UNIVERSITY OF
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Proposed DPhil project (2013 - 17)

Neurobiological and computational mechanisms of complex planning and uncertainty in navigation

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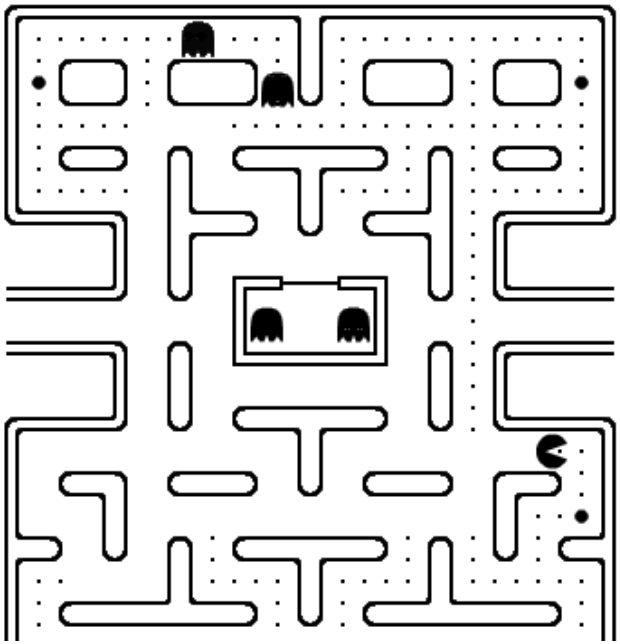
Background

Decisions involve learning about the value of actions.

Reinforcement learning (RL) describes how action values are updated on the basis of prediction errors.

Neurobiology provides evidence that the brain implements RL.

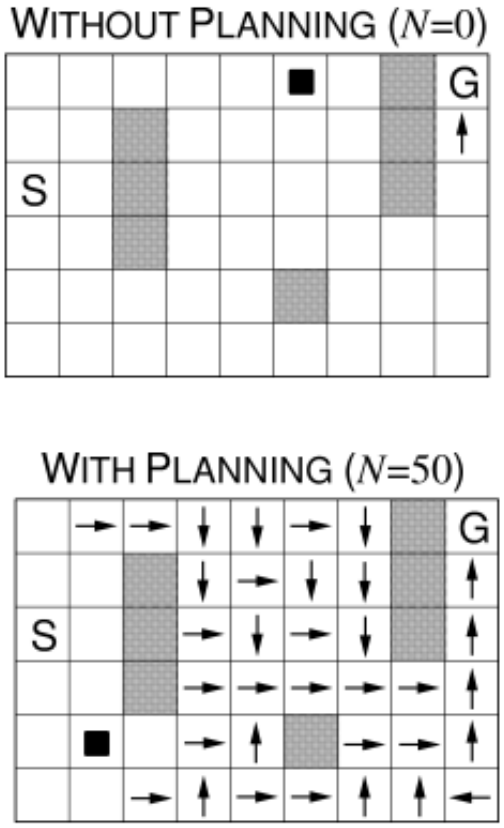
Background



Standard ('model-free') RL has an important limitation.

When several steps are required to harvest a reward, decisions can be improved by *planning.*

