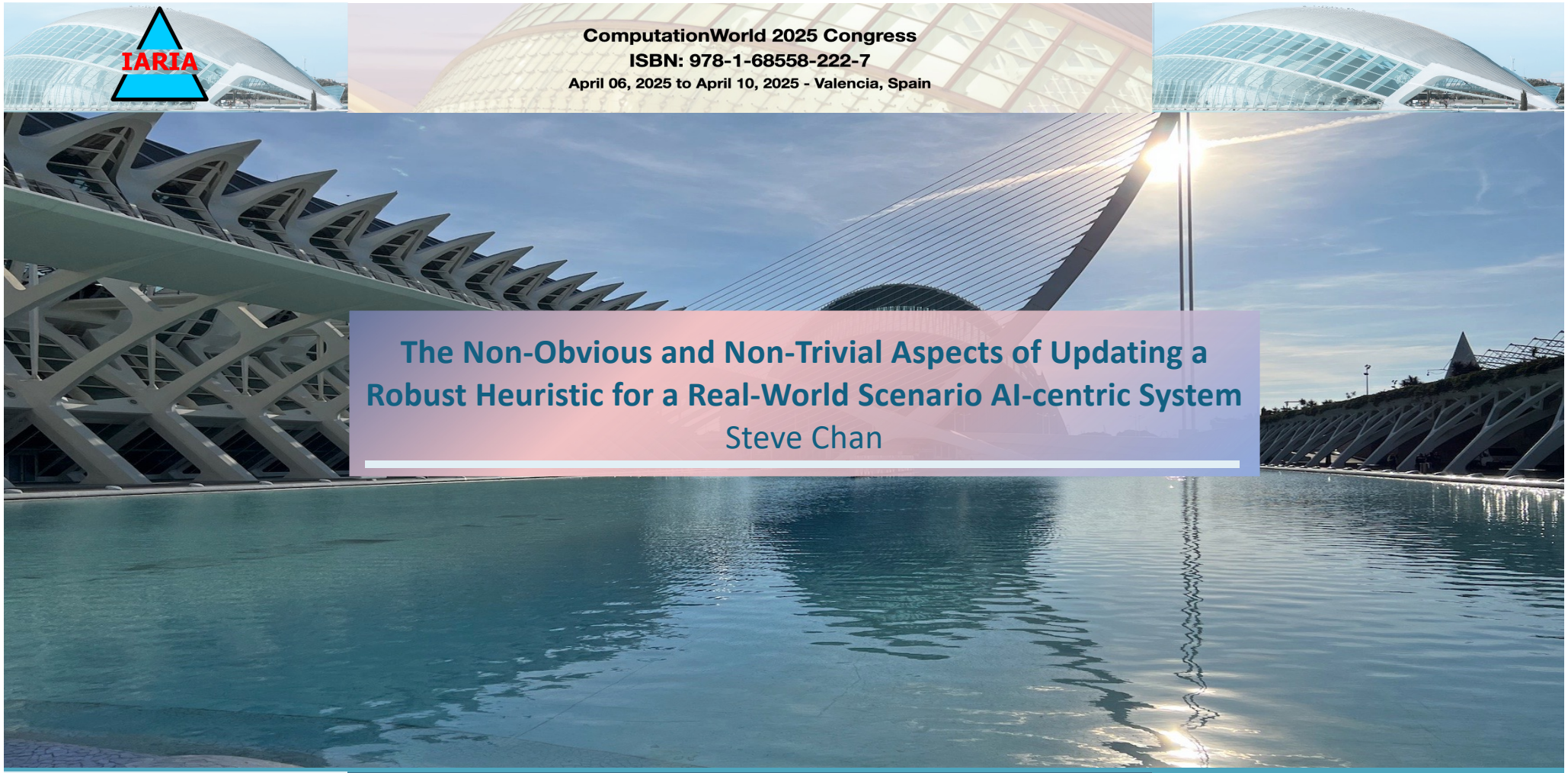
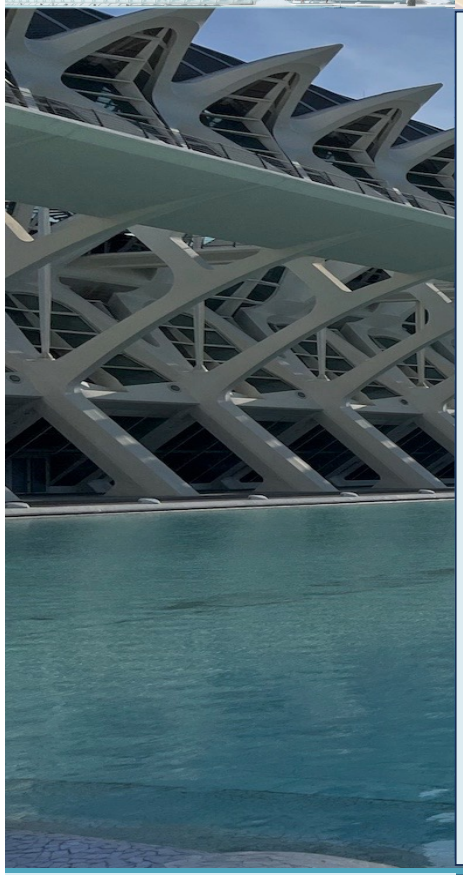


ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain

The Non-Obvious and Non-Trivial Aspects of Updating a Robust Heuristic for a Real-World Scenario AI-centric System

