Catalogue of Decision Support Tools for Complex Decisions under Uncertainty

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Catalogue of D[illegible] Support Tools for Complex [illegible]s under Uncertainty

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Under Construction

WARWICK

AU4DM Network

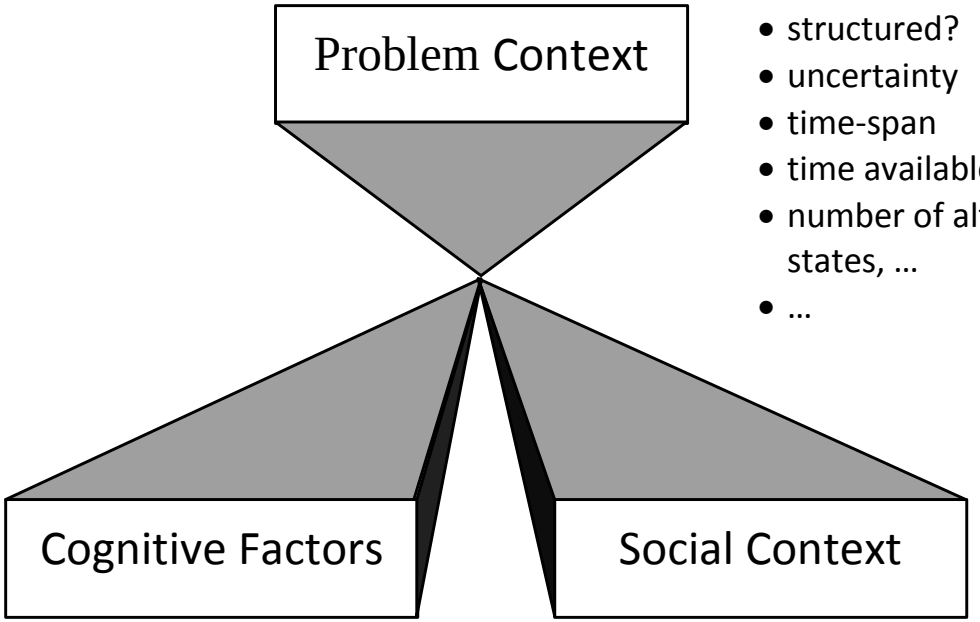
Why the catalogue?

- In academic – dreaming spires and all! – we have developed many ways that we *think* will help in complex decisions
  - but they are not greatly used
- In many arenas, decision-makers, advisers, and others, have asked for support and analysis to help in complex circumstances with high uncertainty
- AU4DM is aimed at bringing the two communities together

Health Warning

- A Mire of Terminology
- Many Incompatibilities between approaches
- Snake-oil salesmen!

Decisions, decisions, decisions!



- structured?
- uncertainty
- time-span
- time available
- number of alternatives, states, …
- …

- calculating power
- knowledge & beliefs
- risk attitude
- preferences & values
- …

- single or group decision making
- stakeholders
- accountability
- …

A Range of Uncertainties

- **Stochastic uncertainties** (physical randomness and variations), e.g.
  - Will the next card be an ace?
  - What will be the height of a randomly selected child in Year 7 schooled in Surrey?
  - What proportion of car batteries will fail in the first year of use?
- **Epistemological uncertainties** (lack of knowledge), e.g.
  - What is happening?
  - What can we learn from the data?
  - What might our competitors do?
  - How good is our understanding of the causes of this phenomenon?
- **Analytical uncertainties** (model fit and accuracy), e.g.
  - How well do we know the model parameters?
  - How accurate are the calculations, given approximations made for tractability?
  - How well does that model fit the world?
- **Ambiguities** (ill-defined meaning), e.g.
  - What do we mean by 'normal working conditions' for a machine?
  - What do we mean by 'human error'?
- **Value uncertainties** (ill-defined objectives), e.g.
  - What do we mean by the patient being in 'good health'?
  - What weight should we put on this objective relative to others?
  - What is the right – ethical – thing to do?

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Uncertainties *external* to the decision-making

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Uncertainties *external* to the decis... making

These are only some types of uncertainties!

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Uncertainties *internal* to the decision-making