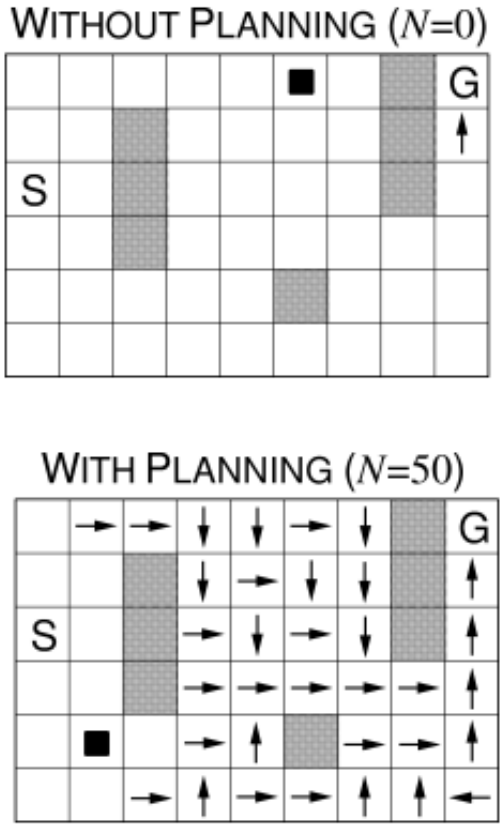
Background



Model-based RL describes how we can plan based on a model of the environment.

Planning allows us to update action values by exploring our model of the world, via mental simulation.

Models



Humans are limited-capacity agents.

We deal with the accuracy/complexity trade-off using heuristic strategies.

An ideal observer will estimate uncertainty when choosing between plans. But estimating uncertainty is costly.

Research questions

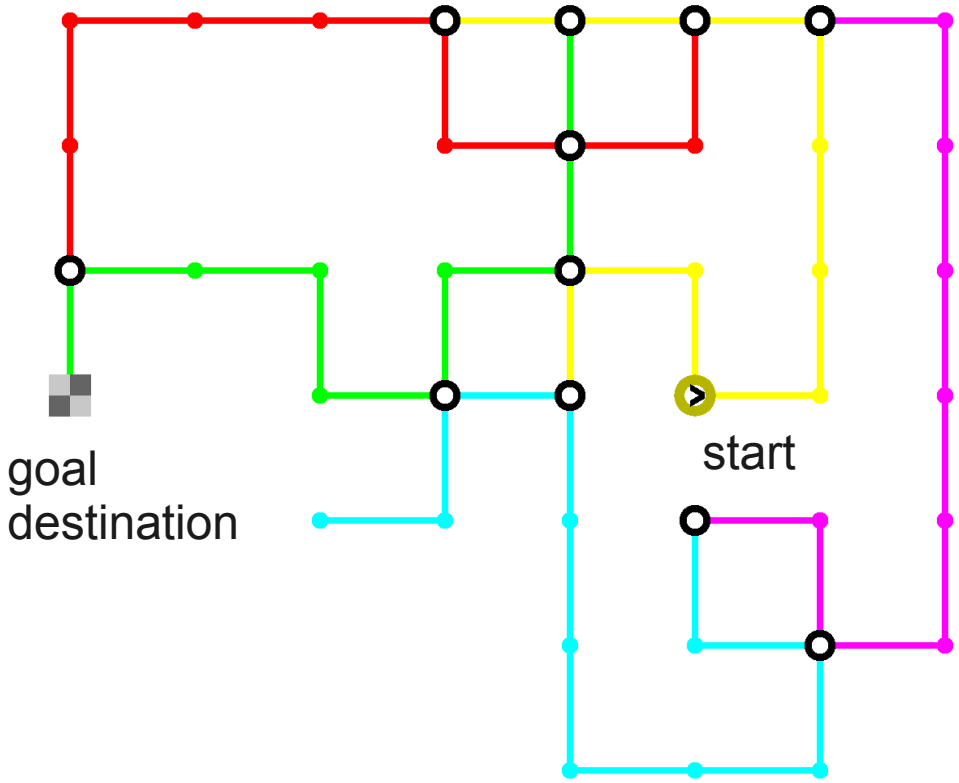
1 \ Are human subjects optimal when making plans to solve multi-step decision problems?

2 \ How do humans deal with exploration / exploitation trade-off in multistep decision problems?

3 \ What are the neural substrates underlying those strategies?

