | Celera Genomics | MIT |
| Scott, Dana | University Professor Emeritus | Bell Telephone f. | x | Xerox | Princeto |
| Seshan, Srinivasan | Pr.; Department Head, CS Dpt. | | x | IBM; Intel [con.] | Berkeley |
| Shaw, Mary | A. J. Perlis Univ. Pr.; Faculty | | x | Research Analysis Corporation | Carnegie |
| Siewiorek, Daniel | Buhl Univ. Pr. of ECE And CS; Fac. | | | | Stanford |
| Simmons, Reid | Research Professor | Schlumberger | | | MIT |
| Sleator, Daniel | Professor | | x | Bell | Stanford |
| Steenkiste, Peter | Professor of CS & ECE | | | | Stanford |

| | | | | | |
|---|---|---|---|---|---|
| Stehlik, Mark | Teaching Pr.; Ass. Dean for Outreach | | | | - (Carneg |
| Sutner, Klaus | Teaching Professor | | | | Munich |
| Touretzky, David | Research Professor | | | | Carnegie |
| Veloso, Manuela M. | Professor Emeritus | AT&T award | x | JPMorgan AI | Carnegie |
| von Ahn, Luis | Consulting Professor | MS, Packard f. | x | G | Carnegie |
| Xing, Eric P. | Professor | IBM aw. | x | F; Petuum Inc. [AI, fo] | Berkeley |
| Zhang, Hui | Consulting Professor | | x | Conviva [fo] | Berkeley |

## 1. Composition of population

All (full) professors of the Computer Science Department at Carnegie Mellon were included, both teaching and research professors and plain alike.

Emeritus professors, present in a small number (total 6[1]), were included (the reader can come to their own conclusions as to how divergent they are as a group).

(n=59)

## 2. Education and research

fig. CMU CS Dpt. full professors - PhD origins

| | | |
|---|---|---|
| Carnegie Mellon | 15 | (29%) |
| MIT | 11 | (19%) |
| Berkeley | 9 | (15%) |
| Stanford | 6 | (10%) |
| each one | 18 | Washington, Oxford, Torino, Polytechnic University ['now NYU-Poly'], Toronto, London, Michigan, Cornell, Kyoto, Hawaii, Colorado, Virginia, Oldenburg, Brown, Pittsburgh, Amherst, Princeton, Munich |

(n,t=59)

fig. CMU CS Dpt. full professors - PhD origins geographical distribution

| | | |
|---|---|---|
| North America | 53 | (90%) |
| — USA 52 | 52 | (88%) |
| UK | 2 | |
| Europe, rest | 3 | (5%) |
| Japan | 1 | |

(n,t=59)

fig. CMU CS Dpt. full professors - PhD origins US public vs private

| | | |
|---|---|---|
| Private | 36 | (69%) |
| Public | 16 | (31%) |

(n,t=52)

Carnegie Mellon follows strategies previously encountered : it recruits primarily from its own ranks, and preferably from the private sector (about 70% of all of CMU's Cs professors with a US PhD).

Note : Cortinas provides the information "*Polytechnic University (now NYU-Poly)*". Tai Sing Lee has 2 PhDs, one from Harvard the other from MIT (engineering, and 'medical physics' respectively).

Erdmann and Mason, both specialists in Robotics, had the same advisor at MIT (Lozano-Perez)?

Stehlik does not appear to have a PhD,

> "*It turned out that Carnegie Mellon's focus on research and my focus on teaching weren't exactly compatible, though. Also, at one point my adviser left Carnegie Mellon to go to Bell Labs, which made me less happy with what I was doing. Then a teaching position opened for a programming class. I applied and got it, expecting that it would just be a short-term position* (...)" [CMU women@scs interviews]

Klaus Sutner, another teaching professor at CMU, makes the following interesting note about his career and coming to computer science :

> "*Actually my degree is in mathematics, and so my very first appointment was as an Assistant Professor of Mathematics. But then, after a year I switched to computer science—for many reasons, but mainly because that's where the action is.*" [ibid.]

[1]Note : CMU keeps listing Manuel Blum as faculty after a public break with the university by the latter (in 2018?) as part of a controversy. Venkatesan Guruswami , despite having left CMU half a year ago (for Berkeley, in Jan.) is also still listed.

### 2.1 Research

CMU has a strong reputation in at least three areas, 2 known to us, and another one :

- Computer architecture, or 'systems' (as they call it) : i.e. Randy Bryant and David O'Hallaron (CMU's counterpart to Hennessy and Patterson at Berkeley)
– with a sub area in "Cloud" or "Edge" computing (O'Hallaron, Satyanarayanan)
- Programming languages, esp. functional : e.g. Dana Scott, David Touretsky (LISP), Robert Harper (ML) ...
- Robotics (e.g. Raj, Erdmann, Mason, Kanade). Robotics Institute was founded by Reddy Raj, while Kanade advances CMU's area PhD program is "*probably the first of its kind in the world.*"

[Berkeley has or had a strong reputation in theoretical computer science i.e. algorithms (Karp); Stanford in AI/ML, in close association with corporations e.g. Google, in addition to a historical strong suit in algorithmic due to Knuth's presence... MIT's reputation is largely built on accomplishments dating back close to half a century for the most important ones, but CSAIL continues to be renowned, whether similarly based on an illustrious lingering past or its actual current state can be argued[2]]

## 3. funded or named chairs, student outcomes

CMU is not very forthcoming about sponsored chairs, (like Berkeley, in that regard), and information was gather whenever available from individuals' data (e.g. CVs).

Most funded or named chairs at CMU, made public, are derived from famous computer scientists or CMU alumni or affiliates (sometimes both).

It is reflective of this discipline that a majority of computer science professors see as an accomplishments to be able to count their former at companies like Google, Facebook and the like (entire sections of CVs are customarily reserved for that purpose, e.g. Eric Xing lists dozens of his students in employment as part of Big Tech).

## 4. Ethics

Dave Andersen, EXEMPLI GRATIA, indicates "*Pronouns: He / him*" and that he will not review "*publications that follow the IEEE or Elsevier copyright policy*", but bizarrely enough saw less issues with employment on AI, of all dangerous things, at Google as part of their elite "Google Brain" project... (thus, incarnating today's perfect liberal : white knight on cultural issues, but silent as soon as his class interests are touched...)
He also "*provided (...) intellectual property consulting and expert witnessing. Research consulting for Intel*" [personal website; CV]

Also "*Expert witness in a smartphone patent lawsuit, 2011-2012*" [CV] was his colleague and fellow Pr. Jonathan Aldrich, *EXEMPLI GRATIA*.

(It is possible that Mr. Aldrich was fighting the little man's fight in the courts, it cannot be excluded, although the inclusion under "Consulting and Industry" in his CV somehow suggests otherwise... Same for Anderson/Intel.)

Pr. Balcan, EX. GRATIA ETC., "*GPA 10.00/10.00*" [CV] in hand, made her corporate debut in America at Microsoft and gets her funding from Google to Amazon through Raytheon.

Guy Blelloch, IN NOMINE PATRIS ET FILII ET SPIRITUS SANCTI, tops everyone with his bizarre entrepreneurial sense :

"*Interested in a vacation in Italy. Here is My parents apartment in Italy, which they rent.*" [Blelloch CMU website, 01/2007]

When not busy with algorithms, the Professor Blelloch does real estate on the side - 5000$ dollars a month for a 2B if you're interested.
(Astonishongtly enough the business was run from the CMU website... )

The Pr. Brumley, whose company we cannot help but note sounds a lot like AllSafe, can count among his many 'accomplishments' to have aided in the arrest and imprisonment of a 17 year old "hacker", Dennis Moran (for targeting a US War on drugs propaganda

[2]In other words, is it a House Usher that everyone continues to perceive as if existing in a non-decayed state.

DARE, and RSA Security...) resulting in a profile by John Markhoff in the NYT. Bravo Mr. Brumley on a dubious use of your science, intellect and time.

Christos Faloutsos, funded in the millions by Google, Boing and IBM among many others, lists "Data Mining" as his first research interest [CMU personal website].

Jodi Forlizzi, deeply tied to Google, going back at least a decade of funding, became "*Dean for Diversity, Equity And Inclusion*" based on a background extremely distant from computer science - originally a designer. "Hey Alexa, What's Up?", a recent coll. study, is as bankrupt as scientific papers get, never seriously considering privacy despite wide spread reporting and their own observation that children start interacting with such devices at a very early age, even before smartphones, because they are drawn to the voice.

It is obvious what kind of "diversity" is going to be promoted here : the narrow, elite variety and corporate saturated kind (areas in which Forlizzi has gathered so much experience already, to much personal benefit, which she is now ready to share - with the right public...).

Phillip Gibbons exported his habits and network from Intel to CMU, including funding : barely a year after being made full prof., an "Intel Science and Technology Center for Visual Cloud Systems" (worth 15 M, per his website) was headquarted at CMU.

Garth Gibson, as soon as he discovered that CMU stood in the way of profit, put himself on leave of absence "to act as Co-Founder and Chief Technology Officer Panasas, Inc." [pers. CMU website 01/2006]

Mor Harchol-Balter, "*Valedictorian*" in her high school [CV], is funded by Google, IBM, Microsoft - list so long we can only refer to the original source.

Robert Harper and David Touretzky, along with dozens of other computer scientists (incl. also Abelson, Boneh, Rivest, Stallman...), contributed to or signed the Brief of amici curiae in support of Goldstein and 2600 in the DeCSS case [00-9185]. [Harper was also signatory of a amici curiae in MGM v Grokster]

Jessica Hodgins, Midwestern congeniality and salt of the earth type, "founded and ran research labs for Disney"[3] and now is doing the same at Facebook...

> "**Like the other internet giants, Facebook acknowledges the importance of the university system. But at the same time, the companies are eager to land top researchers.**
>
> In Pittsburgh, Facebook hired two professors from the Carnegie Mellon Robotics Institute, Abhinav Gupta and Jessica Hodgins, who specialized in computer vision technology.
>
> The new Facebook lab will focus on robotics and "reinforcement learning," a way for robots to learn tasks by trial and error. Siddhartha Srinivasa, a robotics professor at the University of Washington, said he was also approached by Facebook in recent months. It was not clear to him why the internet company was interested in robotics.
>
> Andrew Moore, dean of computer science at Carnegie Mellon, did not respond to a request for comment. But over the past several months, he has been vocal about the movement of A.I. researchers toward the big internet companies. Google also operates an engineering office near Carnegie Mellon.
>
> "What we're seeing is not necessarily good for society, but it is rational behavior by these companies," he said."[4]

[In pure dystopian fashion, Facebook refers to its AI Research by the acronym FAIR...]

Tai Sing Lee, at CMU leads a project to "*Reverse-Engineer Brain Algorithms*"...

O'Hallaron has received a single 1.5M funding for work on "*Liberating Personal Computing from Hardware*" : O'Hallaron's extensive preoccupation with cloud computing taken into account, it appears he is working on displacing personal computing to remote servers - flowery language of pretend "liberation" ignored or discarded - considering additional funding from his longtime employer, Intel, in the amount of over 100,000 USD to work on that area, Amazon 'gifts' related to AWS, finally "cloud" appears 30 times in a CV of 20 pages[5]..

Majd F. Sakr, (in the third person style favored by, some portions of, academia), "*founded the Cloud Computing Lab and co-founded the Qri8 Qatar Robotics Innovation Lab at CMUQ. He also co-founded the Qatar Cloud Computing Center.*" [pers. CMU website, biographical statement]

Sandholm represents, and cumulates all of the follies of computer science academia : low achievement (PhD at Amherst - a great institution in the humanities, but which he avoids mentioning), leading to life long attempts to make up culminating is a 200 pages(!) - in large parts insane - CV, "serial entrepreneur" (his words), corporate tied AI ventures, obsession with rankings (at over 60 he continues keeping track of decades old GPAs with decimal precision - he goes on then to list windsurfing records, everything is a competition) ...

[3] "*From 2008-2016, she founded and ran research labs for Disney, rising to VP of Research and leading the labs in Pittsburgh and Los Angeles.*" [CMU personal website]

[4] NYT 'Facebook Adds A.I. Labs in Seattle and Pittsburgh, Pressuring Local Universities' May 4th 2018.

[5] (compared with the veritable memoirs written by others, arguably less accomplished, it is short for his experience)

Like his most corporate-oriented colleagues, he knows all about the dirty secrets of professor led start ups being "*Founder and CEO of Strategy Robot, Inc., a CMU spinout that builds AI software products for strategic reasoning under imperfect information for US government military, intelligence, security, and cybersecurity applications.*" [CV]

His already bizzare CV includes strange sections like "EVIDENCE OF EXTERNAL REPUTATION"[6] in which he includes such accomplishments as a "*100 Most Intriguing Entrepreneurs, award from Goldman Sachs, 2020.*" as well as accomplishments by his students (often co-directed) which he appears to be attributing to himself, even when taking place multiple years later, as well as a variety of poker (i.e. AI beats poker players-type) news. Someone as lost as Sandholm at his advanced age cannot be saved – not even Christian adorations repeated a thousand times would.//

Sandholm, more than anyone, incarnates the dubious new figure - found again and again in this series of studies - of the professor "captain" of academia and industry combined. It is very unlikely that this new profile of researchers, increasingly dominant and spearheaded by computer science, is to the benefit of science let alone public service.

Srinivasan is listed as "affiliated faculty" on the Intel Pitt. website, but lists this affiliation as or under "consulting" in his CV.

Reid Simmons is of the reported opinion that :

> "*Plenty of people are afraid of AI's capabilities. An expert says those worries are misguided. The larger concern is ensuring engineers understand ethics. (...) When early face-detection software failed to recognize African American faces it wasn't "an evil plot to discriminate against Blacks," Simmons said. "It was a lack of understanding about the diversity of training data that was needed in order to get the nondiscriminatory result."* "

(In his PhD thesis he thanked Schlumberger - a corporation free of ethical concerns, as everyone knows - quote "*for their support, both financially and intellectually, during the course of my research.*")

He, along with his ethical AI and Robotics colleagues, should thus really enjoy this article.

"*on leave at J.P.Morgan AI*" is finally, EXEMPLI GRATIA, the Pr. Manuela Veloso (who specializes in AI and robots, in case there is any doubt).

[6] 79 f.

Ref. : *https://csd.cmu.edu/directory/faculty*

| | |
|---|---|
| Aldrich, Jonathan | https://www.cs.cmu.edu/~aldrich/aldrich-cv.pdf [21 pp.] |
| David Andersen | https://www.cs.cmu.edu/~dga/cv.pdf [12 pp.] ; https://www.cs.cmu.edu/~dga/bio.html |
| Balcan, Nina | https://www.cs.cmu.edu/%7Eninamf/cv_nina.pdf [23 pp.] |
| Blelloch, Guy | https://www.cs.cmu.edu/~guyb/ ; https://www.qatar.cmu.edu/event/blelloch/ |
| Blum, Manuel | https://www.cs.cmu.edu/~mblum/pdfs/manuel_blum_cv.pdf [8 pp.] |
| Brookes, Stephen | https://www.cs.cmu.edu/~brookes/ |
| Brumley, David | https://users.ece.cmu.edu/~dbrumley/ ; https://www.ece.cmu.edu/directory/bios/brumley-david.html |
| Bryant, Randy | https://www.cs.cmu.edu/~bryant/vitae.pdf [8 pp.] |
| Cervesato, Iliano | https://www.cs.cmu.edu/~iliano/cv.shtml [4 pp.] |
| Cortina, Thomas | cs.cmu.edu/~tcortina/ ; http://toilers.mines.edu/archive/CISEBI/media/presentations/TomCortina.pdf |
| Dannenberg, Roger | https://www.cmu.edu/cfa/music/people/Bios/dannenberg_roger.html |
| Eckhardt, Dave | https://www.cs.cmu.edu/~davide/publications.html |
| Erdmann, Michael | https://www.cs.cmu.edu/~me/whois-me.html |
| Faloutsos, Christos | https://www.cs.cmu.edu/%7Echristos/webvitae.pdf [52 pp.] |
| Forlizzi, Jodi | https://jodiforlizzi.com/sites/default/files/Forlizzi_Jan21_online.pdf [54 pp.] |
| Frieze, Alan | https://www.math.cmu.edu/~af1p/ ; https://www.cmu.edu/math/people/faculty/frieze.html |
| Ganger, Greg | https://users.ece.cmu.edu/~ganger/ |
| Garlan, David | https://www.cs.cmu.edu/~garlan/Vitae%202021-06-09.pdf [38 pp.] |
| Gibbons, Phillip | https://www.cs.cmu.edu/~gibbons/Phillip%20B.%20Gibbons_files/gibbons-cv.pdf [34 pp.] |
| Gibson, Garth | https://www.cs.cmu.edu/~garth/ |
| Gligor, Virgil | https://users.ece.cmu.edu/~virgil/ ; https://engineering.cmu.edu/directory/bios/gligor-virgil.html |
| Gupta, Anupam | https://www.cs.cmu.edu/~anupamg/ ; https://simons.berkeley.edu/people/anupam-gupta |
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| Harper, Robert | https://www.cs.cmu.edu/~rwh/ |
| Hodgins, Jessica | https://www.cs.cmu.edu/~jkh/ |
| Kanade, Takeo | https://www.cs.cmu.edu/~tk/ ; https://www.ri.cmu.edu/ri-faculty/takeo-kanade/ |
| Lee, Tai-Sing | https://www.cnbc.cmu.edu/~tai/ |
| Mackey, John | https://www.cmu.edu/math/people/faculty/mackey.html |
| Mason, Matthew | https://www.cs.cmu.edu/~mason/mattscv.pdf [19 pp.] |
| Maxion, Roy | https://www.cs.cmu.edu/~maxion/ ; https://cylab.cmu.edu/directory/bios/maxion-roy.html |
| Mitchell, Tom | https://www.cs.cmu.edu/~tom/resume.pdf [13 pp.] |
| Mowry, Todd | cs.cmu.edu/~tcm/ ; https://www.toddcmowry.org/ [13 pp.] |
| O'Donnell, Ryan | https://www.cs.cmu.edu/~odonnell/vita.pdf [18 pp.] |
| O'Hallaron, David | https://www.cs.cmu.edu/~droh/drohcv.pdf [24 pp.] |
| Pfenning, Frank | https://www.cs.cmu.edu/~fp/cv.html [10 pp. plus annex] |
| Platzer, André | https://lfcps.org/meta/Platzer-CV.pdf [20 pp.] |
| Nancy Pollard | graphics.cs.cmu.edu/nsp/ |
| Ravi, R. | cmu.edu/tepper/faculty-and-research/faculty-by-area/profiles/ravi-r.html ; contrib.andrew.cmu.edu/~ravi/ |
| Reddy, Raj | rr.cs.cmu.edu/ ; https://amturing.acm.org/award_winners/reddy_9634208.cfm |
| Rosenfeld, Roni | https://www.cs.cmu.edu/~roni/ [Googe docs, 42 pp.] |
| Rudich, Steven | https://www.cs.cmu.edu/~rudich/ ; https://www.linkedin.com/in/steven-rudich-6422b8167 |
| Sakr, Majd | https://www.cs.cmu.edu/~msakr/ |
| Sandholm, Tuomas | https://www.cs.cmu.edu/~sandholm/ |
| Satyanarayanan, Mahadev | https://www.cs.cmu.edu/~satya/ |
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| Scott, Dana | https://www.cs.cmu.edu/~scott/career.html |
| Seshan, Srinivasan | https://www.cs.cmu.edu/~srini/ [19 pp.] |
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| Siewiorek, Daniel | https://www.cs.cmu.edu/~dps/ ; https://www.ece.cmu.edu/directory/bios/siewiorek-daniel.html |
| Simmons, Reid | https://www.cs.cmu.edu/~reids/ |
| Sleator, Daniel | https://www.cs.cmu.edu/~sleator/ ; https://www.linkedin.com/in/dannysleator |
| Steenkiste, Peter | https://www.cs.cmu.edu/~prs/ |
| Stehlik, Mark | https://www.cs.cmu.edu/~mjs/ ; http://www.women.cs.cmu.edu/What/Interviews/stehlik.php |
| Sutner, Klaus | https://www.cs.cmu.edu/~sutner/ ; www.women.cs.cmu.edu/What/Interviews/sutner.php |
| Touretzky, David | https://www.cs.cmu.edu/~dst/ e.g. .../DeCSS/touretzky-decl.html |
| Veloso, Manuela M. | https://www.cs.cmu.edu/~mmv/ |
| von Ahn, Luis | https://www.cs.cmu.edu/~biglou/LuisvonAhn_CV.pdf [10 pp.] |
| Xing, Eric P. | https://www.cs.cmu.edu/~epxing/xing_cv_2021.pdf [39 pp.] |
| Zhang, Hui | https://www.cs.cmu.edu/~hzhang/ |


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appendix

- Jonathan Aldrich CV, pp. 18;21 (funding, and "consulting")
- Pr. Balcan CV, pp. 1-2
- Guy Blelloch real estate on the side, Lombardy "condominium" business/inheritance *cs.cmu.edu/ guyb/menaggioHome/* [the price gets higher as the description gets longer...]
- Christos Faloutsos CV, pp. 31-35 (grants)
- Gibbons, Phillip CV, pp. 31-32 ('Grants and Gifts')
- Garth Gibson CMU website 01/2006 ['on leave' for business]
- Mor Harchol-Balter CV, pp. 2-4; 27-36 ['honors', 'grants', 'Google Women in Tech' etc. etc.]
- O'Hallaron CV, pp. 23-24 ('support')
- Sandholm CV extracts (about 20 pages of 200)
- Intel Pittsburgh People (2006)
- Reid Simmons PhD thesis, p. iii (acknowledgments)
- Manuel Veloso CMU website ("on leave" at JPM, "Head, Machine Learning Department", etc.)