Steve Chan

ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain

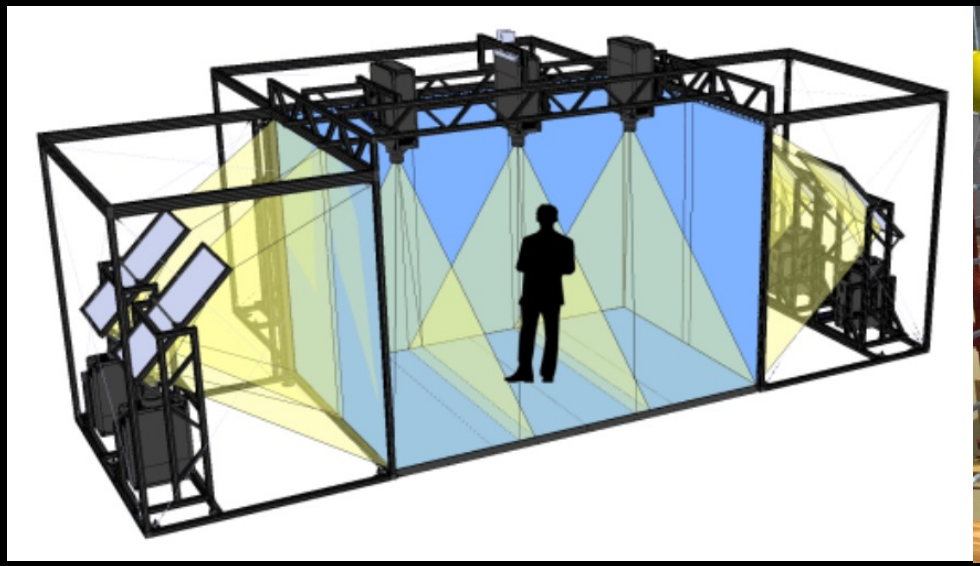


- **Bio:**

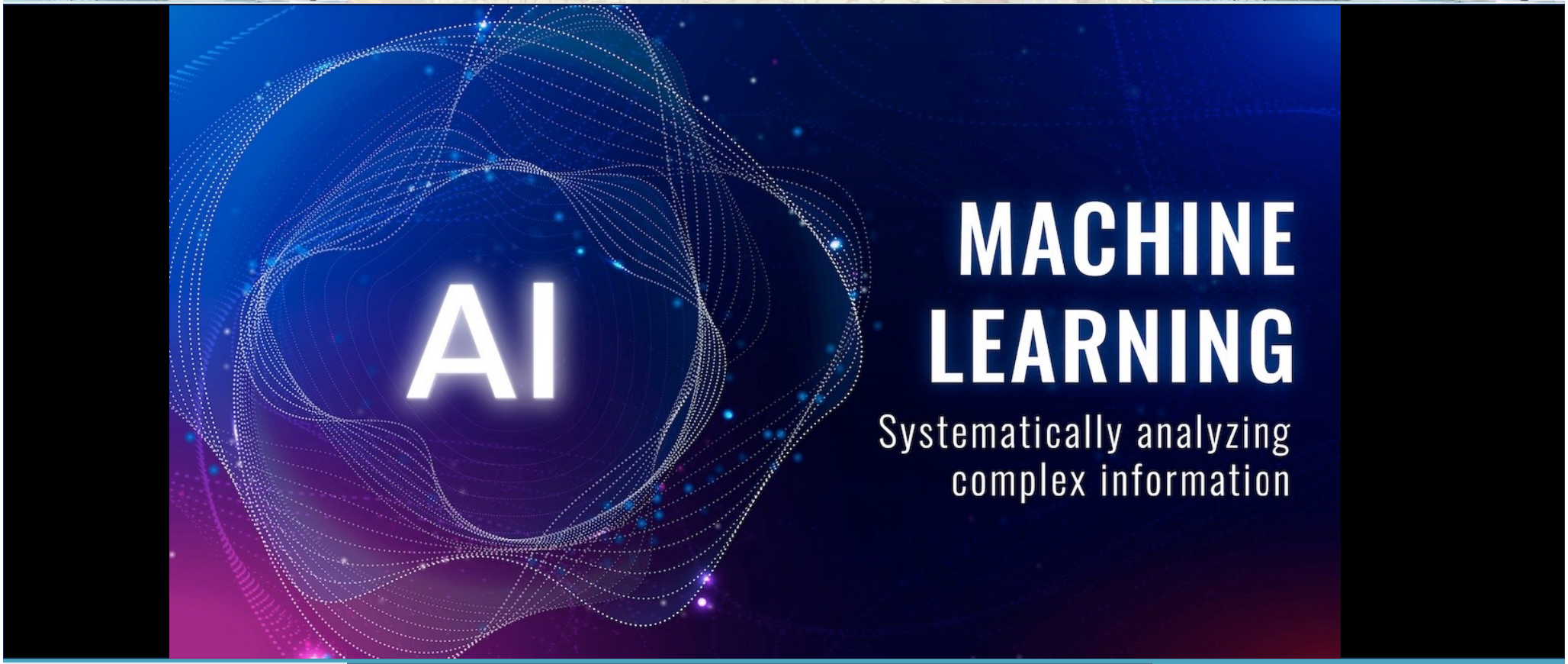
  Dr. Steve Chan is an International Academy, Research and Industry Association (IARIA) Fellow. He has been active with a variety of IARIA venues, such as:
  - IARIA Annual Congress on Frontiers in Science, Technology, Services, and Applications
  - Future Computing
  - Advances on Societal Digital Transformation
  - Cyber-Technologies and Cyber-Systems
  - Data Analytics, etc.

- **Research Interests:**
  - Decision Science/Decision Engineering
  - Artificial Intelligence/Machine Learning and Numerical Methods
  - Cyberspace
  - Information Science and Data Analytics
  - stevec@de-stea.tech

CAVE Automatic Virtual Environment (CAVE)



https://medium.com/xrpractices/hmd-vs-cave-in-the-world-of-vr-a0c9cbfb435a


AI
MACHINE
LEARNING
Systematically analyzing
complex information

ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain

Isomorphic Repertoire Item #1

ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain

Isomorphic Repertoire Item #2

ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain

Isomorphic Repertoire Item #3

https://dronedj.com/2020/04/03/firefighting-drones-extinguish-10-story-blaze-china/

ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain

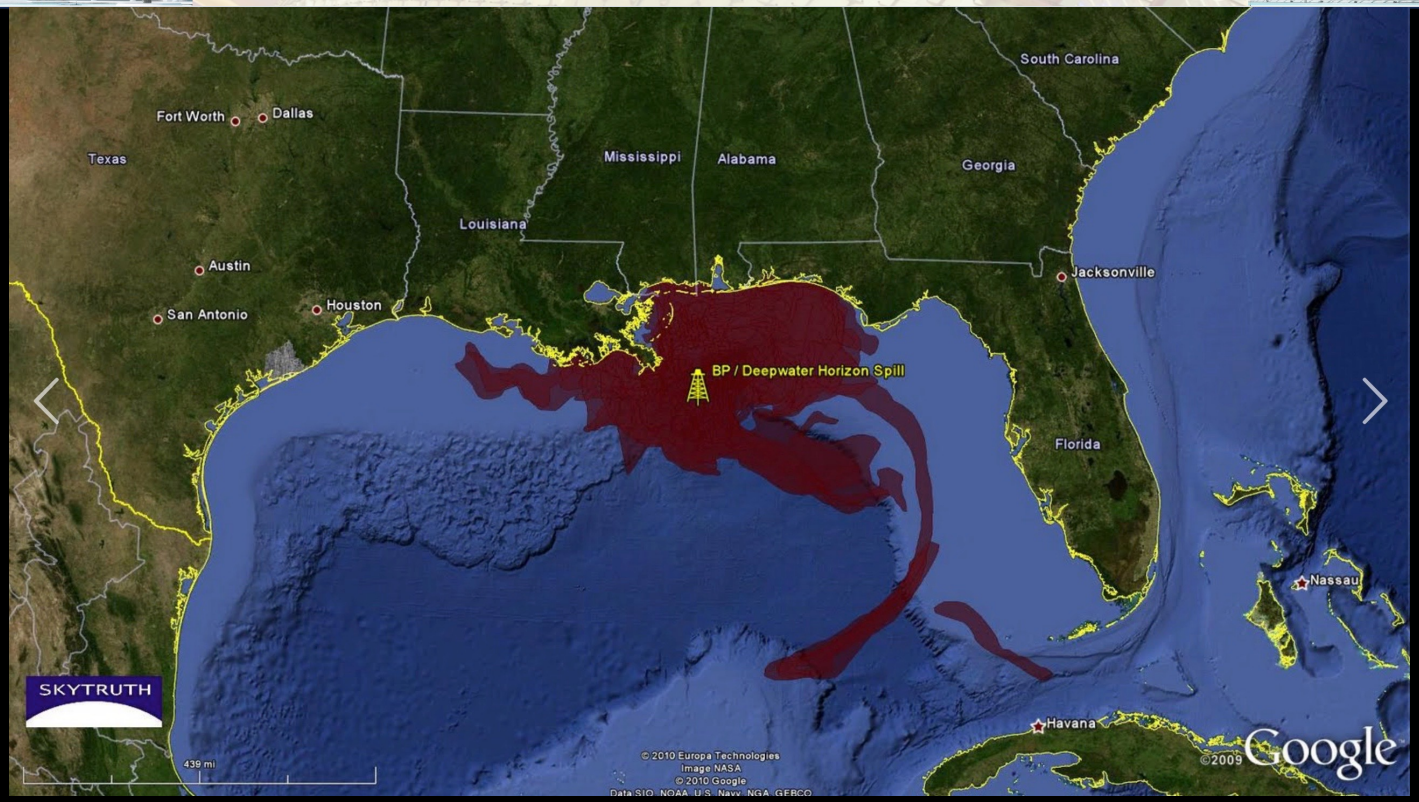
Isomorphic Repertoire Item #4

https://www.nationalgeographic.com/history/article/130108-centralia-mine-fire

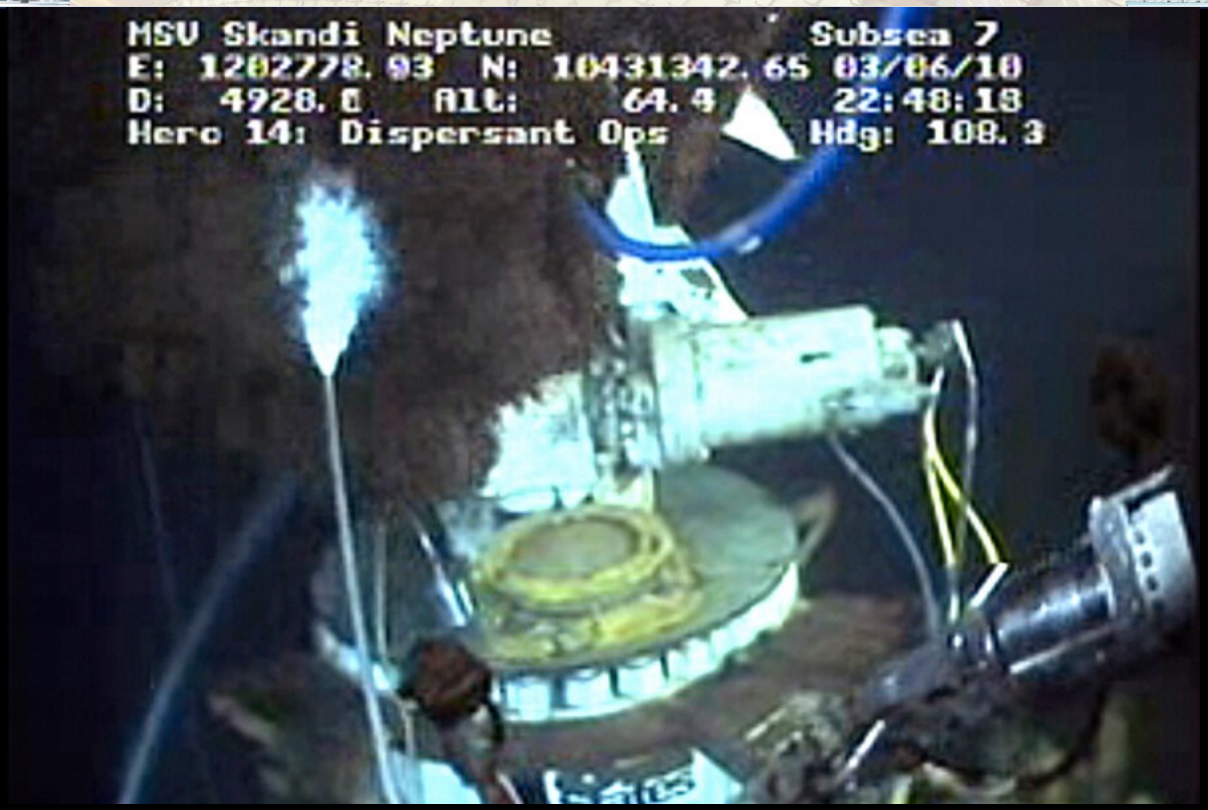
https://www.centraliapa.org/centralia-pennsylvania-disappearing-sign-mystery/

ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain

Isomorphic Repertoire Item #5



https://skytruth.org/section/deepwater-horizon-oil-spill/



https://www.csmonitor.com/USA/2010/0604/Top-cap-on-BP-oil-spill-not-tight-enough-as-crude-keeps-spewing

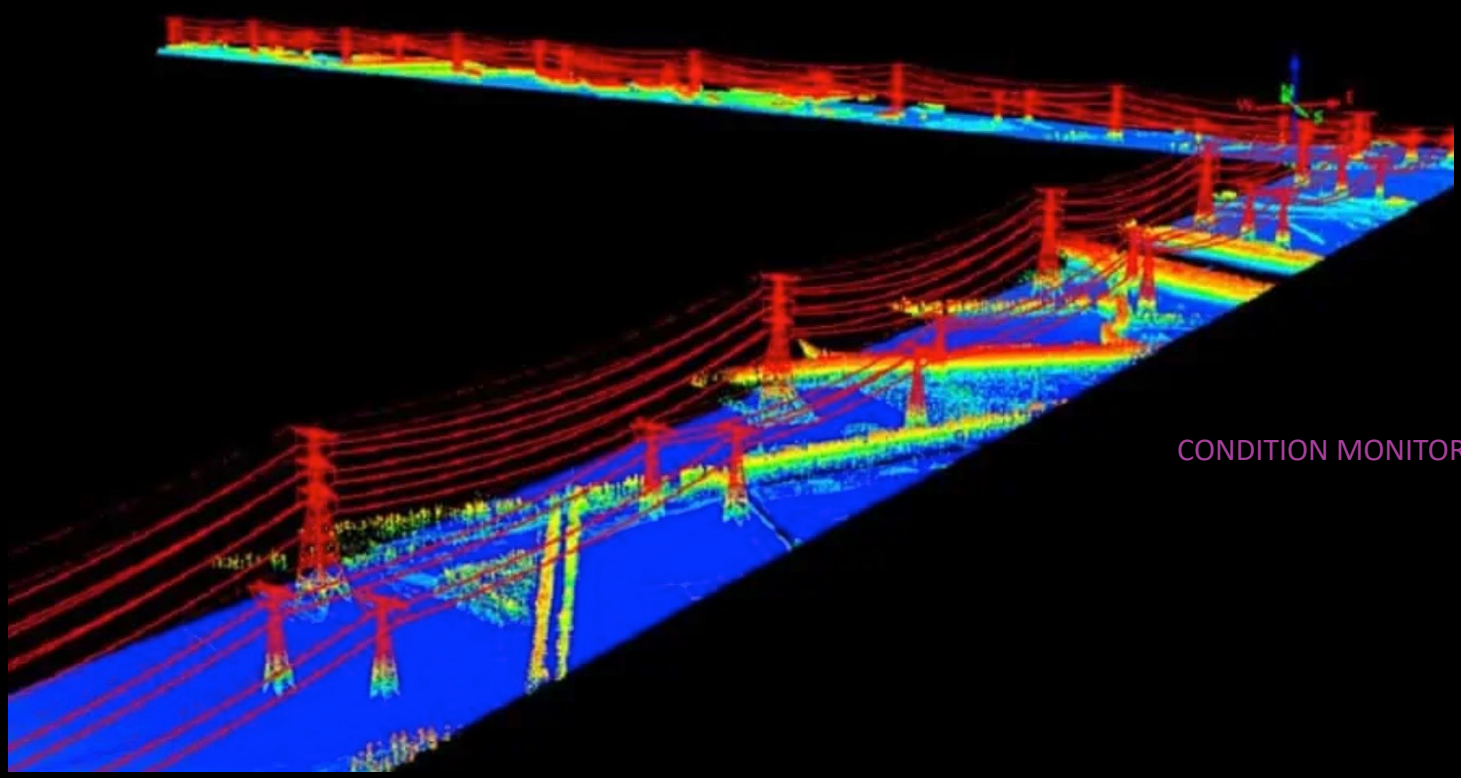
ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain

Isomorphic Repertoire Item #6

https://www.nasa.gov/blogs/smallsatellites/2025/01/15/nasas-latest-cubesat-launches-to-earths-thermosphere/

CYBER Implications

https://scitechdaily.com/the-starling-squadron-nasas-cubesats-take-formation-in-space/

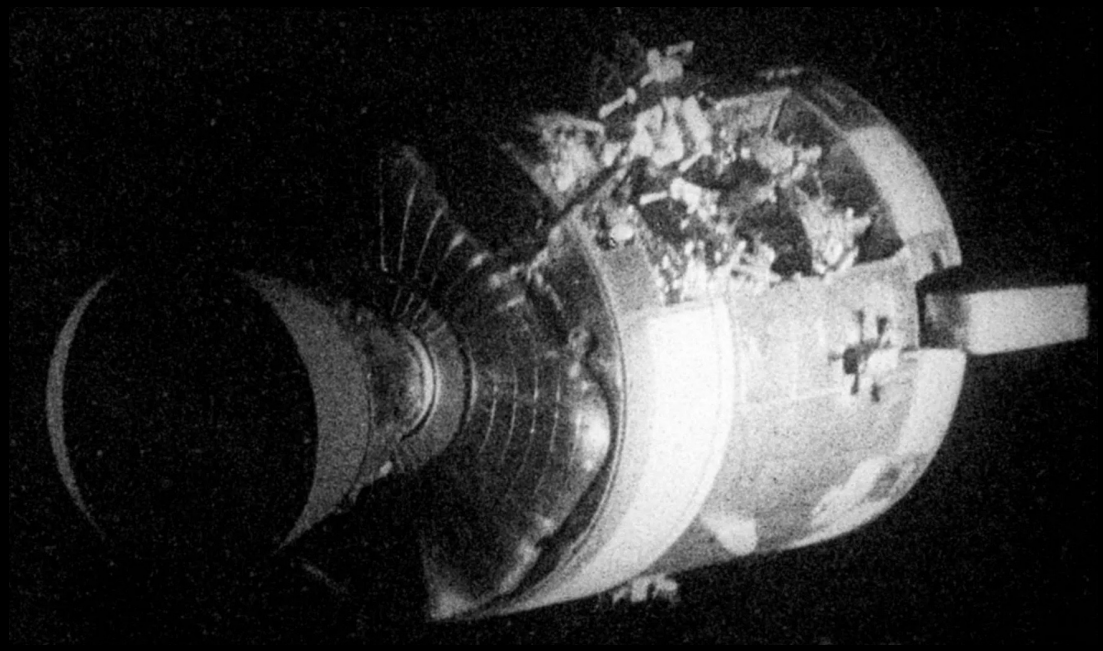


CONDITION MONITORING Implications

https://www.unmannedsystemstechnology.com/2021/06/case-study-power-line-inspection-with-drone-lidar/

ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain

Isomorphic Repertoire Item #7



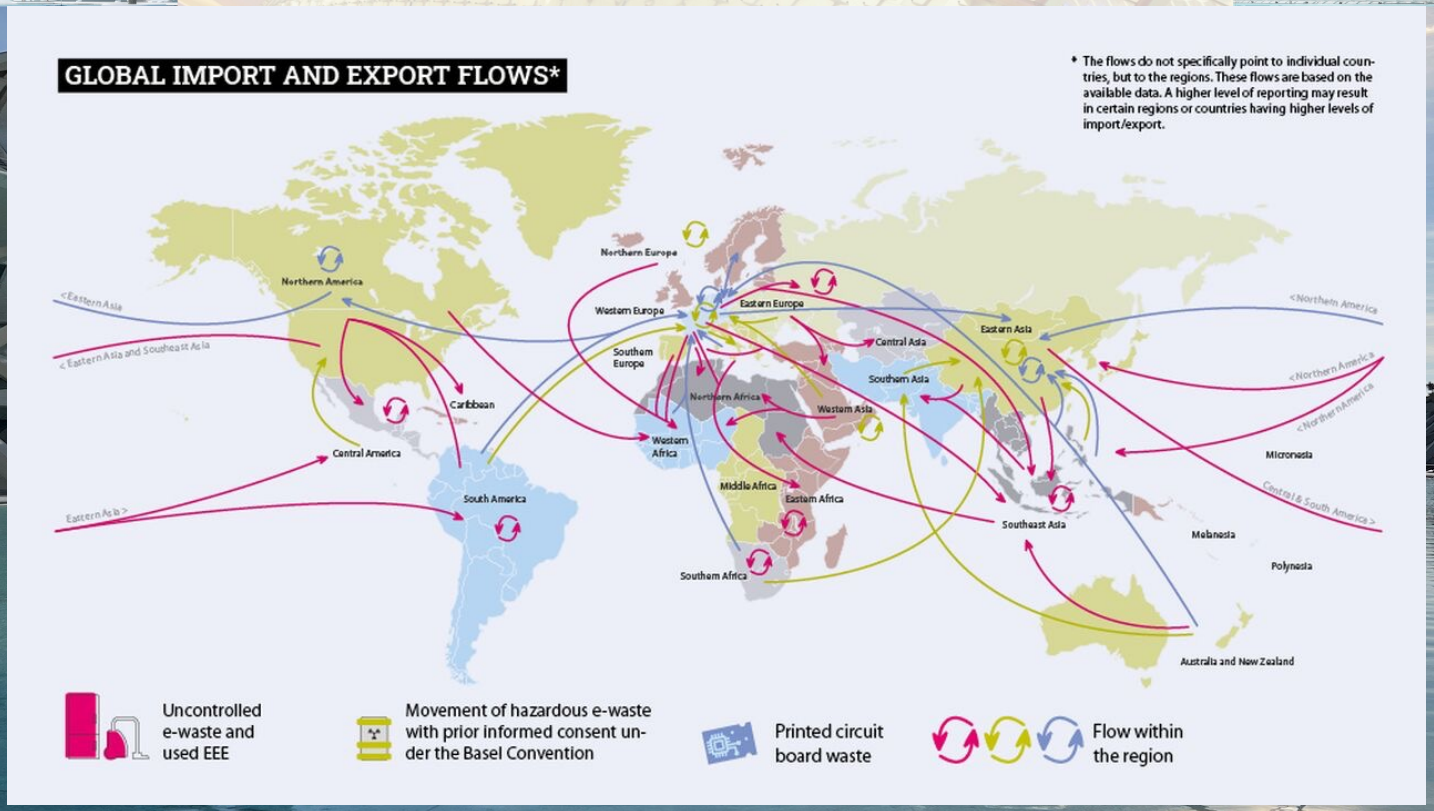
https://www.britannica.com/topic/Apollo-13-mission

