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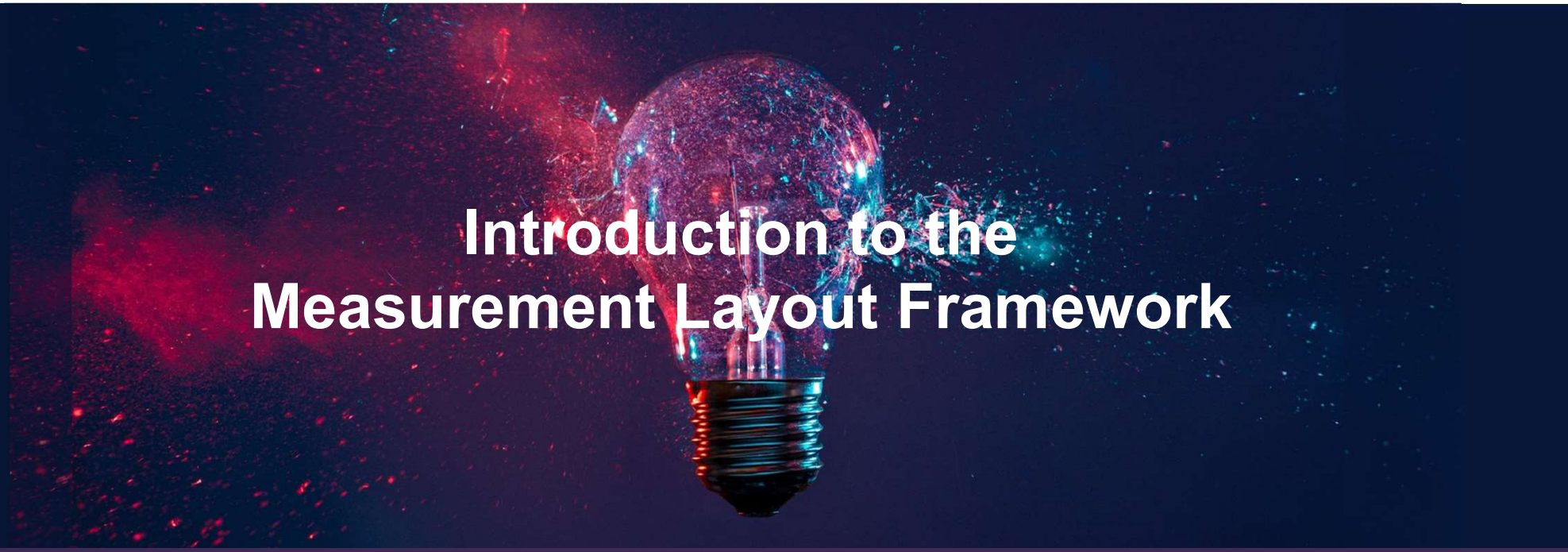