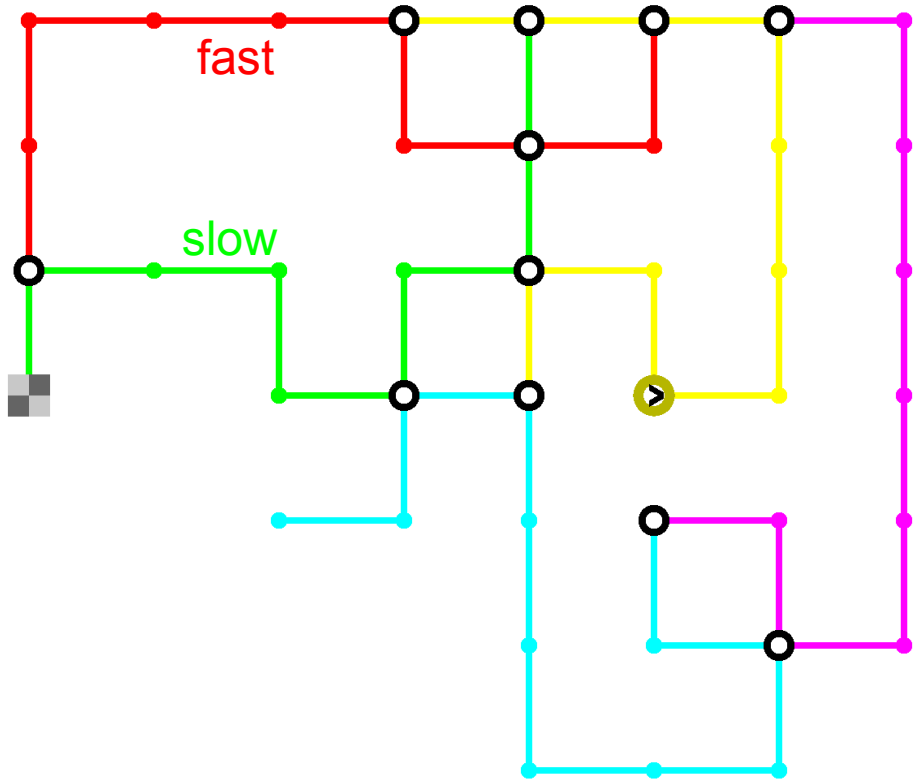
Experiment 1

1 \ Task: planning journeys through a virtual subway network

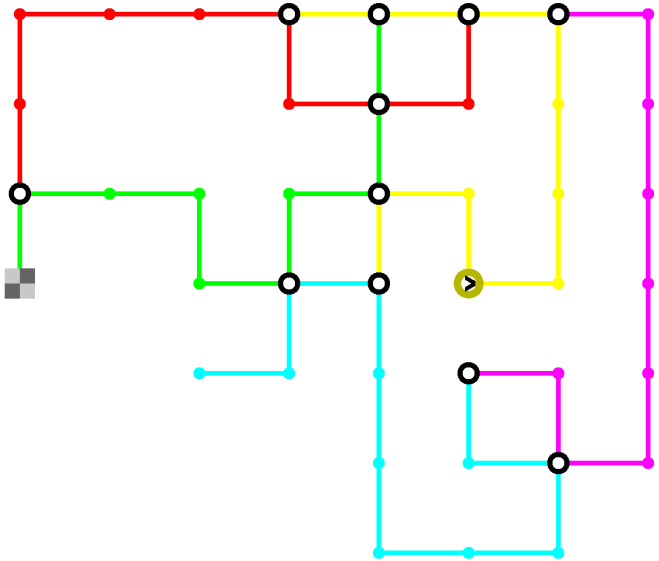


