



Requirement Engineering in the Age of System & Product Complexity – A Literature Review

Maximilian Vierlboeck, M.Sc. - Ph.D. Candidate, Stevens Institute of Technology

Roshanak Nilchiani, Ph.D. - Associate Professor, Stevens Institute of Technology

Content and Agenda



1. Introduction, Situation, Problem
2. Approach and Goals
3. General Complexity
4. Requirement Engineering
5. Product and System Complexity
6. Conclusion and Outlook

1. Introduction, Situation, Problem



1955



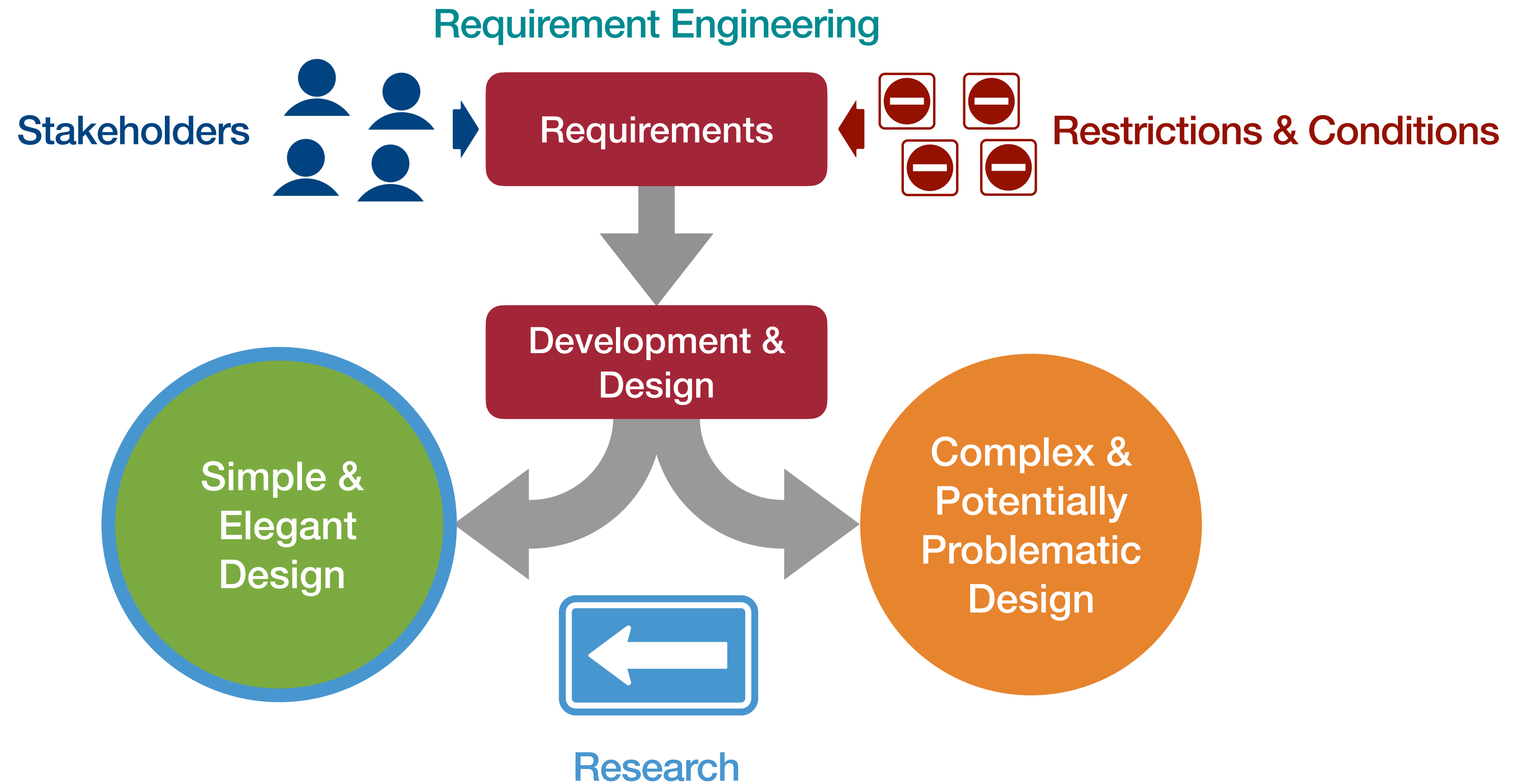
1983



2016

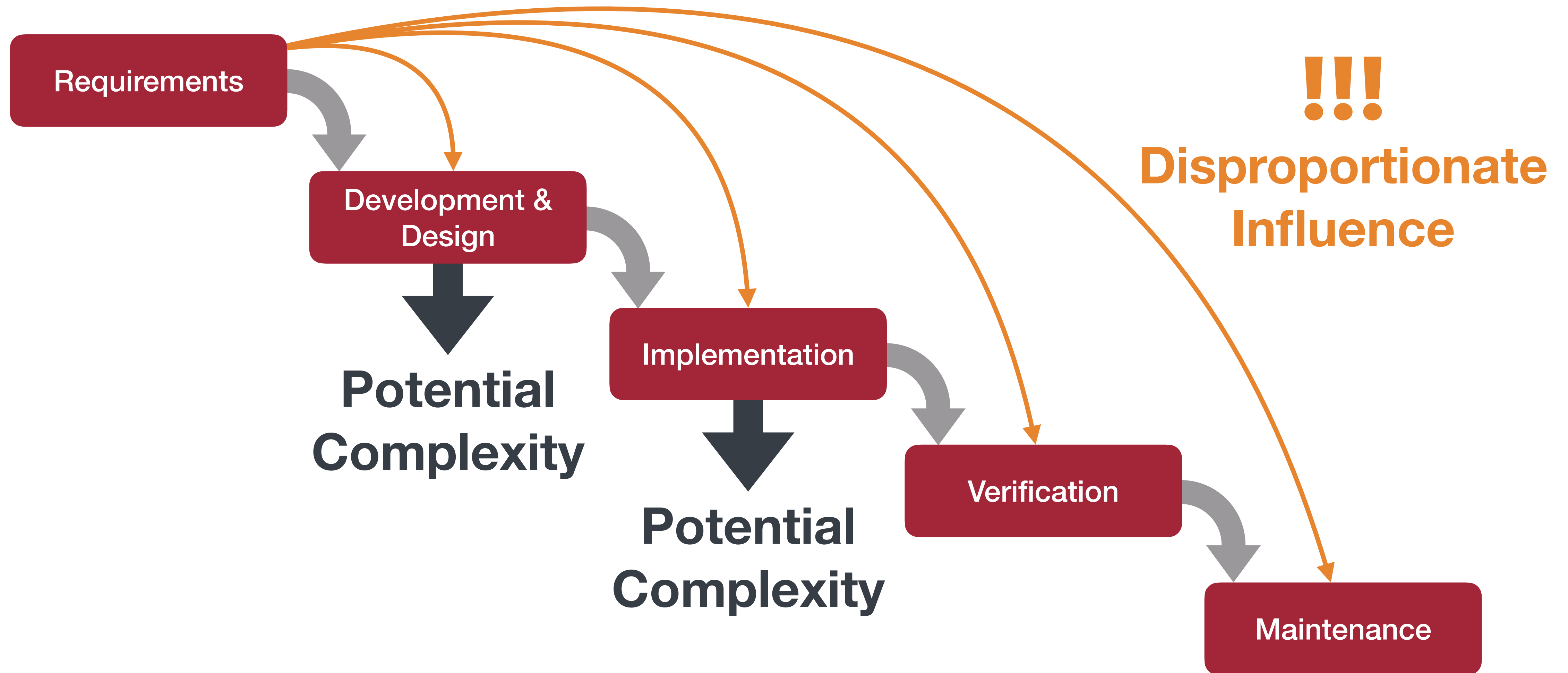
Why do some systems fail?

1. Introduction, Situation, Problem





1. Introduction, Situation, Problem



2. Approach and Goals



