How to Measure Airport Connectivity?

Average Quickest Travel Time as Indicator

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Overview

1. Introduction

2. Method:
   a) Average Quickest Travel Time
   b) Average Fastest Path Velocity

3. Case Studies:
   1. Germany to New York
   3. Worldwide Airport Ranking

4. Conclusions

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Introduction

- Air transport is connecting people and industries worldwide

- Purposes of connectivity measurement
  - Airport and airline industry: self evaluation (e.g. Redondi et al., 2011)
  - Companies: compare attractiveness of regions for location decision (e.g. Kasarda, Lindsay, 2011)
  - Politicians: positive effects on business ties and incoming tourism (e.g. Wittmer et al., 2006)
  - …

- Measurement/Quantification not clear

Introduction

- Overview of indicators given by Burghouwt and Redondi (2013)
- Hitherto indicators only consider one dimension, for example:
- Number of connections/frequencies
  - Are onward flights considered?
  - If yes: Which connections to consider? (e.g. FRA-MXP via DXB)
- Shortest Path Length and Quickest Travel Time:
  - Is it the only good connection?
  - Departure at an acceptable time? (e.g. direct flight at midnight)
  - Distance is not explicitly considered (e.g. FRA-MXP vs. FRA-SYD ?)

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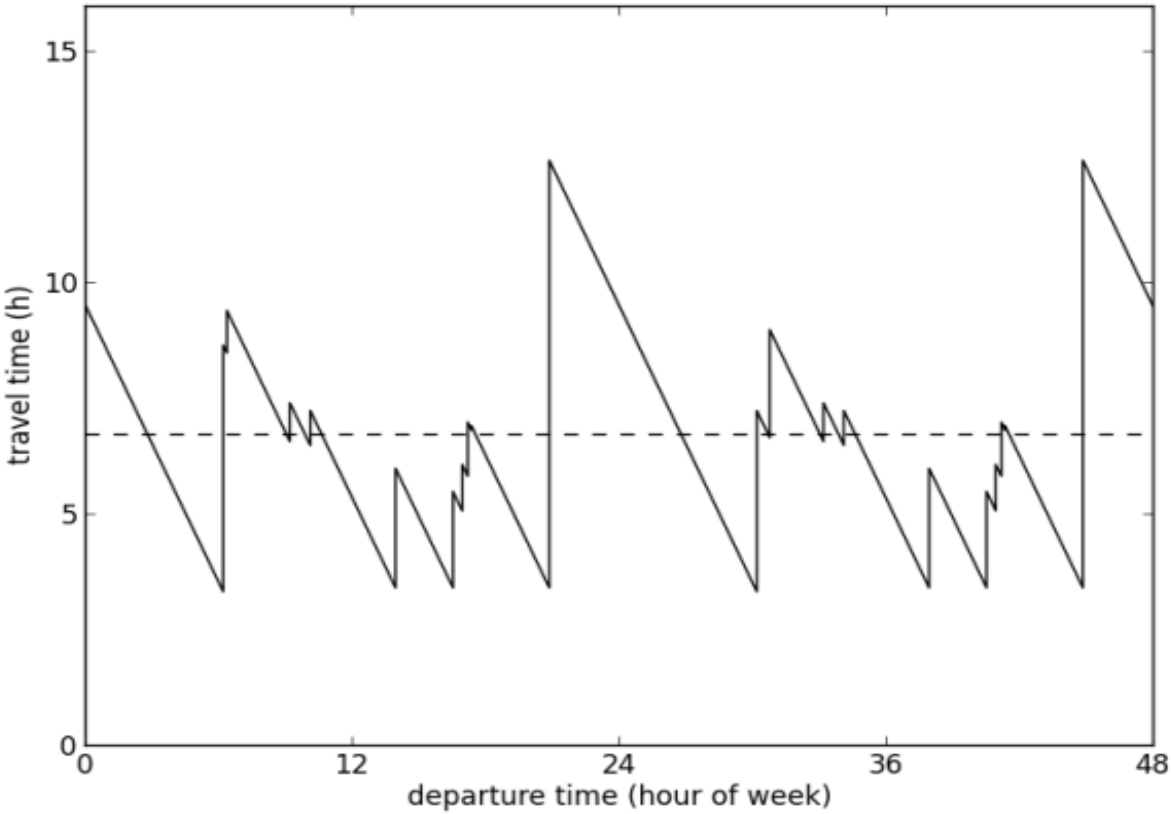
Method: Average Quickest Travel Time

Quickest travel time in dependence of starting time and average quickest travel time indicator (dashed line) for DME-DUS.