# Curriculum Vitae
# Jonathan Aldrich

## Contact Information

Jonathan Aldrich
Institute for Software Research
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**Executive assistant:**

Linda Campbell
lv2c at cs dot cmu dot edu

## Research: Engineering Languages

I work at the intersection of **programming languages** and **software engineering**. My research examines new ways to **express software and its properties** that improve our ability to **engineer software at scale**. Effective software engineering at scale is closely tied to design---how a system is broken into parts, and how those parts compose to achieve the desired functionality and properties of the system. Thus, my research develops new ways to **express design within source code,** where both tools and engineers can most effectively leverage it, thereby improving productivity and reducing errors. My work also focuses on improved **object models**---a foundational composition mechanism---as well as **type systems and logics** for specifying component boundaries and reasoning about the result of composition. I evaluate the systems I develop using a wide variety of techniques, including **mathematical proofs, case studies, code corpus studies, and evaluations with human subjects**. One might say that I work on languages for better software engineering, but that I also take an **engineering approach to language design**: thinking not just about what a language can express, but the cost-benefit tradeoffs of various language constructs and how those constructs work together to help engineers develop software more effectively.

## Education

Ph.D., Computer Science and Engineering, University of Washington, August 2003.
Advisors: Craig Chambers and David Notkin
Thesis: Using Types to Enforce Architectural Design

M.S., Computer Science and Engineering, University of Washington, June 1999.

B.S., Engineering and Applied Science (Computer Science), California Institute of Technology, June 1997.

## Funding

2021 Ethereum Foundation grant, $42,000.

2020 Ethereum Foundation grant, $64,690.

2019 National Science Foundation award, "SHF: Medium: Gradual Verification." $1,017,511 over 4 years, 2019-2023. With Joshua Sunshine.

2019 National Science Foundation award, "SHF: Small: Declaratively Creating Semantics-driven Visualizations." $449,680 over 3 years, 2019-2022. With Joshua Sunshine and Keenan Crane.

2018 Facebook Testing and Verification Award, "Incremental Verification, Gradually." $50,000 gift. With Eric Tanter and Joshua Sunshine.

2017 National Security Agency Lablet, Co-PI (with William Scherlis as Lead PI). Renewable for 3 years.

2015 DARPA BRASS award, Lead PI (with 4 Co-PIs), "Intelligent Model-Based Adaptation for Mobile Robotics", $7.8 million over 4 years, November 2015-2019

2014 Stevens Institute, joint project with Christian Kästner and Joshua Sunshine, as part of a multi-faculty effort with William Scherlis as lead.

2014 National Security Agency Lablet, Co-PI (with William Scherlis as Lead PI). 2014-2017 ($2.3M in 2014).

2013 National Security Agency Lablet award, "Race Vulnerability Study and Hybrid Race Detection." $139,598 over 2 years, 2013-2014.

2012 National Security Agency Lablet award, "A Language and Framework for Development of Secure Mobile Applications." $500,000+ over 3 years, 2012-2014.

2012 National Science Foundation award, "Collaborative Research: Teaching Software Modularity through Architectural Review." $100,000 over 2 years, 2012-2014.

2011 National Science Foundation award, "SHF:Small:Foundations of Permission-Based Object-Oriented Languages." $500,000 over 3 years, 2011-2014.

2010 CMU|Portugal research award, "Aeminium: Freeing Programmers from the Shackles of Sequentiality." $321,0185 over 3 years, 2010-2012.

2008 National Science Foundation award, "CPA-SEL: Practical Typestate Verification with Assume-Guarantee Reasoning." $300,000 over 3 years, 2008-2010.

DARPA Computer Science Study Group member. $600,000 over 3 years, potentially renewable for 2 more years. 2007-2010.

2006 National Science Foundation CAREER award, "Lightweight Modeling and Enforcement of Architectural Behavior," $450,000 over 5 years. 2006-2010.

Human and Robotic Technology: Dependable Real-Time and Embedded Space Software, NASA (Michael Shafto, Program Manager), $1.1 million over one year (2005-2006). Project Lead.

ITR: Synthetic Reality: Physically Rendering Dynamic 3D Objects from Programmable Matter. National Science Foundation (Helen Gill, Progarm Manager), $662,000 over 2 years. Senior Personnel.

Integrating Software Architecture and Software Development. National Science Foundation (Sol Greenspan, Program Director), $300,000 over 3 years. Co-written with advisor Craig Chambers while a graduate student; portions subcontracted to my research group at CMU after graduation.

## External Talks

## Consulting and Industry

Co-founder and CTO, Noteful LLC, 2022

Summer Teaching, Torhea Education Group, 2019

Expert witness in a smartphone patent lawsuit, 2011-2012

Architecture consultant for an embedded software system, 2006

## Professional Societies

Senior Member, Association for Computing Machinery, and SIGSOFT and SIGPLAN special interest groups

Senior Member, Institute of Electrical and Electronics Engineers

**MARIA-FLORINA BALCAN**
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## RESEARCH INTERESTS

Learning Theory, Machine Learning, Theory of Computing, Artificial Intelligence, Algorithmic Economics and Algorithmic Game Theory, Optimization.

## APPOINTMENTS

- **July 2020 - present** Professor, Cadence Design Systems Chair in Computer Science, School of Computer Science, Carnegie Mellon University, Pittsburgh, PA.
- **June 2014 – 2020** Associate Professor, School of Computer Science, Carnegie Mellon University, Pittsburgh, PA. (tenured in 2016)
- **2009 - 2014** Assistant Professor, College of Computing, Georgia Tech, Atlanta, GA.
- **2008 - 2009** Postdoctoral Researcher, Microsoft Research NE, Cambridge, MA.
- **2000 - 2002** Instructor, Computer Science Department, University of Bucharest, Romania.

## EDUCATION

- **Ph.D. 2002 – 2008.** Carnegie Mellon University, Pittsburgh, PA. Computer Science Department.
- **M.S. 2000 – 2002.** University of Bucharest, Romania, Faculty of Mathematics, Computer Science Department, M.S. Degree in Computer Science, GPA 10.00 / 10.00.
- **B.S. 1996 – 2000**. University of Bucharest, Romania. Faculty of Mathematics, Computer Science Dept., GPA 10.00/10.00. "Summa Cum Laude" Diploma.

## HONORS AND AWARDS

### Major Leadership Positions

- General Chair for the 38th International Conference on Machine Learning (**ICML**) 2021.
- Program Committee Co-Chair for the 34th Conference on Neural Information Processing Systems (**NeurIPS**) 2020.
- Invited Co-organizer for the "Machine Learning and Computational Modelling" Session of the Japanese- American-German Kavli Frontiers of Science Symposium, National Academy of Sciences, 2017.
- Co-organizer for "Foundations of Machine Learning", semester long program at the Simons Institute for Theory of Computing, 2017.
- Program Committee Co-Chair for the 33rd International Conference on Machine Learning (**ICML**) 2016.
- Program Committee Co-Chair for the 27th Annual Conference on Learning Theory (**COLT**) 2014.
- Board Member of the International Machine Learning Society (most recent term, 2017- current).

### Other Honors

- 2021, Simons Investigator in Theoretical Computer Science.
- 2020, Cadence Design Systems Chair in Computer Science.
- 2019, ACM Grace Murray Hopper Award (awarded to the outstanding young computer professional of the year).
- 2019, AWS Machine Learning Research Award
- 2019, Bloomberg Data Science Research Award.

- 2019, Exemplary Artificial Intelligence Track Paper, 20th ACM Conference on Economics and Computation.
- 2018, Amazon Research Award.
- 2015, Kavli Frontiers of Science Fellow, National Academy of Sciences.
- 2014, Sloan Research Fellowship.
- 2013, Georgia Power Professor of Excellence.
- 2013, Raytheon Faculty Fellowship.
- 2012, Runner Up Best Paper, 25th Annual Conference on Learning Theory.
- 2011, Google Research Award.
- 2011, Microsoft Faculty Fellowship.
- 2009, NSF CAREER Award.
- 2009, CMU School of Computer Science Distinguished Dissertation Award.
- 2008, Mark Fulk Best Student Paper Award, 21st Annual Conference on Learning Theory.
- 2007 - 2008, IBM Ph.D. Fellowship.
- 2000 - 2001, Romanian Government Merit Fellowship (during my MS studies).
- 1996 - 2000, Romanian Government Merit Fellowship (during my undergraduate studies).
- 2001, World Bank Fellowship, for visiting CNRS, Toulouse, France.
- 1999 - 2000, European Union Erasmus/Socrates scholarship to study at the University of Patras, Greece.

**Selected Distinguished Lectures and Invited Talks**

- Uhlenbeck Lecture, Women in Mathematics, Princeton, 2022.
- Invited speaker, International Congress of Mathematicians, 2022.
- Distinguished Lecture, Max Planck Institute for Software Systems, 2022.
- Distinguished Lecture, ETH Zurich Distinguished Computer Science Colloquium, 2022.
- Invited talk at the 39th International Symposium on Theoretical Aspects of Computer Science (STACS) 2022.
- ACM Tech Talk, 2021.
- Invited talk at the 32nd International Conference on Game Theory, 2021.
- Plenary talk at the Information Theory Workshop, 2020.
- Plenary talk at the 14th Latin American Theoretical Informatics Symposium, 2020.
- AI Research Distinguished Speaker Series Lecture, Boston University, 2019.
- Distinguished Graduate Seminar Series Lecture, ECEE School, Arizona State University, 2019.
- Keynote talk at the European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases (ECML-PKDD) 2019.
- Keynote talk at the 12th International Symposium on Algorithmic Game Theory (SAGT) 2019.
- Keynote talk at the 3rd International Summer School on Deep Learning (DeepLearn) 2019.
- Plenary talk at the 24th LIDS Student Conference, MIT, 2019.
- Distinguished Lecture, University of Southern California (USC) Computer Science Department, 2018.
- Plenary talk at the Information Theory and Applications Workshop (ITA), 2018.
- Plenary talk at the 9th China Theory Week, 2015.
- Plenary talk at the 14th International Conference on Autonomous Agents and Multiagent System (AAMAS), 2015.
- Keynote talk at the 7th Workshop for Women in Machine Learning, 2013.
- Distinguished Lecture, Carnegie Mellon University, School of Computer Science, 2010.

# Guy E. Blelloch

Professor
Department of Computer Science
Carnegie Mellon University

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Other Contact Information

## Research:

**PUBLICATIONS**

I'm co-director of the ALADDIN Center for the study of algorithms.

My research has largely been in the interaction of Algorithms and Programming Languages. Here is some of my more recent research.

- Adaptive Computation. The idea is to keep track of dependencies while executing an algorithm so that you can go back, change history, and propagate the change to the output.
- Data Structures for Graph Compression. We look at how to represent graphs with a small number of bits while still allowing efficient queries on the graphs.
- Algorithms for Multiprocessor Garbage Collection. The goal here is to bound the wait time for a GC while also bounding the memory required.
- Purely Functional Algorithms. We are interested in purely functional (side effect free) algorithms for various problems; most notably algorithms in computational geometry.

and here are other things I've worked on:

- Thread Scheduling
- Parallel Algorithms (Delaunay Triangulation, Treaps, Sorting, Graph Connectivity, List Ranking)
- The NESL Language
- Provably Efficient Language Implementations
- Other: Pipelining with Futures, Multibank Memory Systems.

Most of the research has been done under the umbrella of the ALADDIN center and as part of the Sangria project.
Earlier work was done as part of the PSCICO and Scandal projects.

You can try our animations of parallel algorithms. These were written in NESL and converted to JAVA using our NESL-to-Java-applet translator.
You can also try our Pittsburgh map and restaurant database. The interface is terribly primitive

compared to e.g. mapquest, but this was the first of the map interfaces available on the web.

## Teaching:

- 15-853: Algorithms in the Real World (Fall 04)
- 15-499: Algorithms and Applications (Spring 03)
- 15-451: Algorithms (Spring 02)
- 15-213: Introduction to Computer Systems (Spring 00)
- 15-850: Algorithms for Indexing and Searching (Spring 99)
- 15-849(C): Parallel Computing (Fall 98)

I maintain the SCS faculty information page and guide for new faculty (only available at CMU).

If you are within CMU CS you can try my Side Bar.

Find an address in Pittsburgh:

Or a user's page at CMU CS:

Interested in a vacation in Italy. Here is My parents apartment in Italy, which they rent.

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*Guy.Blelloch@cs.cmu.edu*
*Last Updated: June 30, 2022*

# Holiday Rentals: Vacation Rental Apartment
# *Balcone Di Casate*

**Menaggio ~ Lake Como ~ Italy**
**2 Bedrooms ~ 1 Bathroom ~ Sleeps 4 ~ Pool**
**Rental Rate: 800 Euros/week (high season), or $1000**
**Kids Welcome ~ No Smoking ~ No Pets**

- Nicely landscaped **top-quality condominium** complex with gates and a garage. Quiet.
- **Large Terrace** with a 180 degree view of the most beautiful part of Lake Como, including views of Bellagio and Varenna.
- Very well maintained apartment with **new kitchen**.
- 70sqm (750 sqft). Private Garden.
- Large shared **Pool**, with shallow area for kids.
- Five minute walk to public **boats and ferries**, which take you to most locations on the lake.
- Ten minute walk to the center of **Menaggio**, one of the nicest towns on the lake.
- Beautiful **hikes** or **drives** to local mountains and villages.
- Within 2 kilometers of one of the most picturesque and challenging **golf courses** in Italy.

View of Varenna from the private terrace.

Lovely condominium located in Menaggio that sleeps four people in comfort in gated community with large swimming pool (open mid June to mid-September). The apartment has a living/dining room, a newly remodeled kitchen, two bedrooms and a bathroom. One bedroom has a queen bed and french doors onto the terrace, and the other has bunk beds. The apartment is nicely furnished and includes linen and a fully equipped kitchen. The bathroom has a clothes washer and the kitchen a dishwasher.

Living Room

Kitchen

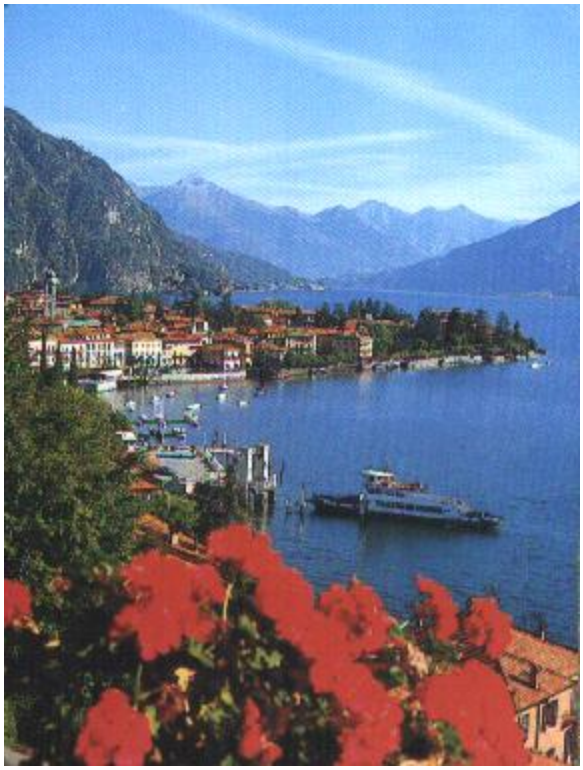
The apartment has a large furnished half-covered terrace with fabulous views over Lake Como. The terrace includes two areas, one with a dining table and one with a sitting area. Each building (5 total) in the complex has 2 floors each with 2 apartments. This apartment is on the lower floor, and has a private garden below the terrace and along the side of the apartment.

Terrace

Private garden, looking down from terrace

It is a 5 minute walk to the dock for lake boats and ferries as well as a minimarket and it is a 10 minute walk to the center of Menaggio with its restaurants, shops and other facilities.

There is a garage on the premises. Menaggio is located 1.5 hours drive from Milan-Malpensa Airport or the center of Milan, 0.5 hour from Lugano, Switzerland and 2 hours to the Upper Engadine (St. Moritz), Switzerland. While a car is recommended, it is not essential. Menaggio is served by an excellent public service system. There is one direct bus a day to and from Malpensa Airport and two more buses connecting in Como. There are hydrofoils, lake boats and ferries allowing access to all points on Lake Como. There are buses to Como, Lugano, St. Moritz and many mountain villages. There are excellent hikes in the mountains surrounding the lake. There is a first rate golf course.



View of Menaggio and Ferry
from the Condominium Complex


Map of Lake Como
(a larger map of the region)

Available mid-July to mid-September 2004. Rent is Euros 1,000 ($1,200) per week. Security deposit of Euros 500 ($600) required. Non-smokers, no pets.

For further information contact pblelloch@aol.com or phone 1-609-799-1475 (USA).

Bedroom 1

Pool, overlooking Lake

Private garden next to terrace

Condiminium Complex

Apartment: Menaggio -->

medium-res and high-res photo

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**Admin:** Marcie Baker
email: christos-admin-support AT cs DOT cmu DOT edu

**If interested in grad studies, postdoc, summer internship, etc:**
Thank you for your interest! Please see this first.

# Christos Faloutsos

**Current Position:** Fredkin Professor of Computer Science.
**Courtesy appointment:** Electrical and Computer Engineering, CMU
**Academic Degrees:** Ph.D. and M.Sc. (University of Toronto.); B.Sc. (Nat. Tech. U. Athens)
**Short bio** and full CV in pdf; customized for funding agencies, 2-page versions .
Up-to-date calendar: here

**Other affiliations:**

- Database group at CMU
- Machine Learning Department
- PDL (Parallel Data Lab)

**Past affiliations:**

- Informedia (1997-2007)
- Computational Biology Department(2003-2015)

# Research Interests:

- Data Mining for graphs and streams
- Fractals, self-similarity and power laws
- Indexing and data mining for video, biological and medical databases
- Data base performance evaluation (data placement, workload characterization)

# Projects

53. *Graph mining and multi- relational learning: Tools and applications.* Shobeir F akhraei and Christos Faloutsos TheWebConf, Ljubljana, Slovenia, April 19-23, 2021.

54. *Graph mining and multi-relational learning: Tools and applications.* Shobeir F akhraei and Christos Faloutsos ECML-PKDD, Sept. 19, 2022.

**GRANTS**

1. IBM FULCRUM project grant, round II (1986-1988). 2 IBM PC AT's, fully equipped (≈ $10,000). The project is to implement a full-text retrieval system, using a novel method, called "signature files".

2. NSF Grant (ID: DCR-8616833), 7/87 to 12/89. Title: *"Signature File Methods for Text Data Bases"*. Amount: $102,176.

3. NSF REU (Research Experience for Undergraduates) grant (IRI-8844914), amendment to the previous NSF grant DCR-8616833. Amount: $3,880.

4. Maryland Industrial Partnerships (MIPS) grant, 1/88 to 6/88. Title: *"Data and Document Interchange in Machine Readable Form"* Amount: $30,241.