Introduction to the Measurement Layout Framework

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University of Cambridge,

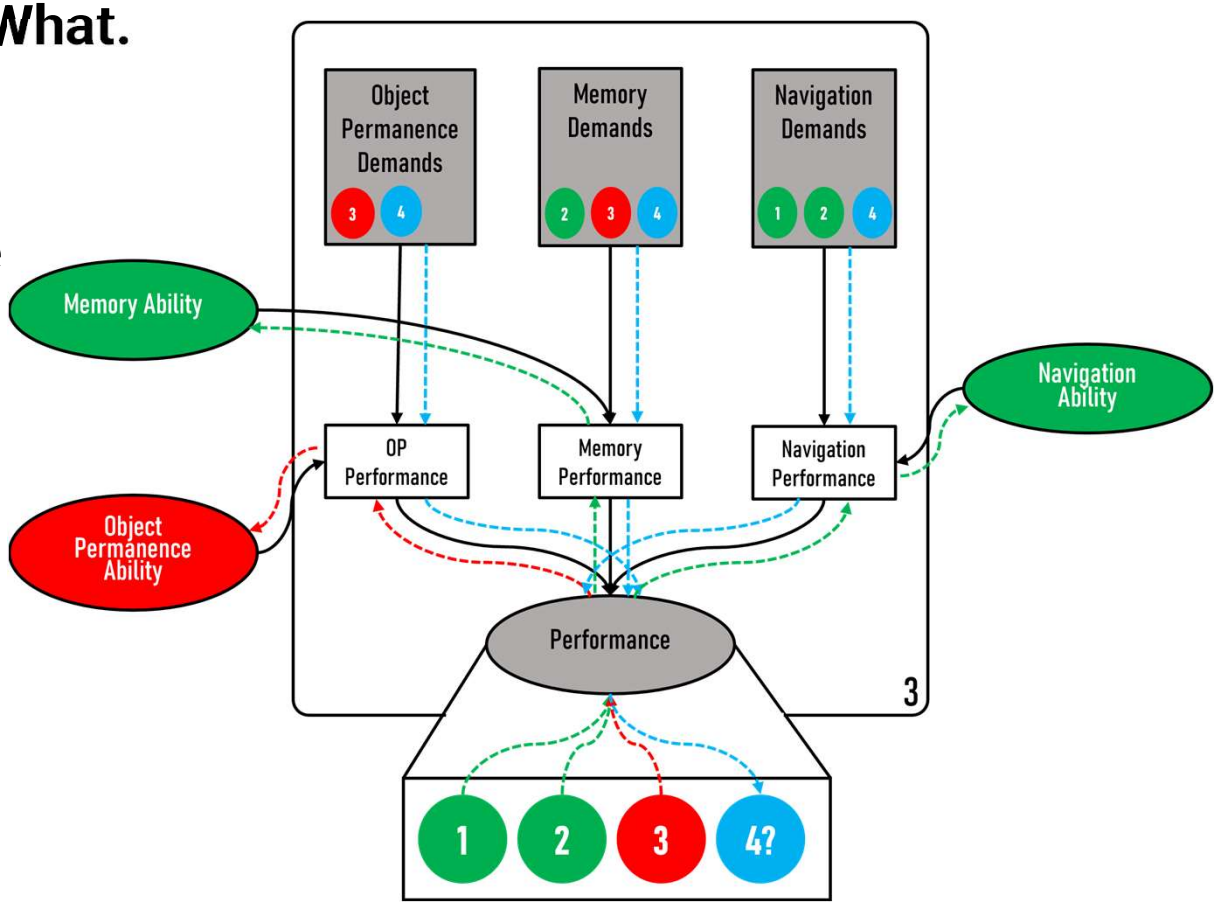
This Session

- Introducing the Measurement Layout Framework:
  - What are they?
  - How are they used?
  - Why do we think they can provide capability-oriented evaluation?

- Hands on experience learning to construct them.

Measurement Layouts – The What.

- If we know the demands of a set of tasks or task instances and how they are related, we can build a Bayesian model that connects system capabilities and task demands.
- From a collection of instances, we can infer capabilities.
- Then we can predict future performance for new instances.

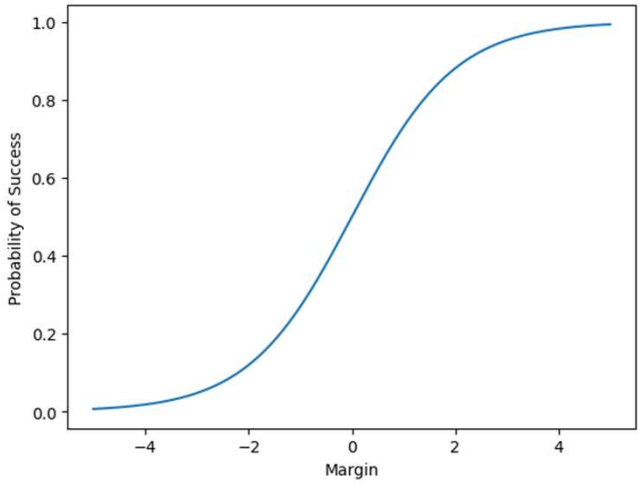


Measurement Layouts – The What

- Increased capabilities make success more likely, while increased demands decrease likelihood of success.
- For a single demand and capability:

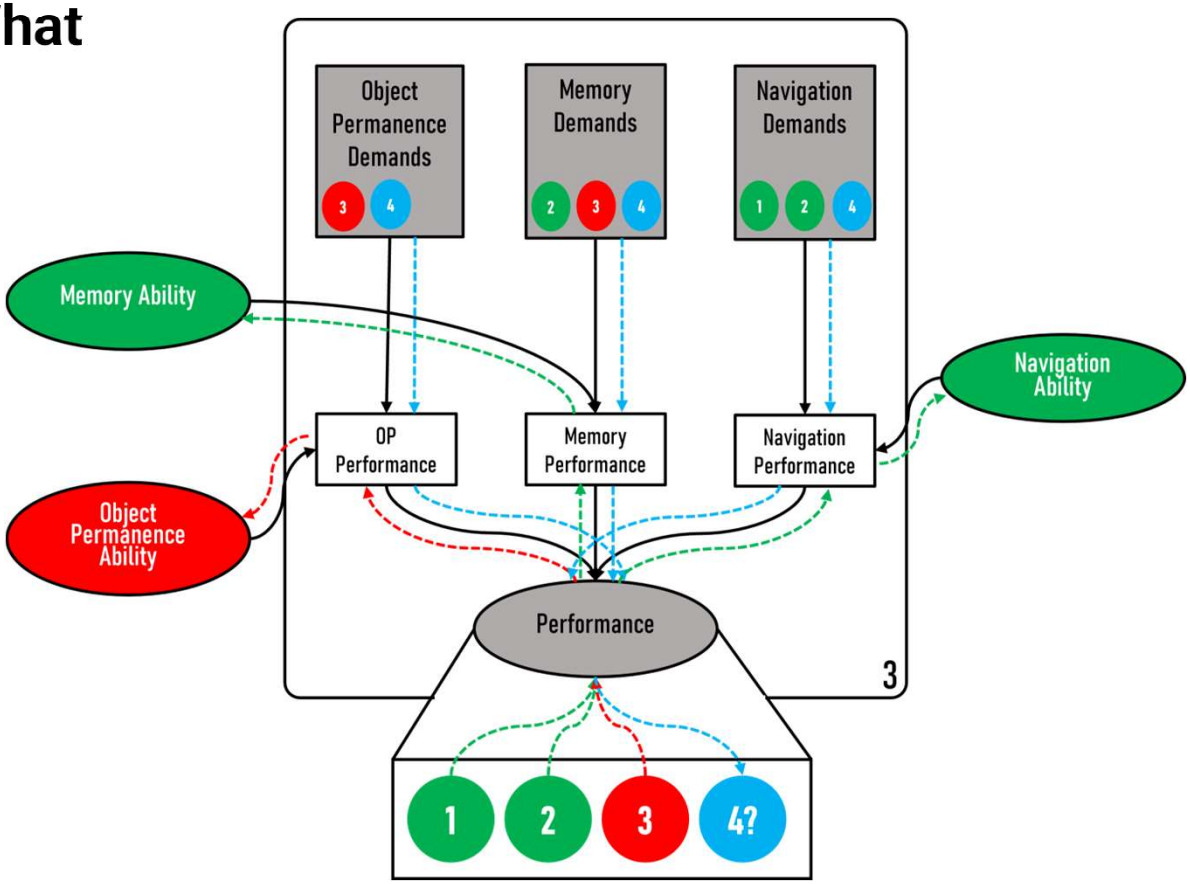
$$P(\mathrm{s}|\mathrm{capability}, \mathrm{demand}) = \sigma(\mathrm{capability} - \mathrm{demand})$$

- The difference between capability and demand is referred to as the *margin*.



Measurement Layouts – The What

- More than a single ability and demand.
- Introduce *partial performance* nodes.
- Final performance will depend on some combination of these.



Measurement Layouts – The What

- The connective structure between nodes can encode knowledge about the task.
- Complex connective structure can arise from the need to accurately distinguish between success, failure, confounding behaviour.
- We refer to the function describing these relationships as *Linking Functions*.
- LFs inform how partial performance is assessed.

Measurement Layouts – The What

- LFs also inform how partial performances are combined to give final performance.
- Some tasks will be non-compensatory. High capabilities in one area will not compensate for lacking in others.
- Some tasks compensatory. One high capability can compensate for low levels in others

Measurement Layouts – The How

- So, we have the structure of a measurement layout in place. What do we do with it?
- Need a data-set with performance outcomes labelled along with demands for each instance.
- Bayesian model needs priors
  - Either encode system knowledge or uninformative.
- We can then leverage a probabilistic programming implementation of the network using PyMC.

Measurement Layouts – The Why

- Why do we expect Measurement Layouts to help provide capability-oriented evaluation.
  - Capabilities are independent of the distribution of tasks instances
  - Allows us to predict future performance at the instance-level. The Measurement Layout models reflect domain expertise
    - Higher internal validity.
    - Enables predictions to be valid even out of distribution.

Exploring Measurement Layouts in PyMC

- https://github.com/Kinds-of-Intelligence-CFI/measurement-layout-tutorial