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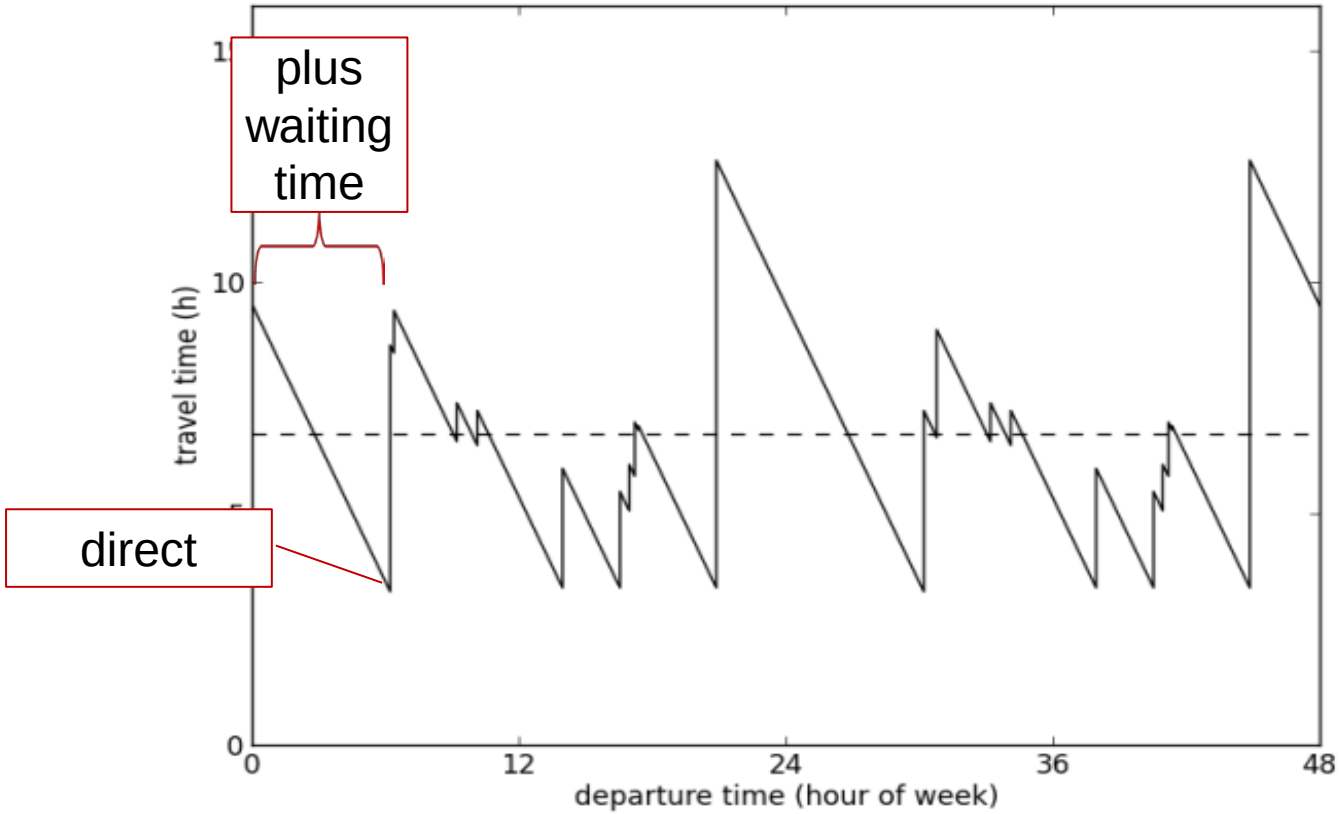