5. NSF Grant (ID: IRI-8719458), 7/88-7/91 Title: *"High Performance Engineering Information Systems"*. Principal Investigator: N. Roussopoulos. Co-Principal Investigators: T. Sellis, L. Mark, C. Faloutsos. Amount: $391,071.

6. AFOSR Grant (ID: AFOSR-89-0303), 4/89-4/92 Title: *Design Issues for High Performance Engineering Information Systems* Principal Investigator: N. Roussopoulos. Co-Principal Investigators: T. Sellis, L. Mark, C. Faloutsos. Amount: $405,000.

7. NSF REU (Research Experience for Undergraduates) grant (IRI-8943224), second amendment to the NSF grant DCR-8616833. Amount: $3,998.

8. NSF CISE grant (IRI-8944635), third amendment to the NSF grant DCR-8616833. Amount: $12,914. The Department provides $14,947 as matching funds.

9. Department of Commerce (Bureau of Census) Joint Statistical Agreement (JSA 91-9), 2/1/91-2/1/92. Title: *"Spatial Orders for Census and Sampling Applications"*. Amount: $15,000. The Department provides $6,143 as matching funds.

10. EMPRESS Software Inc., donation of software and 1 year maintenance contract, 4/91. Amount: $23,610.

11. Thinking Machines Inc., donation of software and 2 years maintenance contract, 1/92. Amount: $130,000.

12. NSF-ESPRIT grant (IRI-9205273), 6/93-6/96. Title: *"Multimedia Information Retrieval Systems"* Amount: $30,000.

13. Illustra Information Technologies Inc., Engines for Innovation Research Grant, 10/94. Title: *Database Support for Genomic and Medical Applications* Principal Investigators: Michael Franklin and Christos Faloutsos. Amount: Database Server Software, Training and Maintenance (dollar value: to be determined).

14. NSF grant (IRI-9625428), 8/1/96-7/31/99 Title: *"Fast Searching of Multimedia Objects by Content"* Amount: $305,837.

15. IBM-SUR grant, 1996-1997 Title *Studies in Multimedia Data Acquisition, Searching and Representation* PIs: Gary Marchionini and Christos Faloutsos Equipment grant.

16. Maryland Procurement, 9/96-9/99 Title: *Document Image, Video and Natural Language Processing* PI: David Doermann and Amy Weinberger Co-PIs/Senior personnel: Christos Faloutsos and Bonnie Dorr Amount: (est.) $575K

17. NSF IIS, 9813354 6/1/98-11/30/98 Title: *"Workshop On Automated Learning And Discovery"* PIs: Sebastian Thrun, Tom Mitchell, Christos Faloutsos, Larry A. Wasserman. $19,545.

18. NSF KDI, DMS-9873442, 10/15/1998-9/30/2001. Title *"KDI: New Algorithms, Architectures and Science for Data Mining of* Massive Astrophysics Sky Surveys." PIs: Andrew W. Moore, Robert C. Nichol; coPIs: Christos Faloutsos, Peter L. Spirtes, Larry A. Wasserman. $1,600,000.

19. INTEL equipment grant, 1/1999. 3 Pentium machines with monitors. Total list price: $21,675.
20. NEC gift, 12/1998. Title: *"Multi-Dimensional Indexing for Information Warehouse"*. Amount: $10,000.
21. NSF, number IIS-98-17496. Title: *"Informedia-II: Integrated Video Information Extraction and Synthesis for Adaptive Presentation and Summarization from Distributed Libraries"*. 5/1/99-04/30/03 PI: Howard Wactlar; Senior personnel: Michael Christel, Christos Faloutsos, Alex Hauptmann, Takeo Kanade. Amount: $4,000,000.
22. NSF, number IIS-9910606 Title *SGER: Fractals for Spatial and Temporal Databases* PI: Christos Faloutsos. 9/15/1999-8/31/2001 Amount: $100,000.
23. DARPA Title *"CONSTELLATION: A Scalable Metrology to Support Theory and Practice of Anomalous-Event Detection"* 8/1/1999 - 7/31/2002. PI: Roy Maxion, Senior personnel: David Banks, Jeffery Hansen, Christos Faloutsos, Karl Levitt, Tom Mitchell, Daniel Siewiorek. Amount: $1,985,858.
24. NSF, number IIS-9988876. Title: *CNPq: IMiMD-Indexing and Data Mining in Multimedia Databases.* PI: Christos Faloutsos. Starting: 9/15/2000, for 3 years. Amount: $200,000.
25. DARPA, contract number N66001-00-1-8936. Title: *Analysis and Simulation of the Internet Topology and its Fault-Tolerance* PI: Michalis Faloutsos. Starting: 7/2000, for 3 years. Subcontractor: Christos Faloutsos (CMU)
26. NSF, number IIS-0083148 Title: *Collaborative Research: Data Mining Meets I/O Performance Evaluation:* Advanced Statistical Tools for Analyzing Bursty Traffic PIs: Christos Faloutsos, Ngai Hang Chan, Tara Madhyastha. Amount for CMU: $420,000. Starting: 9/1/2001, for 3 years.
27. NSF, number IIS-0113089. Title: *A Knowledge Discovery Framework for Civil Infrastructure Contexts* PI: James H. Garrett. Co-PIs: Christos Faloutsos, Sue McNeil. Starting: 2/1/2001, for 3 years. Amount: $241,263.
28. NLM, Grant number 2 R44 LM06520-02A1 Title: *A Bayesian Textual and Multimedia Information Retrieval Engine* PI: Giovanni Marchisio (Insightful). Duration: 9/30/2001-2/29/2003. Amount: $749,224. (CMU portion: $8,000).
29. NSF IIS-0209107 Title: *Collaborative Research: NetMine: Finding Patterns in Network Data* PIs: Christos Faloutsos (CMU); Michalis Faloutsos (UCR) Duration: 9/1/2002-8/31/2005. Amount: $240,000 (CMU portion: $120,000).
30. NSF, IIS-0205224 Title: *Providing Intuitive Access to Human Motion Databases* PIs: Jessica Hodgins, Amy Bruckman, Christos Faloutsos, Nancy Pollard, Randy Pausch Duration: 9/1/2002-8/31/2004. Amount: $510,000.
31. Intel Corporation, Equipment grant Title: *Sensor Network Data Mining* PI: Christos Faloutsos Date: Feb. 2003. Amount: $52,910.
32. PITA/ICES Title: *Automatic Mining on Sensor Data* PIs: Christos Faloutsos, Phil Gibbons Duration: 2003-2004 Amount: $39,079
33. NSF, BES-0329549. Title: *SENSORS: Placement and operation of an environmental sensor network to facilitate decision making regarding drinking water quality and security* PI: Jeanne VanBriessen Co-PIs: Anastassia Ailamaki, Paul Fischbeck, Christos Faloutsos and Mitchell Small. Duration: 09/01/03-8/31/06. Amount: $958,000.00
34. NSF/INT/EAP 03-18547 Title: *Semantic Integration of Stream Data: A Data Mining-based Approach* PI: Christos Faloutsos, Phil Gibbons, Natassa Ailamaki. Duration: Sept 1, 2003 - Aug 31, 2005. Amount: $15,780
35. NSF ITR 03-31697 (large ITR) *ITR: Next Generation Bio-Molecular Imaging and Information Discovery* PI: B. Manjunath et al (UCSB); Robert Murphy et al. (CMU) (C. Faloutsos: Senior Personell) Amount: $3,869,943 Duration: Oct. 1 2003 - Sept. 30, 2008.
36. NSF ITR (medium ITR) 03-26322 *ITR Collaborative Research: Indexing, Retrieval, and Use of Large Motion Databases* PIs: Christos Faloutsos, Jessica Hodgins, Amy Bruckman, Nancy Pollard, Randy Pausch Duration: 3/15/2004 - 2/28/2006. Amount: $706,000.

37. PITA/ICES Title: *Tools for Mining Large Graphs* PI: Christos Faloutsos Duration: 10/1/2004 - 12/31/2005. Amount: $62,243.

38. HP equipment donation *ProLiant DL585R01 server,* Four 2.8GHz Opteron processors, 32Gb memory, 1.4Tb disk. Amount: $49,908. Date: Jan. 30, 2006.

39. PITA/ICES Title: *Distributed Mining in Co-evolving Streaming Sensor Data* PI; Christos Faloutsos Duration: 9/2005-9/2006 Amount: $64K

40. NSF, IIS-0534205 Title: *CISE/IIS: Finding Patterns and Anomalies in Large Time-Evolving Graphs* PI: Christos Faloutsos Duration: 4/15/2006-3/31/2009 Amount: $337,590.

41. IBM Faculty Award, 2006. PI: Christos Faloutsos. Amount: $30,000.

42. Lawrence Livermore National Laboratory (LLNL), Contract No. B526511. Title: *Prediction on Time-Evolving Complex Networks* Duration: 09/01/06 - 09/30/07 Amount: $156,015

43. Yahoo! Research Alliance gift Title: *Analysis and Mining of the Query and Answer System of Yahoo* Duration: 2006-2007. Amount: $75,000.

44. PITA/ICES Title: *Influence Propagation in Large Blog Graphs* PI: Christos Faloutsos Duration: Sept. 2006 - May 2008. Amount: $52,489.

45. NSF Grant No. CNS-0721736 "Collaborative Research: NeTS-NBD: RIDR: Towards Robust Interdomain Internet Routing: Measurements, Models, and Deployable Tools" PI: Faloutsos Duration: Aug. 2007 - July 2010. Amount: $245,000.

46. IBM Faculty Award, 2007. PI: Christos Faloutsos. Amount: $30,000.

47. NSF Grant No. IIS-0705359 *III-COR: Collaborative Research: Mining Biomedical and Network Data Using Tensors* PI: Faloutsos (co-PI: Vassileios Megalooikonomou, Temple University) Duration: 09/15/07- 08/31/10. Amount: $307,985

48. NSF Grant No. DBI-0640543 *Indexing, Mining and Modeling Spatio-Temporal Patterns of Gene Expressions* Eric Xing (PI) and Christos Faloutsos (co-PI). Duration: 08/15/2007 - 07/31/2010. Amount: $1,331,995.

49. Gift from SPRINT (Dr. Jean Bolot). Starting date: 2007. Amount: $52,000.

50. Lawrence Livermore National Laboratory (LLNL), Contract No. B573265. Title: *Mining Large Time-Evolving Graphs* Duration: 03/01/07 - 09/30/08 Amount: $90,387

51. NSF Grant No. IIS0808661 *III-CXT: Collaborative Research: Interactive and Intelligent Searching of Biological Images by Query and Network Navigation with Learning Capabilities* (co-PIs: Eamonn Keogh, James Baldwin, Paul De Ley, Michalis Faloutsos, Amit K. Roy Chowdhury, UC Riverside; Eyualem B. Abebe, Elizabeth City State Univ.). Duration: 8/1/2008-7/30/2011. CMU Amount $149,399.

52. Lawrence Livermore National Laboratory (LLNL), Contract No. B579447 Title: *Mining Large Time-Evolving Graphs* Duration: 12/02/2008 - 09/30/2009 Amount: $50,000.

53. IBM Faculty Award, 2008 PI: Christos Faloutsos. Amount: $20,000.

54. Lawrence Livermore National Laboratory (LLNL), Contract No. B580840 Title: *Trend and Anomaly Detection in Network Traffic Data* Duration: 2/1/2009-09/30-2009 Amount: $100,000.

55. Google grant, Title: *Discovering Patterns and Detecting Anomalies in Large Graphs* Duration: 2009-2010. Amount: $70,000

56. Fujitsu Laboratories gift, 2009. Amount: $35,000.

57. NRO/SAIC Title *Director's Innovative Initiative* Duration: Aug. 2009 - Jan. 2010. Amount: $95,287

58. IBM Faculty Award, 2009 PI: Christos Faloutsos. Amount: $40,000.

59. Lawrence Livermore National Laboratory (LLNL), Contract No. B588309 *Immunization and Mining of Large Cyber Networks* Duration: 02/22/2010 - 12/31/2010 Amount: $100,000

60. Lawrence Livermore National Laboratory (LLNL), *Link-strength estimation in time-evolving graphs* Amount: $50K Duration: 9/2009 - 9/2010

61. Google gift *Wordly Knowledge* (with William Cohen, Tom Mitchell and Garth Gibson) Amount: $1,000,000 Duration: 2010-2012

62. Google gift (renewed) *Wordly Knowledge* (with William Cohen and Tom Mitchell) Amount: $500,000 Duration: 2012-2013

63. DARPA Contract no.: W911NF-09-2-0053 (ARL: CTA-INARC) *Information Network Academic Research Center: an Integrated Approach towards Information Integration, Modeling, Retrieval and Discovery* Total: $16.75M; CMU Amount: $650,000. Duration: 9/2009 - 8/2013.

64. Gordon and Betty Moore Foundation gift. *eScience via data-intensive computing for astr ophysics* (with Garth Gibson and Peter Lee). Total amount: $754,660. Duration: 9/3/2009 - 4/30/2012

65. NSF Grant number 1017415 *III: Small: Influence and Virus Propagation in Large Graphs - Theory and Algorithms* Total: $499,682. Duration: Sept. 2010 - Aug. 2012

66. NSF Grant number 0970179 EAGER: Network Pattern Recognition Project Total: $299,982 PI: Lew Lancaster (UCB) (CMU has sub-contract). Duration: Sept. 2010 - Aug. 2011

67. DARPA contract number HDTRA1-10-1-0120 *Robustness Analysis and Anomaly Detection of Interdependent Physical and Social Networks.* Defense Threat Reduction Agenc y (DTRA). Total amount: $1,062,000. CMU amount: $240K. PIs: Abdelzaher, Eliassi-Rad, Faloutsos, Han. Duration: October 2010 - October 2013.

68. LLNL contract number B594252 *Mining Large, Time-Evolving Data for Cyber Domains* Total: $85,000. Duration: Jan. 2011 - Sept. 2011

69. DARPA (sub-contract to SAIC) Prime Number: W911NF-11-C-0088 Sub Award Number: P010089633 *Anomaly Detection at Multiple Scales (ADAMS)* CMU part: $482,135 Duration: 08/22/2011 - 05/30/2013.

70. DARPA (sub-contract to Leidos) Prime Number: W911NF-11-C-0088 Sub Award Number: P010089633 *Anomaly Detection at Multiple Scales (ADAMS) Phase II*Duration: 6/17/2013-05/30/2015. CMU part: $556,178.

71. DARPA (subcontract to IBM) *Understand and Utilize Context-Aware Information Dissemination in Social Media* Amount: $46K (CMU part); Duration: 01/01/12 - 12/31/14.

72. NSF IIS-1217559 *CGV: Small: Making Sense out of Large Graphs - Bridging HCI with Data Mining* (with Aniket Kittur). Amount: $500K; Duration: 09/15/2012 - 8/31/2015.

73. NSF IIS-1247489, NIH 1R01GM108339-1:*BIGD ATA: Mid-Scale: DA: Collaborative Research: Big Tensor Mining: Theory, Scalable Algorithms and Applications* (with Tom Mitchell; and UMN: Nikos Sidiropoulos, George Karypis). Amount: $894,892 to CMU, ($1.6M total). Duration: Dec. 1, 2012 - Nov. 30, 2016.

74. NSF Award No. CNS-1314632 *TWC: Medium: Collaborative: Know Thy Enemy: Data Mining Meets Networks for Understanding Web-Based Malware Dissemination* Amount: $333,333 to CMU ($1M total). Duration: 9/1/2013 - 8/31/2017.

75. Lawrence Livermore National Laboratory (LLNL), Contract number 30788.1.1990222 *Data Science Initiative University Outreach Project: Quantification and Attribution of Network Changes.* Amount: $30K. Duration: June 2013 - Sept. 2013.

76. Lawrence Livermore National Laboratory (LLNL), *Graph Understanding and Fraud Detection* Amount: $70K Duration: Jan. 2014 - Sept. 2014.

77. NSF Award No. IIS-1408924 *III: Medium: Collaborative Research: Collective Opinion Fraud Detection: Identifying and Integrating Cues from Language, Behavior, and Networks* (Collaborative with Profs. Leman Akoglu (Stonybrook), and Bing Liu (UIC)). Amount: $299,908 to CMU ($1.2M total). Duration: 9/1/2014 - 8/31/2018

78. NSF Award No. IIS-1408924 (REU Supplement) Amount: $8K Duration: 9/1/2014 - 8/31/2018 (same as base award).

79. Yahoo FREP gift. Amount: $10,000. Duration: 9/1/2014-9/1/2015.

80. NSF Award No. DBI-1356505 Amount: $279K *ABI Innovation - Collaborative Research: BCSP: Understanding the design and usage of distributed biological networks* (PI: Ziv Bar-Joseph) Duration: 09/01/2014-08/31/2017
81. PNC Center for Innovation Award, No. PF15003 Amount: $38,380; 2016. Under final negotiations for renewal, at $70,000, for 2017. *F raud Detection in Financial Data* Duration: Dec. 2015 - Dec. 2016.
82. Boeing Amount: $187,918 *Sensor summarization via matrix/tensor analysis* Duration: Sept. 2015 - Sept. 2016; renewed for 2017.
83. Flipkart. Amount: $25,000. Faculty Research Funding - unrestricted.
84. Portuguese Science and Technology Foundation - AIDA grant. Amount $175,000, 3 years, Sept. 2019 - Aug. 2022.
85. Portuguese Science and Technology Foundation - TAMI grant. 3 years, April 2020 - March 2023.
86. Award Number: 54408278001; Pennsylvania Infrastructure Technology Alliance (PITA); 01/01/2020 - 05/31/2021.
87. Innovu gift. Amount: $25K. March 2020.

**FELLOWSHIPS AND AWARDS**

1. Graduate Research Board Summer Research Award 1987: $4,000.
2. 1989 Presidential Young Investigator Award (PYI) - NSF IRI-8958546. Title: *Access methods for large multimedia databases* $125,000 for 5 years; up to $500,00 with matching funds.
3. 1998-2001: Litton Fellow, Computer Science Department, Carnegie Mellon University. Amount: $10,000 per year.
4. 2006: *Research Contribution Award*, in the Int. Conference on Data Mining (ICDM), Hong Kong, China, December 2006.
5. 2010: *Innovations Award*, in ACM SIGKDD, Washington DC, USA, Aug. 2010.
6. 2010: ACM Fellow
7. 2012: Honorary PhD from Aristotle University of Thessaloniki, Greece.
8. 2018: *Distinguished Contribution Award*, in PAKDD, Melbourne, Australia, June 2018.
9. 2019: AI Tang fellowship (CSD, CMU)
10. 2020: Fredkin Professorship in Artificial Intelligence.

**BEST PAPER AWARDS**

1. Award for *Best paper: Integration with theory*, in ACM SIGMOD 1994. (Christos Faloutsos, M. Ranganathan and Yannis Manolopoulos *Fast Subsequence Matching in Time-Series Databases* Proc. ACM SIGMOD, Minneapolis MN, May 25-27, 1994)
2. **1997 VLDB 10 Year Ago Paper Award** (Timos Sellis, Nick Roussopoulos and Christos Faloutsos *"The R+-Tree: A Dynamic Index for Multi-Dimensional Objects"*, VLDB 1987, pp. 507-518
3. *Best Paper Runner-Up* Award, in KDD 2001 (Zhiqiang Bi, Christos Faloutsos and Flip Korn *The "DGX" Distribution for Mining Massive, Skewed Data* KDD 2001, San Francisco, CA, August 2001).
4. *Best student paper* Award, in Perforance 2002 (Mengzhi Wang, Anastassia (Natassa) Ailamaki and Christos Faloutsos *Capturing the spatio-temporal behavior of real traffic data* IFIP Int. Symp. on Computer Performance Modeling, Measurement and Evaluation, Rome, Italy, Sept. 2002
5. *Best student paper* Award Jia-Yu Pan, Christos Faloutsos, Masafumi Hamamoto and Hiroyuki Kitagawa *AutoSplit: Fast and Scalable Discovery of Hidden Variables in Stream and Multimedia Databases* PAKDD, Sidney, Australia, May 2004.
6. *Best research paper* Award: Jure Leskovec, Jon Kleinberg and Christos Faloutsos *Graphs over Time: Densification Laws, Shrinking Diameters and Possible Explanations* KDD 2005, Chicago, IL, Aug.