Colliding Topics and Fields

State of the Research?

Merits and Opportunities?

Application and Measures?

Trends and Developments?

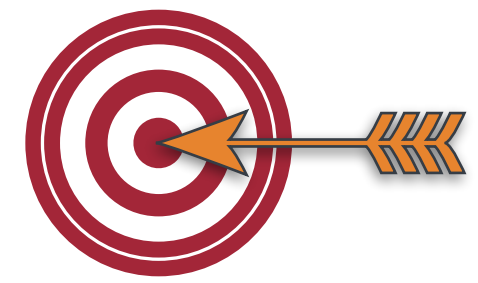
Requirement Engineering

Literature Research

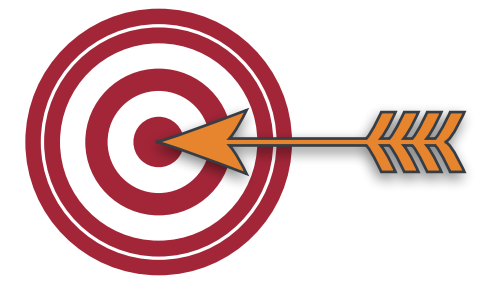
Complexity Science

Product and System Development

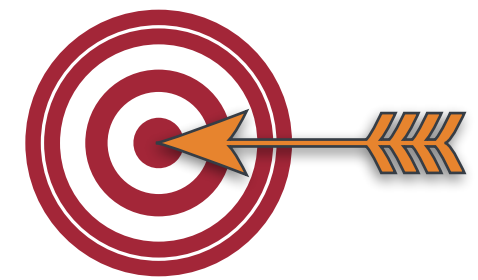
2. Approach and Goals



Define history and current trends of all topics



Elicit overlap of complexity & Requirement Engineering



Provide a foundation for combined research

2. Approach and Goals



→ **General Complexity and Measures**

→ **Requirement Engineering (RE)**

→ **Product and System Complexity**

3. General Complexity



First Discussed in 1948 by Weaver^[6]