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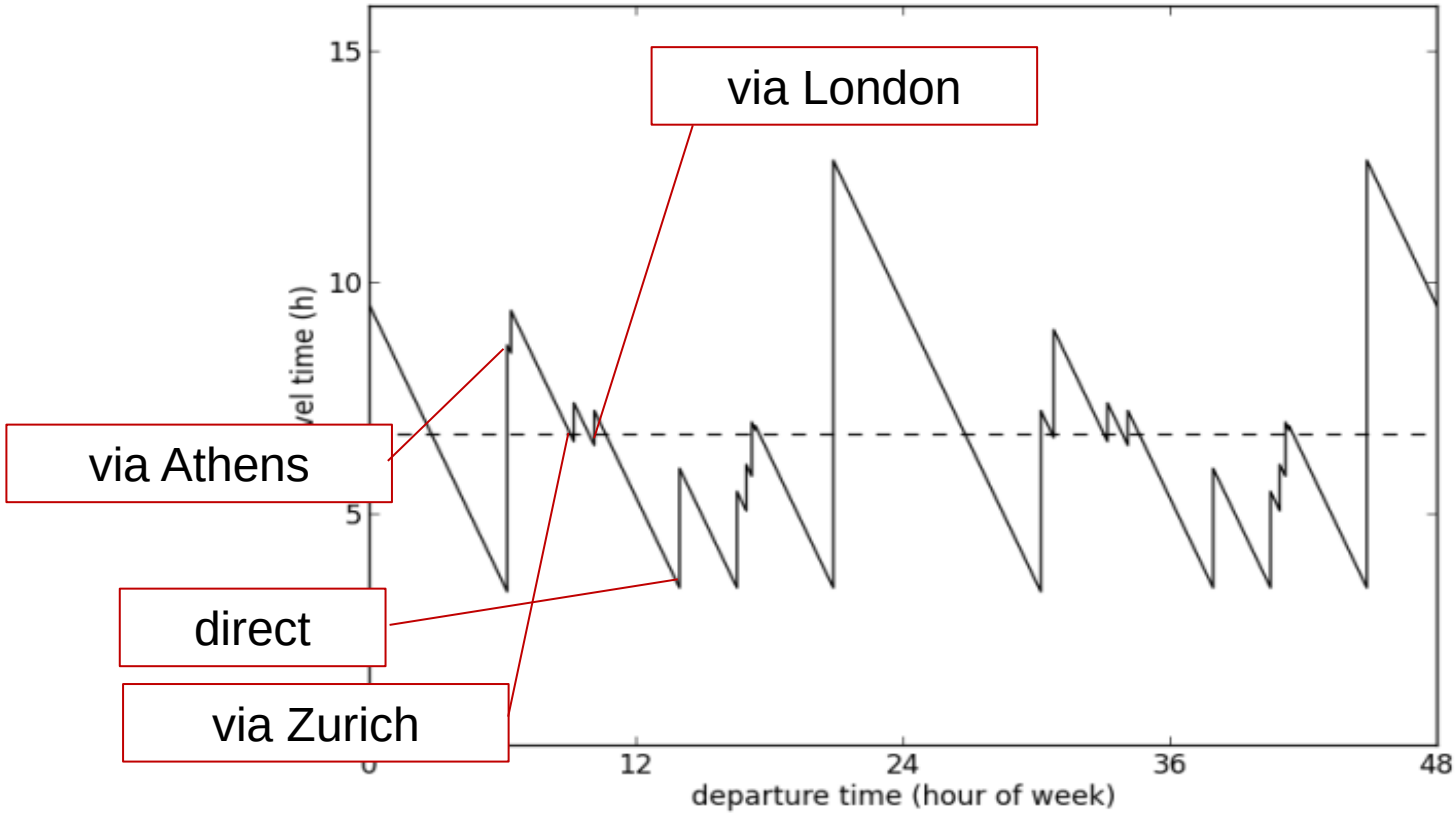