**Jodi L. Forlizzi**

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as of 1/1/21

## Education

Ph.D., Design in Human-Computer Interaction, Carnegie Mellon University, 2007. Advisors: Sara Kiesler and Pamela J. Hinds. Thesis: Product Ecologies: Understanding the Context of Use Surrounding Products.

MDes, Interaction Design, Carnegie Mellon University, 1997. Advisors: Richard Buchanan and Suguru Ishizaki. Thesis: Designing for Experience: An Approach to Human-Centered Design.

BFA, Illustration, Philadelphia College of Art, Philadelphia, PA.

## Employment

Geschke Director and Professor, Human Computer Interaction Institute and School of Design, Carnegie Mellon University, November 2017–present.

Diversity, Equity, and Inclusion Lead, School of Computer Science, 2019-.

Co-Chair, Campus Task Force on Climate, October 2018-October 2019.

Professor, Human Computer Interaction Institute and School of Design, Carnegie Mellon University, July 2014–November 2017.

Associate Professor, Human Computer Interaction Institute and School of Design, Carnegie Mellon University, July 2007–June 2014.

Assistant Professor, Human Computer Interaction Institute and School of Design, Carnegie Mellon University, January 2000–June 2007.

Co-founder, Pratter.us. Co-founder of a healthcare startup publishing outpatient healthcare costs.

Innovator and Project Manager, E-Lab LLC, Chicago, IL 1998-1999. Specialize in research for new product design. Oversee research and design planning, innovating design processes and practices, and developing business proposals for a variety of application areas.

Design Researcher, Novum Design Center, Carnegie Mellon University, 1996-1997. Conceive of, design and execute research funded by Intel and Microsoft.

Founder, Inks Creative Services, Philadelphia, PA, 1986-1996.
Co-owner and principal of a design and photography firm serving the Delaware Valley.

Information Designer, School of Engineering and Applied Science, University of Pennsylvania, 1985-1995.

**Consultant Experience**
Interaction Designer, 1997-present
Interface and interaction design, as well as project management, usefulness and usability testing, strategizing for and managing interdisciplinary design teams.

Clients include: Walmart, Bossanova Robotics, Sheetz, Disney Research, Willow Garage, Vocollect, SDLC Partners, General Motors, BodyMedia, Intelligent Healthcare Systems, University of Pennsylvania School of Engineering, University of Pennsylvania Law School, University of Pennsylvania Linguistic Data Consortium, Lutron Corporation.

**Publication List**

**Books**

[1] Forlizzi, J. (in review). Product Service Ecologies: A Systems Approach to Interaction Design. MIT Press.

[2] Cosley, D., Churchill, E., Forlizzi, J., and Munson, S.A. (2017). Introduction to This Special Issue on the Lived Experience of Personal Informatics. Human-Computer Interaction 32, 5/6, 197-207.

[3] Odom, W., Zimmerman, J., Forlizzi, J. (2016). Engaging teens in dialogue on potential technological futures with user enactments. In Eds. Linda Little, Daniel Fitton, Beth Bell, and Nicola Toth. An HCI Perspective on Working with Teenagers in Research Projects. London, UK: Springer HCI Series.

[4] Holmquist, L. E., and Forlizzi, J. (2014). Introduction to Journal of Human-Robot Interaction Special Issue on Design. Journal of Human-Robot Interaction, 3/1, 1-3.

[5] Special Issue on Design for Wellbeing, Eds. Pieter Desmet, Jodi Forlizzi, and Anna Pohlmeyer. International Journal of Design, 7/3, December, 2013. http://www.ijdesign.org/ojs/index.php/IJDesign/

[6] Forlizzi, J. (2003). Proceedings of the International Conference on Designing Pleasurable Products and Interfaces, Ed. Jodi Forlizzi. New York, NY: ACM Press.

### Other Academic Review Committees

Dissertation Committee, Carlijn Valk, Industrial Design, Technical University Eindhoven, 2020.
Dissertation Committee, Sander Bogers and Janne van Kollenburg, Industrial Design, Technical University Eindhoven, 2019.
Dissertation Committee, New Jersey Institute of Technology, (Richard Schuler), 2017.
Dissertation Committee, NYU, (Junius Gunaratne), 2017.
Dissertation Opponent, Department of Informatics, University of Umea (Fatemeh Moradi), 2017.
Dissertation Opponent, Department of Design, University of Umea (Tara Mullaney), 2016.
Dissertation Committee, I-School, University of Michigan (Rayoung Yang), 2015.
Dissertation Committee, Human Engineering, University of Pittsburgh (Jing/Jenny Wang), 2014.
Dissertation Committee, Industrial Design, University of Montreal, (Annemarie Lesage), 2014.
Dissertation Committee, Computer Science, University of Arizona, (Ryan Brotman), 2013.
Dissertation Committee, METU, Ankara, Turkey (Armagan Kuru), 2013.
Dissertation Committee, Georgia Tech (Ja-Young Sung), 2008.
Dissertation Committee, University of Central Florida (Cindy Bethel), 2008.
Dissertation Committee, Georgia Tech (Susan Wyche), 2008.
Dissertation Committee, KAIST (Sona Kwak), 2008.
Dissertation Committee, Heinz School, CMU (Danny Fernandez), 2008.
Dissertation External Evaluator, University of Oulu Computer Science (Leena Arhippainen), 2008.
Dissertation External Evaluator, Helsinki University of Technology (Anu Kankainen), 2002.

## Contract and Grant Support

### Funded

NSF FW-HTF: Building a Skilled Technological Workforce in the Hospitality Industry. PU with Howie Choset, George Kantor, Chinmay Kulkarni, and Mark Kamlet. September 2020-August 2021.

CMU Block Center: Co-Developing Automation Policy for the Post-COVID Hospitality Industry. Co-I with Sarah Fox and Chinmay Kulkarni. October 2020-September 2021.

NSF CHS: Improving UX Designers' Ability to Envision and Prototype AI Products and Services. Co-I with John Zimmerman. July 2020-June 2023.

Skylight Digital/Air Force STTR: Service Design as Lens for Innovation. Co-I with John Zimmerman. June, 2020.

Accenture: Adapting and Automating "Living" Business Processes. Co-PI with John Zimmerman. October 2019-September 2020.

DOE: Enhancing Student Learning with an Orchestration Tool for Personalized Teacher-Student Interactions in Classrooms Using Intelligent Tutoring Software. Co-PI with Vincent Aleven and Bruce McLaren. July 2018-June 2021.

NSF EAGER: Synthesizing Notes from Electronic Health Records to Make Them Actionable for Heart Failure Patients. Co-PI with John Zimmerman and Carolyn Rosé. September 2017-August 2019.

NSF NNA: Workshop on New Technologies for Navigation in Arctic Regions. Co-PI with David Wettergreen and George Kantor. October 2017-September 2019.

US Army: Leveraging Advanced Algorithms, Autonomy, and Artificial Intelligence (A4I) to Enhance National Security and Defense. Co-I with Martial Hebert, Herman Herman, and Jessica Hodgins, September 2018-August 2023.

Google: Collaborating with Ubiquitous Intelligent Agents and Robots PI, September 2019-August 2020.

Bloomberg: How Analysts work with UX and AI. Co-PI with John Zimmerman, January 2019-December 2020.

**Pending**

AI Institute: Planning: Institute for Collaborative Assistance and Responsive Interaction for Networked Groups: CARING. CMU, Georgia Tech, Oregon State. August 2021 – July 2026.

NSF HCC-M: Centering Bias-Awareness in the Design of AI Systems for High-Stakes Decision-Making. Co-I with Motahhare Eslami, Alexandra Chouldechova, and John Zimmerman. July 2021-June 2025.

NSF ERC: Planning: NSF Engineering Research Center for a New Species of Engineer: Hybrid Intelligence Based on Research in Engineering Teams (HIBRET). CMU, UC Berkeley, Howard University, Penn State University.

Metro 21: Developing Data Collection Systems to Support Community-Driven Mobility Services. Co-I with Patrick Carrington, Sarah Fox, and Nikolas Martelaro. July 2021-June 2022.

Metro 21: Driver's Seat: Interrogating and Designing the Shifting Role of Transit Work Amid Increasing Autonomy. Co-I with Sarah Fox, Nikolas Martelaro, and Patrick Carrington. July 2021-June 2022.

DOE: Improving Student Learning and Engagement Through Game and Learning Analytics. Co-I with Bruce McLaren. July 2021-June 2024.

**Past**

Electronic Sandbox for Teaching Financial Literacy to Children and Their Parents, Part 2. Forlizzi and Zimmerman. PNC Financial Services, 2016-2017.

HMI for IMMS and 6DOF Robots, October 2015-September 2016. Bourne and Forlizzi. Sepro Robotique.

Electronic Sandbox for Teaching Financial Literacy to Children and Their Parents. Forlizzi and Zimmerman. PNC Financial Services, 2015-2016.

Studying the long-term acceptance of personal health informatics tools. Karapanos and Forlizzi. MITI Early Bird Grant, 2015.

Online Design Education: Taking Design Education and Critiques Online. Scupelli, Forlizzi, Dow, Kelliher, Christal, Hammer. Simon Seed Initiative, 2015-2016.

Online Design Education: Developing Playtest Skills in Hybrid Game Design Environments. Hammer, Forlizzi, Christel. Simon Seed Initiative, 2014-2015.

Shared Attention in Human-Robot Collaboration. Google Grant, Co-PI with Sidd Srinivasa, March 2014-March 2015.

Enhancing Math Education with Educational Games: Can Erroneous Examples Help? NSF TSL, co-PI with Bruce McLaren, September 2013-August 2015.

Value Construction with Digital Things. Vodafone Grant, co-PI with John Zimmerman, with University of Granada and KAIST: Korea Advanced Institute of Science and Technology, March 2012-February 2013.

Manifesting Virtual Possessions in the Material World. Google Grant, Co-PI with John Zimmerman, September 2011-August 2012.

Physical Interaction with Dynamically Stabile Moble Robots. NSF CPS, Co-PI with Ralph Hollis, August 2011-July 2014.

ANTIDOTE: Adaptive Networks for Threat and Intrusion Detection or Termination. MURI, submitted with Gaurav Sukhatme, Sven Koenig, Maja Mataric (USC), Daniela Rus (MIT), Vijay Kumar, Robert Ghrist, Maxim Likhachev (Penn), Manuela Veloso, Howie Choset, and Tony Stentz. March 2009-February 2013.

Extending Skills of Elderly Drivers. General Motors Gift, Co-PI with Anind Dey, November 2009-October 2010.

Interaction Design for the HERB Robot. Quality of Life Technology Research Grant, PI, September 2009-October 2010.

Situational Awareness of Older Drivers. Quality of Life Technology Research Grant, co-PI with Anind Dey, October 2008-September 2009.

Snackbot: A Service Robot. Microsoft Robotics Initiative Grant, co-PI with Sara Kiesler, May 2008-April 2009.

Quality of Life Technology Center. NSF ERC, June 2009-May 2014.

A Study of Navigation in Dyads. General Motors Gift, PI, May 2008-April 2009.

Enabling Creativity Using Kinetic Typography. NSF SGER, co-PI with Scott Hudson, September 2008-August 2009.

Enhancing the Value of Mobile Computing Platforms with Techniques for Inattentive and Inexact Interaction. Intel Corporation Research Grant, co-PI with Scott Hudson, September 2007-August 2010.

Aesthetics of Dashboard Display Designs. General Motors, PI, September 2007-August 2008.

Human Dynamics of Robot-Supported Collaborative Work. NSF DHB, Co-PI with Sara Kiesler, Jessica Hodgins, and Sue Fussell, December 06-November 09.

Navigation Display Format Design Optimization. General Motors Corporation, PI, September 06-August 07.

Monitoring and Feedback To Support Physical Exercise Awareness. PA State Funding, Co-PI with Anind Dey, January 06-December 06.

Monitoring and Feedback to Support Physical Exercise Awareness. PITA, PI, with Anind Dey.

Managing Human Attention. NSF ITR, submitted with Robert Kraut and Scott Hudson, September 04-August 07.

Physiological Body Monitors to Prevent Falls in the Aging Population. PITA, PI, submitted with Scott Hudson and Francine Gemperle, December 02-November 03.

Cognitive and Social Design of Assistive Robots. NSF/ITR-PE, Co-PI, submitted with Sara Kiesler, Pamela Hinds, and Sebastian Thrun, September 01-August 06.

Situationally Appropriate Interfaces. NSF/ITR, submitted with Scott Hudson, Sara Kiesler, and Chris Atkeson, September 01-August 06

Augmented Cognition: Combining Human and Digital Memory. DARPA, senior personnel, submitted with Randy Pausch and Dennis Proffitt, September 01-August 05.

Situationally Aware Systems. Co-investigator, DARPA, February 01-December 01, with Scott Hudson.

Enhancing Small Displays: Using multimodal cues to enhance the communication of information. Co-principal investigator, Oracle Corporation, February 01-June 01, with Sara Kiesler.

Using Palm Devices as Universal Personal Controllers. Co-investigator, Pittsburgh Digital Greenhouse, December 00-November 01, with Brad Myers.

Enhancing Small Displays: Using multimodal cues to enhance the communication of information. Principal investigator, Oracle Corporation, May 00-January 01.

Research on New Interactions for 3G Devices and Modular TV. Co-investigator, Samsung Electronics, December 00-March 01, with Dan Boyarski.

User Experience and Interaction Design. Berkman New Faculty Development Fund, January 00.

**Evidence of Teaching Performance**

**Courses taught at Carnegie Mellon**

05-452/652, Service Design, 53 students, Fall 2020.
05-452/652, Service Design, 57 students, Fall 2019.
05-452/652, Service Design, 32 students, Spring 2019.
05-453, Design Perspectives in HCI, 24 students, Spring 2018.
05-898, Service Design, 54 students, Spring 2018.
05-898, Service Design, 34 students, Fall 2017.
05-898, Service Design, 30 students, Spring 2016.
05-898, Service Design, 15 students, Summer 2015.
05-898, Service Design, 36 students, Fall 2015.*
05-392, Interaction Design Overview, 46 students, Fall 2014.
05-392, Interaction Design Overview, 56 students, Spring 2014.*
51-385/785, Designing for Service, 28 students, Fall 2013.
51-385/785, Designing for Service, 28 students, Fall 2012.*
05-774, Design Perspectives in HCI, 20 students, Spring 2012.*
51-702, Graduate Interaction Design Seminar, 10 students, Spring 2012.
05-651, Interaction Design Fundamentals, 15 students, Fall, 2011.*

# Phillip B. Gibbons

## Curriculum Vitae

gibbons@cs.cmu.edu
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May 2022

## Research Interests

Research areas include big data, parallel computing, databases, cloud computing, sensor networks, distributed systems, and computer architecture. My publications span theory and systems, across a broad range of computer science and engineering (e.g., conference papers in APoCS, ASPLOS, ATC, ESA, EuroSys, HPCA, ICML, IPDPS, ISCA, ISPASS, MICRO, MLSys, NeurIPS, NSDI, OSDI, PACT, SoCC, SODA, SOSP, SPAA and VLDB since 2015).

## Education

- **University of California at Berkeley,** Berkeley, California, 1984–1989.
  Ph.D. in Computer Science. Dissertation advisor: Richard M. Karp.
- **Dartmouth College,** Hanover, New Hampshire, 1979–1983.
  B.A. in Mathematics. Graduated summa cum laude and Phi Beta Kappa.

## Professional Experience

- **Carnegie Mellon University,** Pittsburgh, Pennsylvania.
  Professor, Computer Science Department, 2015–present.
  Professor, Electrical and Computer Engineering Department, 2015–present.
  Principal Investigator (PI or co-PI) for the following research projects:
  - *Prescriptive Memory:* Razing the semantic wall between applications and computer systems with heterogeneous compute and memories.
  - *Foundations of PIM:* Theoretical foundations of emerging processing-in-memory systems.
  - *Asymmetric Memory:* Write-efficient algorithms and systems, for settings (such as emerging non-volatile memories) where writes are significantly more costly than reads.
  - *Big Learning Systems:* Mapping out and exploring the space of large-scale machine learning from a systems' perspective. Recent focus on geo-distributed learning over non-IID data.

  Adjunct Professor, Computer Science Department, 2003–2015.
  Adjunct Associate Professor, Computer Science Department, 2000–2003.
  Visiting Professor, Computer Science Department, 2000.
- **Intel Labs Pittsburgh,** Pittsburgh, Pennsylvania. Principal Research Scientist, 2001–2015.
  Principal Investigator for the Intel Science and Technology Center for Cloud Computing
  - A $11.5M research partnership with Carnegie Mellon, Georgia Tech, Princeton, UC Berkeley, and U. Washington.

  Principal Investigator (PI or co-PI) for the following research projects (partial list):
  - *Hi-Spade:* Hierarchy-savvy parallel algorithm and system design, focusing on high-level locality abstractions, smart runtime thread schedulers, and emerging non-volatile memory technologies.
  - *LBA:* Hardware accelerators for online program correctness checking tools.
  - *Sybil Defenses:* Limiting the impact of malicious users in distributed systems.

- D. M. Kristol, E. Gabber, P. B. Gibbons, Y. Matias and A. Mayer.
**Design and Implementation of the Lucent Personalized Web Assistant (LPWA)**.
Bell Laboratories technical report, Murray Hill, NJ, March 1999.

- P. B. Gibbons and Y. Matias.
**Synopsis Data Structures for Massive Data Sets**.
Short summary paper in *Proceedings of the 10th ACM-SIAM Symposium on Discrete Algorithms* (SODA), Baltimore, MD, January 1999, pp. S943–S944.

- P. B. Gibbons, Y. Matias and V. Poosala.
**Aqua Project White Paper**.
Bell Laboratories technical report, Murray Hill, NJ, December 1997.

- P. B. Gibbons.
**What Good Are Shared-Memory Models?**
In *Proceedings of the 1996 ICPP Workshop on Challenges for Parallel Processing*, Bloomingdale, IL, August 1996, pp. 103–114, invited position paper.

- P. B. Gibbons et al.
**A Survey of Query Processing Techniques with Recommendations for the Teradata Database**.
AT&T Bell Laboratories technical report, Murray Hill, NJ, December 1995.

- P. B. Gibbons.
**Bootstrapping HPC into Mainstream Computing**.
In *Suggesting Computer Science Agendas for High Performance Computing*, U. Vishkin (Ed.), ACM, 1994, invited position paper.

- P. B. Gibbons.
**The Asynchronous PRAM: A Semi-Synchronous Model for Shared Memory MIMD Machines**.
Ph.D. thesis, Computer Science Division, University of California at Berkeley, CA, December 1989.

- P. B. Gibbons.
**Towards Better Shared Memory Programming Models**.
In *Opportunities and Constraints of Parallel Computing*, J. L. C. Sanz (Ed.), Springer-Verlag, Proceedings of the 1988 IBM-NSF Workshop, December 1989, pp. 55–58, invited position paper.

## Grants and Gifts

- Oracle Labs, *End-to-End Compiler Optimization of Data Movement Across Modern Fragmented Software Stacks*
Todd Mowry, Phillip Gibbons, $83,250
Gift, June 2021

- National Science Foundation, *Prescriptive Memory: Razing the Semantic Wall Between Applications and Computer Systems*
Phillip Gibbons (PI), Henny Admoni, Nathan Beckmann, Franz Franchetti, Jessica Hodgins, $250,000
October 2020 – September 2022

- Oracle Labs, *End-to-End Compiler Optimization of Data Movement Across Modern Fragmented Software Stacks*
Todd Mowry, Phillip Gibbons, $83,250
Gift, May 2020

- VMware University Research Fund, *Prescriptive Memory*
Phillip Gibbons, $75,000
Gift, January 2020

- National Science Foundation, *Parallel Models and Algorithms for Emerging Memory Systems*
  Guy Blelloch, Phillip Gibbons, $1,200,000
  October 2019 – September 2023

- National Science Foundation, *Multicore to Wide Area Analytics on Streaming Data*
  Phillip Gibbons $492,000
  July 2017 – July 2021

- Intel Corporation, *Intel Science and Technology Center for Visual Cloud Systems*
  Senior Personnel, $4,125,000
  September 2016 – August 2019

- Facebook Research Grant
  Phillip Gibbons, $30,000
  Gift, September 2015

- National Science Foundation, *Write-Efficient Parallel Algorithms for Emerging Memory Technologies*
  Guy Blelloch, Phillip Gibbons, $845,000
  September 2015 – August 2019

While an employee of Intel, I participated in the following grants (as a no cost or unofficial co-PI):

- National Science Foundation, *Parallelism without Concurrency*
  Charles Leiserson, Guy Blelloch, Jeremy Fineman, Phillip Gibbons, $2,428,662
  July 2013 – June 2017

- Intel Corporation, *Intel Science and Technology Center for Cloud Computing*
  Co-PI with Gregory Ganger, $11,500,000
  September 2011 – August 2016

- National Science Foundation, *Locality with Dynamic Parallelism*
  Guy Blelloch, Phillip Gibbons, $449,055
  June 2010 – June 2013

- PITA ICES FY06-D, *Distributed Mining in Co-Evolving Streaming Sensors*
  Christos Faloutsos, Phillip Gibbons, $64,000
  January 2006 – December 2006

- PITA ICES FY03-21, *Automatic Mining on Sensor Data*
  Christos Faloutsos, Phillip Gibbons, $39,079
  November 2003 – December 2004

# Patents

Issued patents, filed by AT&T or Lucent Technologies:

1. P. B. Gibbons.
   **Distinct Sampling System and a Method of Distinct Sampling for Optimizing Distinct Value Query Estimates.**
   U.S. Patent 7,047,230. Issued May 16, 2006.

