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# Problem structuring in OR practice

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University of Exeter Business School, UK

64th Conference of the OR Society (OR64), Warwick, UK.

Soft OR and Problem Structuring Methods (PSM) stream  
Tuesday 13<sup>th</sup> September 2022 16:30-18:00

# Motivation

- The dichotomous framings of Soft/Hard, Wicked/Tame, Swamp/High Ground etc. in Rational Analysis... have served their purpose in defining Soft OR/PSMs as a vibrant field but how do we (re-)integrate Soft OR/PSMs into mainstream OR practice?

# Recent Background

- Dyson, R. G., O'Brien, F., & Shah, D. B. (2021). Soft OR and Practice: The Contribution of the Founders of Operations Research. *Operations Research*, 69(3), pp. 727-738.  
<https://doi.org/10.1287/opre.2020.2051>
- Dyson, R.G. (2022) Soft OR/PSMs through six decades. *64<sup>th</sup> Conference of the OR Society (OR64)*, Warwick, UK.
- Vidoni, M. (2022). Beyond Hard and Soft OR: operational research from a software engineering perspective. *Journal of the Operational Research Society*, 73(4), 693-715.  
<https://doi.org/10.1080/01605682.2020.1865848>

# Provocation

“Perhaps what Soft OR is –  
is what OR should be”

Lesso, W. (2009). The  
Essence of What Attracted  
Me to O.R. *ORMS Today*,  
42(3).

<https://doi.org/10.1287/orms.2009.03.09>



June 1, 2009 in [Letters to the Editor](#)

## Strong Support for Soft O.R.

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PRINT ARTICLE:

<https://doi.org/10.1287/orms.2009.03.09>

### The Essence of What Attracted Me to O.R.

*To the Editor:*

I am somewhat surprised and very disappointed at the response, "Not the Appropriate Outlet," by the editor-in-chief of *Operations Research* to "The Case for Soft O.R." [*OR/MS Today*, Letters to the Editor, April 2009]. The impression I got from reading the response was that if it doesn't contain "rigorous mathematical models," it isn't operations research.

Perhaps we should remember that the field started when it was "operational research" in jolly olde England, or has the field morphed into an erudite, elite domain of mathematicians?

A lot of the early applications did not rely on "rigorous mathematical models," like the flow of vehicular flow through the Holland and Lincoln Tunnels or resource smoothing with Gantt charts. Perhaps these examples are too old, but to me they are the essence of what attracted me to operations research.

I still like the following definition of operations research: "the application of scientific techniques and methods to decisionmaking problems."

Perhaps what Soft O.R. is – is what O.R. should be.

WILLIAM G. LESSO

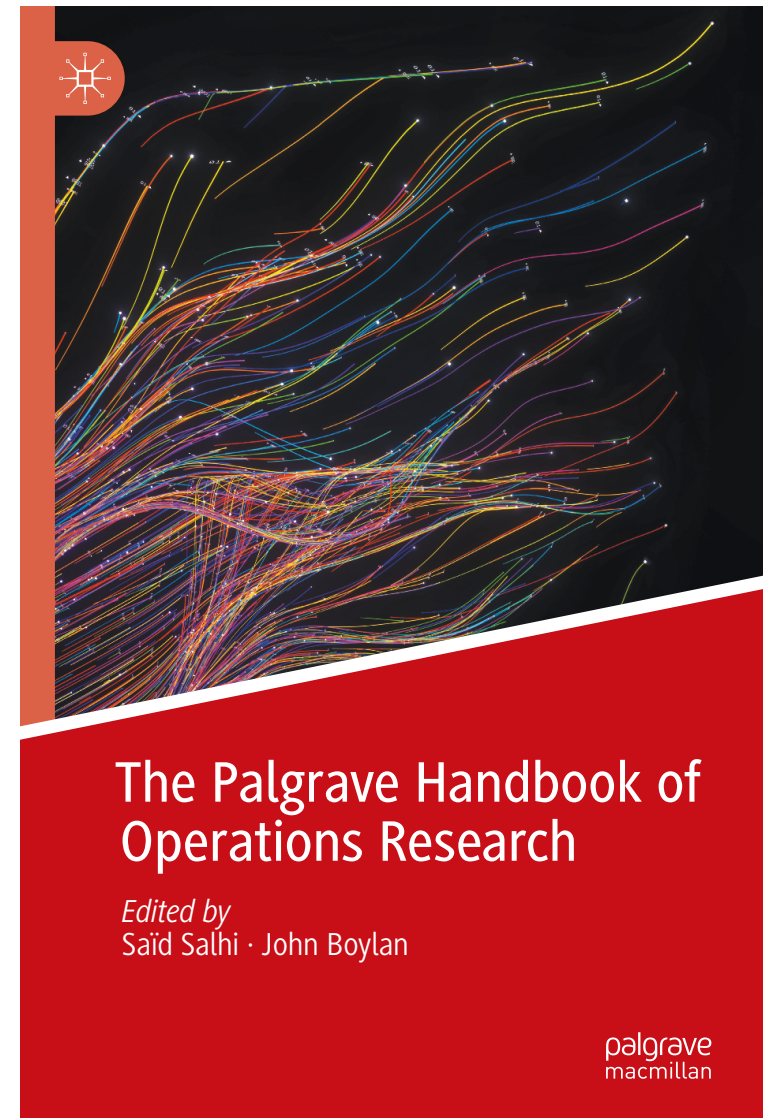
<https://pubsonline.informs.org/doi/10.1287/orms.2009.03.09/full/>

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# Provocation

“At a more fundamental level, should ‘soft OR’ be in scope or out of scope?”

Salhi, S., & Boylan, J.  
(Eds.). (2022). *The Palgrave Handbook of Operations Research*. Palgrave Macmillan Cham.  
<https://doi.org/10.1007/978-3-030-96935-6>



# 'Classic OR' – Problem Formulation

*“Both the consumer's and the researchers' problem must be formulated. The research consumer is the person (or group) who controls the operations under study. (He is also referred to as the decision-maker.) In formulating the consumer's problem an analysis must be made of the system under his control, his objectives, and alternative courses of action. Others affected by the decisions under study must be identified and their pertinent objectives and courses of action must also be uncovered. What we have called the over-all viewpoint is closely connected with the attempt to define objectives. O.R. tries to take into account as broad a scope of objectives as possible. In most general terms, the research problem is to determine which alternative course of action is most effective relative to the set of pertinent objectives. Consequently, in formulating the research problem a measure of effectiveness must be specified and its suitability must be established.”*

Churchman, C.W., Ackoff, R.L., & Arnoff, E.L. (1957). *Introduction to Operations Research*. New York: John Wiley & Sons.

# Rational Analysis for a Problematic World Revisited – Revisited

- Posed problem characterisation through dichotomies that influence formulation
  - Wicked Problems vs Tame Problems
    - Rittel, H.W.J., & Webber, M.M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, 4(2), pp.155-169. doi: <https://doi.org/10.1007/BF01405730>
  - Messes vs Problems
    - Ackoff, R.L. (1981). The Art And Science Of Mess Management. *Interfaces*, 11(1), pp.20-26.
  - Swamp vs High Ground
    - Schön, D.A. (1987). *Educating the reflective practitioner*. San Francisco, CA: Jossey-Bass.
    - Rosenhead, J. (1992). Into the Swamp - The Analysis of Social-Issues. *Journal of the Operational Research Society*, 43(4), 293-305. <https://doi.org/10.1057/jors.1992.44>
  - Soft Systems Thinking vs Hard Systems Thinking
    - Checkland, P. (1981). *Systems thinking, systems practice*. Chichester: John Wiley.

Mingers, J., & Rosenhead, J. (2001). *Rational analysis for a problematic world revisited : problem structuring methods for complexity, uncertainty and conflict* (2nd ed.) Wiley.