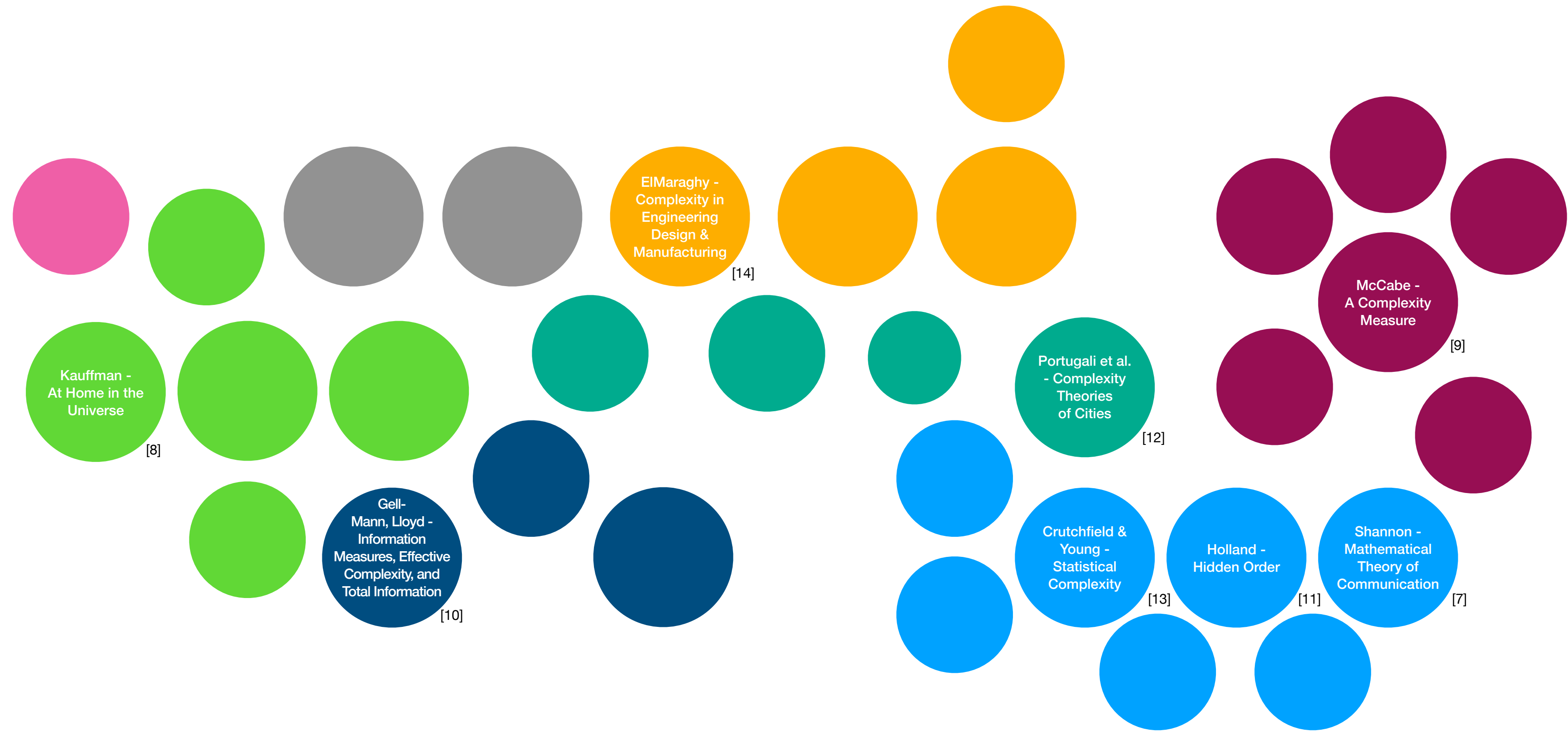
**Organized
Complexity**

- Numerous Variables
- Separate Analysis
- Individual Behavior Relevant

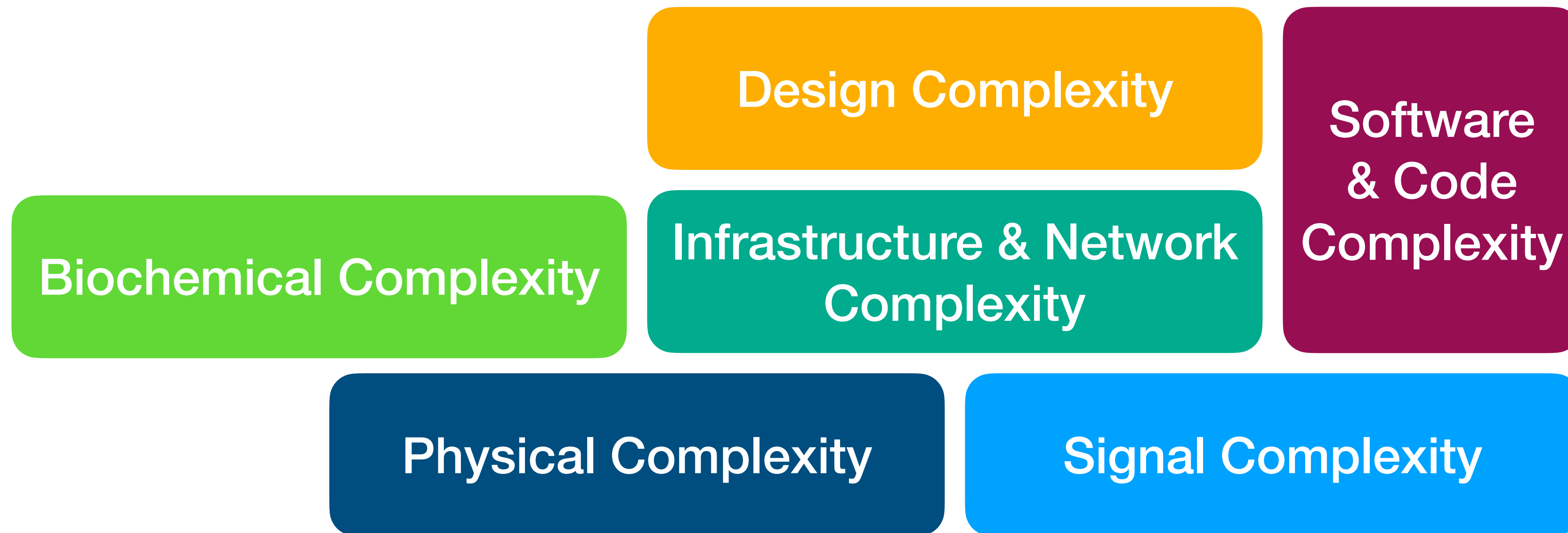
**Disorganized
Complexity**

- Abundance of Variables
- Comprehensive Analysis
- Relation to Statistical Assessment