2. S. Acharya, P. B. Gibbons, V. Poosala and S. Ramaswamy.
   **Join Synopsis-Based Approximate Query Answering.**
   U.S. Patent 6,912,524. Issued June 28, 2005.

3. S. Chen, P. B. Gibbons and T. C. Mowry.
   **System and Method for Improving Index Performance through Prefetching.**
   U.S. Patent 6,772,179. Issued August 3, 2004.

# GARTH GIBSON

**Associate Professor**
Computer Science Dept and
Dept of Electrical and Computer Engineering
Carnegie Mellon University
5000 Forbes Avenue, Pittsburgh, PA 15213-3891
E-mail:
garth.gibson@cs.cmu.edu

on leave from CMU to act as

**Co-Founder and Chief Technology Officer**
Panasas, Inc. www.panasas.com
1501 Reedsdale Street, Pittsburgh PA 15233
Phone: 412-323-3500, FAX: 412-323-3511
E-mail:
garth.gibson@panasas.com

## RESEARCH STATEMENT

My research is centered on

# Mor Harchol-Balter

**Computer Science Department**
**Carnegie Mellon University**
**Pittsburgh, PA 15213**
**harchol@cs.cmu.edu; (412) 268-7893**
**www.cs.cmu.edu/∼harchol**

## RESEARCH AREAS

Design and performance analysis of computer systems including both theory and implementation:

Algorithmic Work: Designing and analyzing algorithms for: resource allocation, task/job scheduling, load sharing, routing, cycle stealing, replication, power-management, multi-class/multi-server scheduling, multi-core parallel scheduling, fairness. Correlated arrival processes, and analysis under high-variability workloads. Known for *"All-Can-Win Theorem"*, demonstrating that scheduling policies which are biased towards favoring small jobs can also be preferable to large jobs.

Stochastic Analysis & Queueing Techniques: Developing new methods for stochastic analysis. Examples include: (i) *Recursive Dimensionality Reduction (RDR)*, a technique that allows one to reduce a Markov chain that grows unboundedly in many dimensions to a Markov chain that grows unboundedly in only one dimension, by using the idea of busy period transitions; (ii) *Recursive Renewal Reward (RRR)* and *Clearing Analysis on Phases (CAP)*, techniques that allow one to obtain closed-form solutions for many one-dimensional infinite repeating Markov chains, including the M/M/k with setup chain; (iii) *Exact analysis of Replication Systems*: the first exact solution (in product-form) for replication systems, involving any number of servers, and number of classes, and any degree of replication. (iv) *SOAP Analysis of Scheduling Policies*: the first exact response time analysis of a huge class of scheduling policies with no prior analysis, including Gittins Index, for optimal scheduling when job sizes are unknown. (v) *Optimal Scheduling for Multi-server systems*: first algorithms and analysis for optimal scheduling in the M/G/k, both with known and unknown job sizes.

Systems implementation: Resource management in data centers and other distributed systems. Implementation of QoS tail latency guarantees for flows in networked storage systems, based on techniques from Stochastic Network Calculus (PriorityMeister and SNC-Meister). Online scheduling of jobs with heterogeneous preferences in data centers with heterogeneous servers (TetriSched). Dynamic power management in multi-tier data centers (AutoScale). Scheduling of Memory Controllers (ATLAS). Pricing and queueing optimizations for cloud services. Kernel-level connection scheduling in Web servers (SyNC). Coping with transient overload in Web servers. QoS for e-commerce applications involving the backend database. Prioritization mechanisms for OLTP transactions in database servers. Job scheduling in supercomputing centers.

Modeling and Workload characterization: Known for discovery of Pareto heavy-tailed distribution of UNIX process CPU lifetimes. Statistical characterization of workloads including UNIX processes, web, OLTP, supercomputing, memory workloads, and parallel jobs.

## EMPLOYMENT

2020 - pres Bruce J. Nelson Professor in Computer Science. Computer Science Department. Carnegie Mellon University.

2014 - pres Full Professor. Computer Science Department. Carnegie Mellon University.

2012 - 2014 Associate Professor. Computer Science Department. Carnegie Mellon University.

2008 - 2011 Associate Professor and Associate Department Head.
Computer Science Department, Carnegie Mellon University.

2005 - 2008 Associate Professor without tenure. Computer Science Department. Carnegie Mellon University.

1999-2005 McCandless Assistant Professor. Computer Science Department. Carnegie Mellon University.

1996-1999 NSF Postdoctoral Fellow. Massachusetts Institute of Technology.
Funded by: NSF Postdoctoral Fellowship in the Mathematical Sciences.
Mentor: Prof. Tom Leighton.

**EDUCATION**

1990-1996 University of California, Berkeley.
Ph.D. in Computer Science, August 1996.
Thesis: *Network Analysis without Exponentiality Assumptions*.
Advisor: Prof. Manuel Blum. Committee: Manuel Blum, Sheldon Ross, Venkat Anantharam.

1984-1988 Brandeis University, Waltham, Massachusetts.
B.A. in Computer Science and Mathematics, May 1988. Summa Cum Laude.
Thesis: *Evaluation of Data Encryption Standard Using Walsh-Hadamard Matrix Factorization*.
Advisor: Prof. Martin Cohn.

**HONORS**

2022 Keynote Speaker: International Teletraffic Congress (ITC 2022)
2022 Keynote Speaker: Matrix Analytic Methods Conference (MAM 2022)
2021 Keynote Speaker: Ubiquitous Computing, Electronics & Mobile Communications (UEMCON 2021)
2021 Distinguished Lecture Series Speaker: Penn State, Computer Science Department.
2021 Keynote Speaker: Data-Driven Queueing Challenges (DDQC 2021)
2021 ACM SIGMETRICS 2021 Best Paper Award.
2021 Second Inaugural Speaker: Scheduling Seminar
2021 Plenary Speaker: STOC Theory Fest Short Plenary Pick, STOC 2021.
2020 Google Faculty Award.
2020 ACM SIGMETRICS 2020 Best Video Award.
2020 Bruce J. Nelson Endowed Chair in Computer Science
2019 ACM SIGMETRICS 2019 Best Student Paper Award.
2019 Keynote Speaker: Queueing Theory and Network Applications (QTNA 2019).
2019 Ruth and Joel Spira Outstanding Teaching Award.
2019 Fellow of IEEE.
2018 IFIP PERFORMANCE 2018 Best Student Paper Award.
2018 Keynote Speaker: Young European Queueing Theory Conference (YEQT 2018).
2018 APS Best Student Paper Award Finalist.
2018 Microsoft Faculty Award.
2018 Distinguished Lecture Series Speaker: UCSD, Computer Science Department.
2018 Distinguished Speaker: Information Modeling and Control of Complex Systems Workshop (IMaCCS 2018)
2018 Plenary speaker at Dutch Queueing Colloquium 40th Anniversary.
2018 Fellow of ACM.
2017 Keynote Speaker: MIT LIDS Student Conference.
2016 Keynote Speaker: CanQueue 2016.
2016 Keynote Speaker: ACM SIGMETRICS 2016.
2016 Distinguished Speaker: Information Modeling and Control of Complex Systems Workshop (IMaCCS 2016)

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| 2016 | EuroSys Best Student Paper. |
| 2011-16 | Intel Faculty Gift every year. |
| 2015 | Google Faculty Award. |
| 2015 | Facebook Faculty Award. |
| 2015 | Keynote Speaker: IEEE ICDCS 2015. |
| 2014 | Keynote Speaker: GreenMetrics 2014. |
| 2014 | CMU Mudge House Dinner with the Deans Honorary Event for Influential Teachers. |
| 2014 | Apple Pie with Alpha Chi Honorary Event for CMU Faculty with Impact on Students. |
| 2013 | Distinguished Speaker Series, Northwestern University. |
| 2013 | General Chair ACM SIGMETRICS 2013. |
| 2012 | Microsoft Faculty Award. |
| 2012 | Invited Speaker: Brandeis University Distinguished High-Tech Alumni Event. |
| 2011 | Microsoft Faculty Award. |
| 2011 | Distinguished Speaker at Opening of Center Computer Engineering, Technion, Israel. |
| 2011 | Kaufman Foundation Faculty Award. |
| 2010 | Microsoft Faculty Award. |
| 2010 | Google Faculty Award. |
| 2010 | Yahoo! Faculty Award. |
| 2010 | IEEE MICRO's Top Picks from 2010 award paper. |
| 2010 | Distinguished Speaker Series, University of Toronto. |
| 2008-09 | Intel Faculty Gift each year. |
| 2009 | Invited Speaker: Columbia Applied Probability Day 2009. |
| 2009 | Yahoo! Faculty Award. |
| 2008 | Keynote Speaker: IEEE MASCOTS 2008. |
| 2008 | Keynote Speaker: SIPEW 2008. |
| 2008 | IBM Faculty Award. |
| 2007 | Microsoft Faculty Award. |
| 2007 | Program co-Chair ACM SIGMETRICS 2007. |
| 2007 | Program co-Chair QEST 2007. |
| 2007 | Plenary Speaker: Annual Lunteren Conference 2007. |
| 2007 | Keynote Speaker: ORSIS 2007. |
| 2006 | Plenary Speaker: Carnegie Mellon 50 Year Anniversary Symposium. |
| 2005 | Invited to IFIP 7.3 WG on Computer Performance Modeling and Analysis. |
| 2001-04 | IBM Faculty Award each year. |
| 2003 | Herbert A. Simon Award for Teaching Excellence, Carnegie Mellon University. |
| 2003 | ACM SIGMETRICS Best Student Paper Award. |
| 2003 | IEEE International Teletraffic Congress Best Student Paper Award. |
| 2001 | NSF CAREER Award. |
| 2001 | EMC Faculty Award. |
| 2001-04 | Anna McCandless Chair for Career Development, Carnegie Mellon University. |
| 1996-99 | NSF Mathematical Sciences Postdoctoral Fellowship. |
| 1996 | ACM SIGMETRICS Best Paper Award for Integrating Systems and Theory. |
| 1990-96 | 6-year National Physical Science Consortium Fellowship for Women and Minorities. |
| 1995 | Demitri Angelakos Altruism Award, U.C. Berkeley. |
| 1994 | Outstanding Graduate Student Instructor Award, Campus-Wide, U.C. Berkeley. |
| 1994 | EECS Graduate Student Instructor of the Year Award, U.C. Berkeley. |
| 1994 | Teaching Effectiveness Award, Campus-Wide, U.C. Berkeley. |
| 1990 | Awarded National Science Foundation Graduate Fellowship. |
| 1990 | Awarded Office of Naval Research Graduate Fellowship. |
| 1988 | Mitchom Prize in Computer Science, Brandeis University. |
| 1988 | Graduated Summa Cum Laude, Brandeis University. |
| 1988 | Undergraduate Thesis Highest Honors, Brandeis University. |

1987 Phi Beta Kappa.
1984-88 Brandeis University 4-year Merit Scholarship.
1984-88 Lulu T. Briggs 4-year Scholarship.
1984 Valedictorian South Brunswick High School, New Jersey.

## PUBLICATIONS

### Books

[22] Mor Harchol-Balter. *IN PROGRESS: Probability Theory for Computer Scientists*. Currently working with publisher. Expected publication date: 2024. *Based on 500 pages of lecture notes from 15-259 class at CMU.*

[13] Mor Harchol-Balter. *Performance Analysis and Design of Computer Systems*. Cambridge University Press. 2013. *Based on 1000 pages of lecture notes from 15-849a,b and 15-857 classes at CMU.*

### Thesis

[96] Mor Harchol-Balter. *Network Analysis without Exponentiality Assumptions.* Ph.D. Thesis. University of California, Berkeley, December 1996.

### Guest Editor

[07] Mor Harchol-Balter. "New Perspectives on Scheduling." *ACM Performance Evaluation Review, Special Issue*, vol. 34, no. 4, March 2007. Guest editor: Mor Harchol-Balter.

### Chapters in Books

[21] Ben Berg, Mor Harchol-Balter. "Optimal Scheduling of Parallel Jobs with Unknown Service Requirements." *Handbook of Research on Methodologies and Applications of Supercomputing*, 2021. pp. 18-40.

[99] Mor Harchol-Balter and Allen Downey. "Exploiting Process Lifetime Distributions for Load Balancing." Book chapter in *Mobility: Processes, Computers and Agents (ACM Press Series),* edited by Dejan Milojicic, Fred Douglis, and Richard Wheeler. Addison-Wesley Publishing Company and the ACM Press, April 1999, pp. 229-259.

[97] Earlier version appeared in: *ACM Transactions on Computer Systems*, vol. 15, no. 3, August 1997, pp. 253-285.

[96] Earlier version appeared in: *Proceedings of ACM SIGMETRICS 1996 Conference on Measurement and Modeling of Computer Systems (SIGMETRICS 96)*, May 1996, Philadelphia, PA, pp. 13-24. Winner of **Best Paper Award for Integrating Systems and Theory**.

[95] Much earlier version appeared in: *Fifteenth ACM Symposium on Operating Systems Principles (SOSP) Poster Session*, Copper Mountain, CO, December 1995.

### Refereed Journal Papers

[21] Mor Harchol-Balter, Takayuki Osogami, Alan Scheller-Wolf, Adam Wierman. "Correction to: Multi-server Queueing Systems with Multiple Priority Classes." *Queueing Systems*.

| | |
|---|---|
| Apr 2005 | Chaired committee for Allen Newell Graduate Teaching Award. |
| Apr 2005 | Chaired committee for Herbert A. Simon Award. |
| Apr 2005 | Presentation to 100 undergraduates on "Applying to Grad School." |
| Mar 2005 | Presentation at Open House Graduate Student Recruiting. |
| Spr 2005 | CS hiring committee: Performance evaluation area. |
| 2005 | Doctoral Review Committee (DRC). |
| 2004-2005 | Instrumenting SCS Perlis Teaching Assistant Award. |
| Jan 2005 | Exam questioner/grading for Tepper School qualifiers. |
| Dec 2004 | Undergraduate math colloquium speaker. Host: Deborah Brandon. |
| Sep 2004 | Women in SCS Road Show. |
| Aug 2004 | Host CSD IC party at my home. |
| May 2004 | Judge for Herbert A. Simon Award. |
| Apr 2004 | Presentation to 100 undergraduates on "Applying to Grad School." |
| Jan 2004 | Exam questioner/grading for Tepper School qualifiers. Also, reader on some summer papers. |
| 2004 | Doctoral Review Committee (DRC). |
| Aug 2003 | Host CSD IC party at my home. |
| May 2003 | Judge for Newell Award. |
| Apr 2003 | Presentation to 100 undergraduates on "Applying to Grad School." |
| Apr 2003 | Heavy involvement in faculty recruiting. Host parties. |
| Jan 2003 | Exam questioner/grading for Tepper School qualifiers. |
| 2003 | Doctoral Review Committee (DRC). |
| Nov 2002 | Presentation to 100 undergraduates on "Applying to Grad School." |
| Aug 2002 | Host CSD IC party at my home. |
| Aug 2002 | Provide interview for undergraduate recruitment tape. |
| July 2002 | Committee to evaluate department chair position. |
| May 2002 | Joined SCS Web advisory committee. |
| May 2002 | Heavy involvement in faculty recruiting. Host parties. |
| Apr 2002 | Presentation to 150 undergraduates on "Applying to Grad School." |
| Mar 2002 | Presentation at Open House Graduate Student Recruiting. |
| Jan 2002 | Exam questioner/grading for Tepper School qualifiers. |
| Nov 2001 | Sent letters to top 130 CMU alumni encouraging them to apply to grad school at CMU. |
| Nov 2001 | Presentation to CMU Women Graduate Organization on "Advising and Being Advised." |
| Aug 2001 | Host CSD IC party at my home. |
| Aug 2001 | Presentation at Andrews Leap to High School students. |
| Apr 2001 | Heavy involvement in faculty recruiting. Host parties/candidates. |
| Mar 2001 | Presentation at Open House Graduate Student Recruiting. |
| Nov 2000 | Presentation at Freshman IC. |
| Nov 2000 | Led Pannel at CS Immigration Course titled "How to be a Great Advisor/ How to be a Great Grad Student." |
| Nov 2000 | Sent letters to top 40 CMU alumni encouraging them to apply to grad school at CMU. |
| Aug 2000 | Host CSD IC party at my home. |
| July 2000 | Presentation at Andrews Leap to High School students. |
| Apr 2000 | Presentation to prospective undergraduates at Undergrad Open House. |
| Mar 2000 | Presentation at Open House Graduate Student Recruiting. |
| Oct 1999 | Presentation to Women in SCS group on "Getting the Most Out of a Conference." |
| Aug 1999 | Presentation at Andrews Leap to High School students. |

**COMMUNITY SERVICE/OUTREACH**

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|---|---|
| 2018 | Google Women in Tech Summit speaker. |

2008-pres Created first-ever Western PA American Regional Mathematics League (ARML) team.
Includes 25 high schoolers from all over Western PA.
Our team ranked 3rd in the nation in the B division in the 2012 competition and is now in the A division.
Organize weekly 3-hour team practices and trips to national math competitions throughout the year.
Receive annual funding from Jump Trading, Chicago, IL.

2004-2005 Volunteer teacher of Elementary School National Math Olympiad Contest at Winchester-Thurston school.
Teach every Monday afternoon.

2002-2004 Volunteer math teacher at Winchester-Thurston School, Pittsburgh, PA.
Teach advanced mathematics to 2nd graders. Wednesday mornings, every other week.

1988-1990 Volunteer Teacher at City Year, Stilling St., Boston, MA.
Volunteer Teacher Boston Partners in Education.
Teach math to disadvantaged students one evening per week.

## CONTRACT AND GRANT SUPPORT

**Current:**

Title: Predictable Scheduling for Borg
PI : Mor Harchol-Balter.
Agency: Google Faculty Award
Duration: August ’20 - unrestricted
Amount: $70,000
Award No: Google

Title: NSF-CMMI: Optimal Scheduling of Parallelizable Jobs in Cloud Computing Environments
PI : Mor Harchol-Balter.
co-PI: Ben Moseley.
Agency: NSF-CMMI.
Duration: Jan ’20 - Dec ’22.
Amount: $549,470.00.
Support: 25%SU.
Award No: 1938909
PM: Georgia-Ann Klutke.

Title: Facebook Graduate Fellowship.
PI : Benjamin Berg (my graduate student).
Duration: Jan ’19 - Jan ’21.

Title: NSF-CSR: Medium: Collaborative Research: Foundations of Cache Network Operations for Content Delivery
PIs : Mor Harchol-Balter and Ramesh Sitaraman.
Agency: NSF-CSR.
Duration: Sept ’18 - Sept ’22.
Amount: $1,200,000.00.
Support: 33%SU.

Award No: 1763701 (originally 180341).
PM: Samee Khan.

**Past:**

Title: NSF-XPS: FULL: Bridging Parallel and Queueing-Theoretic Scheduling – SUPPLEMENT
PIs : Mor Harchol-Balter.
Agency: NSF-XPS – SUPPLEMENT.
Duration: July ’19 - July ’20
Amount: $150,000.
Support: 33%SU.
Award No: 1629444.
PM: Tracy Kimbrel.