# Non-Dichotomous Alternatives

- Constitutive Rules of Non-codified PSM use and the Generic Constitutive Definition
  - Yearworth, M., & White, L. (2014). The non-codified use of problem structuring methods and the need for a generic constitutive definition. *European Journal of Operational Research*, 237(3), 932-945. <https://doi.org/10.1016/j.ejor.2014.02.015>
- Practice Theories
  - Ormerod, R., Yearworth, M., & White, L. (2022). Understanding participant actions in OR interventions using practice theories: a research agenda. *European Journal of Operational Research*. <http://doi.org/10.1016/j.ejor.2022.08.030>.
- Actor Network Theory (ANT)/STS/SSK
  - Callon, M. (1981). Struggles and Negotiations to Define What is Problematic and What is Not. In K. D. Knorr, R. Krohn & R. Whitley (Eds.), *The Social Process of Scientific Investigation* (pp. 197-219). Dordrecht: Springer Netherlands. doi: [https://doi.org/10.1007/978-94-009-9109-5\\_8](https://doi.org/10.1007/978-94-009-9109-5_8)

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# Callon and Problematization

- “*Problematization culminates in configurations characterised by their relative singularity. **There is not one single way of defining problems, identifying and organising what is certain, repressing what cannot be analysed***”
- Callon draws our focus to the simultaneity of perspectives and that problematization (problem formulation) must deal with problematic situations that are *simultaneously* problematic. Therefore, wicked *and* tame, hard *and* soft, swamps *and* high ground... not a position on a continuum or at either end
  - “*an abundance of problematisations*”
  - **Motivation in OR should really acknowledge this selectivity – why this problem? What was the process of deciding?**

Callon, M. (1981). Struggles and Negotiations to Define What is Problematic and What is Not. In K. D. Knorr, R. Krohn & R. Whitley (Eds.), *The Social Process of Scientific Investigation* (pp. 197-219). Dordrecht: Springer Netherlands. doi: [https://doi.org/10.1007/978-94-009-9109-5\\_8](https://doi.org/10.1007/978-94-009-9109-5_8)

# From the 'Founders' paper

- *“We are thus advocating that hard OR should embrace the rigorous and transparent approach of soft OR in problem formulation and address problem structuring in its publications where appropriate”*
- *“Implementation is often raised as a problem in enacting hard OR models, and the deep engagement with stakeholders and the transparency of soft OR may well help to resolve that issue.” – see specific example later*

Dyson, R. G., O'Brien, F., & Shah, D. B. (2021). Soft "OR and Practice: The Contribution of the Founders of Operations Research *Operations Research*, pp12. <https://doi.org/10.1287/opre.2020.2051>

# Applying theory strands to OR

1. Constitutive Rules
  2. Practice Theories
  3. Actor Network Theory
- Retrospective analysis of existing OR literature
    - Review of OR literature with a view to uncovering work on problem formulation/problematisation hitherto unexamined/unknown to the Soft OR/PSM community (underway now)
    - Set out a unifying research agenda (to follow)

# Approach

- Putting aside (for now)...
  - historical reviews
  - searches based on citations of key “problem characterisation” papers
  - searches based on key theoretical papers
  - title/abstract/keyword searches
- Leveraging the existing Soft OR/PSM, Community OR, Behavioural OR literature by extracting its ‘topic signature’ and searching for signs of this signature in the broader OR literature (all of it?)

# Method

1. Train a probabilistic topic model on a substantial OR corpus (using LDA-based techniques)
2. Label topics and identify the ‘useful’ topics for searching (i.e., Soft OR/PSM, Community OR, Behavioural OR) within the overall set of topics
3. Use the probabilistic topic model to classify *any* paper to discover “new” literature, previously not examined for descriptions of problem formulation/problematisation
4. ‘Crunch’ through the literature
  - Initially ~25,000 papers [CABS AJG 2021 4\*, 4 and 3 categories in OR&MANSCI (27 journals) since 2012]

ISSN	Field	Journal Title	Publisher Name	AJG 2021
1526-5501	OR&MANSCI	Management Science	Institute for Operations Research and the Management Sciences	4*
1526-5463	OR&MANSCI	Operations Research	Institute for Operations Research and the Management Sciences	4*
1872-6860	OR&MANSCI	European Journal of Operational Research	Elsevier	4
1941-0026	OR&MANSCI	IEEE Transactions on Evolutionary Computation	IEEE	4
1436-4646	OR&MANSCI	Mathematical Programming	Springer Nature	4
1558-1195	OR&MANSCI	ACM Transactions on Modeling and Computer Simulation	ACM	3
1572-9338	OR&MANSCI	Annals of Operations Research	Springer Nature	3
1573-2894	OR&MANSCI	Computational Optimization and Applications	Springer Nature	3
1873-765X	OR&MANSCI	Computers and Operations Research	Elsevier	3
1540-5915	OR&MANSCI	Decision Sciences	Wiley-Blackwell	3
1530-9304	OR&MANSCI	Evolutionary Computation	MIT Press	3
1573-2908	OR&MANSCI	Fuzzy Optimization and Decision Making	Springer Nature	3
2168-2275	OR&MANSCI	IEEE Transactions on Cybernetics	IEEE	3
2168-2232	OR&MANSCI	IEEE Transactions on Systems, Man, and Cybernetics: Systems	IEEE	3
1545-8830	OR&MANSCI	IIE Transactions	Taylor & Francis	3
1526-5528	OR&MANSCI	INFORMS Journal on Computing	Institute for Operations Research and the Management Sciences	3
1872-8200	OR&MANSCI	International Journal of Forecasting	Elsevier	3
1572-9397	OR&MANSCI	Journal of Heuristics	Springer Nature	3
1573-2878	OR&MANSCI	Journal of Optimization Theory and Applications	Springer Nature	3
1476-9360	OR&MANSCI	Journal of the Operational Research Society	Taylor & Francis	3
1526-5471	OR&MANSCI	Mathematics of Operations Research	Institute for Operations Research and the Management Sciences	3
1520-6750	OR&MANSCI	Naval Research Logistics	Wiley-Blackwell	3
1873-5274	OR&MANSCI	Omega	Elsevier	3
1436-6304	OR&MANSCI	OR Spectrum	Springer Nature	3
1879-0836	OR&MANSCI	Reliability Engineering and System Safety	Elsevier	3
1095-7189	OR&MANSCI	SIAM Journal on Optimization	Society for Industrial and Applied Mathematics	3
1526-5447	OR&MANSCI	Transportation Science	Institute for Operations Research and the Management Sciences	3

25,667 document results    **Increasing at ~16 papers/day !**

(( ISSN (1526-5501) OR ISSN (1526-5463) OR ISSN (1436-4646) OR ISSN (1872-6860) OR ISSN (1941-0026) OR ISSN (1540-5915) OR ISSN (1526-5447) OR ISSN (1476-9360) OR ISSN (1872-8200) OR ISSN (1572-9338) OR ISSN (1873-5274) OR ISSN (1873-765x) OR ISSN (1526-5471) OR ISSN (1545-8830) OR ISSN (1573-2894) OR ISSN (1879-0836) OR ISSN (1095-7189) OR ISSN (1530-9304) OR ISSN (2168-2232) OR ISSN (1526-5528) OR ISSN (2168-2275) OR ISSN (1573-2908) OR ISSN (1436-6304) OR ISSN (1573-2878) OR ISSN (1520-6750) OR ISSN (1558-1195) OR ISSN (1572-9397))) AND ( LIMIT-TO ( PUBYEAR , 2023 ) OR LIMIT-TO ( PUBYEAR , 2022 ) OR LIMIT-TO ( PUBYEAR , 2021 ) OR LIMIT-TO ( PUBYEAR , 2020 ) OR LIMIT-TO ( PUBYEAR , 2019 ) OR LIMIT-TO ( PUBYEAR , 2018 ) OR LIMIT-TO ( PUBYEAR , 2017 ) OR LIMIT-TO ( PUBYEAR , 2016 ) OR LIMIT-TO ( PUBYEAR , 2015 ) OR LIMIT-TO ( PUBYEAR , 2014 ) OR LIMIT-TO ( PUBYEAR , 2013 ) OR LIMIT-TO ( PUBYEAR , 2012 ))