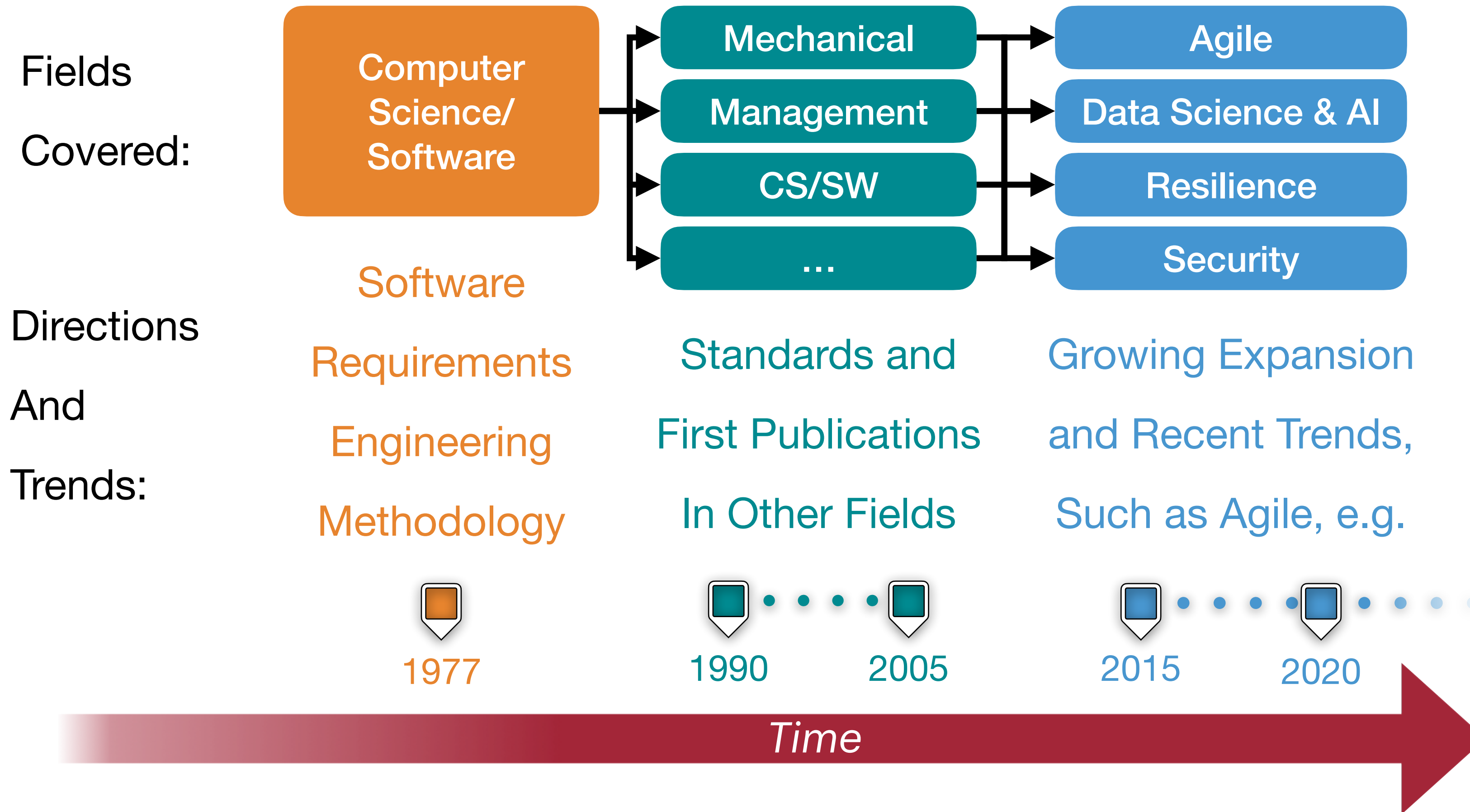
3. General Complexity



3. General Complexity



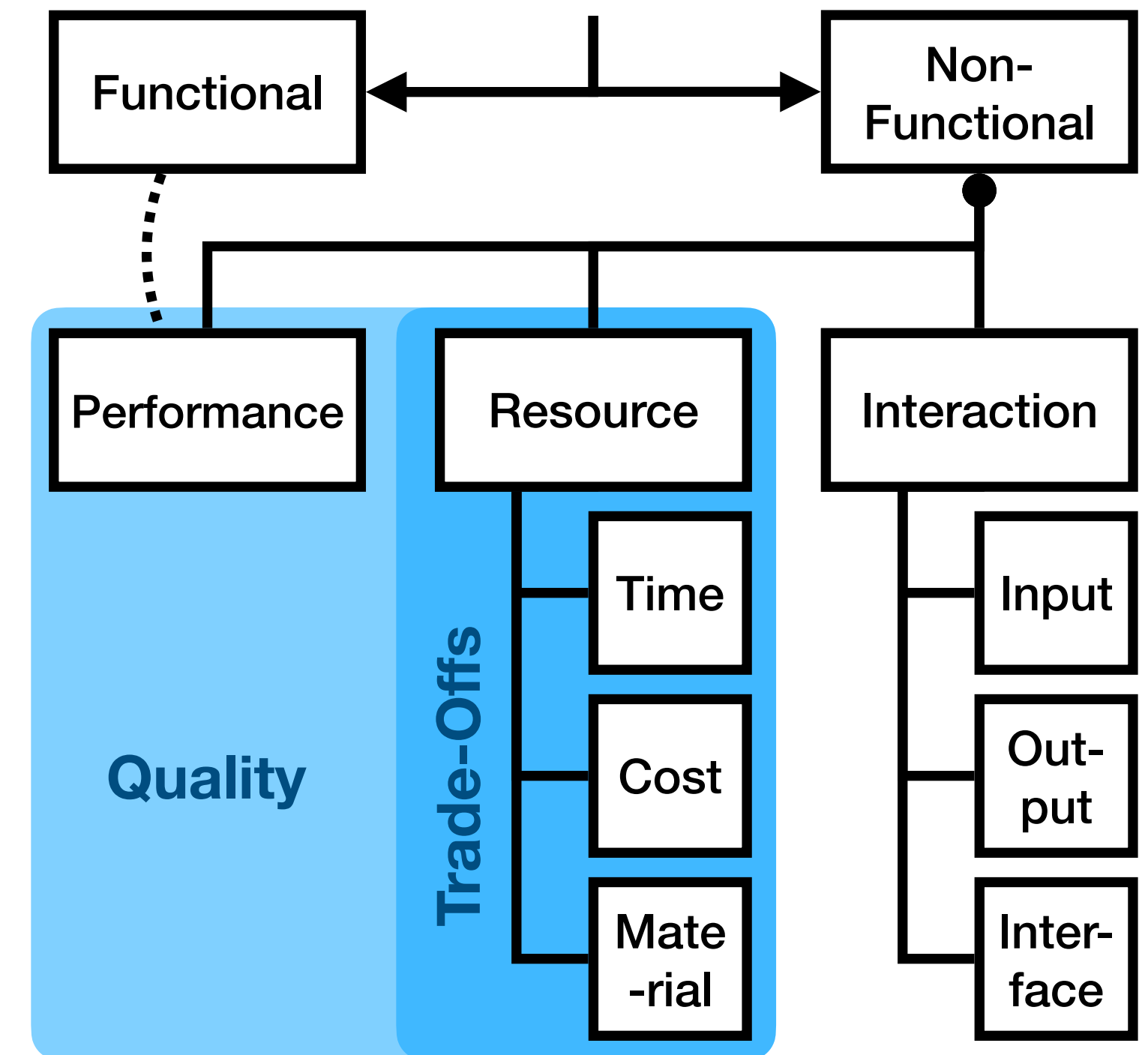