https://www.space.com/boeing-starliner-iss-hot-fire-reentry-preparation

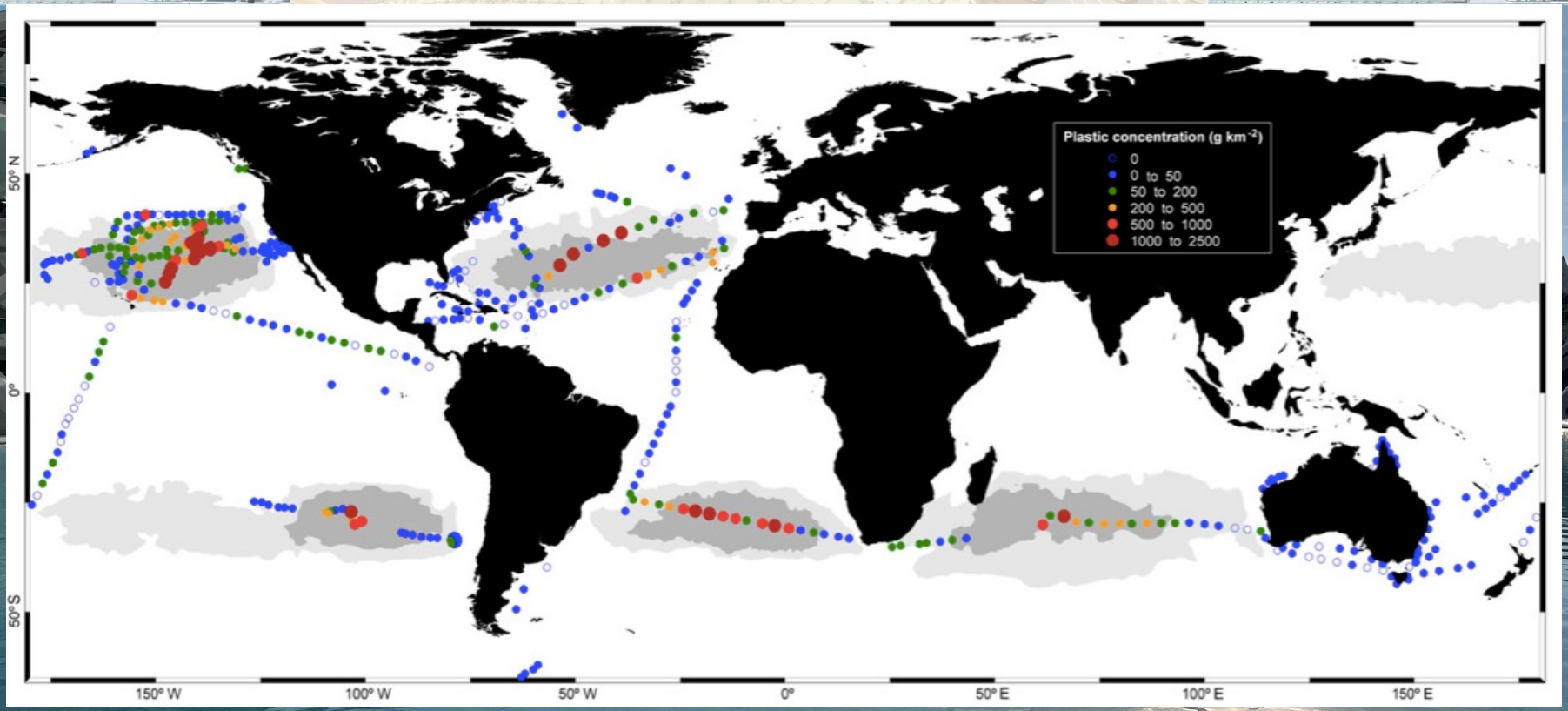
IDEATION & INNOVATION IMPLICATIONS

ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain

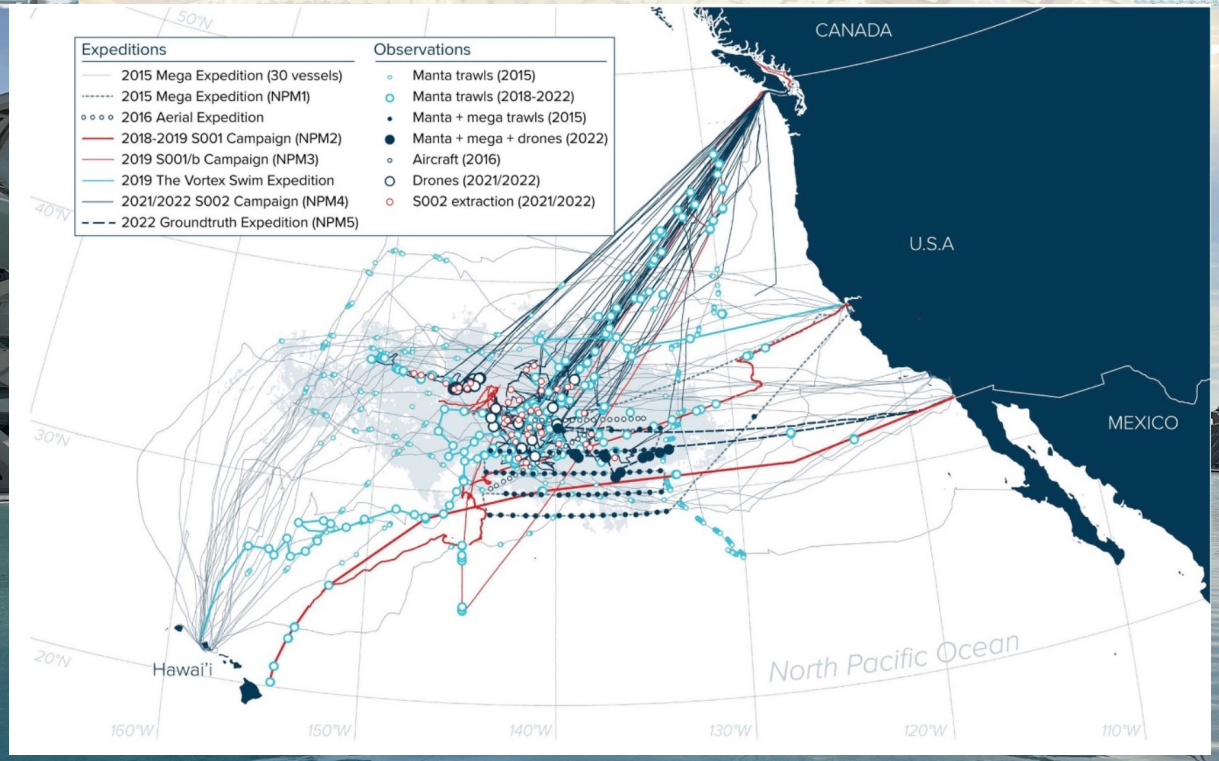
Isomorphic Repertoire Item #8



https://waste-management-world.com/materials/global-e-waste-flows-mapped/



https://www.vox.com/2015/2/12/8028267/plastic-garbage-patch-ocean



https://www.researchgate.net/publication/385947350_Seven_years_into_the_North_Pacific_garbage_patch_legacy_plastic_fragments_rising_disproportionally_faster_than_larger_floating_objects/download

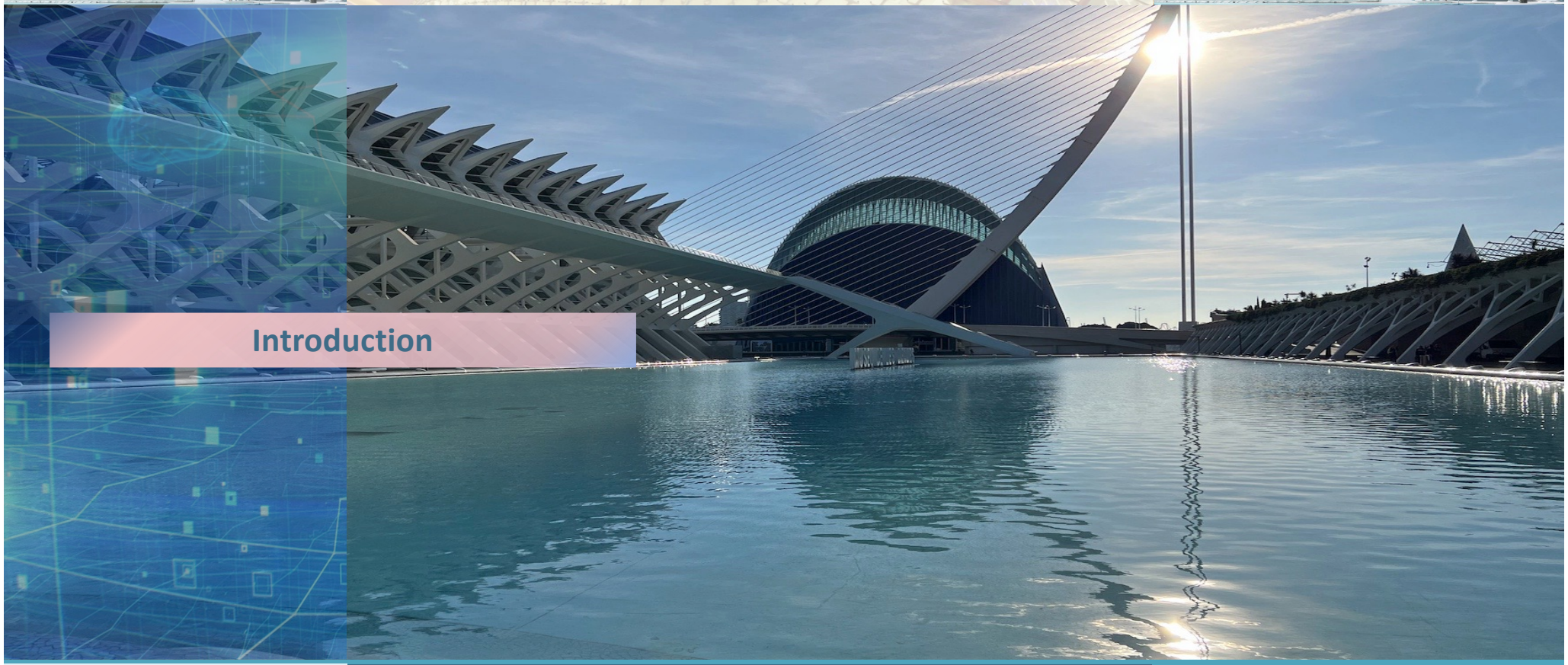
ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain

Isomorphic Repertoire Item #9

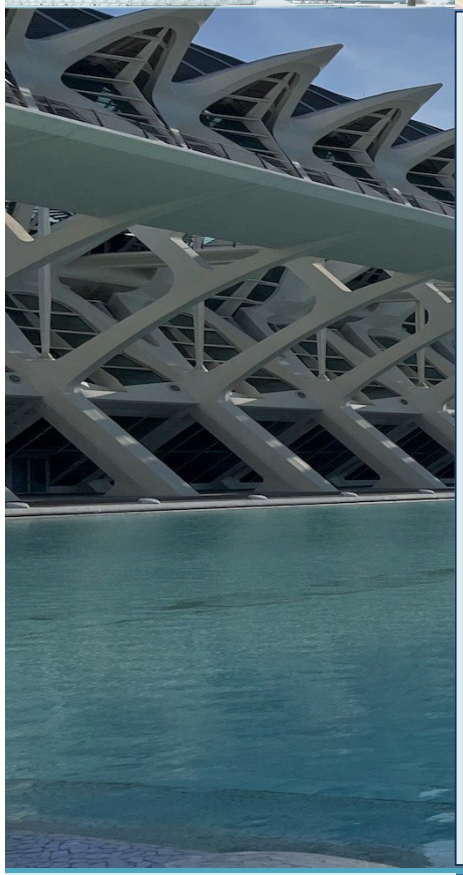
ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain

Isomorphic Repertoire Item #10

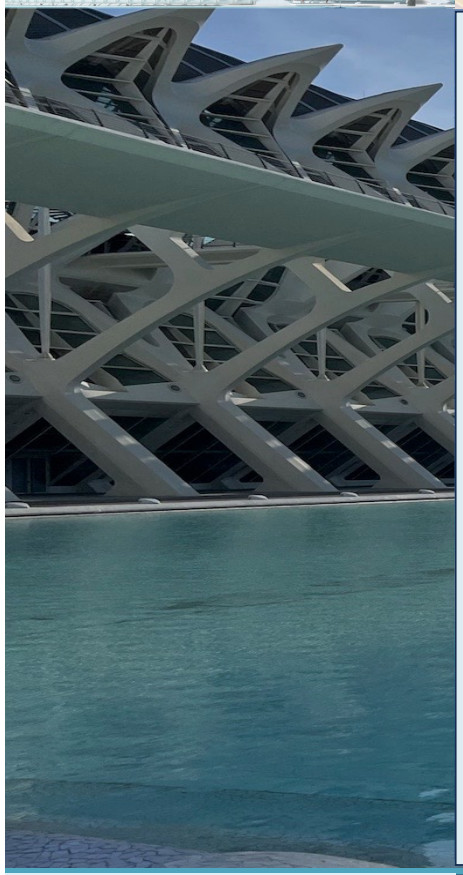
ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain



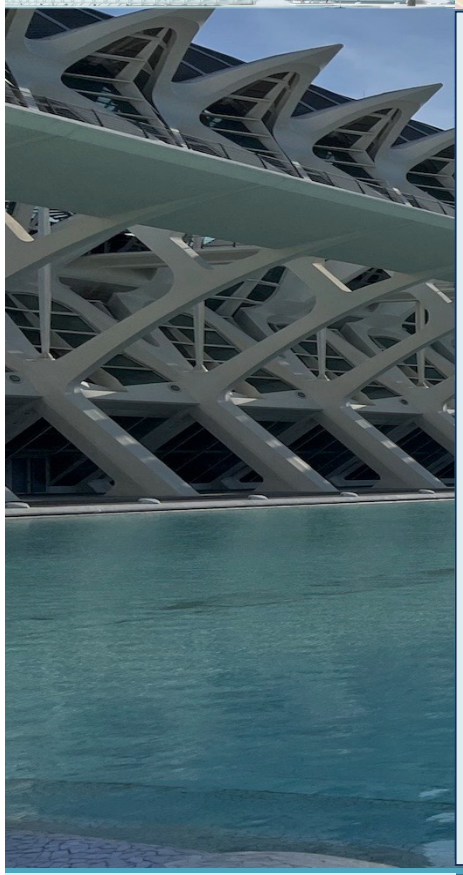
Introduction



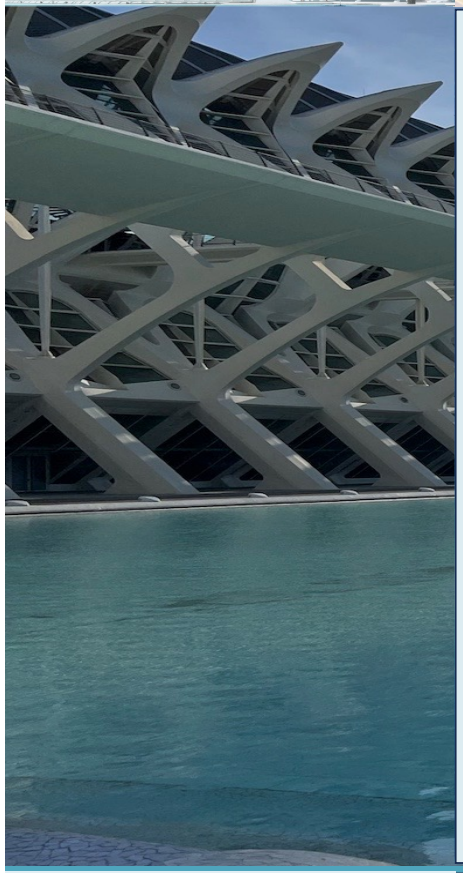
- **Kahneman, Klein, and the isomorphic-centric LAHU/HAUL**
- **Kahneman System 1 -> potential biases**
  - Anchoring Effect
  - Confirmation Bias
  - Selection Bias
- **Klein Recognition-Primed Decision (RPD)**
  - Highly-trained Tasks
- **Low Ambiguity High Uncertainty (LAHU)**
  - Reduces the need for more Big Data
- **High Ambiguity Low Uncertainty (HALU)**
  - Necessitate the need for more Big Data (and elongates Gestaltian Closure)
- **Kahneman System 2 -> potential overthinking/overtraining**
  - Anchoring Effect
  - Confirmation Bias
  - Selection Bias



- **MADM vs. MODM vs. MCDM**
- **Multi-Attribute Decision-Making (MADM)**
  - "According to Qin, MADM 'refers to making preference decisions via assessing a finite number of pre-specified alternatives under multiple and usually conflicting attributes.'"
- **Multi-Objective Decision-Making (MODM)**
  - "According to Roostaee, 'the main characteristics of MODM problems are that decision makers need to achieve multiple objectives while these multiple objectives are noncommensurable and conflict with each other.' Roostaee further notes that MODM 'involves the design of alternatives that optimizes or most satisfies the objectives of decision makers.'"
- **Multi-Criteria Decision-Making (MCDM):**
  - "According to Sorooshian, MCDM — also known as Multi-Criteria Decision Analysis (MCDA) — is a structured approach that endeavors to consider multiple criteria/objectives (often conflicting) and is comprised of the sub-categories of MADM and MODM."

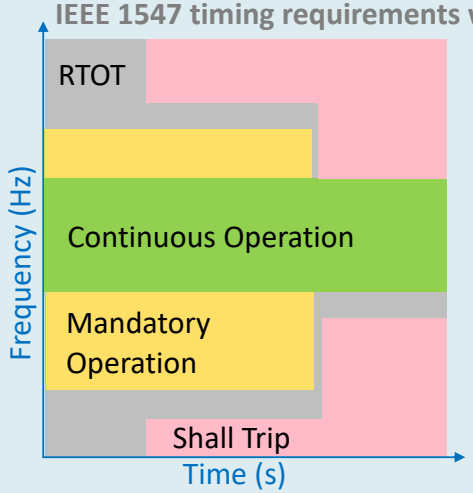


- **Algorithm vs. Heuristic vs. Hyper-Heuristic**
- **Algorithm**
  - According to computer scientist Harold Stone, an algorithm involves “a set of rules that precisely define a sequence of operations” (i.e., “it endeavors to determine an optimal solution that usually involves more computational time”).
- **Heuristic**
  - According to Gigerenzer & Gaissmaier, a heuristic is “a problem-solving method that does ‘not guarantee an optimal solution,’ and is ‘a strategy that ignores part of the information, with the goal of making decisions more quickly, frugally, and/or accurately than more complex methods’” (i.e., “it endeavors to determine a good solution with less computational time”). STEA/I&E can help detect for potential errors, biases, and brittleness as well as areas for optimization and enhancement.
- **Hyper-Heuristic:**
  - According to Drake and Carvalho, a hyper-heuristic is a “problem-solving method that ‘intelligently select[s] or generat[es] a suitable heuristic for a given situation;’ it can start simply as a ‘heuristic to choose heuristics;’ however, when an appropriate heuristic or amalgam of heuristics is not available or sub-optimal, a new heuristic(s) may need to be generated. Zhao and others (e.g., Bouazza) refer to this as an algorithm ‘that adaptively selects the optimizer to address complex problems.’”



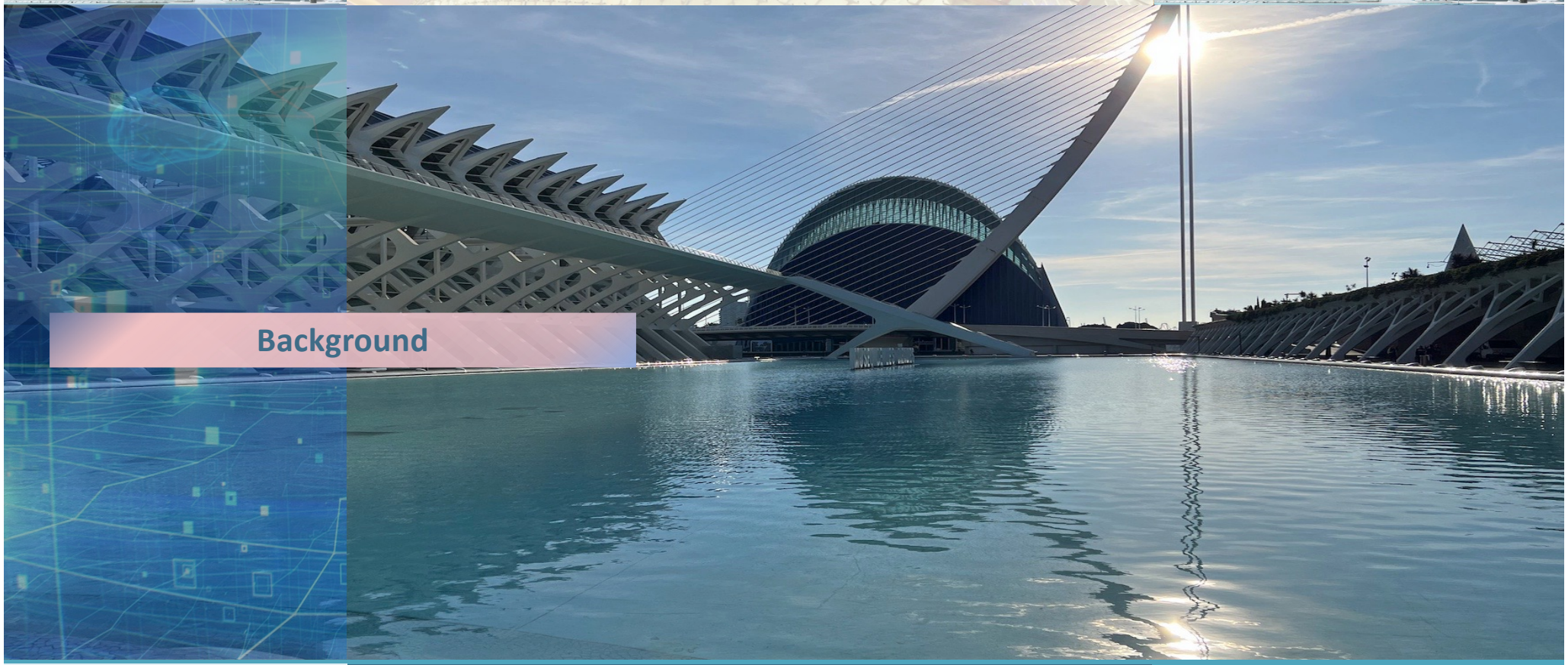
- **What is involved in "updating a heuristic?"**
- **Can it meet the timing requirements?**

  Exemplar Depiction of "Frequency Ride-Through (Default Values for All Categories)" based upon IEEE 1547 timing requirements with "Ride-Through or Trip" (RTOT)



- **How is it aging? It is becoming brittle? Is it still qualified to do the job?**
  - How does the heuristic update itself? Can it update itself?
- **Does "updating a heuristic" involve more than just the heuristic itself?**
  - Perhaps, a Hyper-Heuristic (HH) is involved? Perhaps, an AI System (AIS) is supporting the HH?

ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain

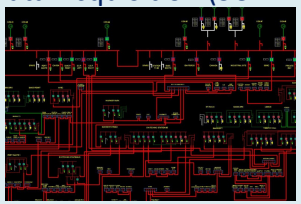


Background

Real World Scenario (RWS) Data

Operational Data

Supervisory Control and Data Acquisition (SCADA)



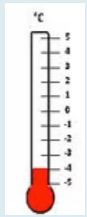
Source: https://www.lucyelectric.com/product/gemini-scada-2/

Intelligent Electronic Device (IED)

https://electrical-engineering-portal.com/ied-intelligent-electronic-device-advanced-functions

Non-Operational Data

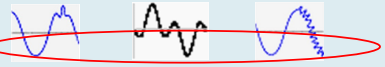
Temperature



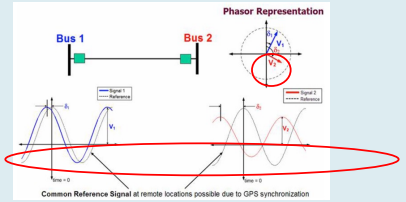
https://www.teacherspayteachers.com/Product/Negative-Numbers-Temperature-4449300

Water Level Gauge

https://www.onetemp.co.nz/hobo-microrx-water-level-station



https://www.qualitrolcorp.com/resource-library/blog/what-is-a-multifunctional-disturbance-fault-recording-device/



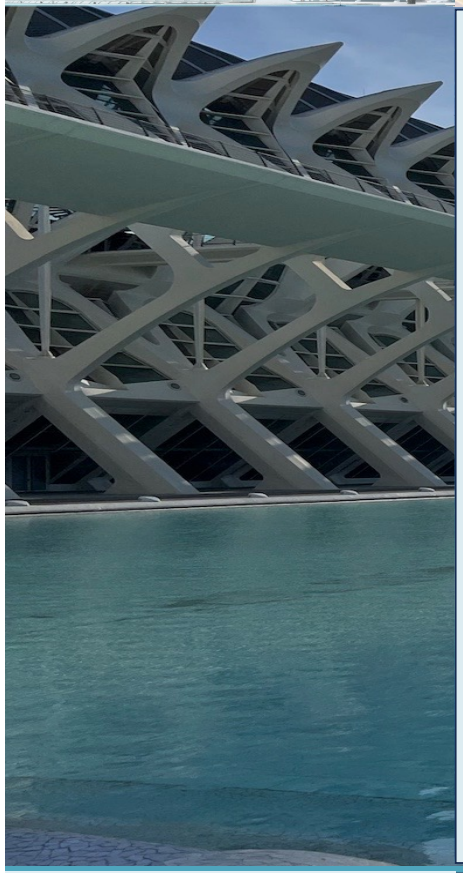
https://dev.energyknowledgebase.com/topics/phasor-measurement-unit-pmu.asp; Source: Consortium for Electric Reliability Technology Solutions

Digital Fault Recorder (DFR)

https://www.elspec-ltd.com/metering-protection/g5-multi-functional-digital-fault-recorder/

Phasor Measurement Unit (PMU)

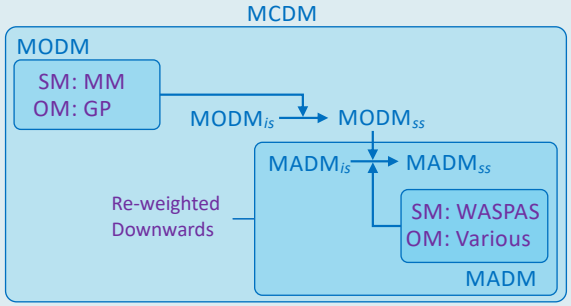
https://www.scopetnm.com/protection-solutions/phasor-measurement-unit/11-protection

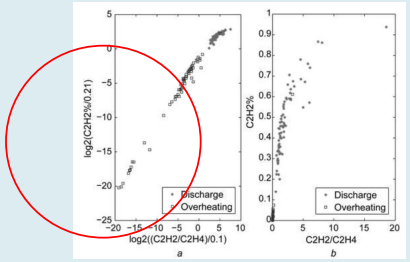


Exemplar MADM Methods

Acronym	Full Form	Method Description
AHP	Analytic Hierarchy Process	Utilizes pairwise comparison, via distance metrics, of various criteria.
COPRAS	COmplex PRoportional Assessment	Considers the "ratio to the ideal solution and the ratio with the ideal-worst solution" [49].
CRITIC	CRiteria Importance through Intercriteria Correlation	Ascertains the relative import of the criteria to determine the apropos weights.
ELECTRE	ELimination Et Choix Traduisant la Realité	Utilizes outranking and pairwise comparisons.
MULTIMOORA	Multi-Objective Optimization by a Ratio Analysis plus the Full Multiplicative Form	Ascertains the ratio of alternatives for various criteria and then aggregates these for a compromise solution.
PROMETHEE	Preference Ranking Organization Method for Enrichment Evaluation	Utilizes outranking iterations with intensity of the preferences.
SAW	Simple Additive Weighting	Utilizes an addition of goal scores multiplied by the criteria weights.
TOPSIS	Technique of Order Preference by Similarity to an Ideal Solution	Compares distances to the ideal and non-ideal solutions.
VIKOR	Fuzzy VIseKriterijumska Optimizacija I Kompromisno Resenje	Focuses on minimal distances to the ideal solutions.
WASPAS	Weighted Aggregated Sum Product Assessment	Combines weighted sum with weighted product.