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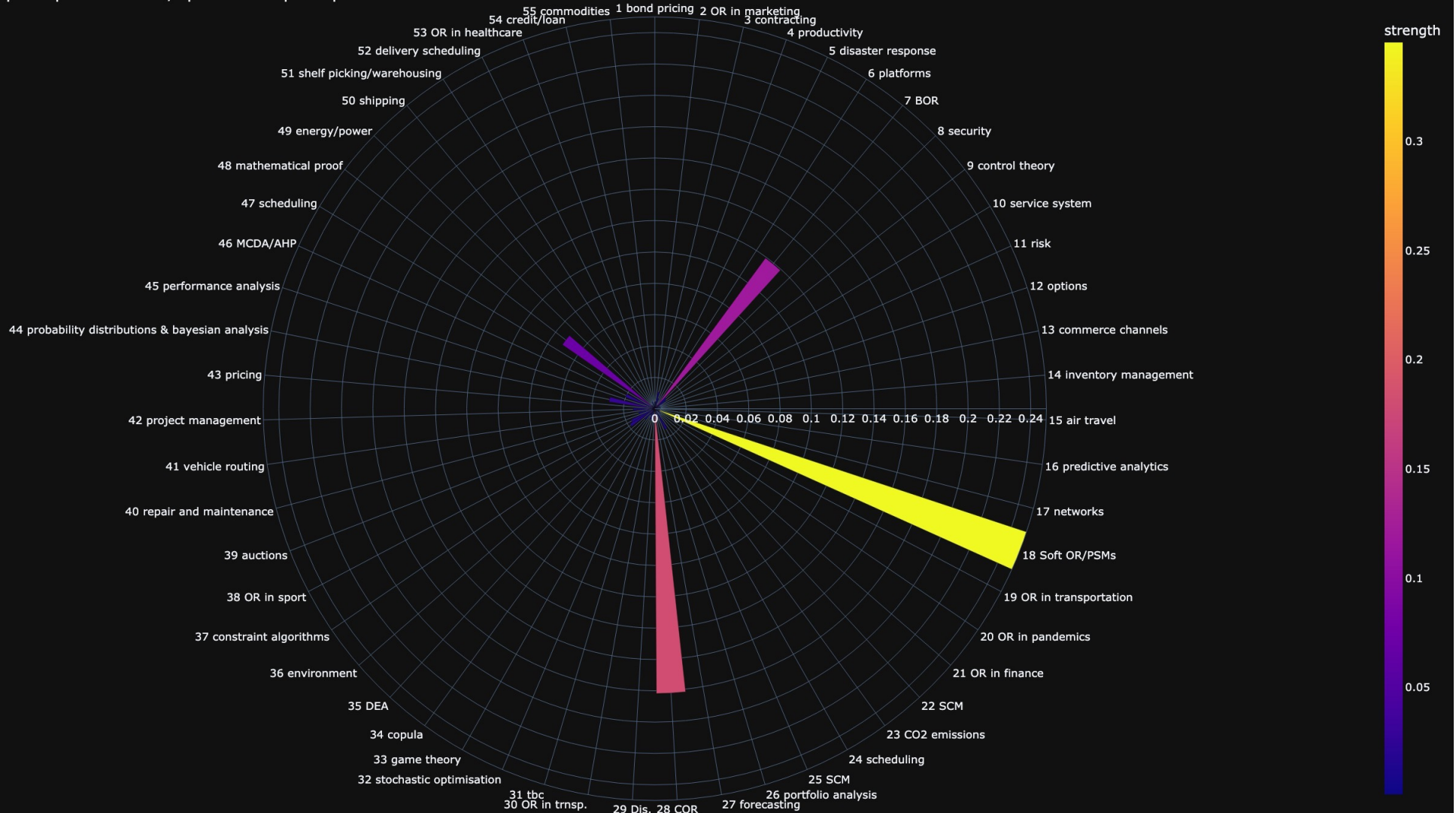
# Proof of Method

- Downloaded from Scopus a corpus of 2,559 documents published by EJOR (2012-2020) [i.e., roughly 10% of total]
- $N_{\text{words}} = 26,617,741$
- $N_{\text{topics}} = 55$
- Topics labelled and 3 topics identified as useful for searching:
  - [7 Behavioural OR]
  - [18 Soft OR/PSMs]
  - [28 Community OR]

## Quick Sanity Check... [i.e., not in training set]

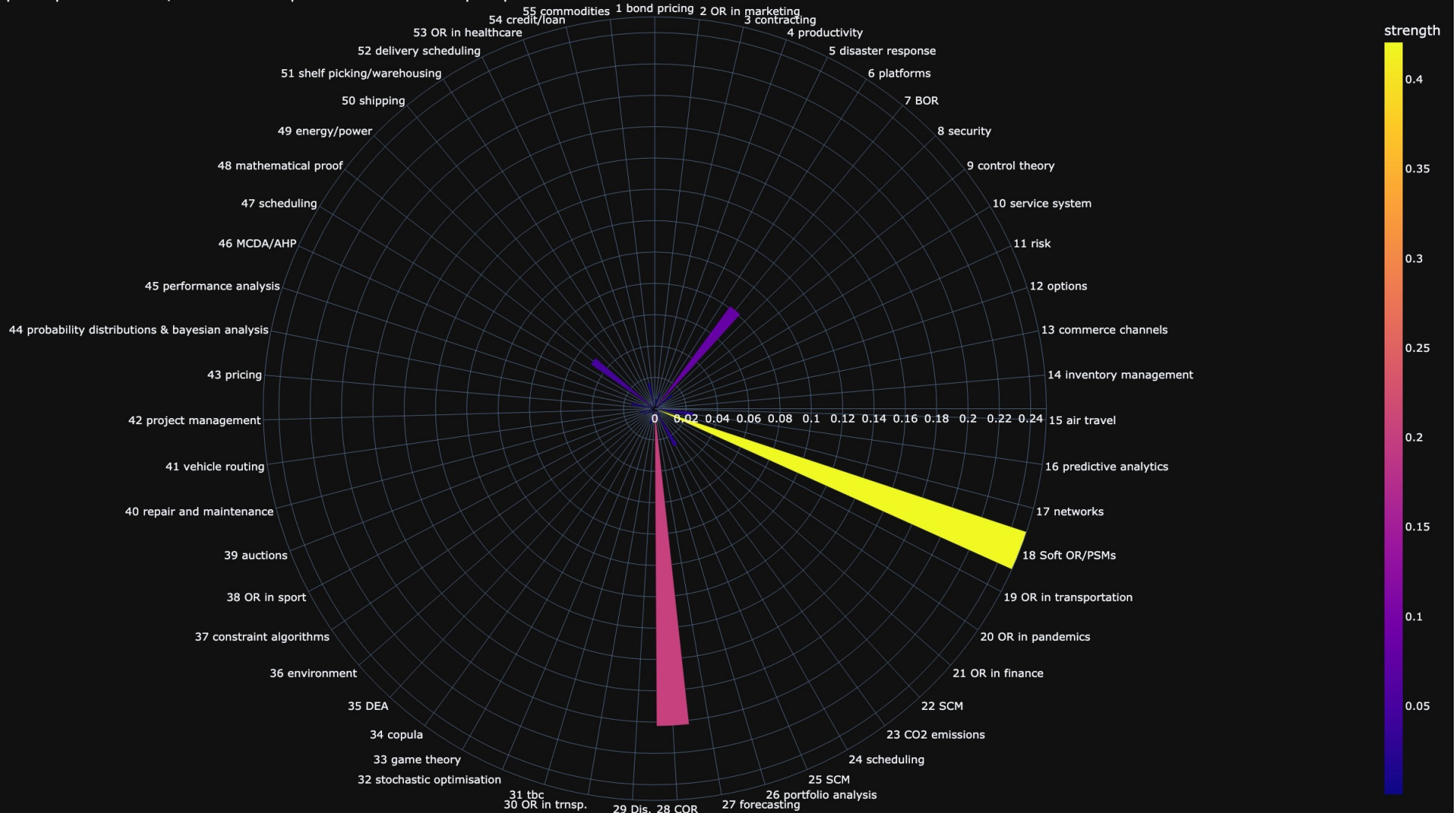
- Ackoff, R. L. (1977). Optimization + objectivity = opt out. *European Journal of Operational Research*, 1(1), 1-7. [https://doi.org/10.1016/S0377-2217\(77\)81003-5](https://doi.org/10.1016/S0377-2217(77)81003-5)
- Ackoff, R. L. (1979). The Future of Operational-Research is Past. *Journal of the Operational Research Society*, 30(2), 93-104. <https://doi.org/10.2307/3009290>
- Ackoff, R. L. (1979). Resurrecting the future of operational research. *Journal of the Operational Research Society*, 30(3), 189-199. <https://doi.org/10.1057/jors.1979.41>