Title: RobinHood: Cache Sharing System
PI : Mor Harchol-Balter.
Agency: Microsoft Faculty Award
Duration: April ’18 - unrestricted
Amount: $30,000
Award No: Microsoft

Title: NSF-XPS: FULL: Bridging Parallel and Queueing-Theoretic Scheduling.
PIs : Guy Blleloch, Umut Acar, Mor Harchol-Balter.
Agency: NSF-XPS.
Duration: July ’16 - July ’19
Amount: $825,000.
Support: 33%SU.
Award No: 1629444.
PM: Tracy Kimbrel.

Title: NSF Graduate Fellowship.
PI : Ziv Scully (my graduate student).
Duration: September ’16 - September ’19.

Title: NSF-CMMI:Reducing Latency by Replicating Jobs.
PI : Mor Harchol-Balter.
Agency: NSF-CMMI.
Duration: Sept ’15 - Sept ’18
Amount: $299,711.
Support: 33%SU.
Award No: 1538204.
PM: Michael Fu.

Title: Performance Analysis and Design of Computer Systems.

PI : Mor Harchol-Balter.
Agency: Facebook Faculty Award
Duration: Sept ’15 - unrestricted
Amount: $30,000
Award No: Facebook

Title: When Many Workloads Share Networked Storage: How to Guarantee Tail Latency SLOs.
PI : Mor Harchol-Balter.
Agency: Google Faculty Research Award: Unrestricted Gift
Duration: February ’15 - February ’16.
Amount: $67,000.
Award No: Google – TBA.

TITLE: NSF REU Supplement
PI: Mor Harchol-Balter.
Agency: NSF-CSR Supplement to NSF-CSR-1116282.
Duration: Summer 2015.
Amount: $8000.
Award No: 25851.2.1122199.
PM: Mimi McClure.

Title: NSF-CMMI:Priority Pricing for Profit Maximization Given Strategic, Delay-Sensitive Customers with a Continuum of Types.
PI : Mor Harchol-Balter (with Mustafa Akan, co-PI).
Agency: NSF-CMMI
Duration: Aug ’13 - Aug ’16
Amount: $290,000.
Support: 25%SU.
Award No: 1334194.
PM: Sheldon Jacobson.

Title: Intel Pittsburgh Cloud Computing ISTC Fellowship for Student.
PI : Timothy Zhu (my graduate student).
Agency: Intel Pittsburgh.
Duration: September ’13 - ’16
Amount: Yearly support for 1 Ph.D. student

Title: NSF-CSR:Small Simple Dynamic Traffic-Oblivious Power Management for Multi-Tier Web Clusters.
PI : Mor Harchol-Balter.
Agency: NSF-CSR
Duration: Aug ’11 - Aug ’15
Amount: $373,472.
Support: 33%SU.
Award No: 1116282.
PM: Krishna Kant.

Title: NSF Graduate Fellowship.
PI : Kristy Gardner (my graduate student).
Duration: September ’12 - September ’15.

Title: Intel Pittsburgh Cloud Computing ISTC Fellowship for Student.
PI : Anshul Gandhi (my graduate student).
Agency: Intel Pittsburgh.
Duration: September ’11 - ’13
Amount: Yearly support for 1 Ph.D. student

Title: Western PA ARML Team Funding.
PI : Mor Harchol-Balter
Agency: Jump Trading, Inc.
Duration: Sept ’12 - Sept ’13.
Amount: $12,000.
Award No: ARML

Title: Maximizing Revenue in a Multi-Class Environment with Unknown Customer Valuations and Unknown Delay Sensitivities.
PI : Mor Harchol-Balter.
Agency: Microsoft-CMU Center for Computational Thinking
Duration: Aug ’12 - Aug ’13.
Amount: $80,000.
Award No: Microsoft

Title: NSF-CSR: Student Travel Support for Sigmetrics 2013.
PI : Mor Harchol-Balter.
Agency: NSF-CSR
Duration: Jan ’13 - Jan ’14
Amount: $10,000.
Award No: 1300202.
PM: Krishna Kant.

Title: Maximizing Pricing Based on Current Delay.
PI : Mor Harchol-Balter.
Agency: Microsoft-CMU Center for Computational Thinking
Duration: Aug ’11 - Aug ’12.
Amount: $74,736.
Award No: Microsoft

Title: Western PA ARML Team Funding.
PI : Mor Harchol-Balter.
Agency: Jump Trading, Inc.
Duration: Sept ’11 - Sept ’12.
Amount: $7,500.
Award No: ARML

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|---|---|
| Title: | Kauffman Foundation Commercialization Grant. |
| PI : | Awarded to my student: Anshul Gandhi. |
| Agency: | Kauffman Foundation |
| Duration: | Jan ’11 - Jan ’12. |
| Amount: | $25,000. |
| Award No: | Kauffman |

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|---|---|
| Title: | Performance Analysis and Design of Computer Systems. |
| PI : | Mor Harchol-Balter. |
| Agency: | Yahoo! Faculty Research Award |
| Duration: | Sept ’10 - Sept ’11. |
| Amount: | $30,000 |
| Award No: | Yahoo |

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|---|---|
| Title: | Energy Efficient and Proportional Datacenter Computing. |
| PI : | Dave Andersen and Mor Harchol-Balter. |
| Agency: | Google Focused Research Award |
| Duration: | February ’10 - February ’11. |
| Amount: | $100,000. |
| Award No: | Google 22796.1-2.5003506 |

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|---|---|
| Title: | Power Management in Data Centers. |
| PI : | Mor Harchol-Balter. |
| Agency: | Microsoft-CMU Center for Computational Thinking |
| Duration: | Aug ’10 - Aug ’11. |
| Amount: | $75,000. |
| Award No: | Microsoft 5004487 Project 24592 |

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|---|---|
| Title: | Building a Power-Efficient Load Balancer. |
| PI : | Mor Harchol-Balter. |
| Agency: | Yahoo! Faculty Research Award |
| Duration: | Sept ’09 - Sept ’10. |
| Amount: | $25,000 |
| Award No: | 5004676 |

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|---|---|
| Title: | IBM Faculty Award |
| PI : | Mor Harchol-Balter. |
| Agency: | IBM Faculty Research Award |
| Duration: | June ’08 - May ’09. |
| Amount: | $30,000 |
| Award No: | 5002343 |

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|---|---|
| Title: | POW! Project |
| PI : | Mor Harchol-Balter. |

Agency: Innovation Works
Duration: June ’09 - Sept ’09.
Amount: $15,000
Award No: N/A

Title: Optimizing Server Farm Performance in Power-Constrained Environments.
PI : Mor Harchol-Balter.
Agency: The Technology Collaborative of Pittsburgh.
Duration: January ’09 - June ’10.
Amount: $124,000.
Support: 66%SU.
Award No: 1010970

Title: Optimizing Server Farm Performance in Power-Constrained Environments.
PI : Mor Harchol-Balter.
Agency: Matching funds (in kind) from Project Olympus and the Idea Foundry, Pittsburgh.
Duration: January ’09 - June ’10.
Amount: $30,000.

Title: Efficient Power Management by Alternating Between “Extreme” Power States.
PI : Mor Harchol-Balter.
Agency: CMU Technology Transfer Center & Project Olympus.
Duration: January ’09 - June ’10.
Amount: $40,000.
Award No: 2001801

Title: Intel Pittsburgh Lab Fellowship for Student.
PI : Anshul Gandhi (my graduate student).
Agency: Intel Pittsburgh.
Duration: September ’08 - May ’10.
Amount: 1.5 years graduate student support.

Title: SMA/PDOS Collaborative Research: Design, Analysis, and Control of Adaptive Sharing Mechanisms.
co-PI : Mor Harchol-Balter (with Vishal Misra, Dan Rubenstein, Ed Coffman, and Predrag Jelenkovic).
Agency: NSF.
Grant No: NSF CCR-0615262. Division of Computer and Network Systems. Computer Systems.
Duration: August ’06 - July ’09.
Amount: $1,000,000.
Support: 33%SU.
Center No: 15653.1.1120828.

Title: SGER: Collaborative Research: CSR-SMA:
New Breakthrough in Analyzing Limited Resource Sharing Systems.
PI : Mor Harchol-Balter (with Jim Dai and Bert Zwart).
Agency: NSF.
Grant No: NSF CNS-0719106.

Duration: August ’07 - August ’08.
Amount: $100,000.
Support: 33%SU.
Center No: 17666.1.1121054

Title: Scheduling the TeraGrid.
PI : Mor Harchol-Balter.
Company: Microsoft Research. Award Number: 16101.
Duration: May ’07 - May ’08.
Amount: $75,000.
Support: Winner of Microsoft Breakthrough Research Grant. Unrestricted Gift.

Title: CAREER: The Impact of Resource Scheduling on Improving Server Performance.
PI : Mor Harchol-Balter.
Agency: NSF.
Grant No: NSF CCR-0133077. CAREER Award. Division of Computer and Network Systems. Distributed Systems.
Duration: March ’02 - February ’08.
Amount: $350,000.
Support: 33%SU.
Center No: 8061.1.1120231.

Title: ITR: Improving the Performance of Web Servers under Overload.
PI : Mor Harchol-Balter.
Agency: NSF.
Grant No: ITR-0313148. Division of Computer and Communication Foundations.
Duration: August ’03 - July ’07.
Amount: $280,000.
Support: 8%SU.
Center No: 10575.1.1120449.

Title: Siebel Fellowship.
PI : Adam Wierman (my graduate student).
Duration: September ’06 - September ’07.

Title: External QoS Management System for Backend Database Servers.
PI : Mor Harchol-Balter.
Agency: The Technology Collaborative of Pittsburgh.
Duration: August ’05 - August ’06.
Amount: $188,550.
Support: 33%SU.
Center No: 13821.1a.1010629.

Title: Analysis of Cycle Stealing and other Problems via new Dimensionality Reduction Approach.
PI : Mor Harchol-Balter.
Agency: NSF.
Grant No: CCR-0311383. Division of Computer and Communication Foundations. Theory of Computing.

Duration: July ’03 - July ’06.
Amount: $150,000.
Support: 25%SU.
Center No: 10372.1.1120427.

Title: NSF PhD Graduate Fellowship for Student.
PI : Adam Wierman (my graduate student).
Agency: NSF.
Duration: July ’03 - July ’06.
Amount: 3 years graduate student support.

Title: QOS for Online Shopping: Providing Priority by Scheduling the Database.
PI : Mor Harchol-Balter (with Natassa Ailamaki, Co-PI)
Agency: Pittsburgh Digital Greenhouse.
Duration: August ’03 - August ’05.
Amount: $265,192.
Support: 33%SU.
Center No: 10363.1.1010366.

Title: IBM Faculty Award with PhD Graduate Fellowship for Student.
PI : Bianca Schroeder (my graduate student).
Agency: IBM.
Duration: September ’03 - September ’05.
Amount: 2 years graduate student support.

Title: ITR: Exploiting Remote Infrastructure for Mobile Information Access.
PI : M. Satyanarayanan (Mor Harchol-Balter, Co-PI).
Agency: NSF.
Grant No: ITR ANI-0081396. Division of Computer and Network Systems.
Duration: September ’00 - September ’05.
Amount: $448,820.
Support: 33%SU.
Center No: 6748.1.1120092.

Title: Running Web Servers under Overload.
PI : Mor Harchol-Balter.
Agency: Pittsburgh Digital Greenhouse.
Duration: August ’01 - August ’02.
Amount: $200,500.
Support: 50-100%AY.
Center No: 6737.1.1010099.

Title: Connection Scheduling in Web Servers.
PI : Mor Harchol-Balter.
Agency: Pittsburgh Digital Greenhouse.
Duration: August ’00 - August ’01.

Amount: $200,075.
Support: 67-100%SU.
Center No: 4737.1.1010099.

Title: Faculty Gift.
PI : Mor Harchol-Balter.
Agency: EMC$^2$ Corporation.
Duration: April '01 - March '04.
Amount: $100,000.
Support: 0-22%AY.
Center No: 8236.1.1010272.

Title: IBM Faculty Award with PhD Graduate Fellowship for Student.
PI : Nikhil Bansal (my graduate student).
Agency: IBM.
Duration: September '01 - September '03.
Amount: 2 years graduate student support.

Title: Postdoctoral Fellowship Mathematical Sciences.
PI : Mor Harchol-Balter.
Agency: NSF.
Grant No: 9627445.
Duration: September '96 - August '00.
Support: Postdoctoral Research Fellowship Stipend.

**INDUSTRY EXPERIENCE**

2021 - pres Collaborating with Voltron on Database Scheduling.

2019 - pres Collaborating with Google on Borg Scheduling.

2020 - pres Collaborating with Google on Execution Economy.

2019 - 2021 Collaborating with Facebook on Caching Systems.

2017 - 2019 Collaborating with Microsoft on Web Caching.

2016 - 2018 Collaborating with Akamai on CDN Caching Algorithms.

2015 - 2016 Collaborating with Google on Meeting Tail QoS Guarantees for Shared Networked Storage.

2008 - 2016 Collaborating with Intel Research-Pittsburgh on Data Center Power Management (Mike Kozuch).

2012 - 2014 Collaborating with Microsoft Research-Cambridge on Prioritizing Mixed Workloads (Eno Thereska).

2001: SCS Facilities Committee, SCS Facilities Committee, ECE Quals Committee, ECE Undergraduate Studies Committee

2000: SCS Systems Hiring Committee, ECE Undergraduate Studies Committee

1999: ECE Undergraduate Studies Committee, Computer Engineering Curriculum Committee (chair)

1998: ECE Undergraduate Studies Committee

**Support** *PicoCTF*, National Science Foundation, 2014-2017, awarded, **$225,000** co-PI with David Brumley (CMU ECE).

*Amazon Research grant, AWS credits for developing autograding service*, June, 2013, **$2,000**

*Research award, Intel Corporation, Cloud computing research*, June, 2010, **$125,000**

*Intel equipment grant, Autograding Cluster for 15-213: Intro to Computer Systems, Mar, 2010,* **$50,000**.

Unrestricted gifts*, Anonymous Donor, through the Vanguard Charitable Endowment,* **$300,000***, 2006–2013.*

*Towards Petascale Simulation of Urban Earthquake Impacts, National Science Foundation, (OCI-0749227), Sept 2007–Aug 2011,* **$1,600,000***, co-PI with Jacobo Bielak (CMU CEE), Gregory Fenves (UC Berkeley), Ahmed Elgamal (UCSD), Kwan-Liu Ma (UCSD).*

Liberating Personal Computing from Hardware*, National Science Foundation, (IIS-0429334), Sept 2004–Aug 2007,* **$1,320,000***, co-PI with Satya (CMU SCS), Perrig (CMU ECE) and Farber (CMU ISRI).*

Deployment-based Insights from Internet Suspend/Resume*, Carnegie Mellon CyLab, July 2006 - June 2007,* **$60,000***, co-PI with Satya.*

IBM equipment grant, Blade Center for Internet Suspend/Resume *, Aug, 2004,* **$130,056***, PI, (co-PI: Satya).*

Computational Database Systems for Massive Scientific Datasets*, National Science Foundation, (IIS-0429334), Sept 2004 - Aug 2007,* **$1,320,000***, PI (co-PIs: Ganger (ECE) and Ailamaki (SCS))*

Seurat: Self-Diagnosis of Network Systems*, Carnegie Mellon CyLab, July 2004–June 2005,* **$70,000***, PI (co-PI: Hui Zhang, CMU SCS).*

The SCEC Community Modeling Environment - An Information Infrastructure for System Level Earthquake Research*, National Science Foundation, Sept 2001–August 2006,* **$395,000**. *co-PI with J. Bielak (CMU CEE).*

Seismic Propagation in Urban Regions*, National Science Foundation, Sept 2000–March 2001,* **$130,000**. *co-PI with J. Bielak (CMU CEE).*

Large-Scale Modeling and Forecasting of Complex Earthquake Ground Motion in Sedimentary Basins, *National Science Foundation KDI award, (CMS-9980063), Sept 1999–Aug 31, 2002,* **$2,131,000**. *co-PI with J. Bielak and O. Ghattas (CMU CE), J. Shewchuk (UC-Berkeley), and S. Day (San Diego State University).*

Intel equipment grant, Intel Computer Systems Cluster for CS 213*, Aug, 1999,* **$101,320***, co-PI with Randy Bryant.*

Microsoft software grant for Intel Computer Systems Cluster*, Aug, 1999,* **$49,920***, co-PI with Randy Bryant.*

Resource Management Under Application Control*, Defense Advanced Research Projects Administration (DARPA), Oct, 1996–Sept, 1999,* **$2,920,810***, co-PI with T. Gross.*

Unrestricted Grant for Research in the Performance of Finite Element Earthquake Simulations on Parallel Systems*, 1994, Intel Corp,* **$40,000***, PI.*

Equipment Grant for Research in Parallel Scientific Computing*(72-node Paragon system), 1994, Intel Corp,* **$2,000,000***, PI.*

Earthquake Ground Motion Modeling in Large Basins.*, National Science Foundation Grand Challenge Award (CMS-9318163), Sept, 1993–Feb, 1998,* **$2,154,000***, co-PI with J. Bielak (CE, PI), and O. Ghattas (CE).*

Automatic Tools for Developing Fine-Grained Signal Processing Programs on Multicomputers.*, Air Force Office of Scientific Research (AFOSR), Washington, DC, Jan, 1992–Dec, 1994,* **$395,000***, PI, (H.T. Kung, co-PI)*

Unrestricted Grant for Research in Programming Tools for Parallel Computing*, E-Systems Corp, Falls Church, VA. 1992, 1993,* **$12,000***, PI.*

Complete Tool Set for Developing Large Scale Signal Processing Applications on Multicomputers.*, Office of Naval Research(ONR), Washington DC, Air Force Office of Scientific Research (AFOSR), Washington, DC, and Naval Ocean Systems Center (NOSC), San Diego, CA, March, 1989–April, 1990,* **$200,000** *(funded by AFOSR),* **$50,000** *(funded by NOSC), co-PI with H. T. Kung.*

Initialization and Restart in Automated Manufacturing Facilities. *National Bureau of Standards, Gaithersburg, MD, January, 1986,* **$120,000***, co-PI with P. F. Reynolds, Jr.*

# BIOGRAPHY

Tuomas Sandholm is Angel Jordan University Professor of Computer Science at Carnegie Mellon University and a serial entrepreneur. His research focuses on the convergence of artificial intelligence, economics, and operations research. He is Co-Director of CMU AI. He is the Founder and Director of the Electronic Marketplaces Laboratory. He has published over 500 peer-reviewed papers, holds 25 US patents, and his h-index is 91. In addition to his main appointment in the Computer Science Department, he holds appointments in the Machine Learning Department, Ph.D. Program in Algorithms, Combinatorics, and Optimization (ACO), and CMU/UPitt Joint Ph.D. Program in Computational Biology.

He has built optimization-powered electronic marketplaces since 1989, and has fielded several of his systems. In parallel with his academic career, he was Founder, Chairman, first CEO, and CTO/Chief Scientist of CombineNet, Inc. from 1997 until its acquisition in 2010. During this period the company commercialized over 800 of the world's largest-scale generalized combinatorial multi-attribute auctions, with over $60 billion in total spend and over $6 billion in generated savings.

Since 2010, his algorithms have been running the national kidney exchange for the United Network for Organ Sharing, where they autonomously make the kidney exchange transplant plan for 80% of U.S. transplant centers together each week. He also co-invented never-ending altruist-donor-initiated chains and his algorithms created the first such chain. Such chains have become the main modality of kidney exchange worldwide and have led to around 10,000 life-saving transplants. He invented liver lobe and multi-organ exchanges, and the first liver-kidney swap took place in 2019.

Sandholm has developed the leading algorithms for several general classes of game with his students. The team that he leads is the multi-time world champion in computer heads-up no-limit Texas holdem, which is the main benchmark and decades-open challenge problem for testing application-independent algorithms for solving imperfect-information games. Their AI Libratus became the first and only AI to beat top humans at that game. Then their AI Pluribus became the first and only AI to beat top humans at the multi-player game. That is the first superhuman milestone in any game beyond two-player zero-sum games. He is Founder and CEO of Strategy Robot, Inc., a CMU spinout that builds AI software products for strategic reasoning under imperfect information for US government military, intelligence, security, and cybersecurity applications. The company has already built four such software products for game-theoretic analysis of four different classes of DoD problems: COA generation, portfolio planning, aerial planning, and base defense.

