Australian Government
Department of Defence
Defence Science and Technology Group

The Future of Machine Learning: *Decision-making under uncertainty*

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Economics, Decision-making and Uncertainty

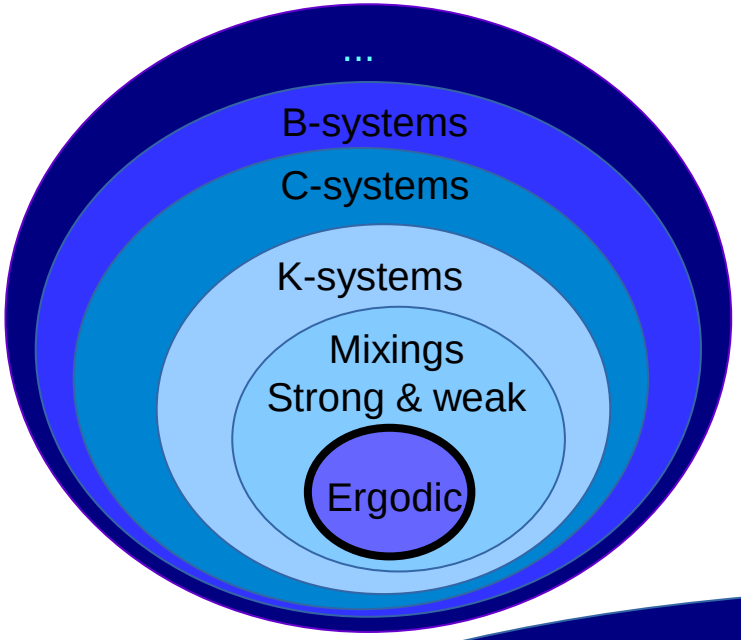
Economics:

- The study of the allocation of scarce resources
  - Different mechanisms have different outcomes at different levels
  - Behaviour of agents and results of interactions of agents
- Resource allocation under capital rationing and fundamental uncertainty

Economic agent:

- Autonomous decision-makers in some system of resource allocation.
- *All* decision-making *is* resource allocation