Topic Map of : TestFiles/OptimisationOptOut.pdf



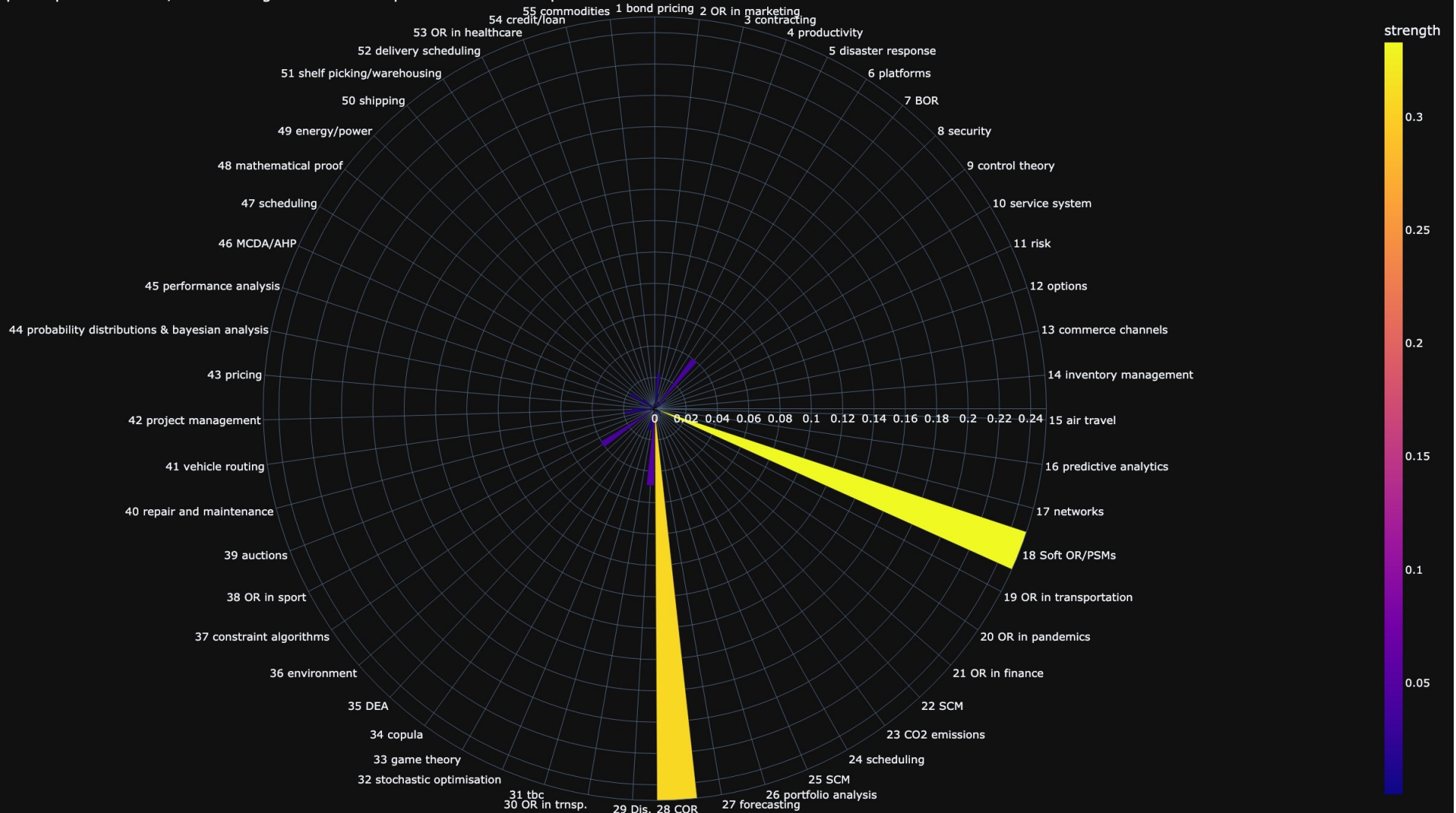
Ackoff, R. L. (1977). Optimization + objectivity = opt out. *European Journal of Operational Research*, 1(1), 1-7.

Topic Map of : TestFiles/the-future-of-operational-research-is-past.pdf



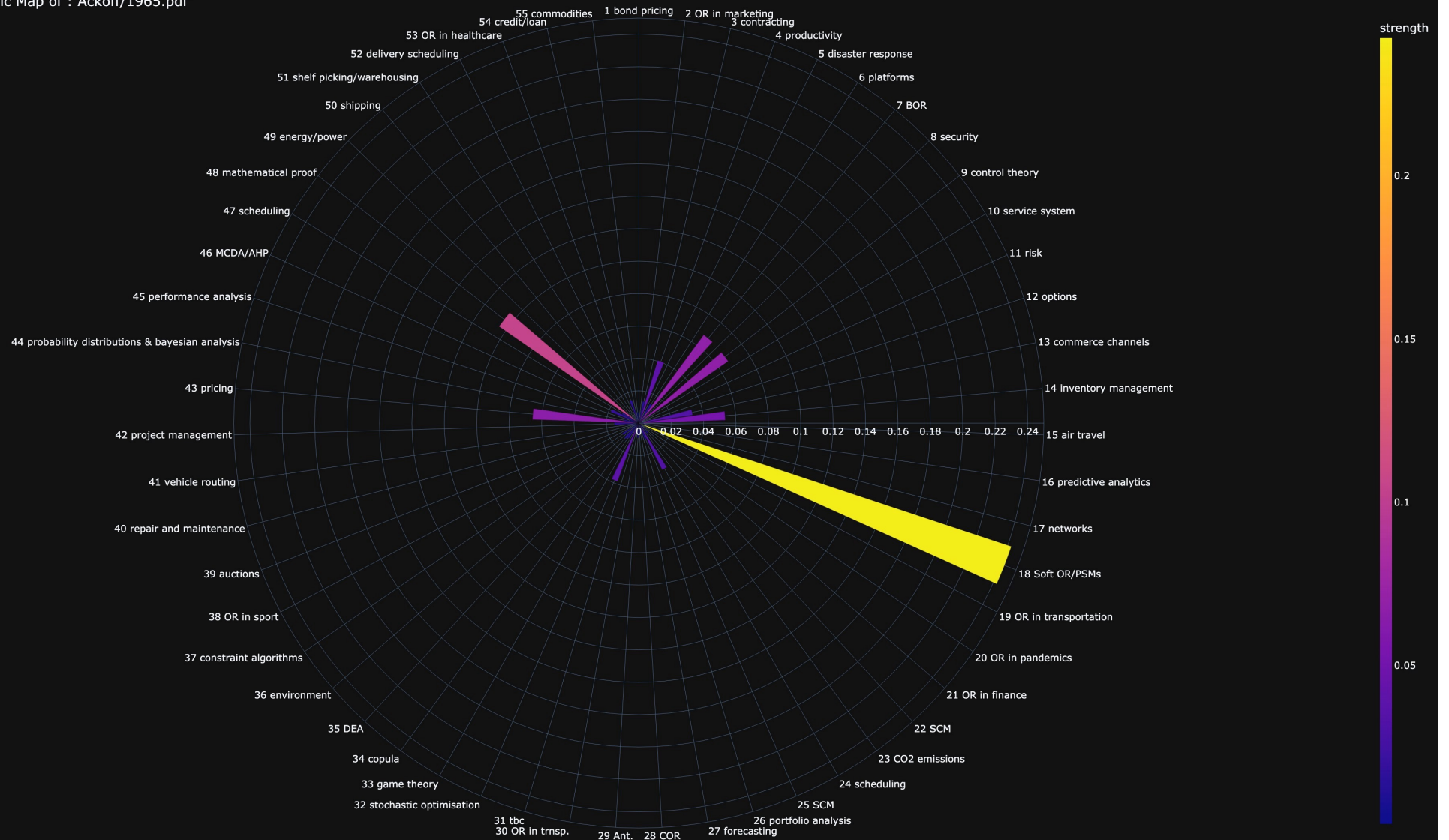
Ackoff, R. L. (1979). The Future of Operational-Research is Past. *Journal of the Operational Research Society*, 30(2), 93-104.