Exemplar MADM/MODM Counterpoising

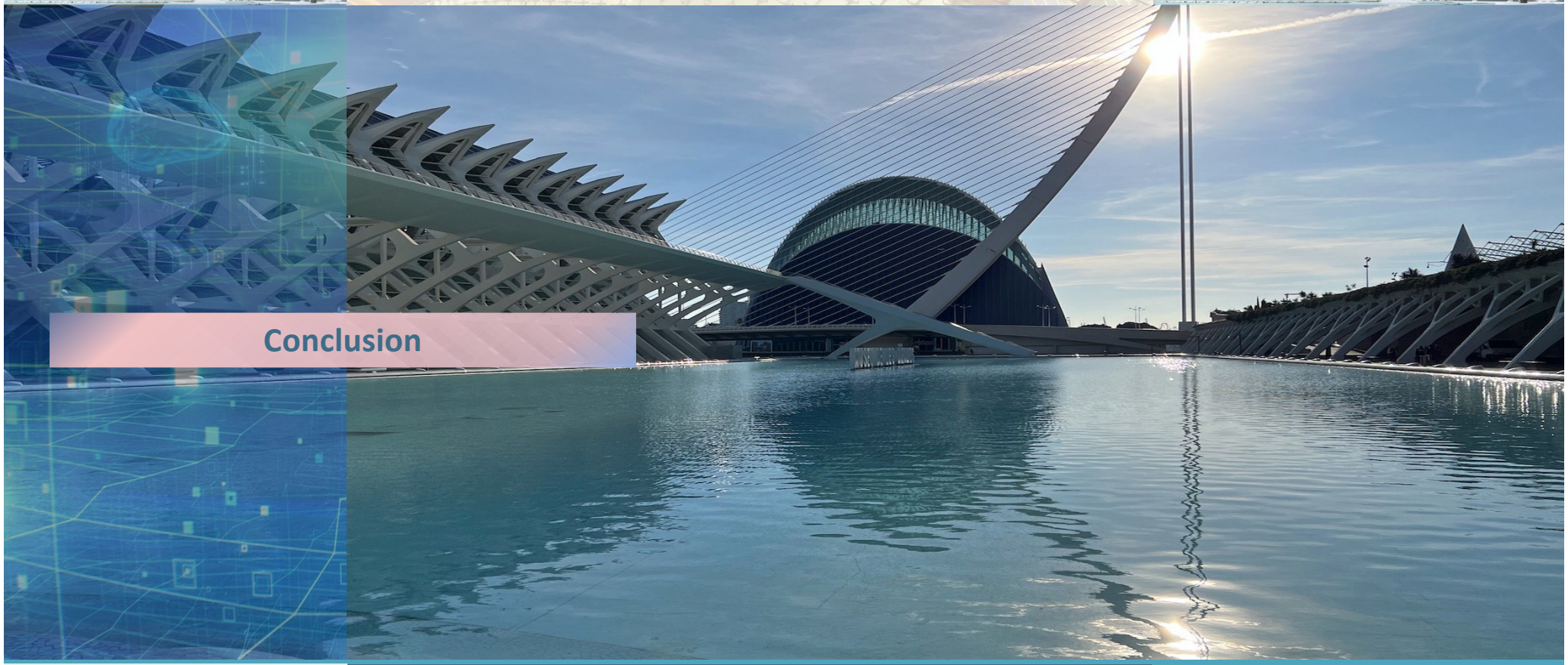




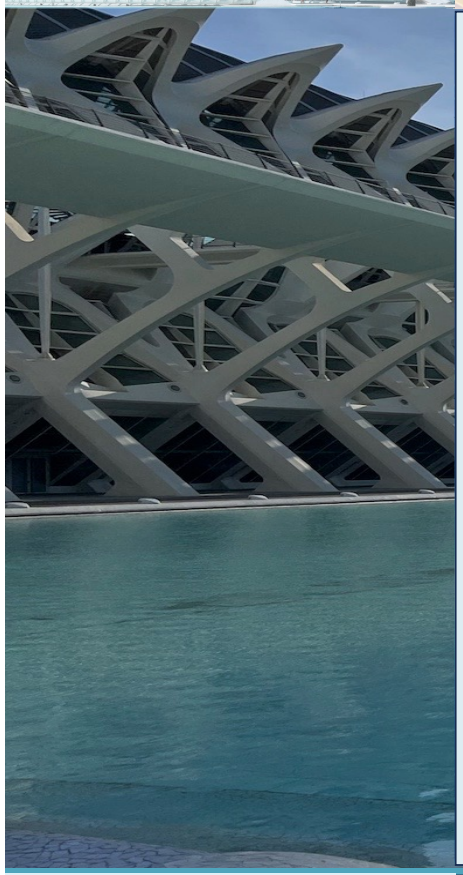
https://ietresearch.onlinelibrary.wiley.com/doi/epdf/10.1049/iet-epa.2014.0085

AHP, SAW, and PROMETHEE may be intrinsically challenged in the handling of negative values, as an example.

ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain



Conclusion

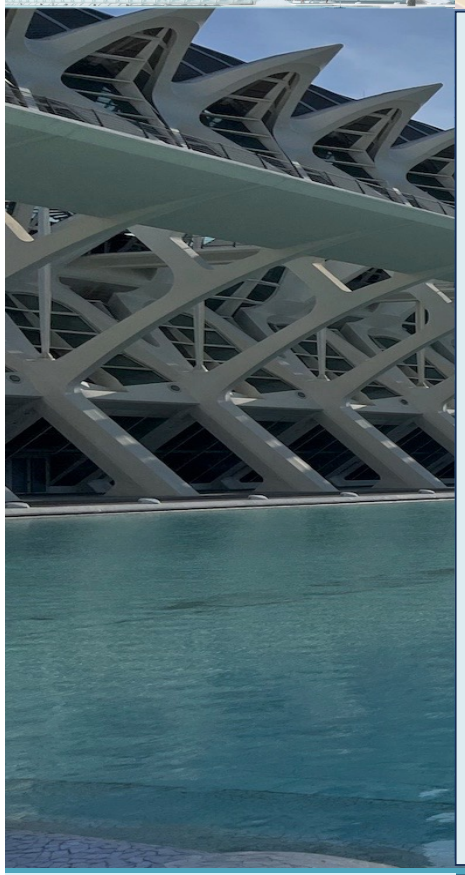


- **Some thoughts:**
- **The Non-Obvious and Non-Trivial Nature of "Updating a Heuristic:"**
  - In an uncomfortably high number of cases "heuristics may lead to sub-optimal paradigms." According to Methling, this could equate to "60.34% of cases." Hence, matters may need to be referred "back to the upstream HH." This paradigm alludes to the fact that the matter of "updating a heuristic" is likely "non-obvious and non-trivial."
  - In a conventional sense, "updating a heuristic" can be three-pronged:

    (1) "recognizing that the heuristic is not qualified to handle the incoming information and may need to be referred back to the HH;"

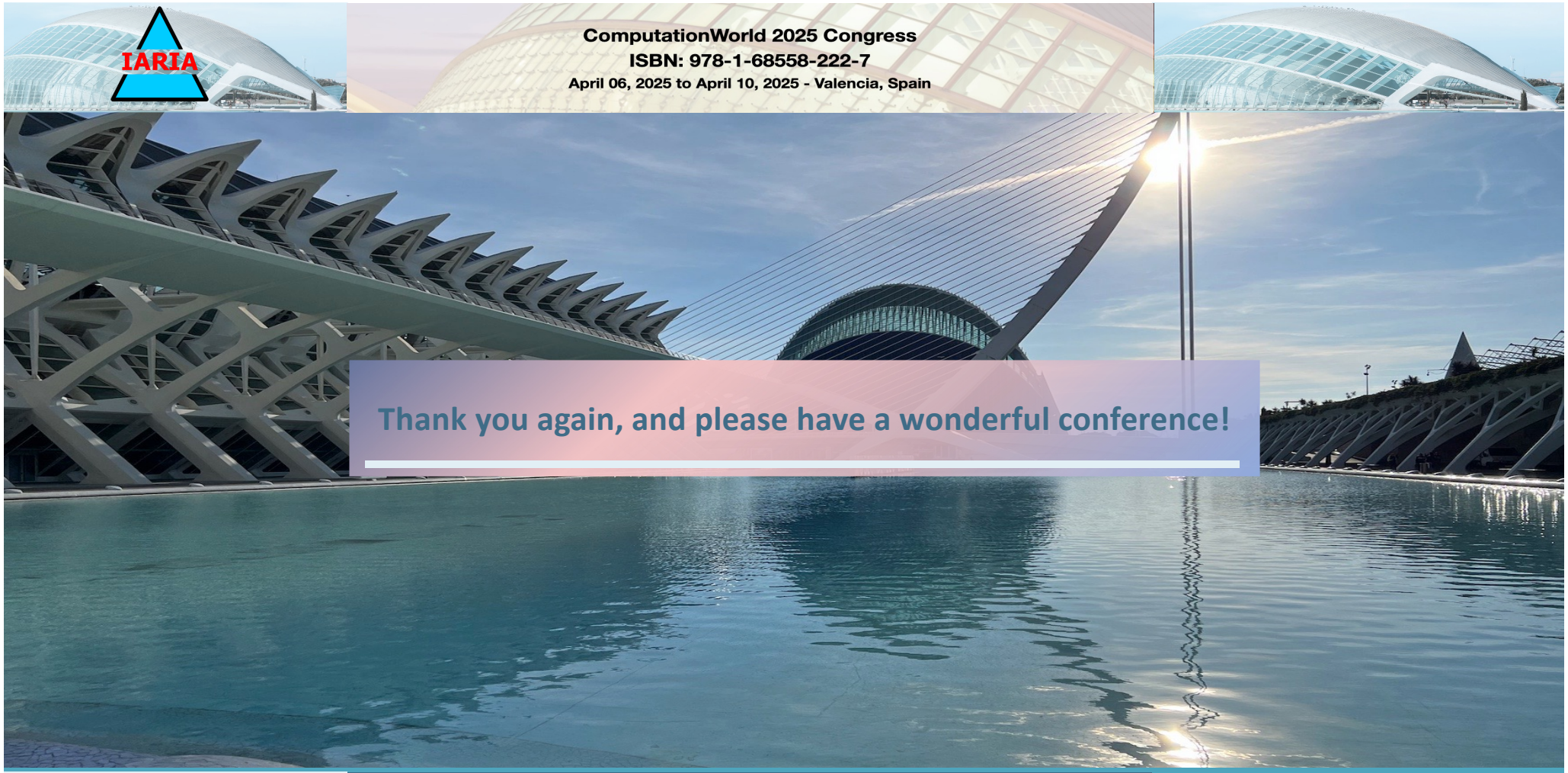
    (2) "mitigating against the prospective brittleness of the heuristic itself;" and

    (3) "furthering the execution of the heuristic-algorithm amalgam, if even possible." After all, in a number of cases, "the spawning of further NP-hard problems may occur and serve as an impasse."
  - For a high efficacy "updating [of] a heuristic," "the machinations of the heuristic need to be to plainly evident enough for the AI/ML mechanism to process, interpret, and learn from it. In other words, the involved methods need to have a sufficient STEA/I&E posture so as facilitate the requisite ML on ML."
  - Interestingly, Pradhan well points out that the "prototypical heuristic (i.e., LLH) does not well contend with the nonconvex optimizations prevalent in RWS." This is in contradistinction to HH and MH, which do indeed "actively contend with nonconvex optimizations."



- **Proxy Use Cases & Real-World Scenarios**


IARIA
ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain
Thank you very much to the conference organizers


IARIA
ComputationWorld 2025 Congress
ISBN: 978-1-68558-222-7
April 06, 2025 to April 10, 2025 - Valencia, Spain
Thank you again, and please have a wonderful conference!