He served as the redesign consultant of Baidu's sponsored search auctions and display advertising markets in 2009–2013; within two years Baidus market cap increased 5x to $50 billion due to doubled monetization per user. He has served as consultant, advisor, or board member for Yahoo!, Google, Chicago Board Options Exchange, swap.com, Granata Decision Systems (now part of Google), Rare Crowds (now part of Media Math), and others.

He earned a Ph.D. and M.S. in computer science and a Dipl. Eng. (M.S. with B.S. included) with distinction in Industrial Engineering and Management Science. Among his honors are the IJCAI Minsky Medal, IJCAI McCarthy Award, AAAI Engelmore Award, IJCAI Computers and Thought Award, inaugural ACM Autonomous Agents Research Award, CMU's Allen Newell Award for Research Excellence, Sloan Fellowship, NSF Career Award, Carnegie Science Center Award for Excellence, Edelman Laureateship, and the Goldman Sachs 100 Most Intriguing Entrepreneurs Award. He is Fellow of the ACM, AAAI, INFORMS, and AAAS. He holds an honorary doctorate from the University of Zurich.

# EMPLOYMENT

(Founding of companies and consulting are listed separately later.)

| | |
|---|---|
| 1/2001– | **Carnegie Mellon University**<br>*Angel Jordan University Professor of Computer Science*, 5/2020–<br>*Angel Jordan Professor of Computer Science*, 2/2018–<br>*Professor*, 7/2006–2/2018<br>*Associate Professor*, 1/2001–6/2006<br>Computer Science Department |
| 2017– | **Carnegie Mellon University**<br>*Co-Director*<br>CMU AI |
| 1/2001– | **Carnegie Mellon University**<br>*Founder and Director*<br>Electronic Marketplaces Laboratory |
| 5/2013– | **Carnegie Mellon University**<br>*Member*<br>Ph.D. Program in Algorithms, Combinatorics, and Optimization (ACO) |
| 12/2012– | **Carnegie Mellon University**<br>*Affiliated Professor*<br>Carnegie Mellon/University of Pittsburgh Joint Ph.D. Program in Computational Biology |
| 12/2007– | **Carnegie Mellon University**<br>*Affiliated Professor*<br>Machine Learning Department |
| 1/2001– | **Carnegie Mellon University**<br>*Affiliated Faculty*<br>Theory Group |
| 7/2000–12/2000 | **Washington University**<br>*Associate Professor*<br>Department of Computer Science |
| 8/1996–6/2000 | **Washington University**<br>*Assistant Professor*<br>Department of Computer Science |
| 8/1997-12/2000 | **Washington University**<br>*Adjunct faculty member (courtesy appointment)*<br>Center for Optimization & Semantic Control<br>Department of Systems Science and Mathematics |

9/1992–8/1996 **University of Massachusetts, Amherst**
*Research Assistant*
Distributed Problem Solving Lab, Department of Computer Science

9/1995–12/1995 **University of Massachusetts, Amherst**
*Teaching Associate*, Full lecturing responsibility
Department of Computer Science

12/1990—8/1992 **Technical Research Centre of Finland**
*Research Scientist*, Laboratory for Information Processing
Espoo, Finland

6/1990–12/1990 **Nokia Research Center, Knowledge Engineering Department**
*Research Scientist* (intern during college)
Espoo, Finland

12/1988—5/1990 **Kielikone Co.**
*Programmer (during college studies)*
Espoo, Finland

6/1989–7/1989 **Smart and Final Iris, Co.**
*Database Developer (during a college summer break)*
Los Angeles, CA

# EDUCATION

5/1994–9/1996 **Ph.D., Computer Science, GPA 4.0/4**
University of Massachusetts, Amherst
Thesis title:
Negotiation among self-interested computationally limited agents
Ph.D. Committee:
1. Victor Lesser (chair), University of Massachusetts, Computer Science
2. James Kurose, University of Massachusetts, Computer Science
3. Shlomo Zilberstein, University of Massachusetts, Computer Science
4. Mark Fox, U. of Toronto, Industrial Engineering/Computer Science
5. Herbert Gintis, University of Massachusetts, Economics

9/1992–5/1994 **M.S., Computer Science, GPA 3.95/4**
University of Massachusetts, Amherst
Master's Project (2 parts):
1. Utility-based termination of anytime algorithms
2. A new order parameter for 3SAT

9/1988–12/1991 **Dipl. Eng. (like M.S. with B.S. included) *with distinction***
**Industrial Engineering and Management Science**
Helsinki University of Technology, Finland
Majors:
1. Knowledge engineering, GPA 4.7/5
2. Business strategy and international marketing, GPA 4.2/5
3. Systems and operations research, GPA 5.0/5
In addition, 18 post-Master's credits in majors 1. and 3.

8/1987–7/1988 **Airforce Academy, Finland**
Pilot Second Lieutenant
Obligatory military service; highest possible officer rank achieved

# PERSONAL

- Born December 1968, Helsinki, Finland. Citizenships: US and Finland. Married, two children.
- URL: http://www.cs.cmu.edu/~sandholm
- Languages: Finnish, English, Swedish, German.
- Security clearance: Top Secret.
- Hobbies:
  - Windsurfing. Best results: 12th in the Worlds (1987), 5th in the Europeans (1987), 1st in the Finnish Nationals (1987), ranking #1 in Finland (1986), Formula class US Masters 2nd place (2005).
  - Sailboat racing. Best results: Beneteau 36.7 Corinthian class North American Champion 2016 (as tactician), 10th in Flying Scot North American Championships 2019 (as captain).
  - Squash
  - Infrequent hobbies: chess, Go, poker, snowboarding
  - Past hobby: Airplane piloting, including acrobatic

**Primary research interests:** Artificial intelligence; market design; optimization (search and integer programming, combinatorial optimization, stochastic optimization, and convex optimization); kidney exchange; liver exchange; cross-organ exchange; game theory; mechanism design; electronic commerce; multiagent systems; auctions and exchanges; automated negotiation and contracting; equilibrium finding; algorithms for solving games; opponent modeling and exploitation; advertising markets; sourcing; prediction markets; voting; coalition formation; preference elicitation (especially from multiple agents); normative models of bounded rationality; resource-bounded reasoning; fairness; privacy; multiagent learning; safe exchange; machine learning.

**Secondary research interests:** Constraint satisfaction; reputation mechanisms; networks.

# PUBLICATION LIST

## JOURNAL PAPERS

1. Schmucker, R., Farina, G., Faeder, J., Fröhlich, F., Sinan Saglam, A., and Sandholm, T. 2022. Combination treatment optimization using a pan-cancer pathway model. *PLOS Computational Biology*. Earlier version available in bioRxiv.

2. Ayers, B., Sandholm, T., Gosev, I., Prasad, S., and Kilic, A. 2021. Using Machine Learning to Improve Survival Prediction After Heart Transplantation. *Journal of Cardiac Surgery* 36(11):4113–4120.

3. Kroer, C. and Sandholm, T. 2020. Limited Lookahead in Imperfect-Information Games. *Artificial Intelligence* 283, Special Issue on Autonomous Agents Modelling Other Agents.

4. Braggion, E., Gatti, N., Lucchetti, R., Sandholm, T., and von Stengel, B. 2020. Strong Nash equilibria and mixed strategies. *International Journal of Game Theory*, 49(3): 699–710.

5. Blum, A., Dickerson, J., Haghtalab, N., Procaccia, A., Sandholm, T., and Sharma, A. 2020. Ignorance is Almost Bliss: Near-Optimal Stochastic Matching with Few Queries. *Operations Research* 68(1): 16–34.

6. Kroer, C., Waugh, K., Kilinç-Karzan, F., and Sandholm, T. 2020. Faster algorithms for extensive-form game solving via improved smoothing functions. *Mathematical Programming* Series A, 179: 385–417.

7. Dickerson, J., Procaccia, A., and Sandholm, T. 2019. Failure-Aware Kidney Exchange. *Management Science* 65(4): 1768-1791.

- International Joint Conference on Artificial Intelligence Workshop on Adaptation and Learning in Multiagent Systems, Montreal, Canada, 1995.
- European Conference on Artificial Intelligence Workshop on Learning in DAI Systems, Budapest, Hungary, 1996.
- AAAI Spring Symposium Series: Adaptation, Coevolution and Learning in Multiagent Systems, Stanford University, CA, 1996.

**Professional affiliations**

- American Association for Artificial Intelligence (AAAI)
- Association for Computing Machinery (ACM)
- The Game Theory Society
- Institute for Operations Research and the Management Sciences (INFORMS)
- Constraint Programming Society in North America (CPNA)
- American Economic Association (AEA)
- The Econometric Society
- American Association for the Advancement of Science (AAAS)
- Institute of Electrical and Electronics Engineers (IEEE)

**Companies founded**

2/2018– **Strategy Robot, Inc.**
*Founder, President, CEO, and Chairman*
This CMU spinout is in the business of AI software solutions for strategic reasoning under imperfect information for US government military, intelligence, security, and cybersecurity applications. The company has already built four such software products for game-theoretic analysis of four different classes of DoD problems: COA generation, portfolio planning, aerial planning, and base defense.

3/2017– **Strategic Machine, Inc.**
*Founder, President, CEO, and Chairman*
This CMU spinout is in the business of technology solutions for strategic reasoning under imperfect information. The company has exclusively licensed for this space from Prof. Sandholm's Carnegie Mellon University Electronic Marketplaces Laboratory the Libratus technology, which was the first to beat top professional poker players at Heads-Up No-Limit Texas Hold'em, and a host of other technologies. The company targets a broad set of applications ranging from poker to other recreational games to business strategy, negotiation, cybersecurity, physical security, military applications, strategic pricing, product portfolio planning, finance, auctions, political campaigns, and steering evolution and biological adaptation, for example, for medical treatment planning.

7/2012– **Optimized Markets, Inc.**
*Founder, President, CEO, and Chairman*
CMU spinout in optimization and electronic marketplaces. Products are in advertising campaign sales, proposal generation, inventory allocation, scheduling, and pricing, optimization, as well as supply prediction. For further information, see `www.optimizedmarkets.com`.

9/2011– **Sandholm Enterprises, Ltd.**
*Founder, President, CEO, and Chairman*
Consulting on market design and optimization; technology and software development; intellectual property generation and holding.

5/1999–6/2010 **CombineNet, Inc. (acquired)**
*Founder and Chief Scientist 12/2008–6/2010*
*Founder, Chairman of the Board, and Chief Scientist 3/2006–11/2008*
*Founder, Chairman of the Board, and Chief Technology Officer 5/1999–2/2006*
Fielded over 800 of the most complex combinatorial auctions in the world.
CombineNet develops and runs optimization systems for markets, such as procurement auctions with expressive bidding.
Over 50 big-name customers (mainly Global 2,000 companies).
Grew to 130 employees with operations on four continents.
Over $60 billion in trading volume 2002–2010; over $6 billion saved.
Raised $44 million of venture capital.
First acquired 6/7/2010. Acquired by SciQuest (now Jaggaer) 9/2013.

**Consulting work, corporate boards, and corporate advisory boards**

4/2014–6/2014 **Chicago Board Options Exchange (CBOE)**
Legal expert on an automated market making patent case.

8/2012–1/2015 **Granata Decision Systems, Inc. (now part of Google)**
*Chairman of the Board (6/2013–1/2015)*
*Board member, technical advisor, and business advisor (8/2012–1/2015)*
Granata Decision Systems provided software that helps businesses and consumers make complex, data-driven group decisions. For one, it helps advertisers optimize the targeting of multiple campaigns.
Toronto, Canada

10/2011– **Technion-Microsoft Electronic Commerce Research Center**
*(Founding) Scientific Advisory Board member*
The Technion-Israel Institute of Technology, Microsoft Research (MSR) and Microsoft Online Services Division (OSD) co-established 10/2011 the Academic Research Center for E-Commerce Technologies. The new Research Center will promote and fund basic research in areas of computer science, artificial intelligence, game theory, economic and psychology, focusing on the connections between these subjects in the e-commerce domain. The center is the first academic research program by Microsoft Research in Israel, a part of the Microsoft R&D Center in Israel.

8/2010–8/2011 **swap.com / Netcycler**
*Consultant*
Helped re-design the core matching algorithm for their Internet barter exchange ("a moneyless eBay") to make them scalable. Invented the ways how barter chains can be employed for commercial (e.g., used) goods. Tens of thousands of users.

2/2009–8/2013 **Baidu**
*Market design consultant*
Helped Baidu completely redesign its sponsored search auctions. Already in the first two years of the engagement, monetization per eyeball doubled and Baidu's market cap increased from $10 billion to $50 billion. Also consulted on the design of their Internet display advertising markets.
Beijing, China

7/2012–11/2014 **Rare Crowds, Inc. (acquired by MediaMath 11/2014)**
*Consulting Chief Scientist*
Startup that developed capabilities for highly detailed targeting in display advertising markets.
Seattle and New York

2008 **Google**
Legal expert on an electronic marketplaces patent case.

2005–2008 **Yahoo!**
*Consultant*
Re-designing Yahoo's display advertising market and sponsored search auctions. Gave several day-long tutorials and talks on expressive optimization-based markets for the purpose. Proposed the idea of a market that integrates campaign-based advertising and spot advertising, and Yahoo! is now using that idea, with some newer enhancements. Also, Yahoo! is using a version of our optimize-and-dispatch architecture.
Sunnyvale, CA; Santa Clara, CA; Pasadena, CA; Burbank, CA

2/16/2006 **Mars, Inc.**
Combinatorial optimization and expressive commerce.
Mclean, VA

4/2001-12/2001 **Raytheon**
Designing electronic marketplaces.
Denver, CO

8/2000 **Pavillion Technologies, Inc.**
Designing electronic marketplaces.
Austin, TX

5/1999–6/1999 **perfect.com** (originally iwanto.com)
Designing electronic marketplaces.
Palo Alto, CA

1997–2001 **BusinessBots, Inc.**
*Chief Scientist.* (Later I asked my duties to be reduced to *Technical Advisor.*)
*Board observer.*
Intelligent agent-mediated electronic marketplaces.
Strategic alliance with Andersen Consulting. Member of CommerceNet consortium.
Raised over $12,000,000 in venture financing.
San Francisco, CA

6/1997 **Mitsubishi Horizon Systems Laboratory**
Designing electronic marketplaces, and economic resource allocation mechanisms for mobile agents.
Waltham, MA

7/1997–7/1998 **Hewlett Packard**
Automated negotiation, contracting, and electronic markets.
Bristol, UK

2/1997 **University of Ronneby**
Consulting on developing a market-based multiagent system for electricity distribution for Southern Sweden
Ronneby, Sweden

2/1997 **Lund University**
Consulting on developing a market-based multiagent system for electricity distribution for Southern Sweden
Lund, Sweden

7/1994 **Technical Research Centre of Finland**
*Laboratory for Information Processing*
Consulting on further development of the fielded EPO truck transportation optimization package
Espoo, Finland

1993 **Technical Research Centre of Finland**
*Laboratory for Information Processing*
Consulting on developing the EPO train transportation optimization package
Espoo, Finland

1989–2000 **Parodent Co. (acquired in 2000)**
Voting member, Board of Directors
Helsinki, Finland

# CONTRACT AND GRANT SUPPORT

Total since 5/1/97 is $22,188,966, of which $13,359,253 as Principal Investigator. These figures do not include the $55,800,000 (12M + 1.8M + 6M + 12M + 12M + 9M + 3M) of venture capital raised. The dollar amounts also do not include the value of the grants of supercomputing time and advanced support.

**Current academic grants**

10/1/2019–9/30/2023 **RI: Medium: Learning to Search: Provable Guarantees and Applications**
*NSF IIS-1901403*
Nina Balcan and Tuomas Sandholm
US$ 1,199,995

1/31/2022–1/31/2024 **NSF Computing Innovation Fellow Postdoctoral Fellowship to do a postdoc in my laboratory (Stephen McAleer).**
US$ 255,010

9/1/2017–8/31/2022 **Algorithms in the Field: Algorithms and Mechanisms for Kidney Exchange**
*NSF AitF*
Ariel Procaccia (PI), Avrim Blum (co-PI), Tuomas Sandholm (co-PI)
US$ 799,621

2019–2021 **My PhD student Gabriele Farina received a Facebook Fellowship.**
Around US$ 200,000

**Pending academic grants**

- DoD Vannevar Bush fellowship. Sole PI: Sandholm. $3,000,000, 2022–2027. Short proposal was selected for full proposal submission. Full proposal submitted 3/2022.
- "RI: Medium: Subgame and Certificates Solving for Multi-Step Imperfect-Information Games". Sole PI: Sandholm. $1,200,000, 6/1/2022–5/31/2025, NSF CISE RI.
- "Fast, Optimal AI Techniques for Game-Theoretic Team Coordination and Extensive-Form Correlation". Sole PI: Sandholm. $834,614, 5/2022–4/2025, ARO.

- NSF AI Institute on AI for Cybersecurity. $20,000,000, 2022–2027. PI: VS Subramanian, Northwestern University. Prof. Sandholm is the CMU PI. CMU's share: $1,885,000. Prof. Sandholm's research group's share: $1,140,921.

**Past academic grants**

| | |
|---|---|
| 4/30/2020–4/29/2021 | **High-Performance CPU-GPU Compute Cluster for Research on Computational Game Theory and Biological Steering**<br>*ARO DURIP*<br>Tuomas Sandholm (PI)<br>US$ 485,750 |
| 9/1/2017–8/31/2020 | **RI: Small: New Computational Techniques and Market Designs for Kidney Exchanges and Other Barter Markets**<br>*NSF IIS*<br>Tuomas Sandholm (PI)<br>US$ 420,000 |
| 3/20/2019–3/19/2020 | **Facebook gift to Prof. Sandholm's CMU Electronic Marketplace Laboratory**<br>*Facebook*<br>Tuomas Sandholm (PI)<br>US$ 50,000 |
| 9/2015– | **Information Brokers in Multi-Agent Systems and Mechanism Design Research Program**<br>*ISF-NSFC*<br>David Sarne and Pingzhong Tang (PIs)<br>Provides travel funding for me and my students to collaborate on kidney exchange research. Amount TBD. |
| 2019–2021 | **My PhD student (co-advised with Nina Balcan) Ellen Vitercik received an IBM Fellowship and a Fellowship in Digital Health (CMU's Center for Machine Learning and Health).**<br>Around US$ 176,272 |

1/16/2017–4/30/2020 **Steering T-Cell Adaptation Using Opponent Exploitation Algorithms and Computational Game Theory**
*ARO*
Tuomas Sandholm (PI) and Penelope Morel
US$ 750,000

7/1/2016–6/30/2019 **RI: Small: Computational Techniques for Large Multi-Step Incomplete-Information Games**
*NSF Robust Intelligence*
Tuomas Sandholm (PI)
US$ 450,000

2/2016–3/2021 **European Network for Collaboration on Kidney Exchange Programmes**
*COST Action OC-2015-2*
Joris Klundert (PI)
This is a very large grant among several European countries. I am an official foreign collaborator. Provides travel funding for me and my students to collaborate on kidney exchange work. Amount TBD.

2018–2019 **My PhD student Noam Brown received an Open Philanthropy AI Fellowship and a Tencent AI Lab Fellowship.**
Around US$ 200,000

7/1/2017–6/30/2018 **Supercomputing for equilibrium finding, biological steering, and kidney exchange**
*NSF XSEDE*, renewal of grant CCR090023
Tuomas Sandholm (PI)
7,024,270 Service Units (i.e., core hours) on the Bridges supercomputer CPUs, 2.6PB of storage, and 16,800 GPU Service Units.

2016–2019 **My PhD student (co-advised with Nina Balcan) Ellen Vitercik received the NSF Graduate Research Fellowship**
US$ 138,000

2016–2019 **My PhD student (co-advised with Nina Balcan) Ellen Vitercik received the Microsoft Research Women's Fellowship**
US$ 17,000

1/2017 **Sponsorship for the Brains vs. AI rematch**
*Carnegie Mellon University, Rivers Casino, GreatPoint Ventures, Avenue4Analytics, TNG Technology Consulting, Artificial Intelligence, Intel, and Optimized Markets, Inc.*
Tuomas Sandholm (PI)
US$ 200,000

2016-2017 **My PhD student Christian Kroer received a Facebook Fellowship**
US$ 161,000

10/23/2016–12/31/2016 **Supplement to supercomputer time grant "Large-shared-memory supercomputing for game-theoretic analysis with fine-grained abstractions, and novel tree search algorithms"**
*NSF XSEDE*
Tuomas Sandholm (PI)
6,276,000 Service Units (i.e., core hours) on the new Bridges supercomputer and 1 petabyte of storage.