Topic Map of : TestFiles/Resurrecting the Future of Operational Research.pdf



Ackoff, R. L. (1979). Resurrecting the future of operational research. *Journal of the Operational Research Society*, 30(3), 189-199.

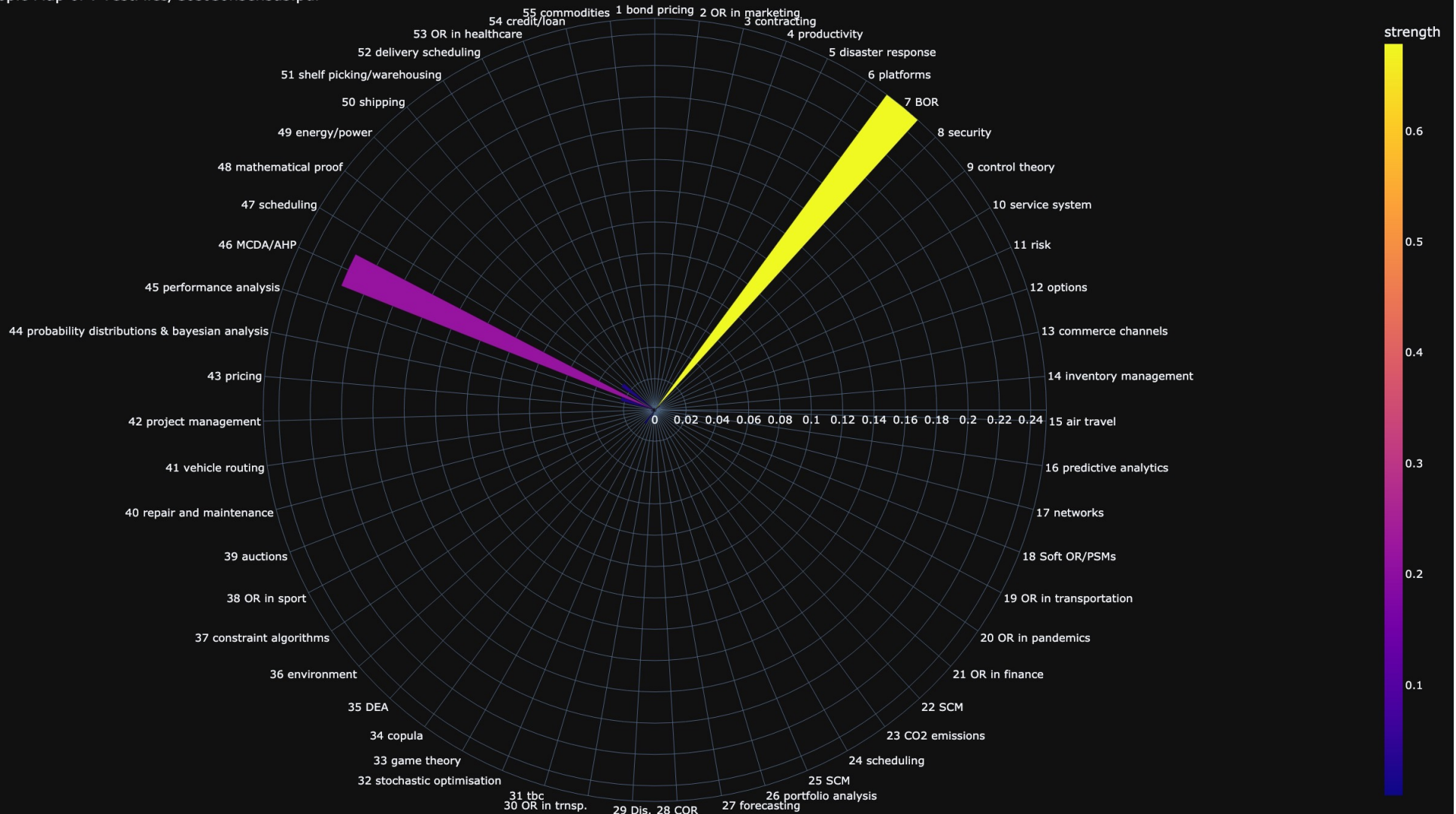
Topic Map of : Ackoff/1965.pdf



# Examples of “discovered” papers

- Labella, Á., Liu, H., Rodríguez, R. M., & Martínez, L. (2020). A Cost Consensus Metric for Consensus Reaching Processes based on a comprehensive minimum cost model. *European Journal of Operational Research*, 281(2), 316-331. <https://doi.org/10.1016/j.ejor.2019.08.030> [7 Behavioural OR, 46 MCDA/AHP]
- Ghosh, S., & Troutt, M. D. (2012). Complex compound option models - Can practitioners truly operationalize them?. *European Journal of Operational Research*, 222(3), 542-552. <https://doi.org/10.1016/j.ejor.2012.05.007> [12 Options, 18 Soft OR/PSMs]
- Doukas, H., & Nikas, A. (2020). Decision support models in climate policy. *European Journal of Operational Research*, 280(1), 1-24. <https://doi.org/10.1016/j.ejor.2019.01.017> [18 Soft OR/PSMs, 46 MCDA/AHP]
- Etc. ...