Method: Average Quickest Travel Time

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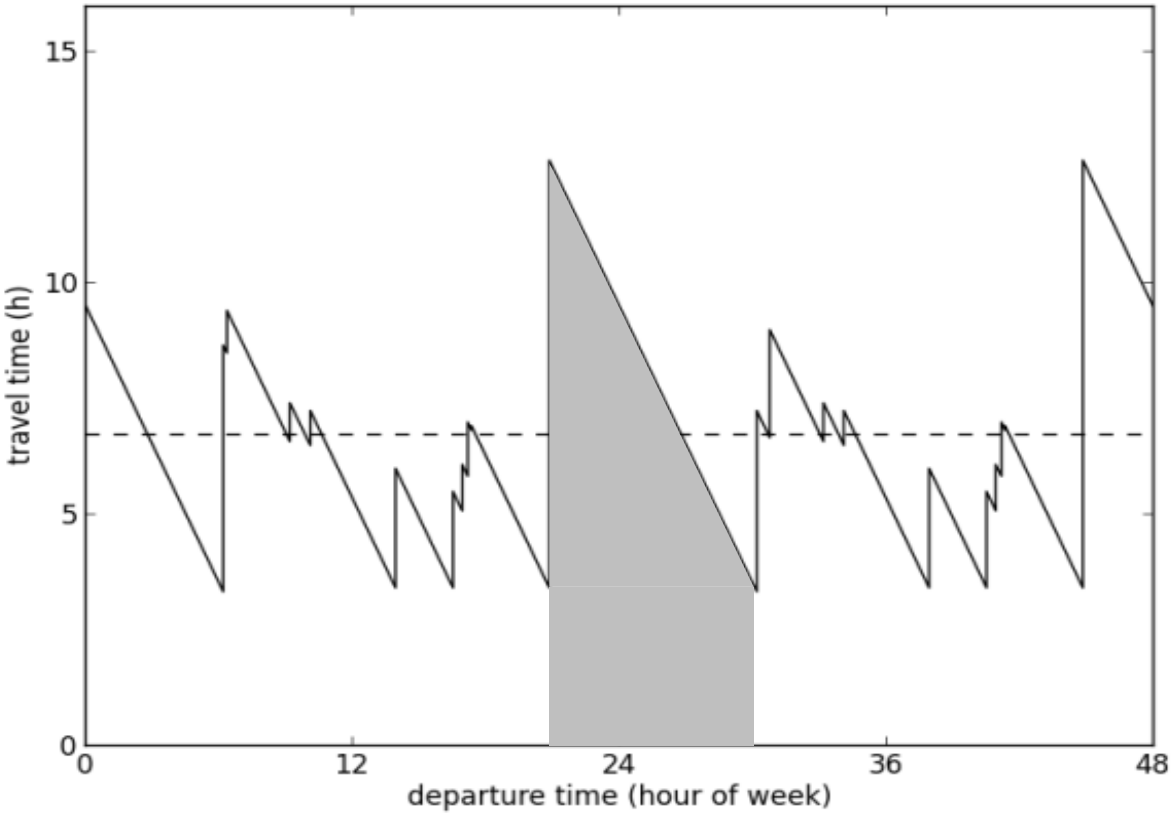