Experiment 1

2 \ Vary parameters such as mean and variance of speed of each line

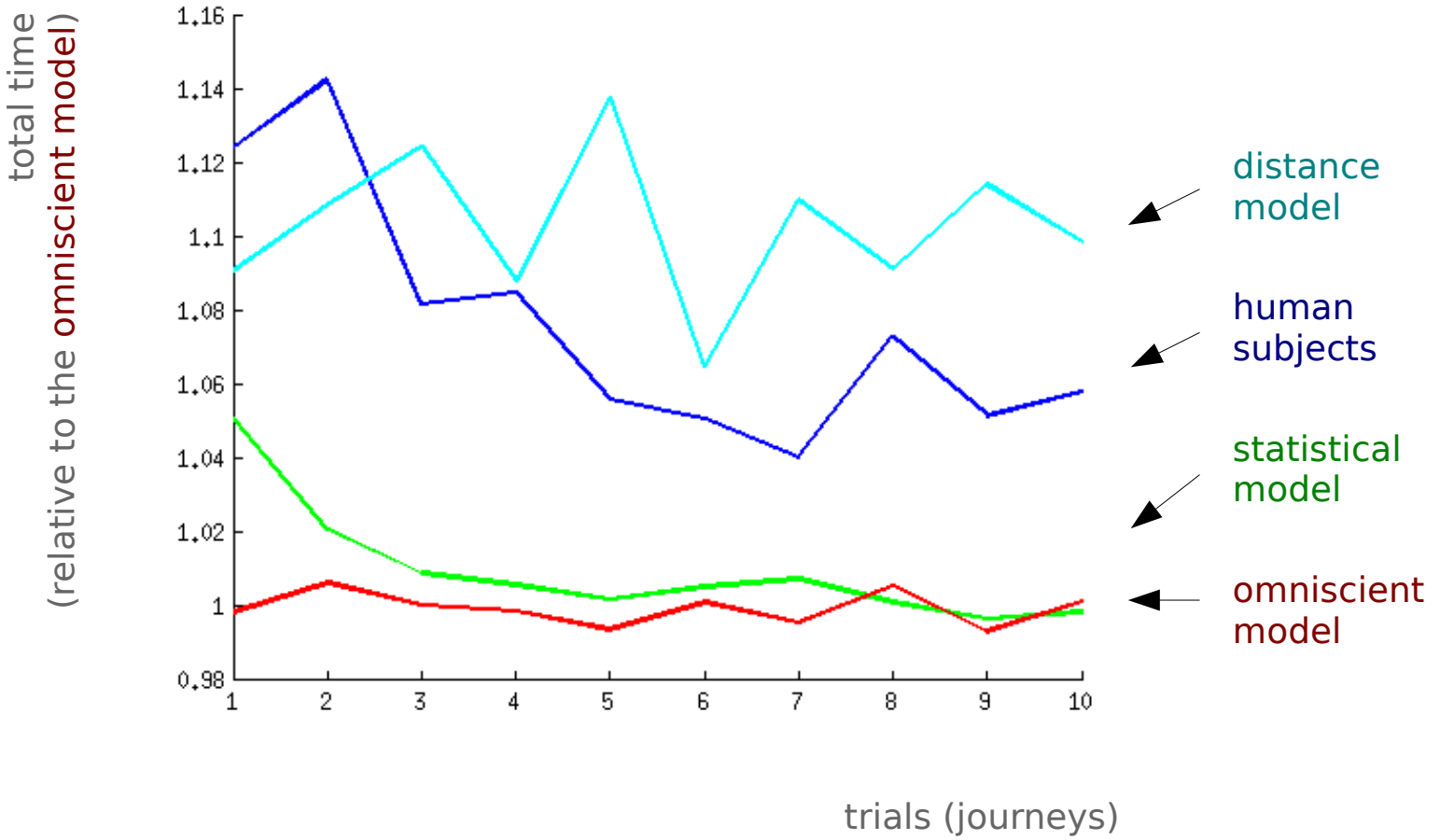


Pilot data