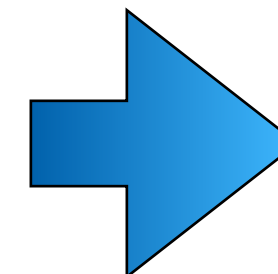
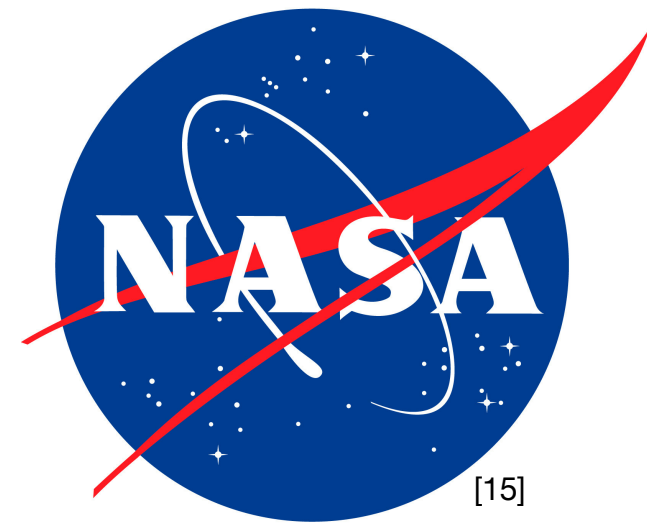
4. Requirement Engineering