Analytical calculation of functional mean

$$\bar{f} = \frac{\int_T f(t)\ dt}{|T|}$$

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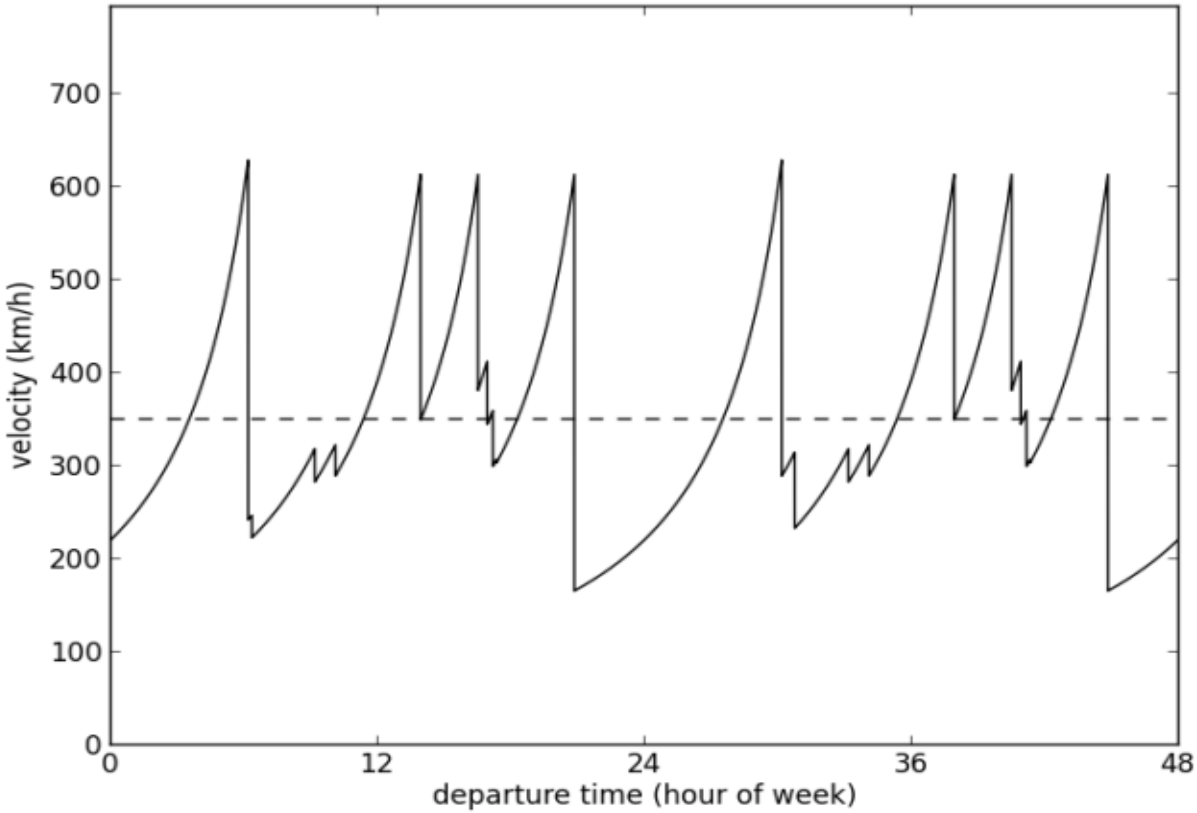
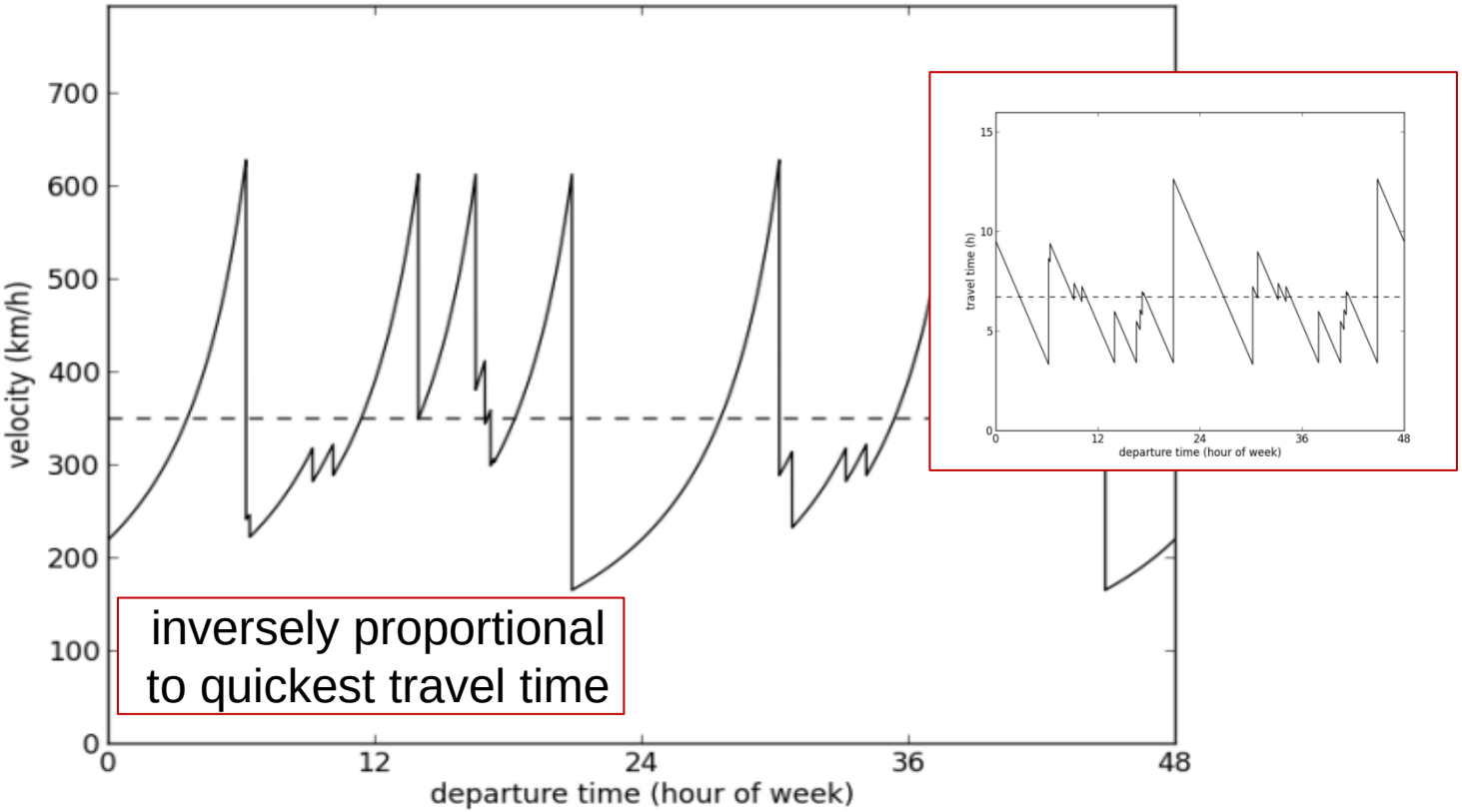
Method: Average Fastest Path Velocity