AU4DM Network

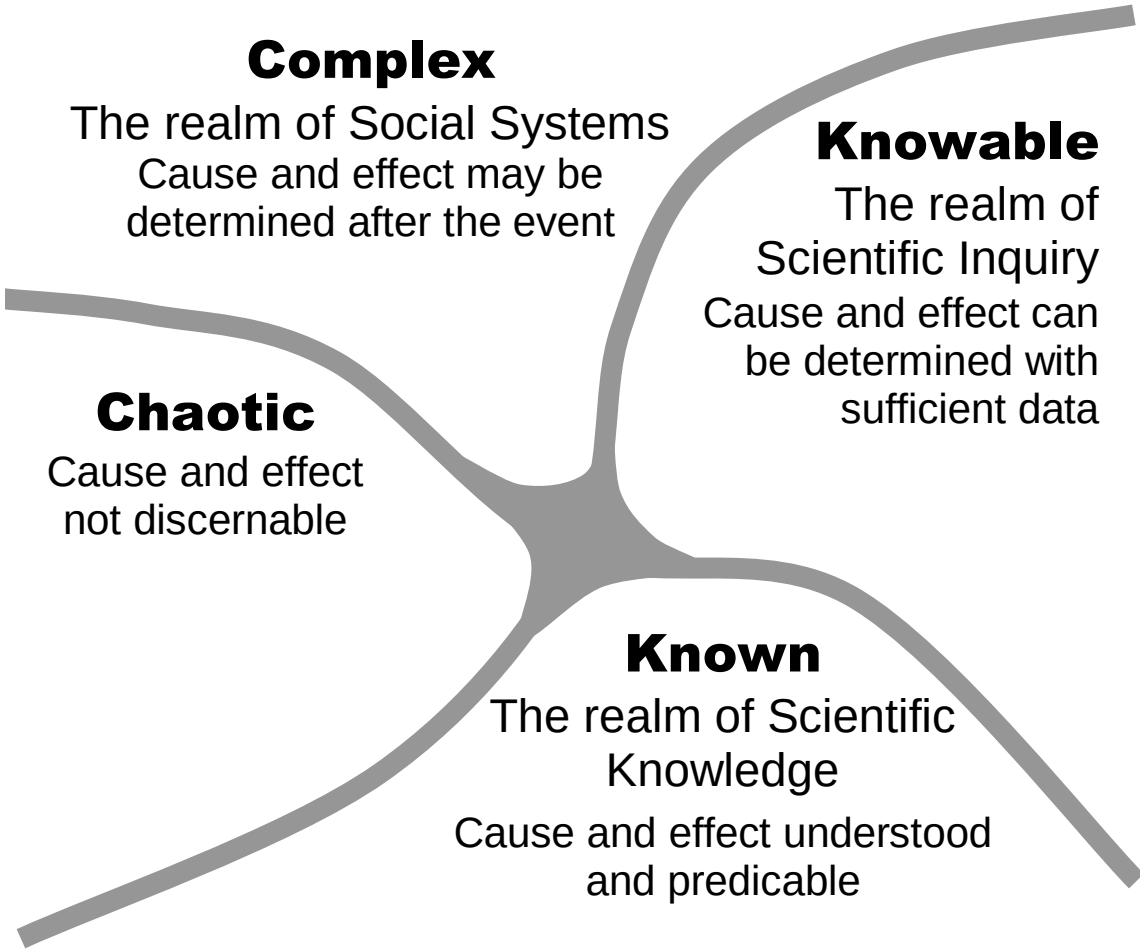
Deep or Knightian Uncertainty

- Knight (1921) distinguished:
  - ***Risk***: probabilities known and available
  - ***(Strict) Uncertainty*** , now often called deep uncertainty: probabilities unknown or unavailable and no relevant data available (within time constraints)
- Some uncertainties are ***so deep*** that while any expert might express his or her uncertainties as probabilities, the range of these probabilities over a group of experts is effective 0-1?
- Sensitivity analysis will give almost anything as possible.
- Some uncertainties are ***too great*** to build a ***'useful' model***.