Three views of uncertainty

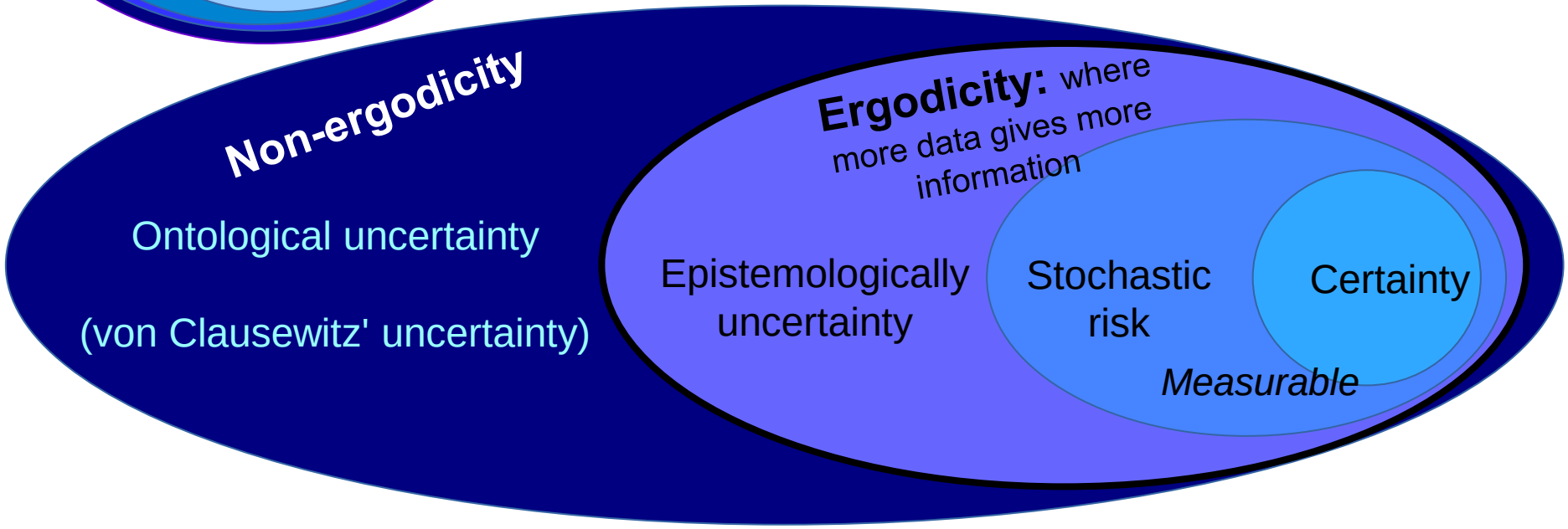


Paradoxes & Incompleteness

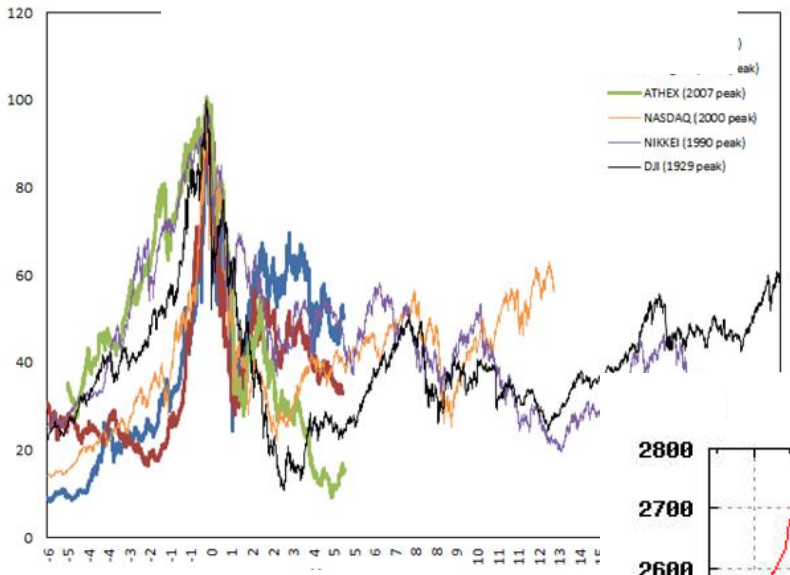
f p ↔ ~□p
"(solve) 'This sentence is unprovable'."

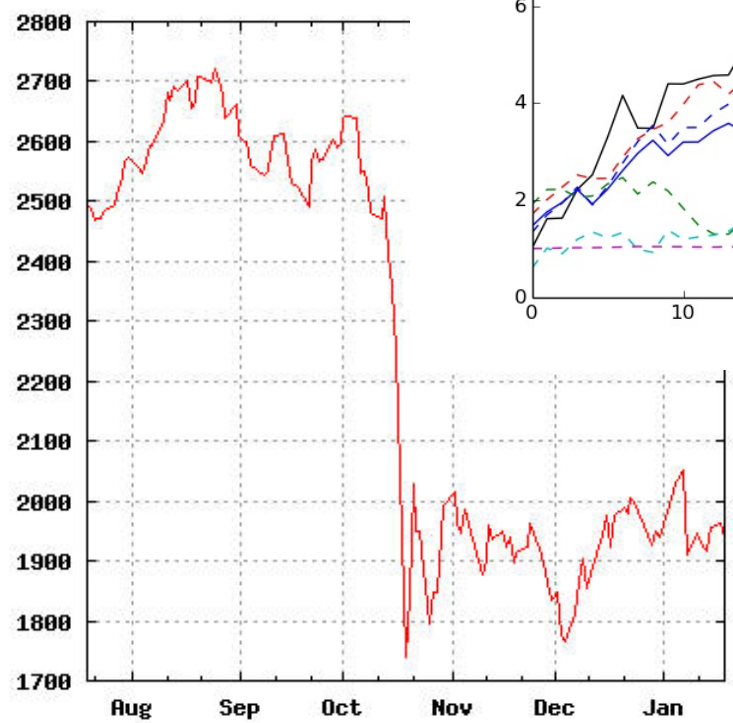
'If this sentence is provable, there is a shorter proof of its negation'

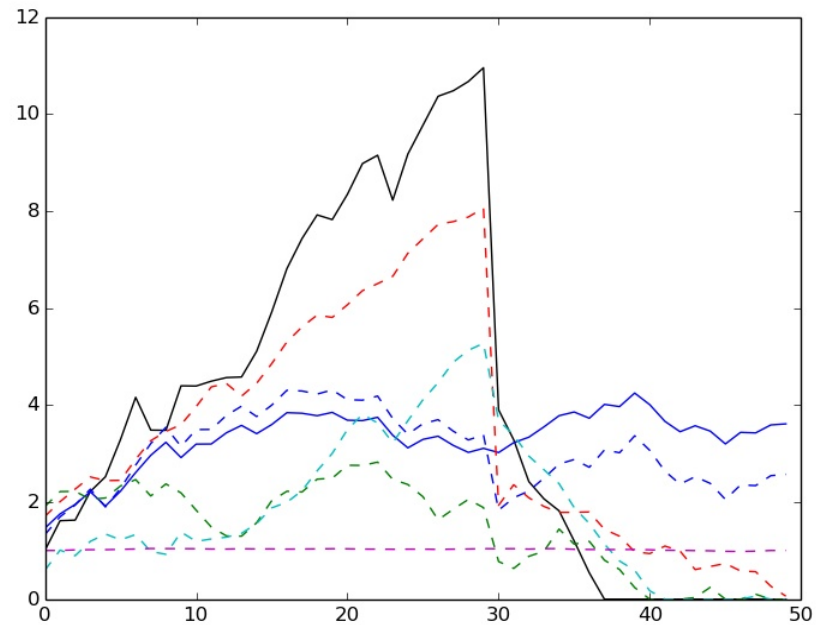
f = ~□(◊T)→◊T
"(solution) 'If PA proves its own consistency, it is inconsistent; if PA is consistent, it cannot prove its own consistency.'"



Complexity & unpredictability in markets







The paradoxes of agency

The actions of agents define the environment, and the environment shapes the actions of the agents

Economic bubbles and subsequent crashes occur because:

1. speculative demand builds on itself (chartists)
2. dynamic asset valuation errors (fundamentalists)

Trading strategies all attempt to handle uncertainty, and indeed are about benefiting from non-stationarity

What might be rational for an individual need not be rational in aggregate, and vice versa

Asymmetry in logic, asymmetry in failure

The paradox of self-knowledge: agents require a theory of self to drive self-allocation