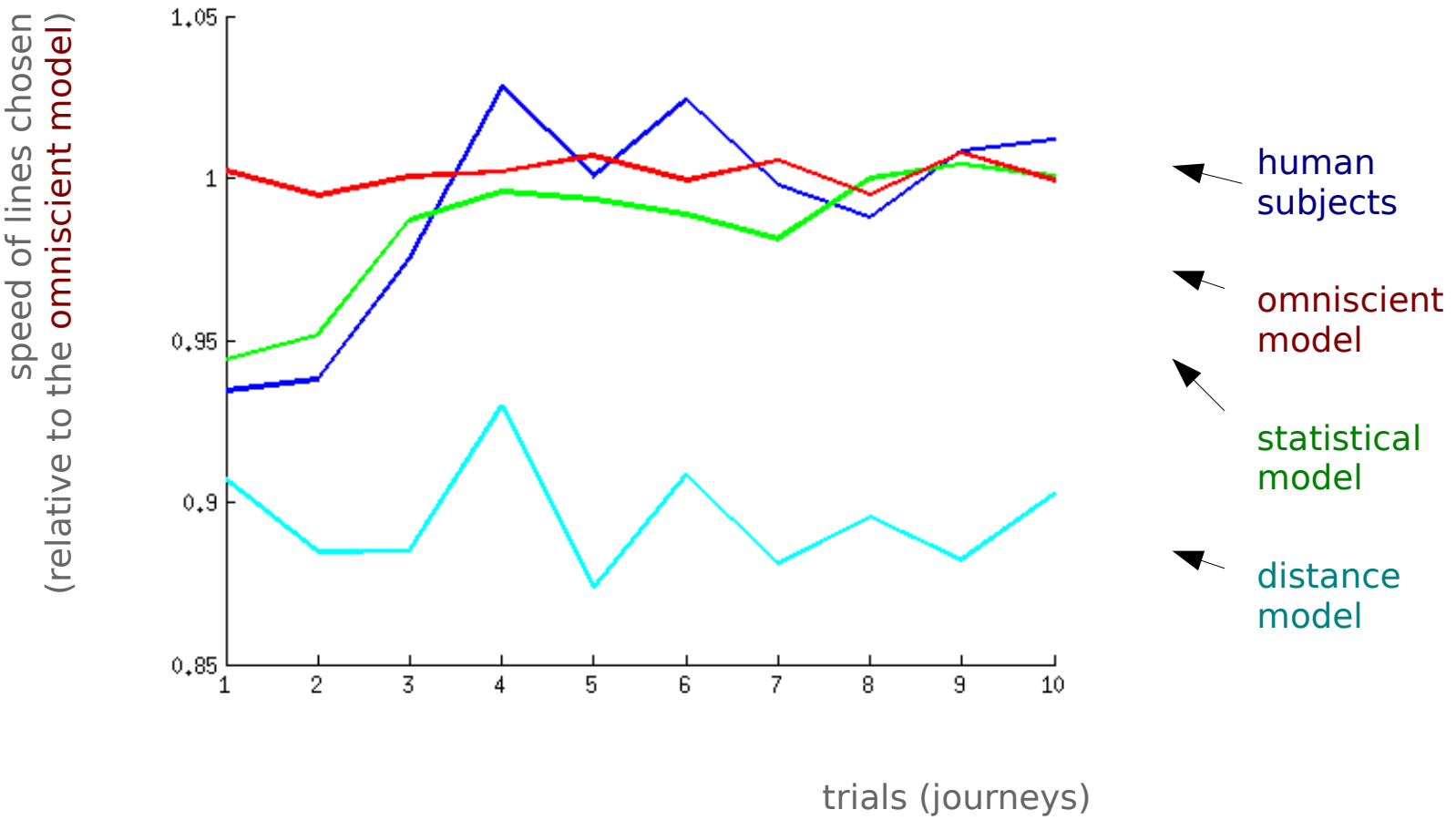


- 10 subjects
- 10 trials/map
- goal: minimize travel time
- Fixed mean of the speed of each line, with some variability