Fastest path velocity (= distance/travel time) in dependence of starting time and average quickest path velocity indicator (dashed line) for DUS-DME.



Method: Average Fastest Path Velocity

Fastest path velocity (= distance/travel time) in dependence of starting time and average quickest path velocity indicator (dashed line) for DUS-DME.



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Case Studies: Input

- OAG Flight schedules of 7th to 20th of May 2012
- After deletion of error prone data: 171.621.035 flights, 2.972 airports

- Path search was done with a newly developed algorithm (based on Dijkstra, 1959)

- Boundary conditions:
  - departure within first week
  - minimum transfer time of 1 hour
  - airline specific (+ code share)
    - optimal connections are picked out among airline specific results

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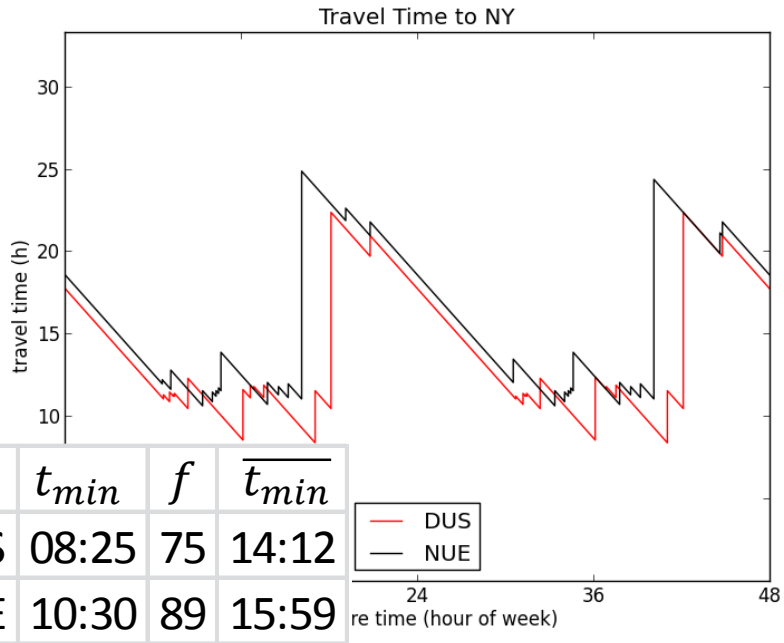
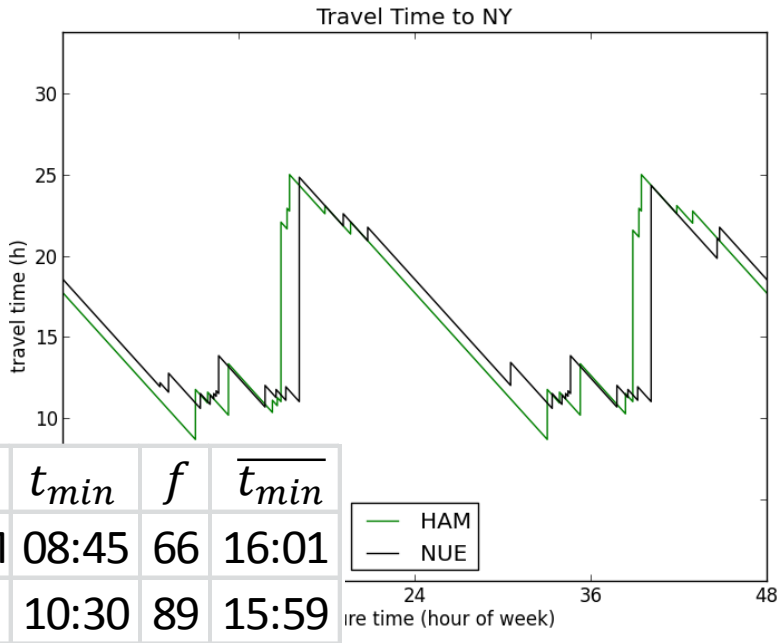
Case Study 1: Germany to New York

