An Impact Measurement Manager Approach to AI Safety

Master's thesis in Mathematical Statistics, Statistical Learning and AI

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Opponents:	Jens Ifver and Calvin Smith Universty of Gothenburg

Introduction

Aim of Thesis

Investigation

- Provide an in-depth investigation on current litterature on AI safety.

Simulation

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- Specifically, low-impact AIs using impact measurements.

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- Evaluate it in different environmets.
- Compare the results with the current litterature.

Overview of Presentation

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- Finally, I will present the results.

AI Safety

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- What is Artificial Intelligence (AI)?
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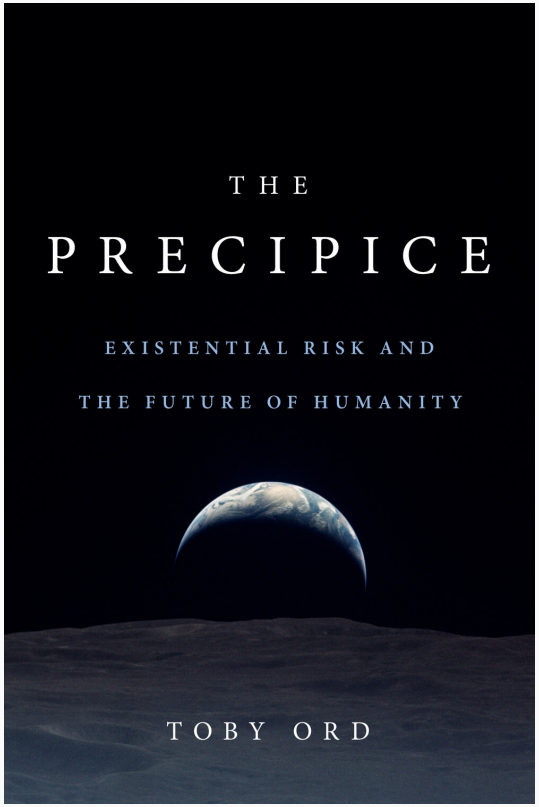
- AI will likely become more intelligent then us.

Risk of existential catastrophe

Toby Ord in his book *The Precipice* loosely estimates the chance of a existential catastrophe in the upcoming century to be:



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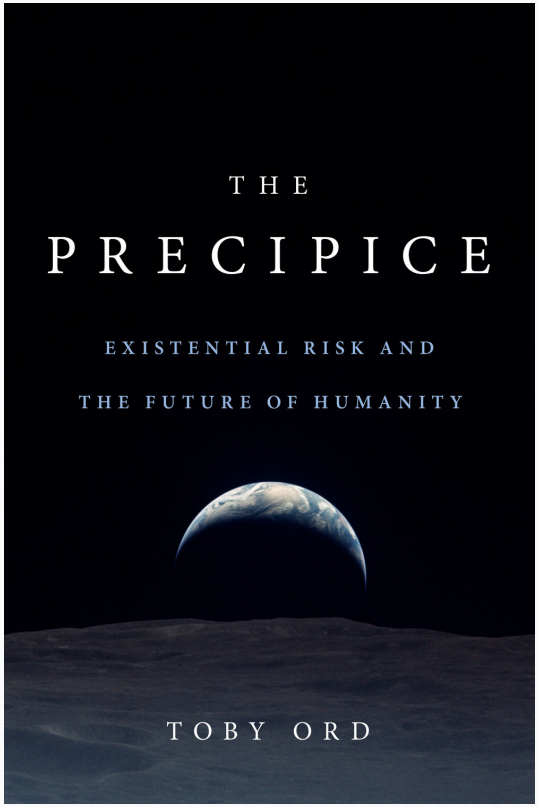

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- Prepotent AI:
  An TAI that once deployed would be unstoppable.

Existential risk

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An existential risk is any risk that has the potential to eliminate all of humanity or, at the very least, kill large swaths of the global population, leaving the survivors without sufficient means to rebuild society to current standards of living.