Cynefin: a Welsh habitat

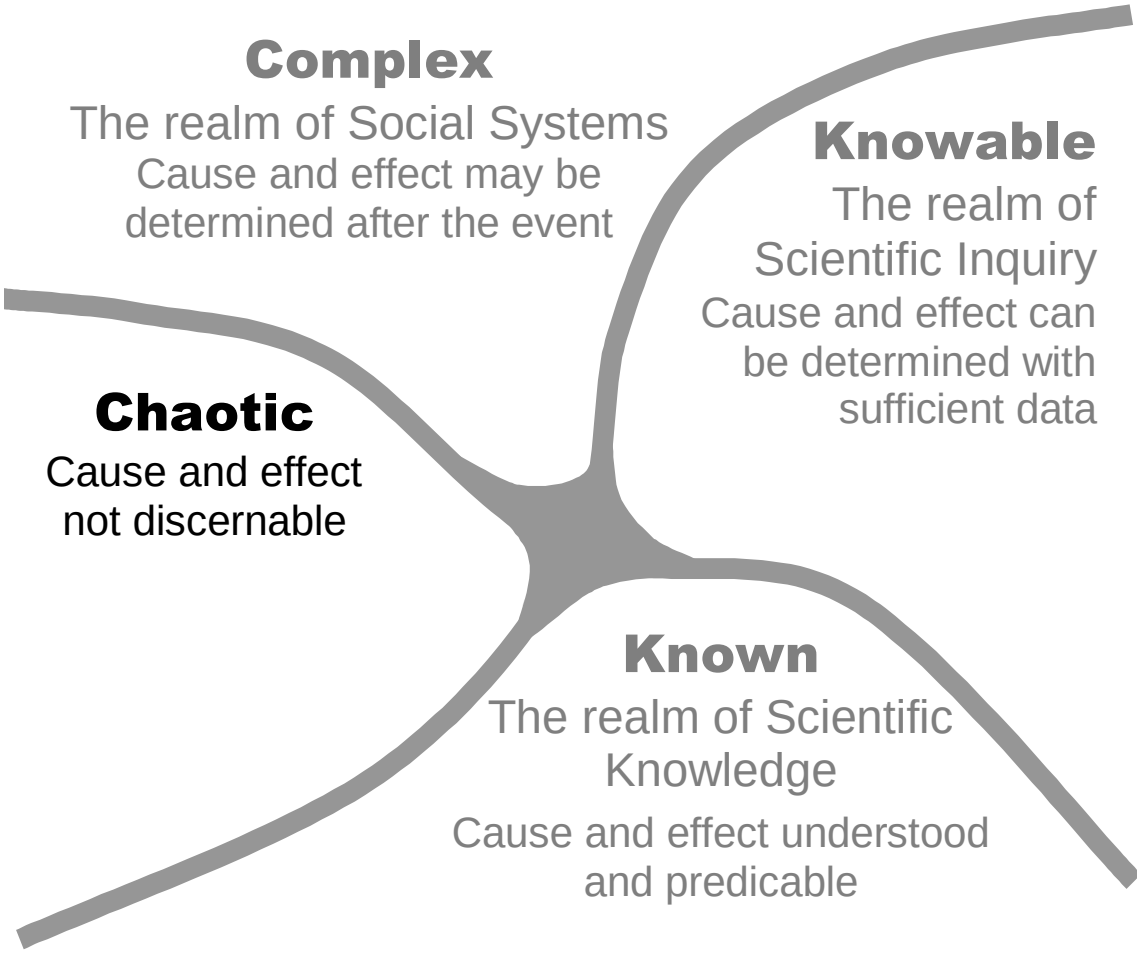
Cynefin:

- physical environment
- cultural environment
- social environment
- historical environment…..



D. Snowden (2002). "Complex acts of knowing - paradox and descriptive self-awareness." *Journal of Knowledge Management* **6** pp. 100-11.