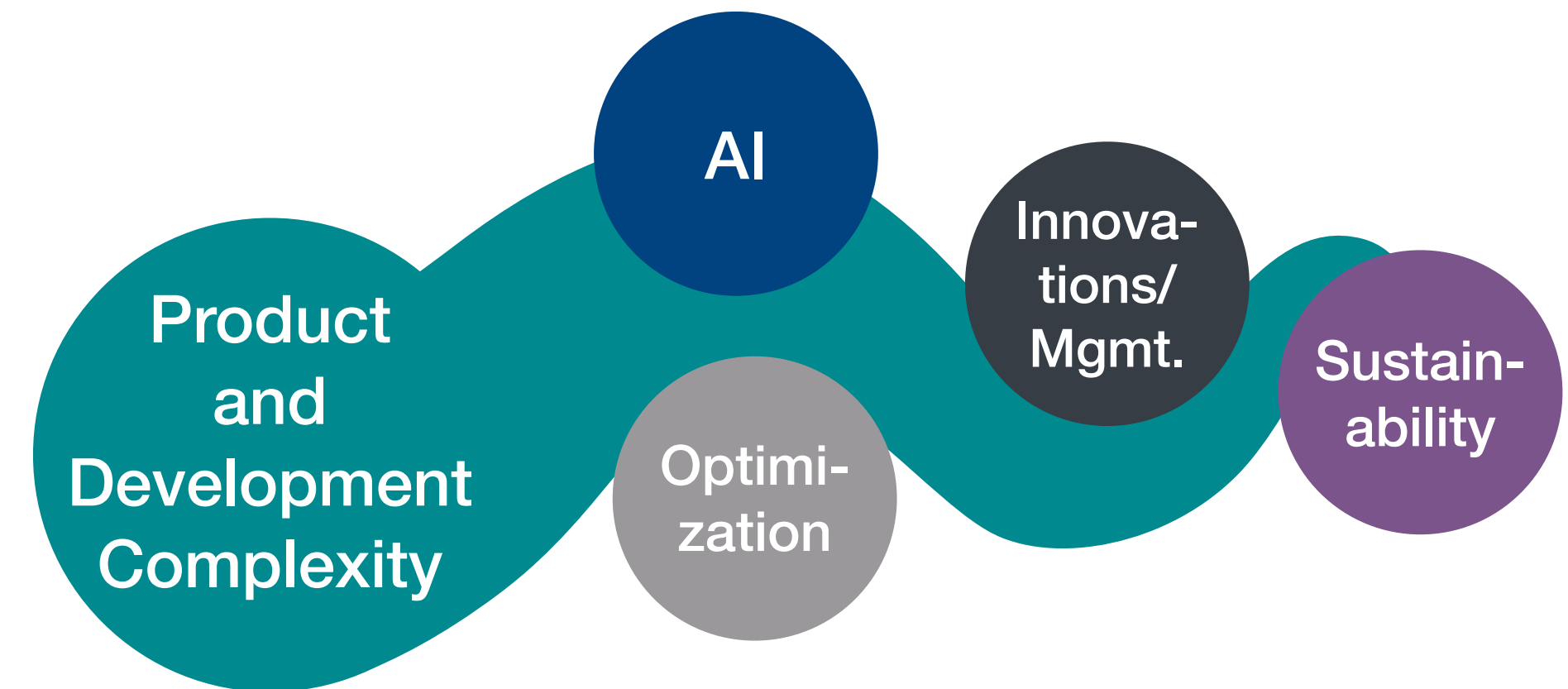