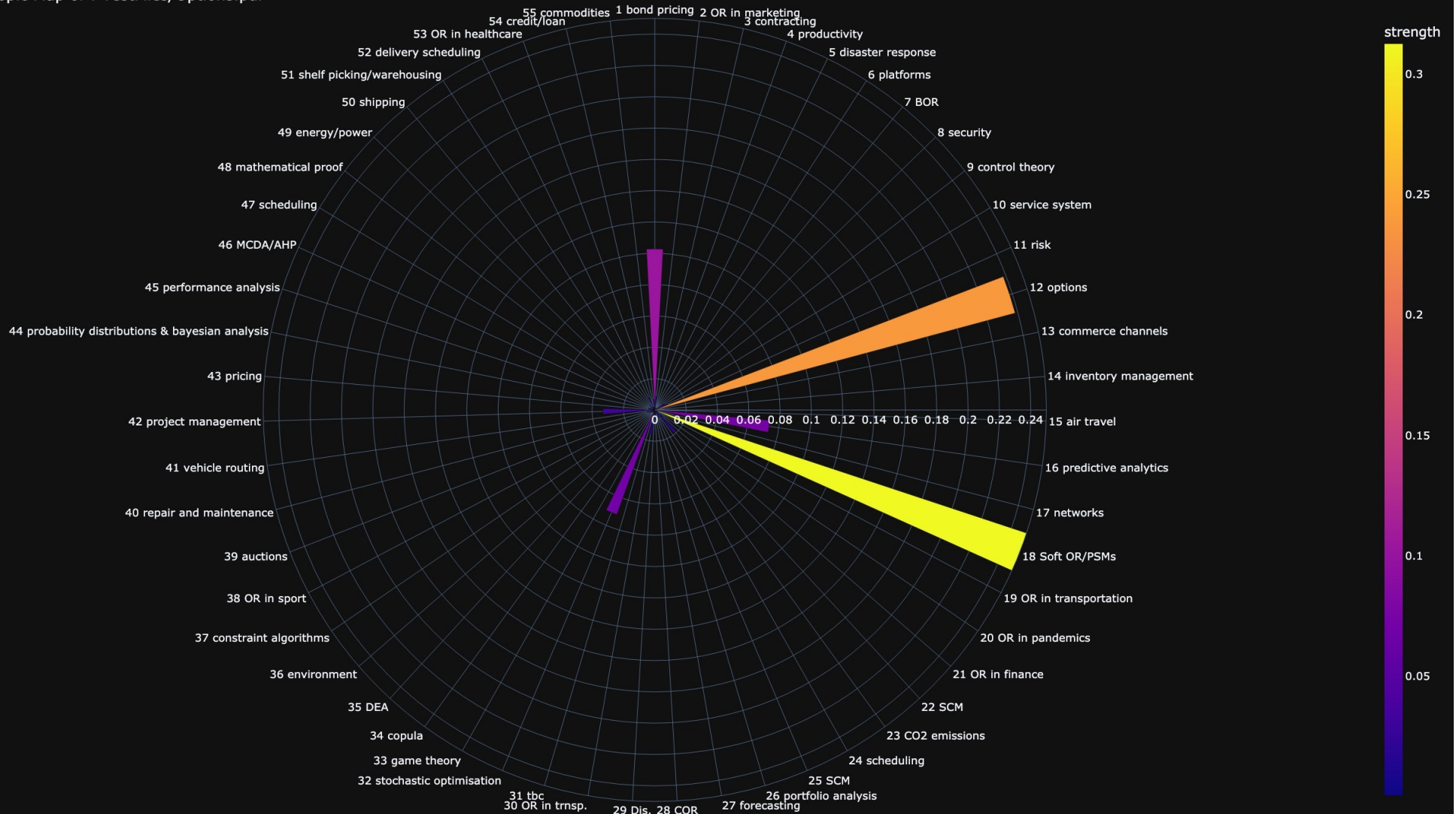
Topic Map of : TestFiles/CostConsensus.pdf



Labella, Á., Liu, H., Rodríguez, R. M., & Martínez, L. (2020). A Cost Consensus Metric for Consensus Reaching Processes based on a comprehensive minimum cost model.

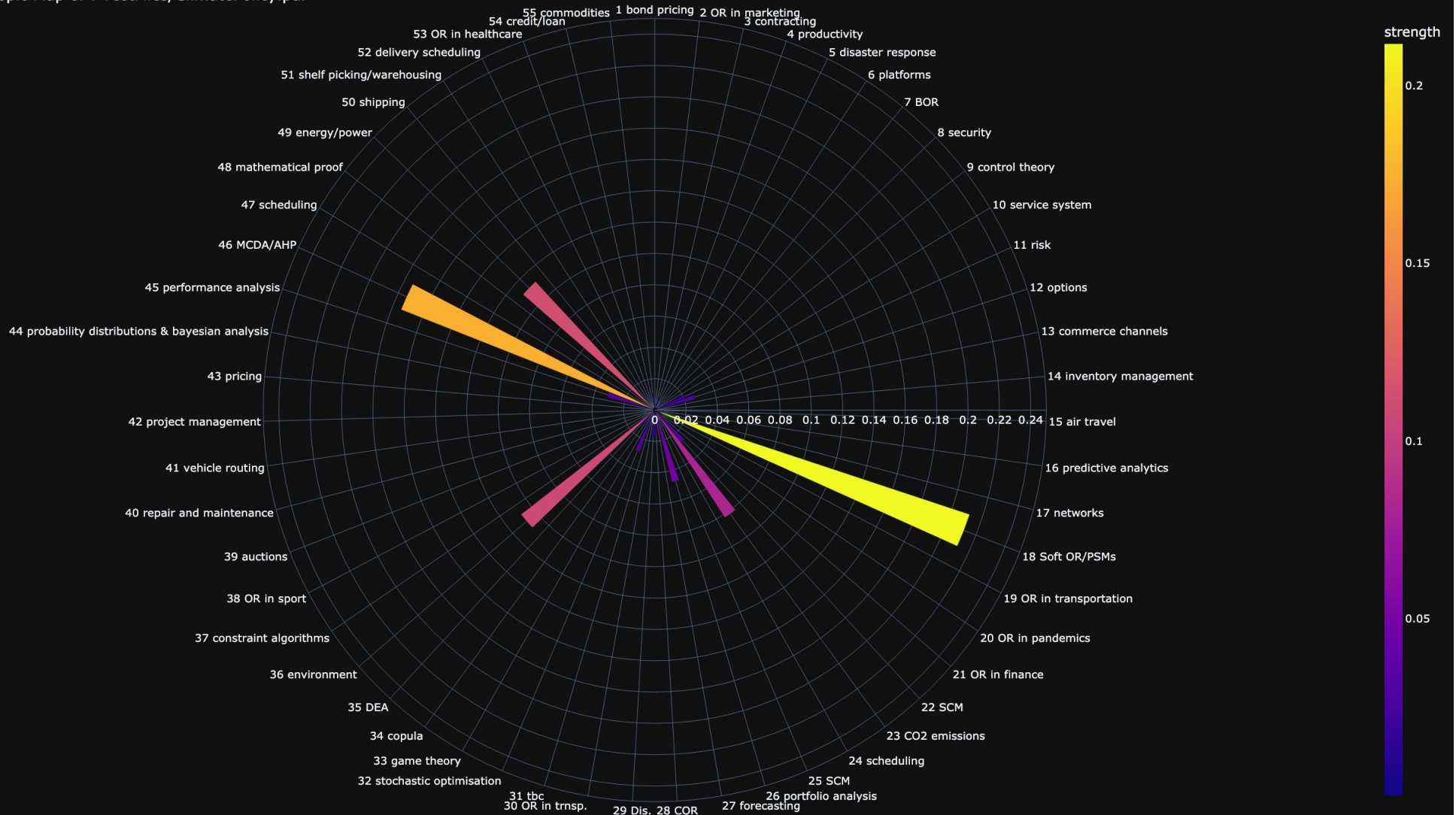


Topic Map of : TestFiles/Options.pdf



Ghosh, S., & Troutt, M. D. (2012). Complex compound option models - Can practitioners truly operationalize them? *European Journal of Operational Research*, 222(3), 542-552

Topic Map of : TestFiles/ClimatePolicy.pdf



Doukas, H., & Nikas, A. (2020). Decision support models in climate policy. *European Journal of Operational Research*, 280(1), 1-24

# Conclusions



Callon's work, the GCD (constitutive rules), and practice theories can provide us with the theoretical (common) ground we need for a broader science of intervention that encompasses all of OR practice – without dichotomisation



Apply these theoretical lenses with vigour to the broad OR literature selected using this probabilistic topic modelling approach