The human fragility argument

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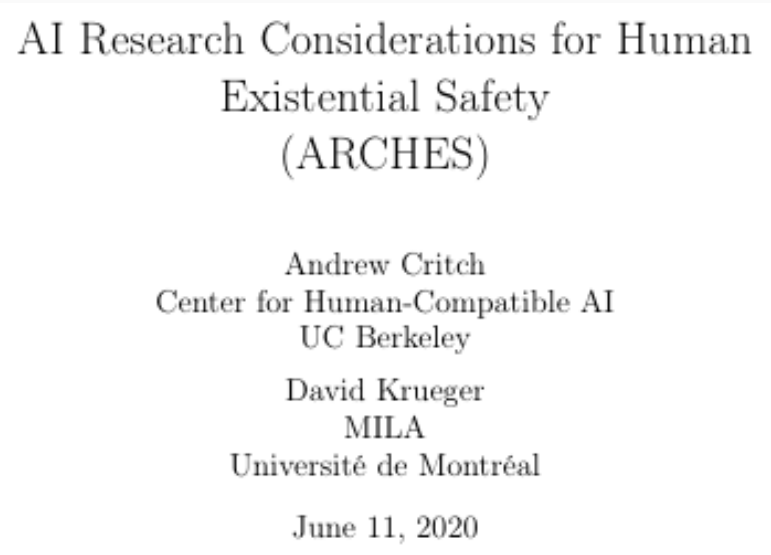
Human fragility argument:



AI Research Considerations for Human Existential Safety (ARCHES)

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June 11, 2020

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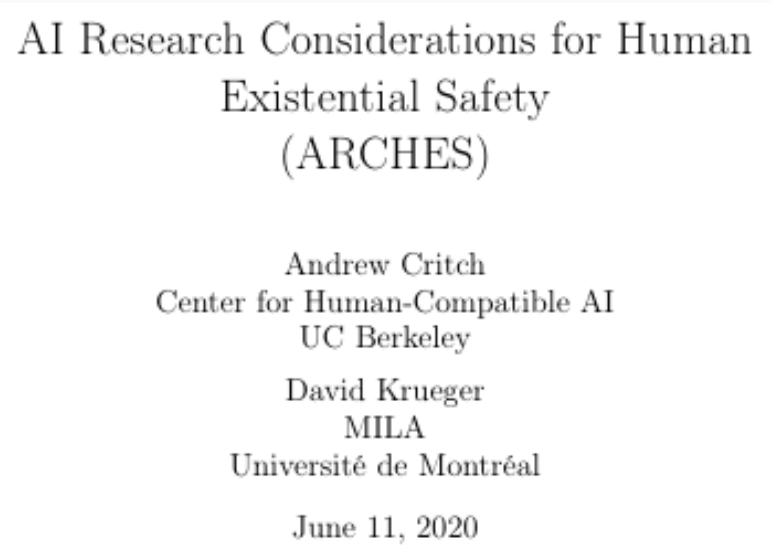

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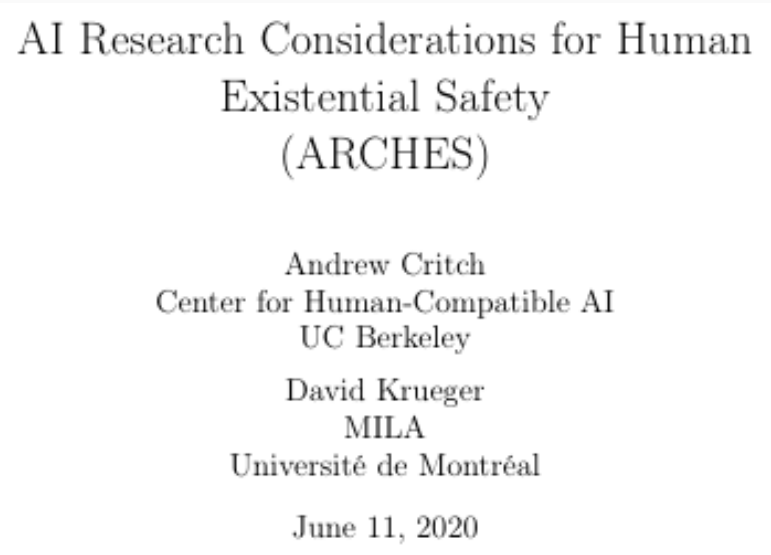