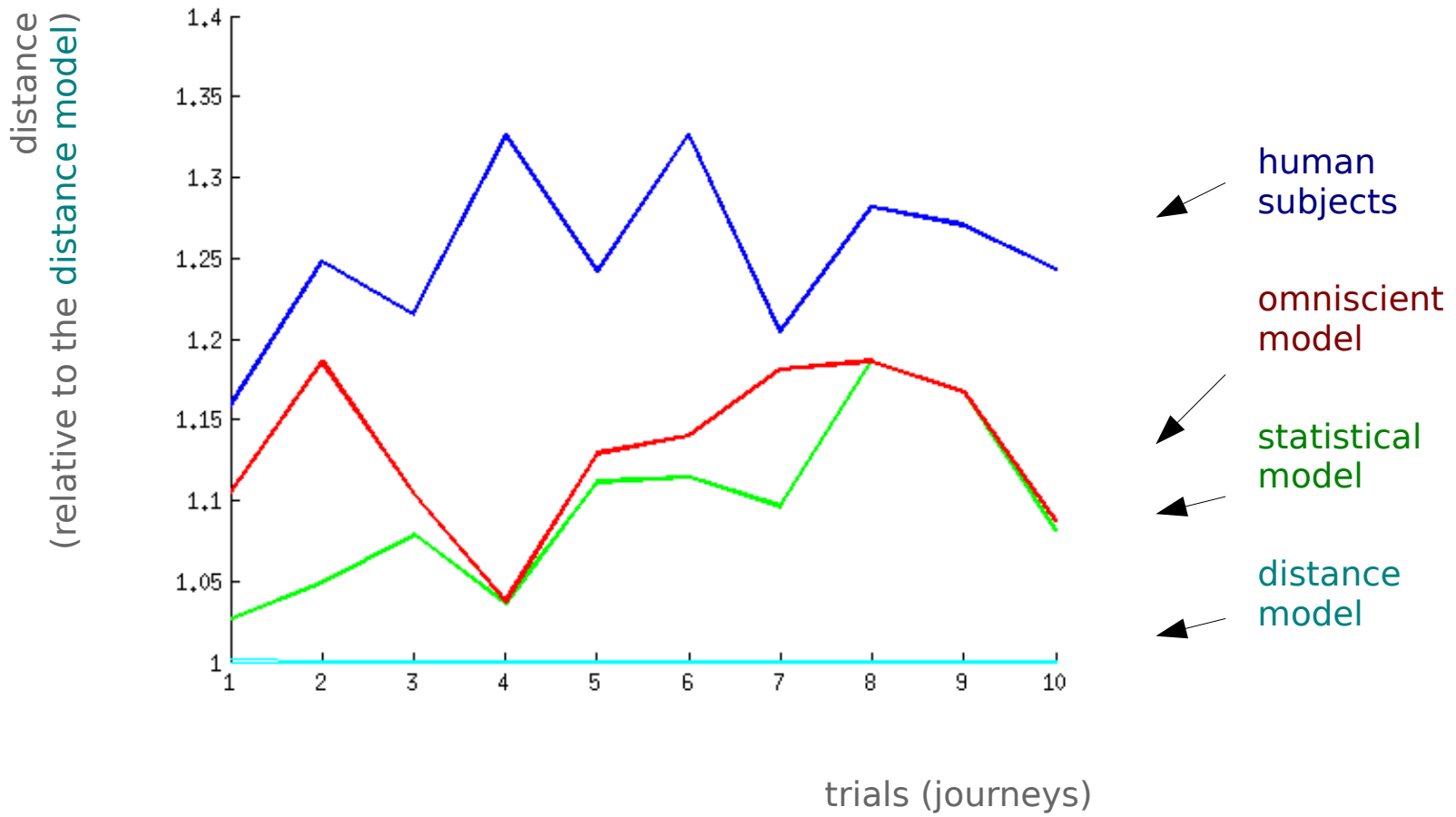
Comparison of human and model data



Humans increase speed across trials



Humans maintain distance across trials



Future plans and conclusions

1 \ Are human subjects optimal during navigation planning?

2 \ How humans deal with exploration/exploitation trade-off in multi-step decision problems?

3 \ What are the neural substrates underlying those strategies?

Pilot of Experiment 1:
Proof of concept

Experiment 2:
Same task with both different mean and variance

Computational models
...taking risk into account

Experiment 3:
Use the computational models to predict brain activity in the fMRI scanner