Cynefin: a Welsh habitat



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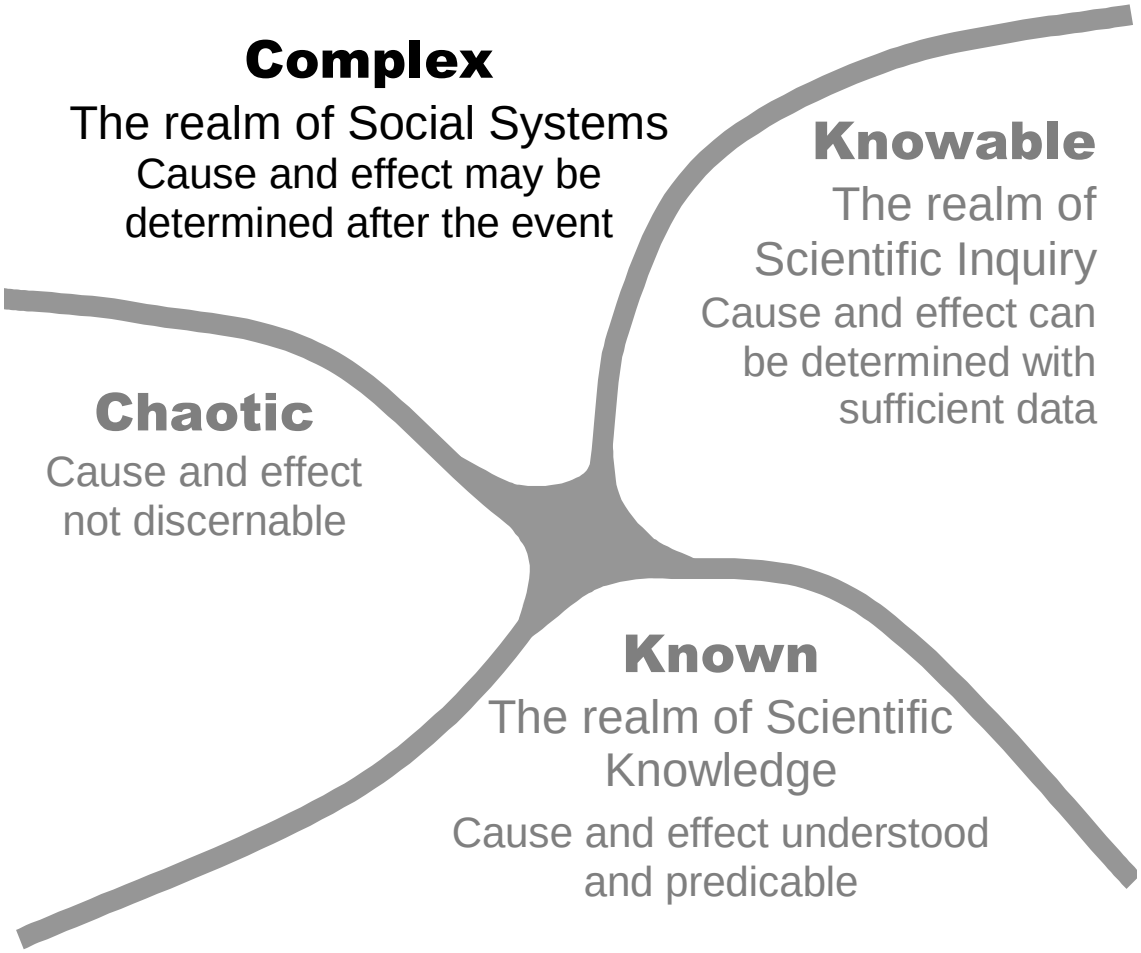
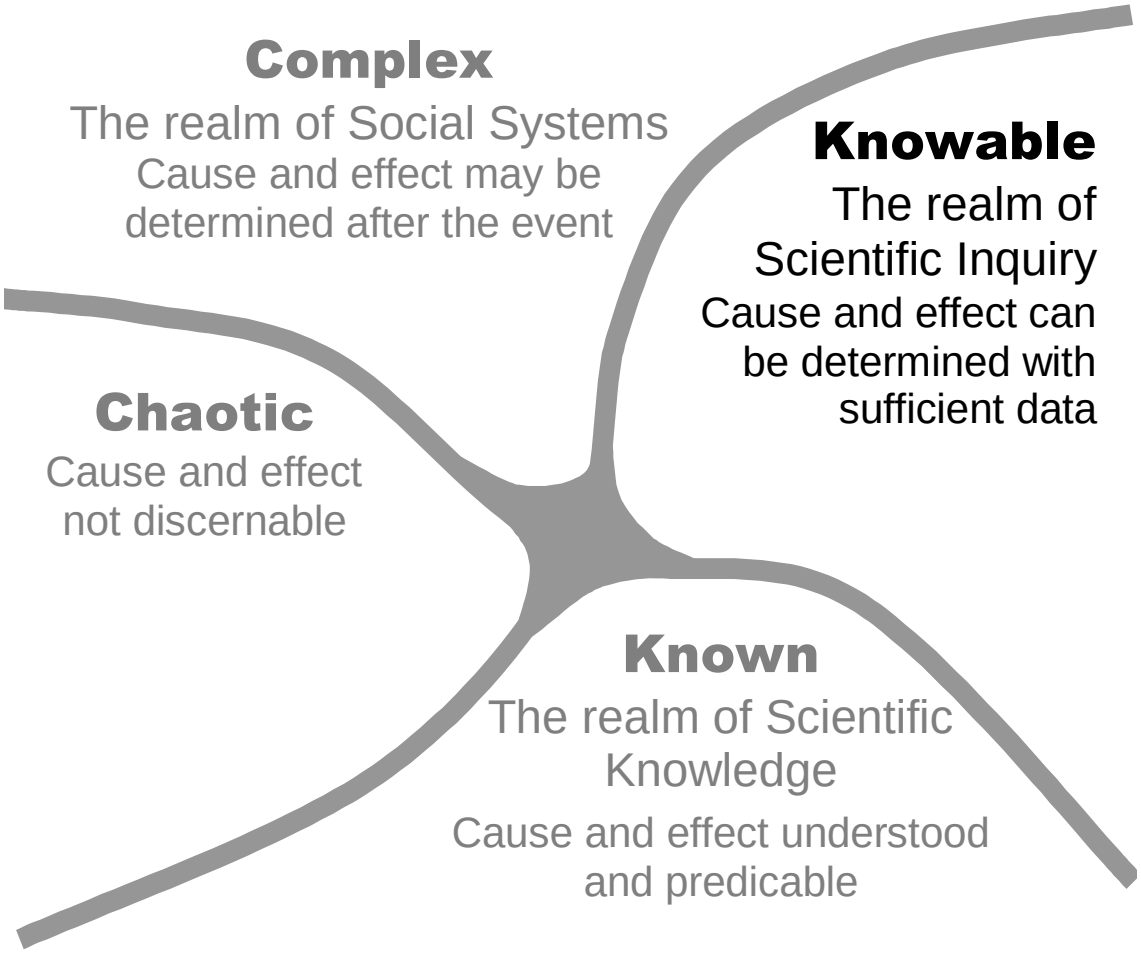