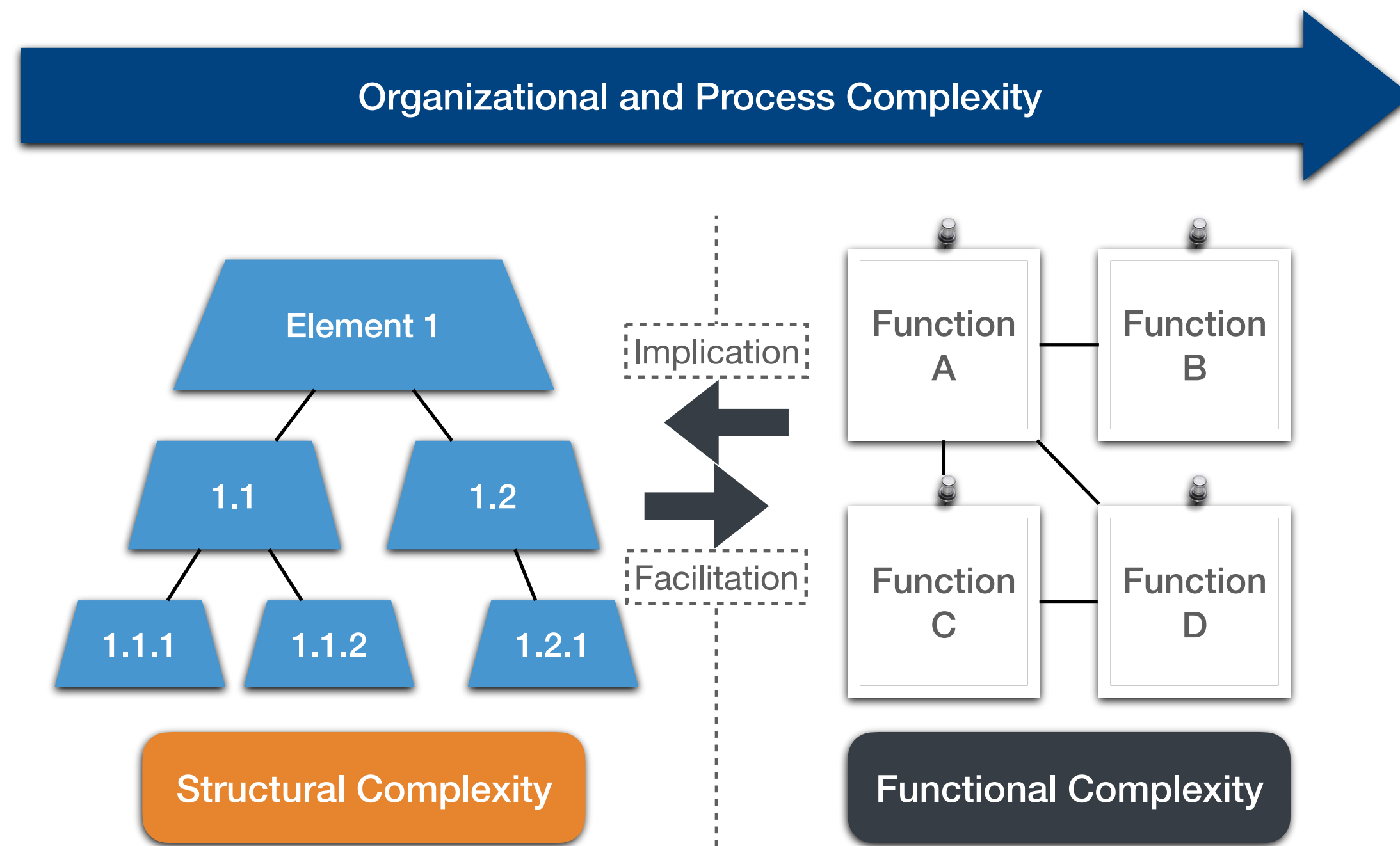
4. Requirement Engineering