1/1/2016–12/31/2016 **Renewal to supercomputer time grant "Large-shared-memory supercomputing for game-theoretic analysis with fine-grained abstractions, and novel tree search algorithms"**
*NSF XSEDE*
Tuomas Sandholm (PI)
10,000,000 Service Units (i.e., core hours) on the new Bridges supercomputer and 1.4 petabytes of storage.

9/1/2013–8/31/2016 **RI: Small: Expressiveness and Automated Bundling in Mechanism Design: Principles and Computational Methodologies**
*NSF Robust Intelligence*
Tuomas Sandholm (PI)
US$ 425,000

9/1/2015–8/31/2016 **EAGER: Exploiting a myopic opponent in imperfect-information games: Toward medical applications**
*NSF Robust Intelligence*
Tuomas Sandholm (PI)
US$ 100,000

2/5/2016–11/4/2016 **Initial Computational Research on Steering T Cell Differentiation**
*Army Research Office (ARO)*
Tuomas Sandholm (PI)
US$ 50,000

2015–2016 **Optimization-Based Digital Ad Campaign Sales and Allocation**
*Adobe Digital Marketing Research Awards Program*
Tuomas Sandholm (PI)
US$ 50,000

9/23/2015–1/5/2016 **San Diego Supercomputing Center's Director's Discretionary Award"**
*NSF XSEDE*
Tuomas Sandholm (PI)
1,600,000 Service Units (i.e., core hours) on Comet at the San Diego Supercomputing Center.

8/1/2015–7/29/2016 **My PhD student John Dickerson won a Siebel Fellowship**
US$ 80,000

6/1/2015–5/31/2016 **My PhD student John Dickerson received a Facebook Fellowship**
US$ 161,000

8/1/2011–7/31/2015 **AIR: Sophisticated Electronic Markets for TV Advertising, Powered by Novel Optimization**
*NSF*
Tuomas Sandholm (PI)
US$ 300,000

7/25/2013–7/31/2015 **Supplement for Sophisticated Electronic Markets for TV Advertising, Powered by Novel Optimization**
*NSF AIR*
Tuomas Sandholm (PI)
US$ 50,000

9/1/2012–5/31/2015 **My PhD student John Dickerson received a 2012 National Defense Science and Engineering Graduate (NDSEG) Fellowship**
US$ 218,410

8/15/2015–12/31/2015 **Supplement to supercomputer time grant "Large-shared-memory supercomputing for game-theoretic analysis with fine-grained abstractions, and novel tree search algorithms"**
*NSF XSEDE*
Tuomas Sandholm (PI)
200,000 Service Units (i.e., core hours) on Comet at the San Diego Supercomputing Center.

1/1/2015–12/31/2015 **Renewal to supercomputer time grant "Large-shared-memory supercomputing for game-theoretic analysis with fine-grained abstractions, and novel tree search algorithms"**
*NSF XSEDE*
Tuomas Sandholm (PI)
1,043,779 Service Units (i.e., core hours), worth $141,388, on the world's largest shared-memory supercomputer, Blacklight (4,096 cores and 32 Terabytes of RAM).

4/15/2014–12/31/2014 **Supplement (i.e., addition) to supercomputer time grant "Large-shared-memory supercomputing for game-theoretic analysis with fine-grained abstractions, and novel tree search algorithms"**
*NSF XSEDE*
Tuomas Sandholm (PI)
1,000,000 Service Units (i.e., core hours) on the world's largest shared-memory supercomputer, Blacklight (4,096 cores and 32 Terabytes of RAM). Also, 120 Terabytes of storage on the Data Supercell.

1/1/2014–12/31/2014 **Renewal (i.e., addition) to supercomputer time grant "Large-shared-memory supercomputing for game-theoretic analysis with fine-grained abstractions, and novel tree search algorithms"**
*NSF XSEDE*
Tuomas Sandholm (PI)
1,548,291 Service Units on the world's largest shared-memory supercomputer, Blacklight (4,096 cores and 32 Terabytes of RAM).

4/2015–5/2015 **Sponsorship for the Brains Vs. AI event**
*Microsoft Research*
Tuomas Sandholm (PI)
US$ 50,000

4/2015–5/2015 **Sponsorship for the Brains Vs. AI event**
*Rivers Casino*
Tuomas Sandholm (PI)
US$ 50,000

4/2015–5/2015 **Sponsorship for the Brains Vs. AI event**
*Artificial Intelligence journal (Elsevier)*
Tuomas Sandholm (PI)
Euro 3,000

9/1/2012–8/31/2014 **Drug Design and Treatment Planning via Sequential Games**
*Microsoft Computational Thinking Center at CMU*
Tuomas Sandholm (PI)
US$ 75,000

6/17/2010–5/31/2014 **RI: Medium: Abstraction, Equilibrium Finding, Safe Opponent Exploitation, and Robust Strategies for Imperfect-Information Games**
*NSF*
Tuomas Sandholm (PI)
US$ 719,830

5/1/2011–4/30/2014 **ICES: Small: New and Better Markets via Automated Market Making**
*NSF*
Tuomas Sandholm (PI)
US$ 324,340

5/19/2013–12/31/2013 **Supplement to supercomputer time grant "Large-shared-memory supercomputing for game-theoretic analysis with fine-grained abstractions, and novel tree search algorithms"**
*NSF XSEDE*
Tuomas Sandholm (PI)
250,000 Service Units on the world's largest shared-memory supercomputer (4,096 cores and 32 Terabytes of RAM).

10/1/2011–9/30/2013 **Supercomputer time grant "Large-shared-memory supercomputing for game-theoretic analysis with fine-grained abstractions, and novel tree search algorithms"**
*NSF XSEDE*
Tuomas Sandholm (PI)
4,000,000 Service Units on the world's largest shared-memory supercomputer (4,096 cores and 32 Terabytes of RAM).

10/1/2011–9/30/2013 **Supercomputer advanced support (ASTA) grant "Large-shared-memory supercomputing for game-theoretic analysis with fine-grained abstractions, and novel tree search algorithms"**
*NSF XSEDE*
Tuomas Sandholm (PI)

7/1/2009–6/30/2012 **RI: Medium: Algorithms for Robust Barter Exchanges, with Application to Kidneys**
*NSF*
Tuomas Sandholm (PI)
US$ 855,259

10/1/2011–5/30/2012 **My PhD student Abe Othman received the Google scholarship in Market Algorithms**
*Google*
US$ 75,600

4/1/2010–3/31/2011 **Supercomputer time grant "Leveraging supercomputing for large-scale game-theoretic analysis: Renewal"**
*NSF XSEDE*
Tuomas Sandholm (PI)
360,000 Service Units on a 768-core 1.5 Terabyte RAM cc-NUMA shared-memory supercomputer. Later converted to allocation on the world's largest shared-memory supercomputer (4,096 cores and 32 Terabytes of RAM).

4/1/2010–3/31/2011 **Supercomputer advanced support (ASTA) grant "Leveraging supercomputing for large-scale game-theoretic analysis: Renewal"**
*NSF XSEDE*
Tuomas Sandholm (PI)

10/2009 **CombineNet, Inc. gift to CMU**
Tuomas Sandholm (PI)
US$ 14,000

8/2010–8/2011 **Siebel fellowship for PhD student Michael Benisch**
US$ 35,000

4/1/2009–3/31/2010 **Supercomputer time grant "Solving large sequential games of imperfect information"**
*NSF XSEDE*
Tuomas Sandholm (PI)
400,000 Service Units on a 768-core 1.5 Terabyte RAM cc-NUMA shared-memory supercomputer.

9/1/2004–8/31/2009 **ITR - (ECS + ASE) - (dmc + soc): Automated Mechanism Design**
*NSF ITR (Information Technology Research)*
Tuomas Sandholm (PI)
US$ 1,100,000

9/1/2008–7/1/2009 **Computational Thinking for Optimal Kidney Exchange**
*Funded by Microsoft Research, at Carnegie Mellon University PROBE (PRoblem-Oriented Exploration)*
Tuomas Sandholm (PI)
US$ 65,000

12/2008 **CombineNet, Inc. gift to CMU**
Tuomas Sandholm (PI)
US$ 13,867

8/2008–8/2009 **Siebel fellowship for PhD student Andrew Gilpin**
US$ 25,000

3/2008–3/2009 **'Friendly user' time grant on new Altix machines**
*NSF XSEDE*
Tuomas Sandholm (PI)

10/9/2007 **Machine gift from Intel Corporation**
Tuomas Sandholm (PI)
US$ 39,192

10/1/2007–9/30/2008 **CombineNet, Inc. gift to CMU**
Tuomas Sandholm (PI)
US$ 13,000

5/2007 **Susquehanna International Group (SIG) gift to CMU**
Tuomas Sandholm (PI)
US$ 25,000

5/1/2007–4/30/2008 **Yahoo! fellowship for PhD student David Abraham**
US$ 5,000

10/1/2006–9/30/2007 **CombineNet, Inc. gift to CMU**
Tuomas Sandholm (PI)
US$ 12,800

9/15/2001–8/31/2006 **ITR/PE+SY: Collaborative Research: Foundations of Electronic Marketplaces: Game Theory, Algorithms, and Systems**
*NSF ITR (Information Technology Research)*
Tuomas Sandholm (PI)
Co-PIs: Avrim Blum (CMU), Subhash Suri (UCSB CS), Mark Satterthwaite (Northwestern University, MEDS), Rakesh Vohra (Northwestern University, MEDS), Ming Kao (Northwestern University, CS).
US$ 2,800,000
Share of Carnegie Mellon University (lead university): $ 1,200,338.

9/16/2003–9/15/2006 **Alfred P. Sloan Foundation Fellowship**
Tuomas Sandholm (PI)
US$ 40,000

10/1/2005–9/30/2006 **CombineNet, Inc. gift to CMU**
Tuomas Sandholm (PI)
US$ 12,000

9/1/2005–8/31/2006 **IBM Fellowship**
To fund my PhD student Vincent Conitzer
US$ 48,815

1/1/2001–8/31/2004 **ITR/SOC: Secure Automated Negotiation under Limited Computation: Deliberation in Equilibrium**
*NSF ITR (Information Technology Research)*
Tuomas Sandholm (PI)
US$ 388,225
Entire amount transferred from Washington University to CMU

5/1/1998–8/31/2003 **Advanced Contract Types for Automated Negotiation**
*NSF (Computation and Social Systems)*
Tuomas Sandholm (PI)
US$ 120,000
Balance $71,900 transferred from Washington University to CMU

6/1/1997–5/31/2003 **Coalition Formation among Self-Interested Computationally Limited Agents**
*NSF CAREER award (Information Technology and Organizations)*
Tuomas Sandholm (PI)
US$ 456,098
Balance $177,502 transferred from Washington University to CMU

7/15/1997–9/30/2000 **Optimal Mechanisms for Negotiation under Message Passing and Belief Revision**
*NSF (Information Technology and Organizations)*
Tuomas Sandholm (PI), Ronald Loui
US$ 199,052

5/1/1997–4/30/2000 **High Performance Distributed Object Environment with Emphasis on Adaptive End-to-end QoS Guarantees**
*DARPA (Quorum program)*
Guru Parulkar (PI), Douglas Schmidt, Tuomas Sandholm, Jonathan Turner
US$ 650,000

8/1/1992–12/31/1992 **Neural Networks in Bankruptcy Prediction**
*Technical Research Centre of Finland*
*Laboratory for Information Processing*
Grantor: Remote Area Development Fund
Tuomas Sandholm (PI)
Funding approved but project never initiated (PI went to graduate school)
100,000 Finnish marks

1/31/1992–12/31/1992 **Intelligent Agents (INTELAGENT)**
*Technical Research Centre of Finland*
*Laboratory for Information Processing*
Seppo Linnainmaa (PI), Tuomas Sandholm, Aarno Lehtola.
500,000 Finnish marks

**Industrial grants received**

1/1/2014–6/30/2014 **SBIR Phase I: Advertising Sales and Traffic Optimization: Difficult Customer-Requested Optimization Constraints and Scalability on Real Data**
*NSF SBIR*
Tuomas Sandholm (PI). I later transferred the official PI-ship to my PhD student John Dickerson due to SBIR full-time regulations.
US$ 150,000

8/1/2011–7/31/2013 **Matching funds for the NSF Accelerating Innovation Research grant**
*Innovation Works and CMU*
Tuomas Sandholm (PI).
US$ 300,000

6/2002–6/2005 **Scalable and Usable Technology for Markets with Expressive Bidding**
*NIST, US Department of Commerce Advanced Technology Program (ATP)*
Tuomas Sandholm (PI). Awarded to CombineNet, Inc.
US$ 1,836,530

11/1/1997–10/31/2000 **An open component-based architecture for Internet commerce**
*NIST, US Department of Commerce Advanced Technology Program (ATP)*
Awarded to BusinessBots, Inc., CommerceNet, CNGroup, and Tesserae Information Systems
US$ 5,000,000

# Pittsburgh People

## People

### Lab Directors

Limor Fix, Associate Director, Homepage
Todd Mowry, Director, Homepage

### Lab Administration

Kim A Kaan, Lab Administrator, (Email)
Russ Stoebe, Sys Admin, (Email)
David J Westfall, Lab Operations Manager, (Email)

### Intel Research Staff

Jason Campbell, Homepage
Shimin Chen, Homepage
Phillip B Gibbons, Homepage
Casey J Helfrich, Lab Research Engineer, Homepage
Michael Kaminsky, Homepage
Michael A Kozuch, Homepage
Padmanabhan (Babu) Pillai, Homepage
Steve Schlosser, Homepage
Siddhartha Srinivasa, Homepage
Rahul Sukthankar, Homepage
Haifeng Yu, Homepage

### Graduate Students

Mike De Rosa, Homepage
Stano Funiak, Homepage
Yan Ke, Carnegie Mellon, Homepage
Amit Manjhi, Carnegie Mellon, Homepage
Partho Nath, Homepage
Jeff Pang, Homepage
Ben Rister, Carnegie Mellon, Homepage

### Affiliated Faculty

Mark Abbott, Oregon State, Homepage
Anastassia Ailamaki, Carnegie Mellon, Homepage
Guy Blelloch, Carnegie Mellon, Homepage
Tat Jen Cham, Nanyang Technological University, Homepage
Mark Derthick, Carnegie Mellon, Homepage
Christos Faloutsos, Carnegie Mellon, Homepage
Babak Falsafi, Carnegie Mellon, Homepage
David Farber, Homepage
Jason Flinn, Homepage
Greg Ganger, Carnegie Mellon, Homepage

Ramesh Govindan, USC
Rob Holman, Oregon State, Homepage
Kai Li, Princeton University, Homepage
Brian Noble, Homepage
Illah Nourbaksh, Carnegie Mellon, Homepage
Dave O''Hallaron, Carnegie Mellon University, Homepage
Adrian Perrig, Carnegie Mellon, Homepage
James M. Rehg, Georgia Institute of Technology, Homepage
Erik Riedel, Seagate Research, Homepage
Henry Schneiderman, Carnegie Mellon, Homepage
Chuck Sears, Oregon State
Srinivasan Seshan, Carnegie Mellon, Homepage
Scott Shenker, ICSI and UC Berkeley
John Stanley, Oregon State
Peter Steenkiste, Carnegie Mellon, Homepage
Srikanta Tirthapura, Iowa State, Homepage
Nuno Vasconcelos, University of California San Diego, Homepage

## Intel Affiliate Researchers

Don Cameron
Steven Conner, CTG Wireless & Mobility
Lakshman Krishnamurthy, CTG Wireless & Mobility
Mike Mesnier
Hans Mulder
Sylvia Ratnasamy, Intel Research Berkeley
Mahadev Satyanarayanan, Director Emeritus, Homepage
Rumi Zahir

## Alumni

Kevin Bowers, Carnegie Mellon, Homepage
Thomas Bressoud, Homepage
Spencer Charlie Brubaker, Homepage
Amol Deshpande, Homepage
Bancha Dhammarungruang, Homepage
Scott Garriss, Homepage
J. Michael German
Ashish Gupta
Derek Hoiem, Carnegie Mellon, Homepage
Larry Huston, Homepage
Brad Karp, Homepage
Hyang-ah Kim, Carnegie Mellon, Homepage
Vasileios Liaskovitis
Suman K. Nath, Carnegie Mellon, Homepage
James Newsome, Carnegie Mellon, Homepage
Ramprasad Ravichandran
Arrvindh Shriraman, Homepage
Shafeeq Sinnamohideen, Carnegie Mellon, Homepage
Dilip Sundarraj, Homepage
Sonesh Surana, Homepage
Niraj Tolia, Carnegie Mellon, Homepage, (Email)
Patrick Vinograd, Homepage
Rajiv Wickremesinghe, Homepage
Ming Zhang, Homepage

## Acknowledgements

During my brief tenure at MIT (brief, at least, by geologic standards) many people have contributed to making it an intellectually and personally rewarding experience. Foremost has been my advisor Randy Davis who, by word and deed, taught me how to do research critically and express the results intelligibly. He was always available to comment on my ideas and writings, invariably giving sound advice (even if it was not always heeded).

Members of the hardware-troubleshooting research group — Walter Hamscher, Brian Williams, Mark Shirley, and Jeff Van Baalen, in particular — have provided much intellectual stimulation and friendship. It is a privilege to have been associated with them over the years. My committee members, Chuck Rich and Peter Szolovits, supplied crucial insights into what was important and interesting about the research. I have also benefited from discussions with Phil Agre and David Chapman.

I am grateful to Schlumberger for their support, both financially and intellectually, during the course of my research. In particular, I have benefited much from interactions with Reid Smith, Marty Tenenbaum, John Mohammed, and Roy Nurmi, who taught me to do geologic interpretation. Many others outside the MIT community have had an impact on my work, including Bruce Buchanan, Drew McDermott, Tom Dean, Yoav Shoham, Kris Hammond and Ken Forbus. To these and many others, my heartfelt thanks.

Most importantly, I thank my dear wife Pearl, who is a continual source of love, friendship and amusement. She has been a source of strength and comfort when I needed it the most. I eagerly anticipate embarking on this new phase of my life with her.

# Welcome!

**MANUELA M. VELOSO**
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or mmv at cs dot cmu dot edu)
School of Computer Science
MLD, CSD, RI, and ECE
Carnegie Mellon University
Pittsburgh PA 15213-3890, USA
(To visit me, I will schedule one of our CoBot robots
to escort you to my office.)

Some news/talks:

- Interview: What's the Role of Multiagent Systems in Finance," ML Minutes, (October 2020)
- Interview: Humanity and AI will be Inseparable, The Verge", (November 15, 2016)
- Lecture at the MIT Technology Review EmTech Digital", (May 23, 2016)
- Keynote at the 2015 Grace Hopper Conference", (October 15, 2015)
- Lecture at the "Admiravel Mundo Novo", in Portuguese, (June 12, 2015)
- CBS Saturday Morning, (February 21, 2015, with Anthony Mason, and producer Gregory Mirman)
- MIT Technology Review article. (November 11, 2014, by Will Knight)
- Wired article. (August 6, 2012, by Christina Bonnington)

**Short vitae**
**Herb Simon's** talk on "Forecastig the Future or Shaping it?" video and paper (CMU, October 2000), and clip on robot soccer (which I presented in my Presidential Address at AAAI'14, July 30, 2014).

**RESEARCH:**

- LIST OF PUBLICATIONS.
- Also please see below the PhD theses of my students.
- CORAL - My research group on intelligent robots that Cooperate, Observe, Reason, Act, and Learn.
- **Our CMDragons team is the 2015 RoboCup Small Size World Champion! See the news and the video highlights of ALL the games (6-0, 10-0, 10-0, 15-0, 2-0, 5-0).**

**CoBots - Collaborative Mobile Robots:**

- Learn more. Watch CoBot videos. See the publications.
- We research on effective autonomous indoor mobile service robots. We aim at contributing to a multi-robot, multi-human symbiotic relationship, in which robots and humans coordinate and