Sample: Quickest travel times from Dusseldorf (DUS) - NY and Hamburg (HAM) - NY, each compared to Nuremberg (NUE) - NY.



	t_{min}	f	$\overline{t_{min}}$
DUS	08:25	75	14:12
NUE	10:30	89	15:59



	t_{min}	f	$\overline{t_{min}}$
HAM	08:45	66	16:01
NUE	10:30	89	15:59

→ Integration of frequency and quickest travel time

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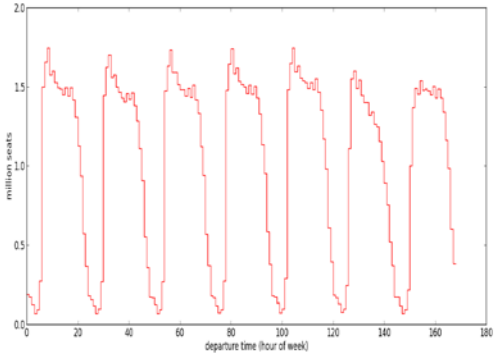
Case Study 3: World's Top 10 Airports

- Calculation of airport average (average of averages)

- Valuation of destination airport:
  - by importance for traffic
    ≈ departing seats offered by airport
  - uniform weights (=1)
- Modify by: weights of reachable divided by weights of all destinations

- Valuation of departure time:
  - by passenger preference
    ≈ globally departing seats per hour of week
  - uniform weights (=1)



Case Study 3: World's Top 10 Airports

valuation of destination		uniform			departing seats		
of starting time		uniform		varying	uniform		varying
average quickest travel time	LHR	43:23:44	LHR	42:15:03	LHR 17:46:10	LHR	16:49:35
	FRA	45:04:55	FRA	43:47:33	FRA 18:02:03	FRA	16:58:19
	CDG	46:01:51	CDG	44:29:55	CDG 18:06:36	CDG	17:01:51
	LAX	48:26:02	JFK	46:41:09	AMS 18:48:24	AMS	17:46:26
	JFK	48:32:04	MUC	47:37:18	MUC 18:49:00	MUC	18:00:17
	MUC	48:42:35	LAX	47:43:48	JFK 19:09:54	JFK	18:02:34
	ZRH	49:21:52	ORD	48:37:00	LAX 19:20:20	ORD	18:19:35
	BCN	49:45:11	ZRH	48:37:21	ZRH 19:21:22	ZRH	18:39:12
	MAD	50:00:12	AMS	48:57:07	ORD 19:41:17	LAX	18:41:37
	SFO	50:04:29	BCN	49:10:11	DUS 19:42:24	YYZ	18:49:39
average quickest path velocity	LAX	204	LAX	209	SYD 458	SYD	475
	SYD	200	SYD	205	LAX 445	LAX	463
	SIN	193	SFO	197	SIN 441	MEL	446
	SFO	193	NRT	194	MEL 439	SFO	445
	LHR	185	LHR	192	SFO 426	SIN	439
	NRT	185	SIN	192	GRU 421	GRU	434
	BKK	182	FRA	189	AKL 416	NRT	431
	HKG	180	JFK	187	BKK 415	AKL	429
	FRA	180	HKG	186	HKG 411	HKG	428
	MEL	178	CDG	182	PER 407	EZE	418