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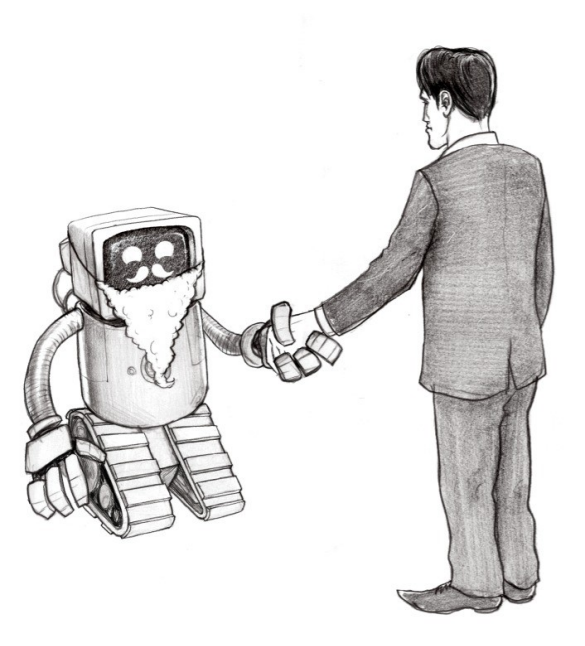

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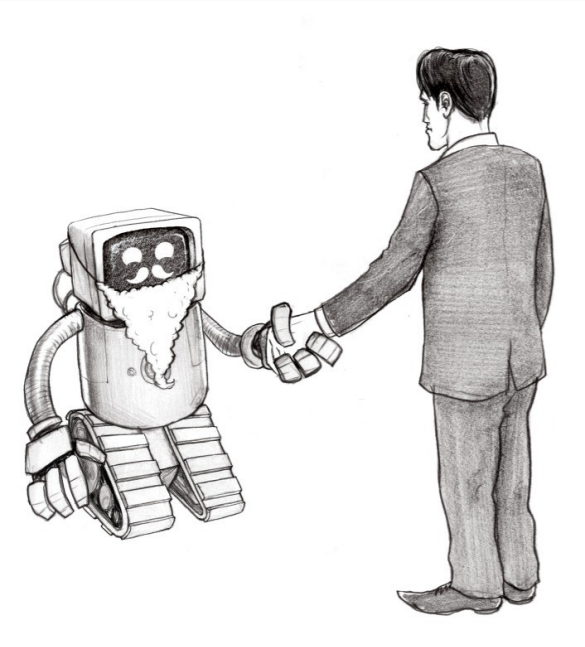

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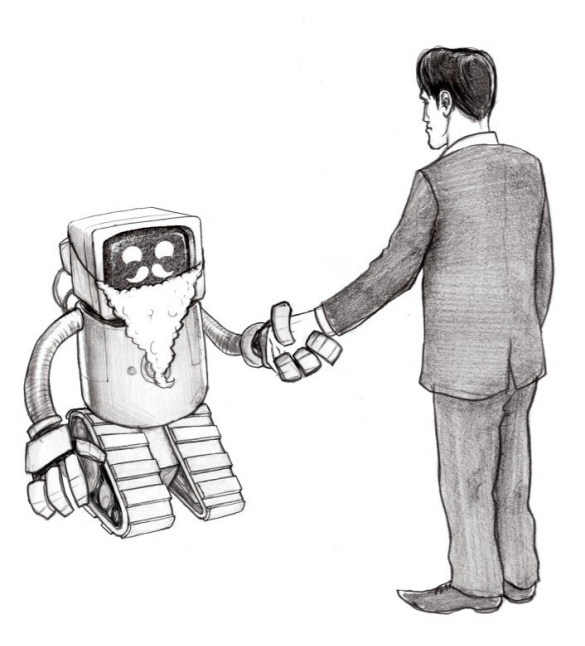

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- For example, corrigibility and interruptibility.
- And, inverse reinforcement learning.
- But I have focused on side effect minimization.