Various Standards and Categorizations



5. Product and System Complexity



6. Conclusion and Outlook



- Active research in all considered areas, over 100 sources
- Little to no overlap of Complexity & Requirement Engineering
- Complexity mostly treated as a product of the process
- Prospective assessment of complexity potentially useful
- Combinatory approach in development



References and Bibliography

- [1] "Boeing B-52 Stratofortress." Wikipedia. https://en.wikipedia.org/wiki/Boeing_B-52_Stratofortress (accessed January 14, 2021).
- [2] B. Granath. "Fallen Astronauts Honored on Day of Remembrance." NASA. www.nasa.gov/feature/fallen-astronauts-honored-on-day-of-remembrance (accessed January 14, 2021).
- [3] A. Newcomb. "Samsung Finally Explains the Galaxy Note 7 Exploding Battery Mess." NBC news.www.nbcnews.com/tech/tech-news/samsung-finally-explains-galaxy-note-7-exploding-battery-mess-n710581 (accessed June 30, 2020).
- [4] J. Wang. "Samsung dissects Galaxy Note 7 cause of death." <https://pocketnow.com/samsung-dissecting-galaxy-note-7-cause-of-death> (accessed January 18, 2021).
- [5] A. Rędzikowski. "Złącze międzysegmentowe rakiety SRB.svg." Wikimedia Commons. https://upload.wikimedia.org/wikipedia/commons/d/df/Z%C5%82%C4%85cze_mi%C4%99dzysegmentowe_rakiety_SRB.svg (accessed January 15, 2021).
- [6] W. Weaver, "Science and Complexity," *American Scientist*, vol. 36, pp. 536-544, 1948.
- [7] C. E. Shannon, "A mathematical theory of communication," *The Bell System Technical Journal*, vol. 27, no. 3, pp. 379-423, 1948, doi: 10.1002/j.1538-7305.1948.tb01338.x.
- [8] S. A. Kauffman, *At Home in the Universe*. Oxford, United Kingdom: Oxford University Press, 1996.
- [9] T. J. McCabe, "A Complexity Measure," *IEEE Transactions on Software Engineering*, vol. SE-2, no. 4, pp. 308-320, 1976, doi: 10.1109/TSE.1976.233837.
- [10] M. Gell-Mann and S. Lloyd, "Information measures, effective complexity, and total information," *Complexity*, vol. 2, no. 1, pp. 44-52, 1996, doi: 10.1002/(SICI)1099-0526(199609/10)2:1<44::AID-CPLX10>3.0.CO;2-X.

References and Bibliography



- [11] J. H. Holland, *Hidden Order* (Helix Books). Reading, MA: Addison-Wesley, 1996.
- [12] J. Portugali, H. Meyer, E. Stolk, and E. Tan, *Complexity Theories of Cities Have Come of Age*. Berlin Heidelberg, Germany: Springer-Verlag, 2012.
- [13] J. P. Crutchfield and K. Young, "Inferring statistical complexity," *Physical Review Letters*, vol. 63, no. 2, pp. 105-108, 1989, doi: 10.1103/PhysRevLett.63.105.
- [14] W. ElMaraghy, H. ElMaraghy, T. Tomiyama, and L. Monostori, "Complexity in engineering design and manufacturing," *CIRP Annals*, vol. 61, no. 2, pp. 793-814, 2012, doi: 10.1016/j.cirp.2012.05.001.
- [15] "NASA Logo." NASA. <https://www.nasa.gov/sites/all/themes/custom/nasatwo/images/nasa-logo.svg> (accessed January 15, 2021).
- [16] European Cooperation for Space Standardization. <https://ecss.nl> (accessed January 21, 2021).
- [17]. "ISO Logo (Red square).svg." Wikimedia Commons. [https://commons.wikimedia.org/wiki/File:ISO_Logo_\(Red_square\).svg](https://commons.wikimedia.org/wiki/File:ISO_Logo_(Red_square).svg) (accessed January 15, 2021).
- [18] "Master Brand and Logos." IEEE. <https://brand-experience.ieee.org/templates-tools-resources/resources/master-brand-and-logos/> (accessed January 15, 2021).
- [19] International Electrotechnical Commission. <https://www.iec.ch/homepage> (accessed January 15, 2021).