*Preliminary...*

“Perhaps what Soft OR is – is what OR should be” → “Soft OR is already here – It's just not very evenly distributed” (apologies to William Gibson)

# Any Questions?

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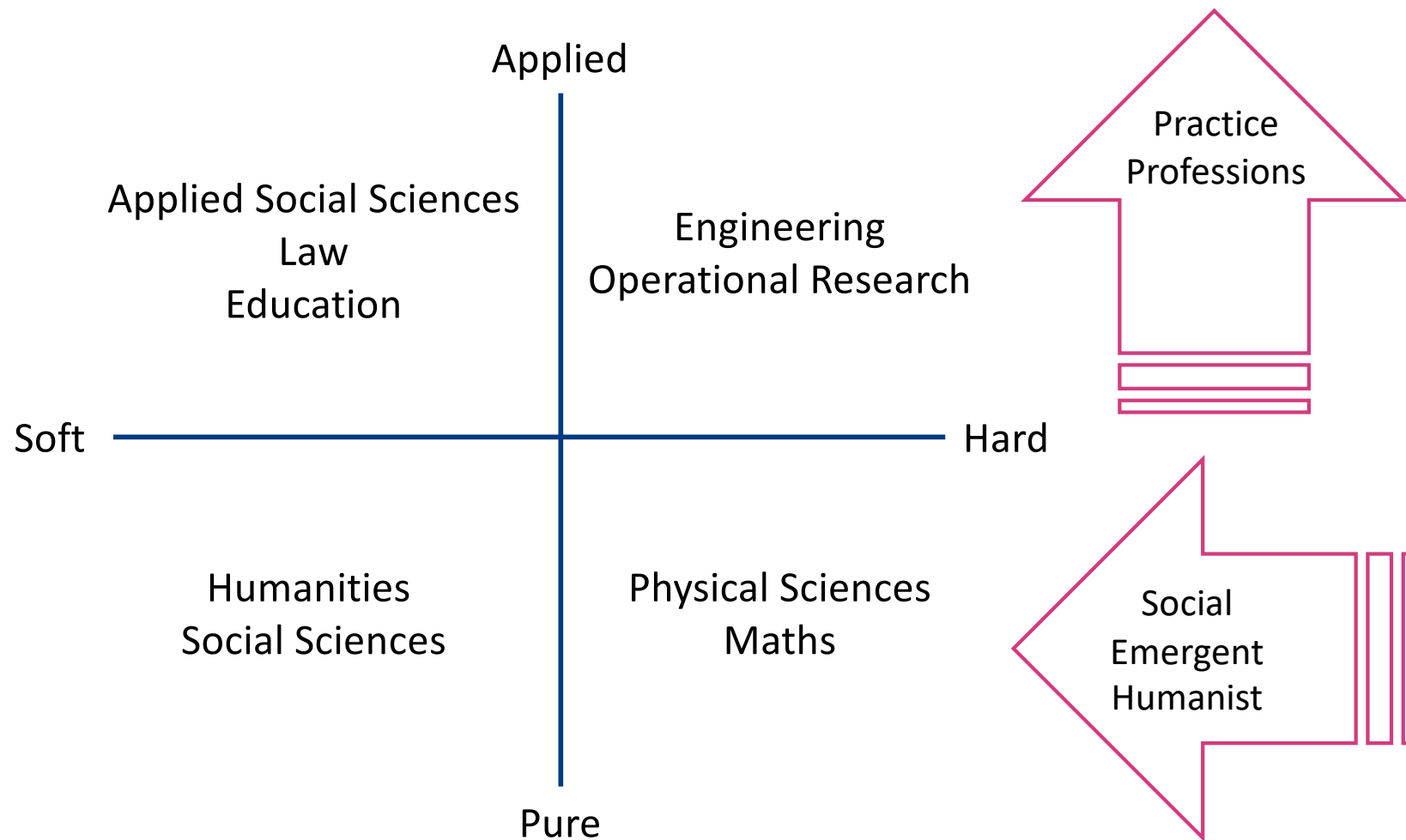
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[https://business-school.exeter.ac.uk/about/people/profile/index.php?web\\_id=Mike Yearworth](https://business-school.exeter.ac.uk/about/people/profile/index.php?web_id=Mike_Yearworth)

<https://twitter.com/MikeYearworth>

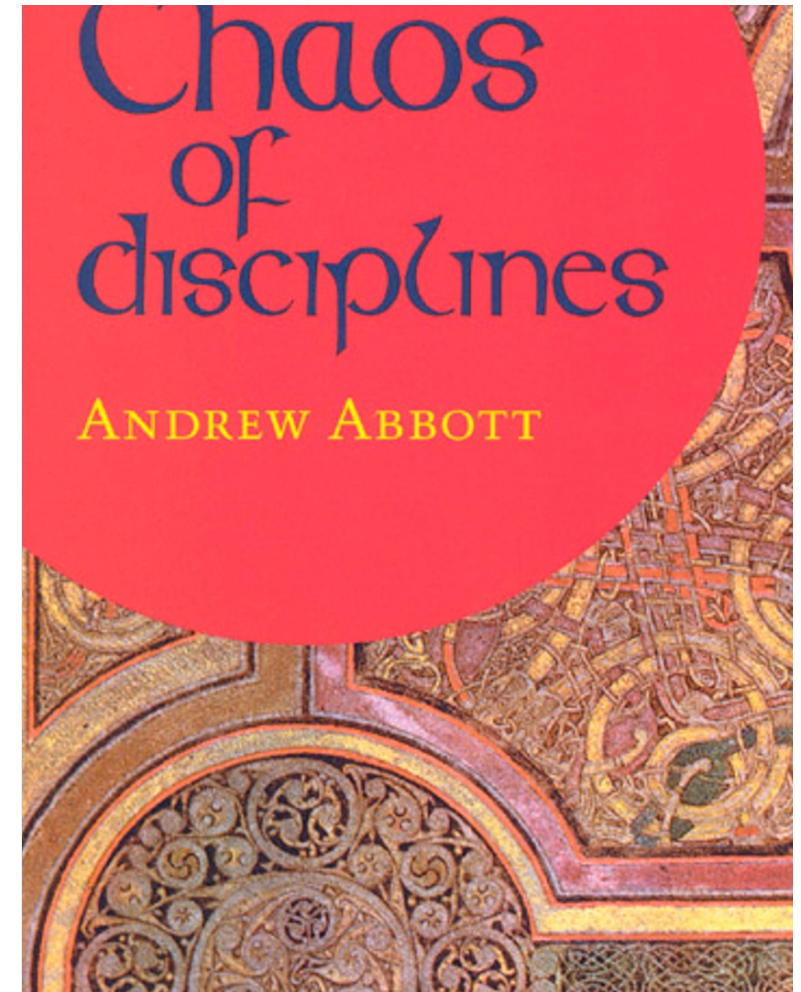
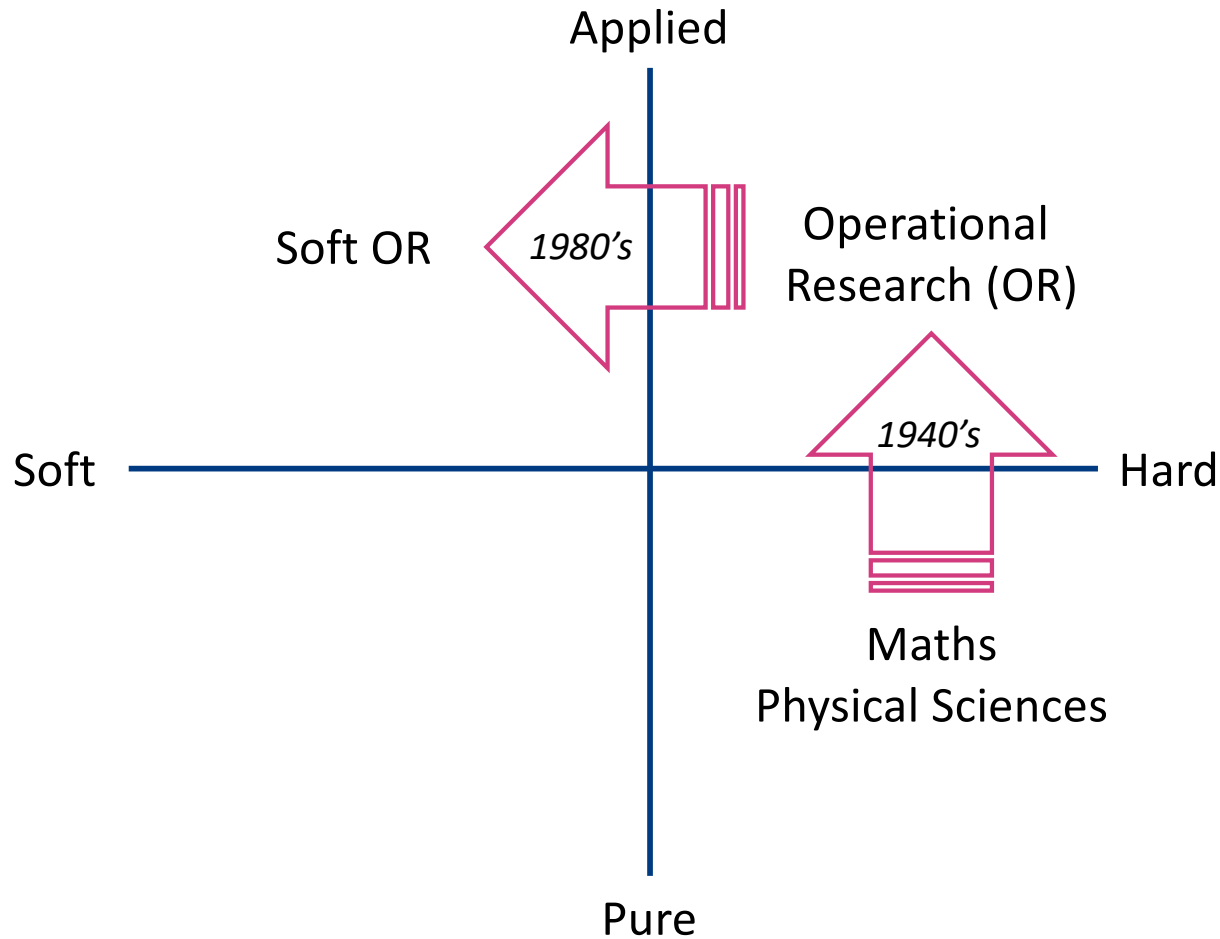
<https://www.linkedin.com/in/mikeyearworth/>