Side effects

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When an AI impacts the environment in a way that is unnecessary for achieving its objective.

Low impact AI

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Low impact AI

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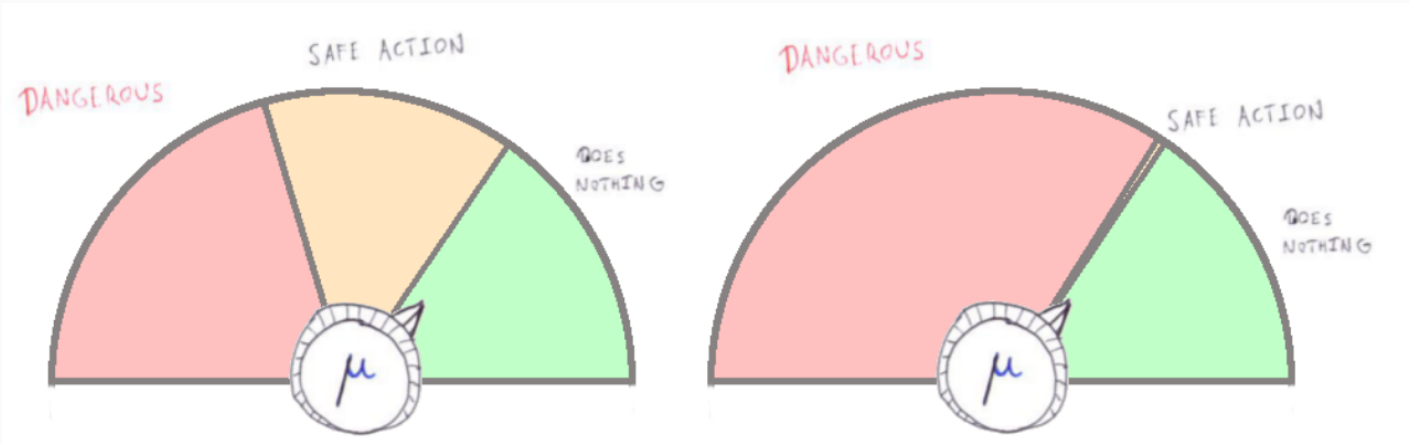
- The idea is to penalize the AI based on its impact.
- The key here is to find the right value for the penalization.



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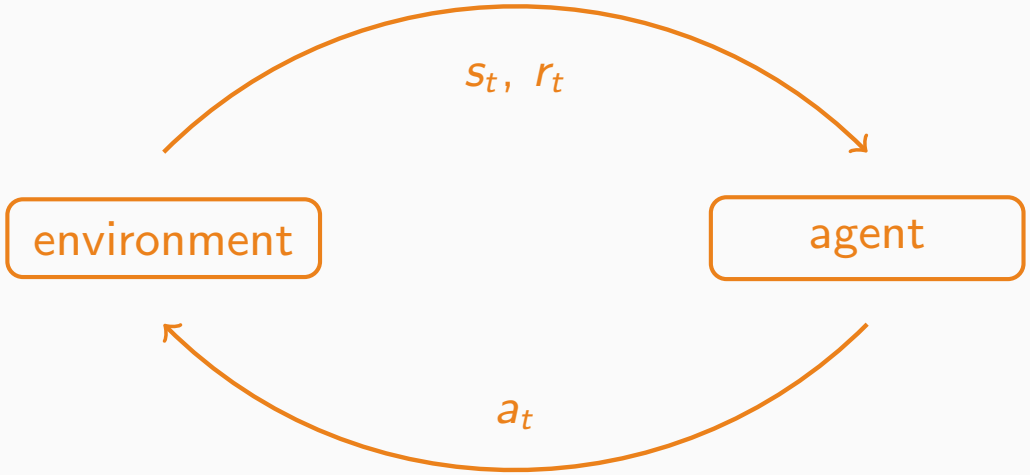