Cynefin: a Welsh habitat



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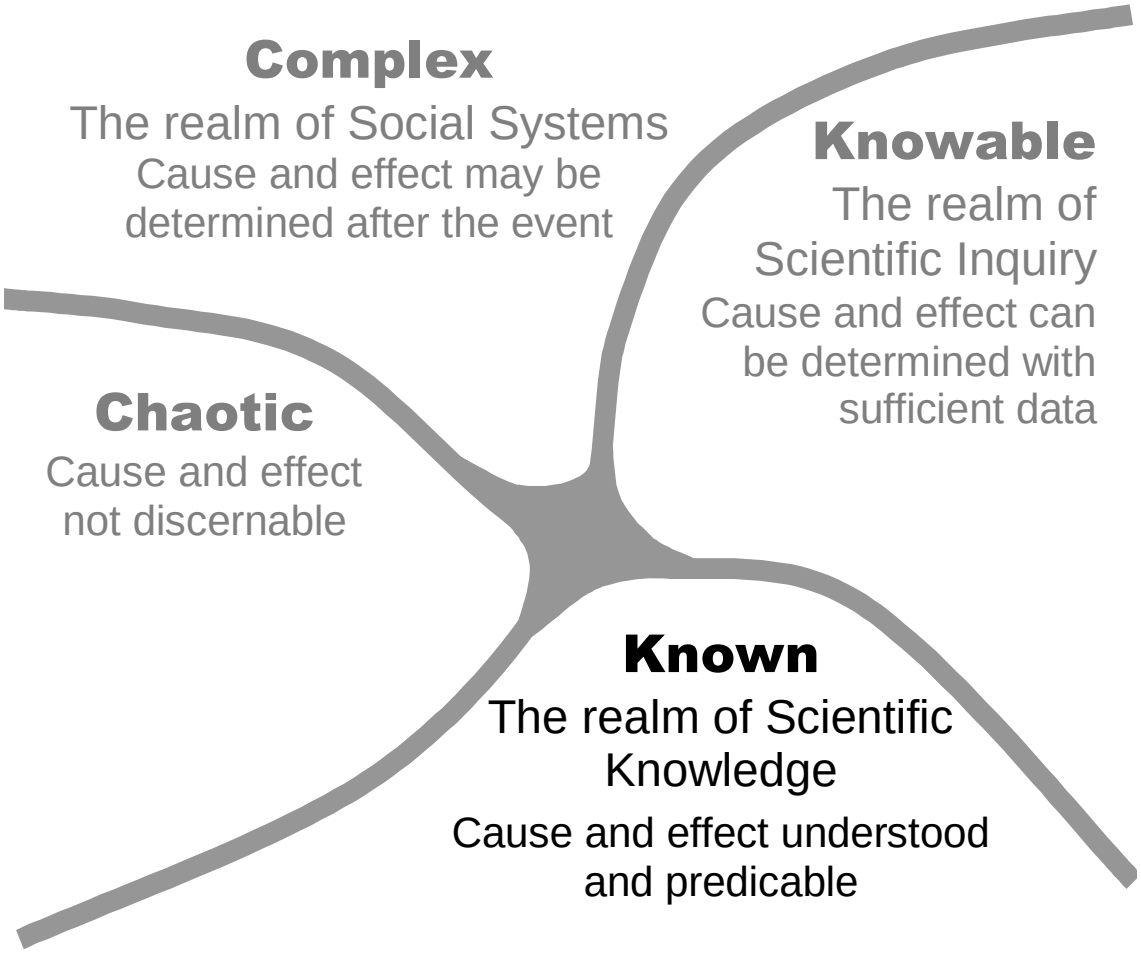

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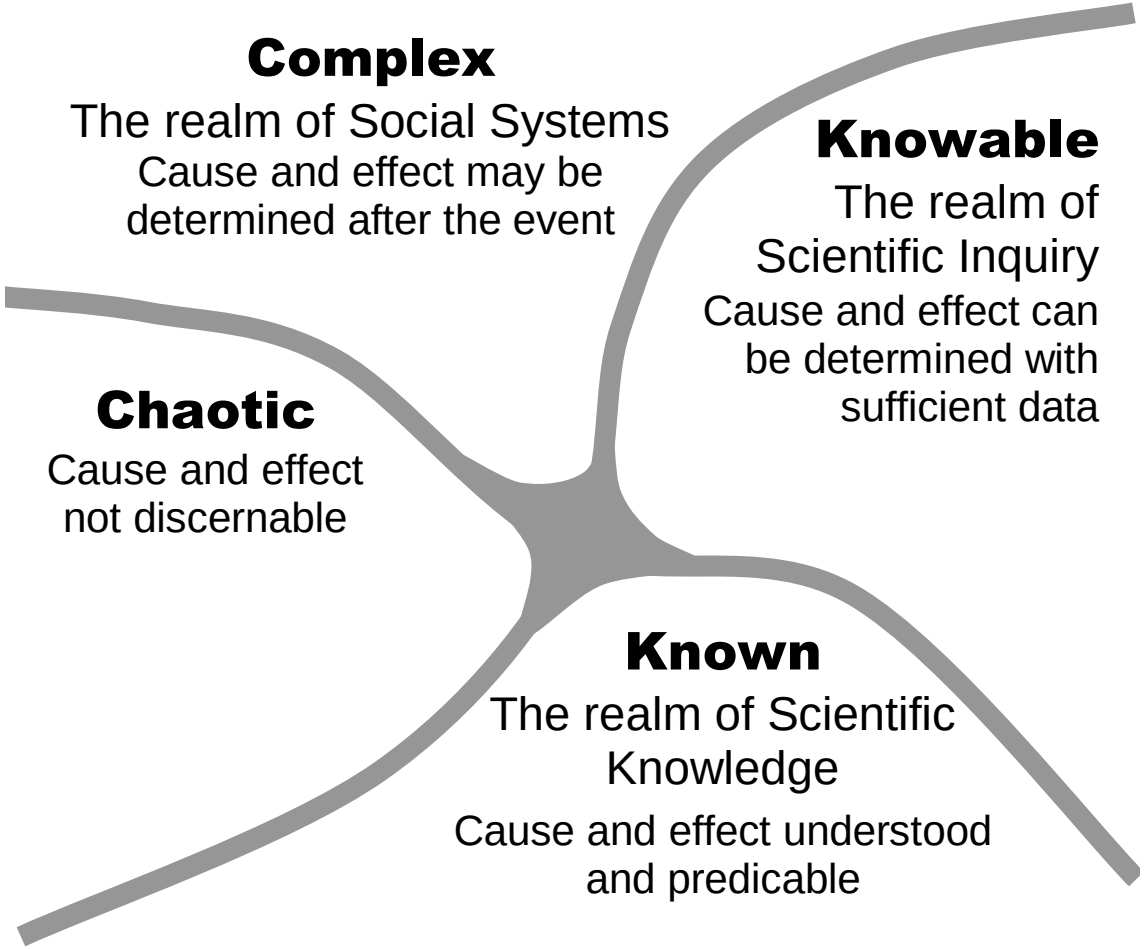
Deep Uncertainty