# Categorising Disciplines



Biglan, A. (1973). The characteristics of subject matter in different academic areas *Journal of Applied Psychology*, 57(3), 195-203. <https://doi.org/10.1037/h0034701>

# Evolution Over Time



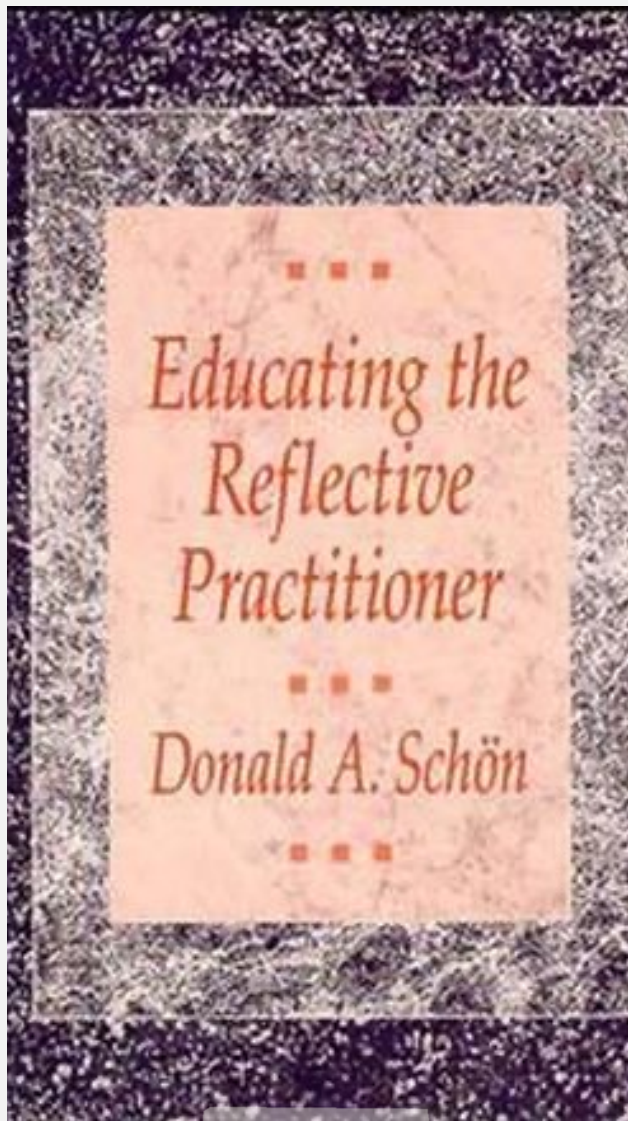
# Example of Dichotomous Problem Formulation – Hard/Soft Systems

*“3.3 The thinking embodied in 'systems engineering' and 'systems analysis' is essentially the same. Analysis of many different accounts of these activities shows that they all assume that problems can be formulated as the making of a choice between alternative means of achieving a known end. The belief that real-world problems can be formulated in this way is the distinguishing characteristic of all 'hard' systems thinking.”*

*“3.5 The research described in Chapters 6 and 7 assumed that the concept of a human activity system would be relevant to tackling the 'soft' ill-structured problems of the real world, those before which the methodology of natural science is impotent. The idea was to apply one of the versions of hard systems thinking to real-world situations in which the actors perceived they had problems, in order to find out whether, why, and how the hard methodology was inadequate. The intention was to find a systems methodology for tackling problems which defy formulation in the hard sense.”*

Checkland, P. (1981). Systems thinking, systems practice. Chichester: John Wiley.

# Example of Dichotomous Problem Formulation – Swamp/High Ground



- “In the varied topography of professional practice, there is a high, hard ground overlooking a swamp. On the high ground, manageable problems lend themselves to solutions through the use of research-based theory and technique. In the swampy lowland, messy, confusing problems defy technical solution. The irony of this situation is that the problems of the high ground tend to be relatively unimportant to individuals or society at large, however great their technical interest may be, while in the swamp lie the problems of greatest human concern. The practitioner must choose. Shall he remain on the high ground where he can solve relatively unimportant problems according prevailing standards of rigor, or shall he descend to the swamp of important problems and non rigorous enquiry?”
- This dilemma has two sources: first, the prevailing idea of rigorous professional knowledge, based on technical rationality, and second, awareness of indeterminate, swampy zones of practice that lie beyond its canons....
- Depending on our disciplinary backgrounds, organizational roles, past histories, interests, and political/economic perspectives we frame problematic situations in different ways.”



# Some benefits of dichotomous framing

- Ontological Errors/Category Mistakes
  - Declaring that it is possible to solve or cure a wicked problem – there are no ‘solutions’, ‘cures’... [Rittel & Webber]
  - Assuming to possess an objective viewpoint and thus know what is e.g., optimal, best, right, smart, ... [Checkland]
  - Misrepresenting or ignoring plurality [Checkland]
- Fallacy of Composition
  - Solving the solvable part of the problem solves the whole problem – is false [Ackoff]
- These have been useful for clarifying/setting out the domain of interest for Soft OR/PSMs. However...