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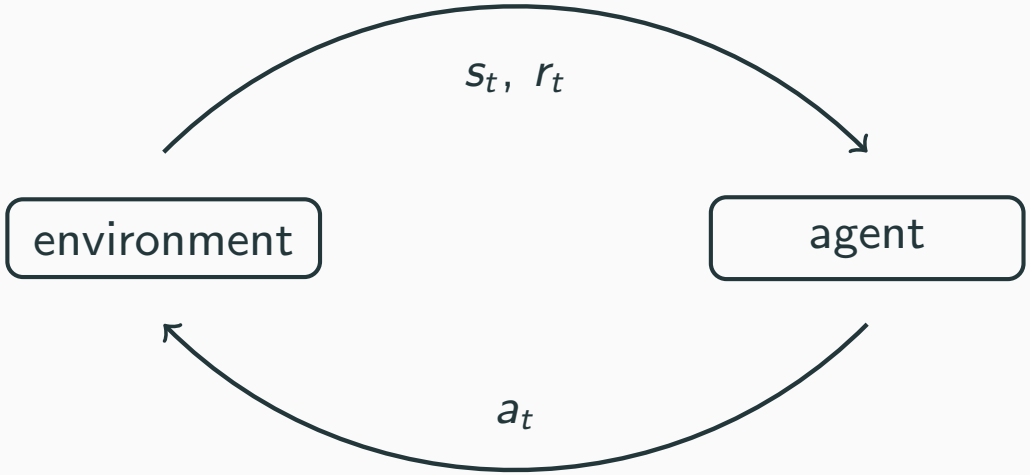


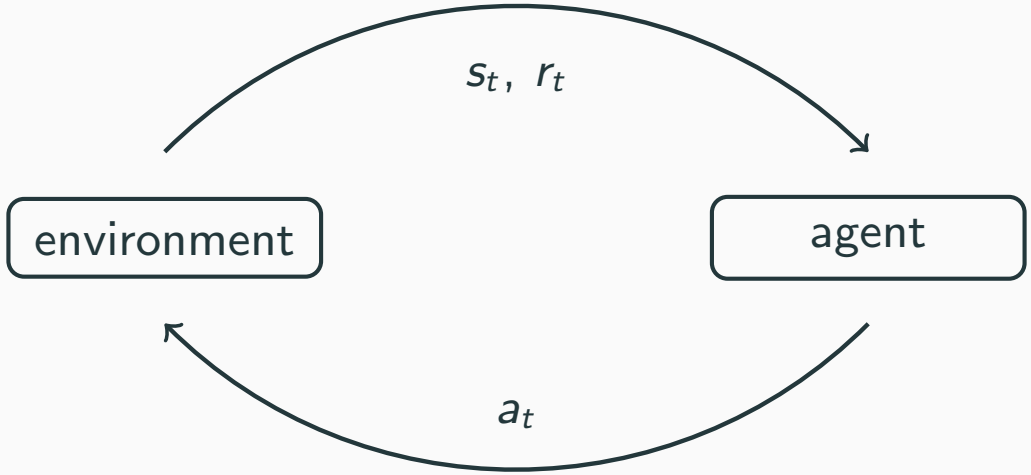
- The impact measurement is added to the reward function.

$$R'(s_t) := R(s_t) - \lambda d(s_t, s'_t).$$

Manager Approach

Reinforcement learning

Reinforcement Learning (RL)