Behavioural Issues

- **System 1 Thinking**
  - 'intuition' or 'gut reaction'
  - superficial analysis/interpretation of the relevant information
  - based on much simpler forms of thinking on the fringes or outside of consciousness. ⇒ **FAST**
- **System 2 Thinking**
  - conscious analytical thought
  - detailed evaluation of a broad range of information ⇒ **SLOW**
  - often based on a theory of rationality, but not necessarily a sensible one!!
  - Note System 2 does not mean forgetting emotions and values.

Some Broad Methodologies

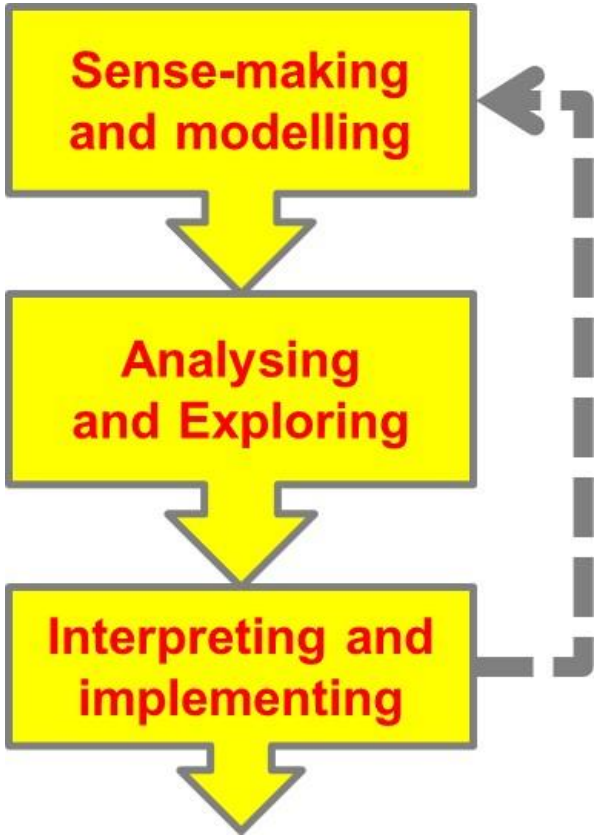
- Bayesian Methods
- Interval Methods
- Multi-Criteria Decision Analysis (MCDA)
- Outranking Methods
- Decision Making under Deep Uncertainty (DMDU)
- Soft Modelling

The Catalogue

Action Tracker	
Def.	A tool for tracking identified risks and the actions which need to be taken to respond to them.
Ref.	Raz, T. & Micheal, E. (2001) 'Use and benefit of tools for project risk management', International Journal of Project Management, 19(1): 9-17.

Agent Based Modelling	
Def.	A type of modelling based on simulating the actions of autonomous agents in their environment, in order to develop an opinion of their effects on the system as a whole. Needs to make assumptions about the beliefs and preferences that drive the agents' behaviours.
Ref.	Axelrod, R. (1997) The Complexity of Cooperation: Agent-based models of competition and collaboration, Princeton University Press. Princeton, USA.