Connectivity provided by AA and UA from Chicago O'Hare using different indices

Case Study 3: World's Top 10 Airports

valuation							
of destination		uniform			departing seats		
of starting time		uniform		varying	uniform		varying	
average quickest travel time	LHR	43:23:44	LHR	42:15:03	LHR	17:46:10	LHR	16:49:35
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	CDG	46:01:51	CDG	44:29:55	CDG	18:06:36	CDG	17:01:51
	LAX	48:26:02	JFK	46:41:09	AMS	18:48:24	AMS	17:46:26
	JFK	48:32:04	MUC	47:37:18	MUC	18:49:00	MUC	18:00:17
	MUC	48:42:35	LAX	47:43:48	JFK	19:09:54	JFK	18:02:34
	ZRH	49:21:52	ORD	48:37:00	LAX	19:20:20	ORD	18:19:35
	BCN	49:45:11	ZRH	48:37:21	ZRH	19:21:22	ZRH	18:39:12
	MAD	50:00:12	AMS	48:57:07	ORD	19:41:17	LAX	18:41:37
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average quickest path velocity	LAX	204	LAX	209	SYD	458	SYD	475
	SYD	200	SYD	205	LAX	445	LAX	463
	SIN	193	SFO	197	SIN	441	MEL	446
	SFO	193	NRT	194	MEL	439	SFO	445
	LHR	185	LHR	192	SFO	426	SIN	439
	NRT	185	SIN	192	GRU	421	GRU	434
	BKK	182	FRA	189	AKL	416	NRT	431
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Valuation of departure time, e.g

Connectivity provided by AA and UA from Chicago O'Hare using different indices

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valuation of destination	of starting time	uniform		uniform		departing seats		uniform		varying	
average quickest travel time		LHR	43:23:44	LHR	42:15:03	LHR	17:46:10	LHR	16:49:35
		FRA	45:04:55	FRA	43:47:33	FRA	18:02:03	FRA	16:58:19
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		LAX	48:26:02	JFK	46:41:09	AMS	18:48:24	AMS	17:46:26
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		SFO	193	NRT	194	MEL	439	SFO	445
		LHR	185	LHR	192	SFO	426	SIN	439
		NRT	185	SIN	192	GRU	421	GRU	434
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Valuation of destinations, e.g.

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Case Study 3: World's Top 10 Airports

Travel time: mainly European airports

valuation of destination	of starting time	uniform uniform	uniform varying	departing seats uniform	departing seats varying
average quickest travel time		LHR 43:23:44	LHR 42:15:03	LHR 17:46:10	LHR 16:49:35
		FRA 45:04:55	FRA 43:47:33	FRA 18:02:03	FRA 16:58:19
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		ZRH 49:21:52	ORD 48:37:00	LAX 19:20:20	ORD 18:19:35
		BCN 49:45:11	ZRH 48:37:21	ZRH 19:21:22	ZRH 18:39:12
		MAD 50:00:12	AMS 48:57:07	ORD 19:41:17	LAX 18:41:37
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		SYD 200	SYD 205	LAX 445	LAX 463
		SIN 193	SFO 197	SIN 441	MEL 446
		SFO 193	NRT 194	MEL 439	SFO 445
		LHR 185	LHR 192	SFO 426	SIN 439
		NRT 185	SIN 192	GRU 421	GRU 434
		BKK 182	FRA 189	AKL 416	NRT 431
		HKG 180	JFK 187	BKK 415	AKL 429
		FRA 180	HKG 186	HKG 411	HKG 428
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Case Study 3: World's Top 10 Airports

Path velocity: many airports located around the pacific

Connectivity provided by AA and UA from Chicago O'Hare using different indices

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average quickest travel time		LHR	43:23:44	LHR	42:15:03	LHR	17:46:10	LHR	16:49:35
		FRA	45:04:55	FRA	43:47:33	FRA	18:02:03	FRA	16:58:19
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Conclusions

- Indicators combine travel time of individual connections and flight frequencies into single value indicators
- Indicator is meaningful, non-artificial (not like score system)
- Possibility of temporal valuation and valuation of destinations using weighted averages
- Travel time indicators overrate airports in the network center
- Velocity indicator exaggerates big airports at the periphery
- Coming next: Further evaluation of indicators

Thank you for your attention! Questions?

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