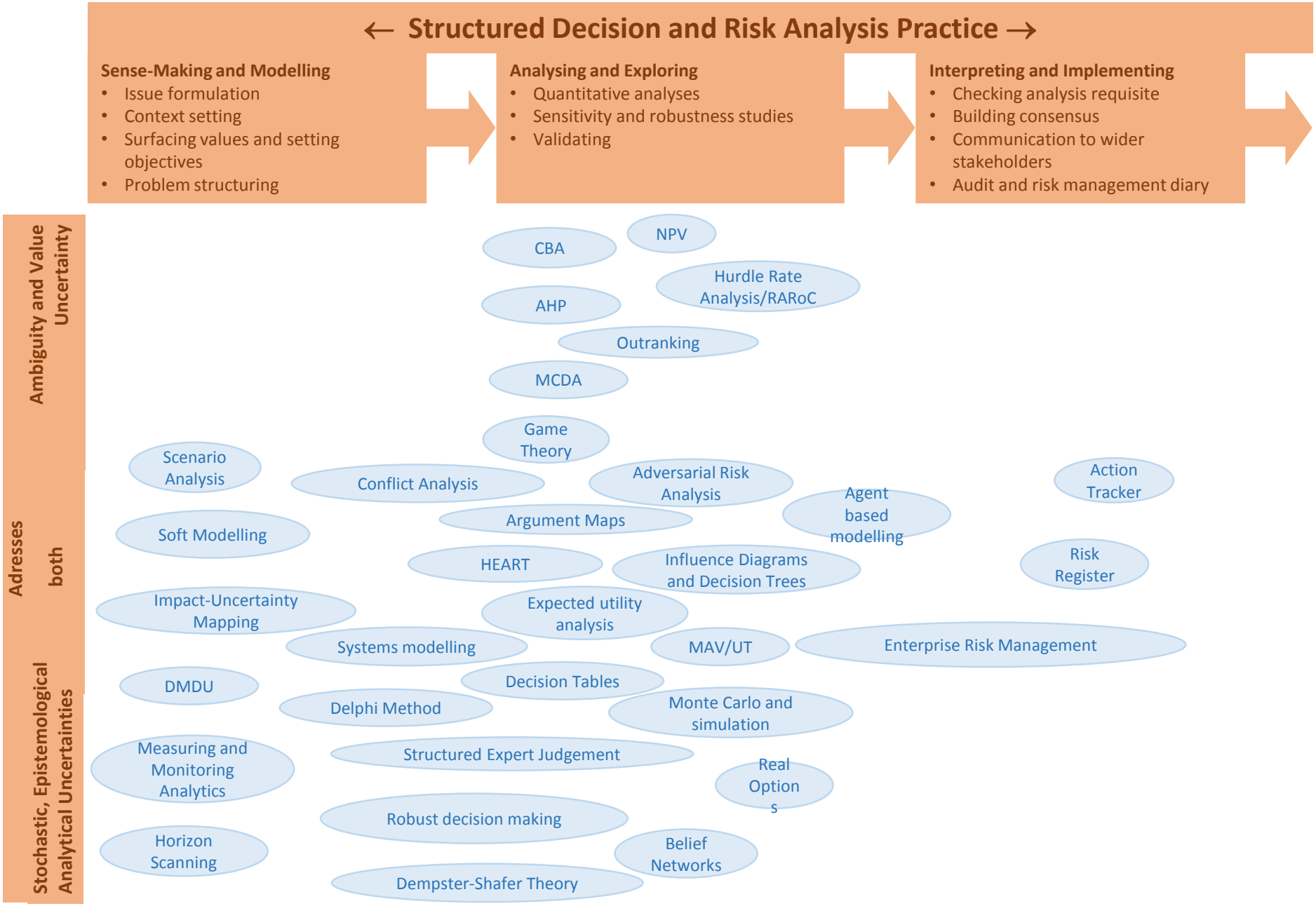
Decision Making Process

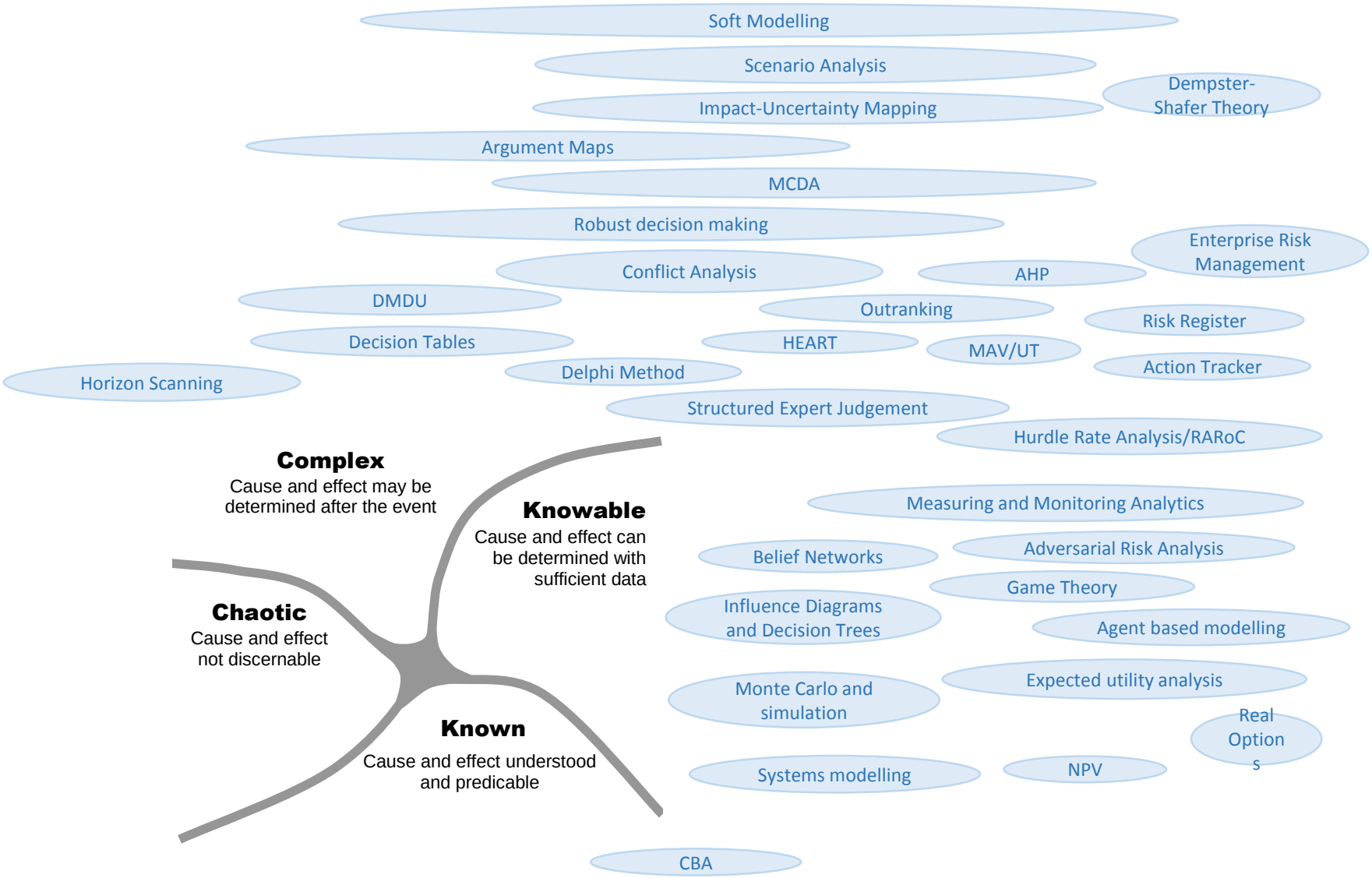


- Issue formulation
- Context setting
- Surfacing values and setting objectives
- Problem structuring

- Quantitative analyses
- Sensitivity and robustness studies
- Validating

- Checking analysis requisite
- Building consensus
- Communication to wider stakeholders
- Audit and risk management diary


← Structured Decision and Risk Analysis Practice →
Sense-Making and Modelling
• Issue formulation
• Context setting
• Surfacing values and setting objectives
• Problem structuring
Analysing and Exploring
• Quantitative analyses
• Sensitivity and robustness studies
• Validating
Interpreting and Implementing
• Checking analysis requisite
• Building consensus
• Communication to wider stakeholders
• Audit and risk management diary
Ambiguity and Value Uncertainty
Adresses both
Stochastic, Epistemological Analytical Uncertainties
CBA
NPV
Hurdle Rate Analysis/RARoC
AHP
Outranking
MCDA
Game Theory
Scenario Analysis
Conflict Analysis
Adversarial Risk Analysis
Action Tracker
Agent based modelling
Argument Maps
Soft Modelling
HEART
Influence Diagrams and Decision Trees
Risk Register
Impact-Uncertainty Mapping
Expected utility analysis
Systems modelling
MAV/UT
Enterprise Risk Management
DMDU
Decision Tables
Delphi Method
Monte Carlo and simulation
Measuring and Monitoring Analytics
Structured Expert Judgement
Real Options
Robust decision making
Horizon Scanning
Belief Networks
Dempster-Shafer Theory


Soft Modelling
Scenario Analysis
Dempster-Shafer Theory
Impact-Uncertainty Mapping
Argument Maps
MCDA
Robust decision making
Enterprise Risk Management
Conflict Analysis
AHP
DMDU
Outranking
Risk Register
Decision Tables
HEART
MAV/UT
Action Tracker
Horizon Scanning
Delphi Method
Structured Expert Judgement
Hurdle Rate Analysis/RARoC
Complex
Cause and effect may be determined after the event
Knowable
Cause and effect can be determined with sufficient data
Measuring and Monitoring Analytics
Belief Networks
Adversarial Risk Analysis
Game Theory
Chaotic
Cause and effect not discernable
Influence Diagrams and Decision Trees
Agent based modelling
Expected utility analysis
Monte Carlo and simulation
Real Options
Known
Cause and effect understood and predicable
Systems modelling
NPV
CBA