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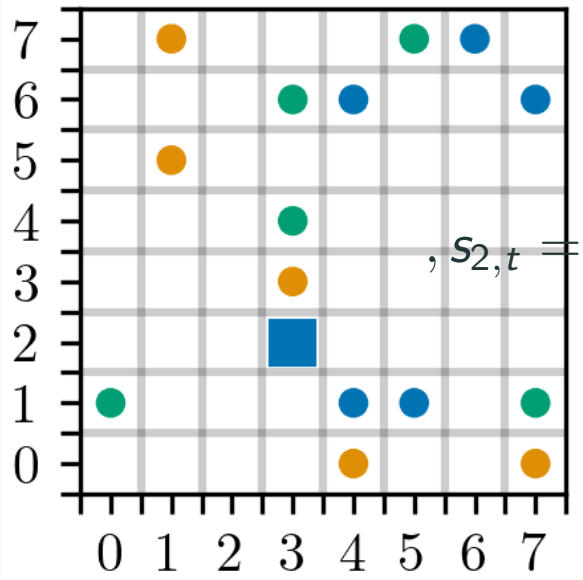
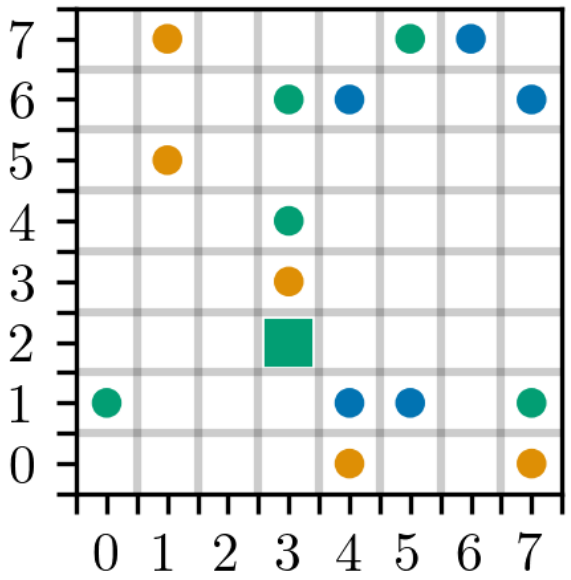
$$L^{CLIP}(\theta) = \mathbb{E}_t \left[\min(\delta_t(\theta)\ \hat{A}_t,\ \text{clip}(\delta_t(\theta), 1-\epsilon, 1+\epsilon)\ \hat{A}_t) \right]$$

$$\delta_t(\theta) = \frac{\pi_\theta(a_t|s_t)}{\pi_{\theta_{old}}(a_t|s_t)}$$

Grid worlds

Live demo!

Auxiliary tasks

$s_{1,t} =$  , $s_{2,t} =$ 

The manager approach

With a trained manager, we use the following formula for the impact measurement:

$$d(s_t, s_{t+1}) := \sum_{x=1}^{2} \hat{V}_\phi(s_{x,t+1}) - \hat{V}_\phi(s_{x,t}).$$

$$R'(s_{t+1}) = R(s_{t+1}) + \lambda d(s_t, s_{t+1}).$$

Training the manager

Require: An MDP, a pre-trained policy π, and initial manager parameters ϕ_0

1: **for** k = 0, 1, 2, ... **do**

2: Collect set of trajectories $\mathcal{D}_k = \{\tau_i\}$

3: Randomly select augmentation x

4: Fit manager estimate by regression using the mean-squared error:

$$\phi_{k+1} = \arg\min_{\phi} \frac{1}{|\mathcal{D}_k| T} \sum_{\tau \in \mathcal{D}_k} \sum_{t=0}^{T} \left(\hat{V}_{\phi}(s_t^x) - V^{\pi}(s_t) \right)$$

5: **end for**

Experiments

The following environments will be used:

environment	grid	observation	food objects	termination	max length
MDP	8×8	-	15	3	100
POMDP	8×8	5×5	15	3	100
POMDP large	16×16	5×5	30	6	200

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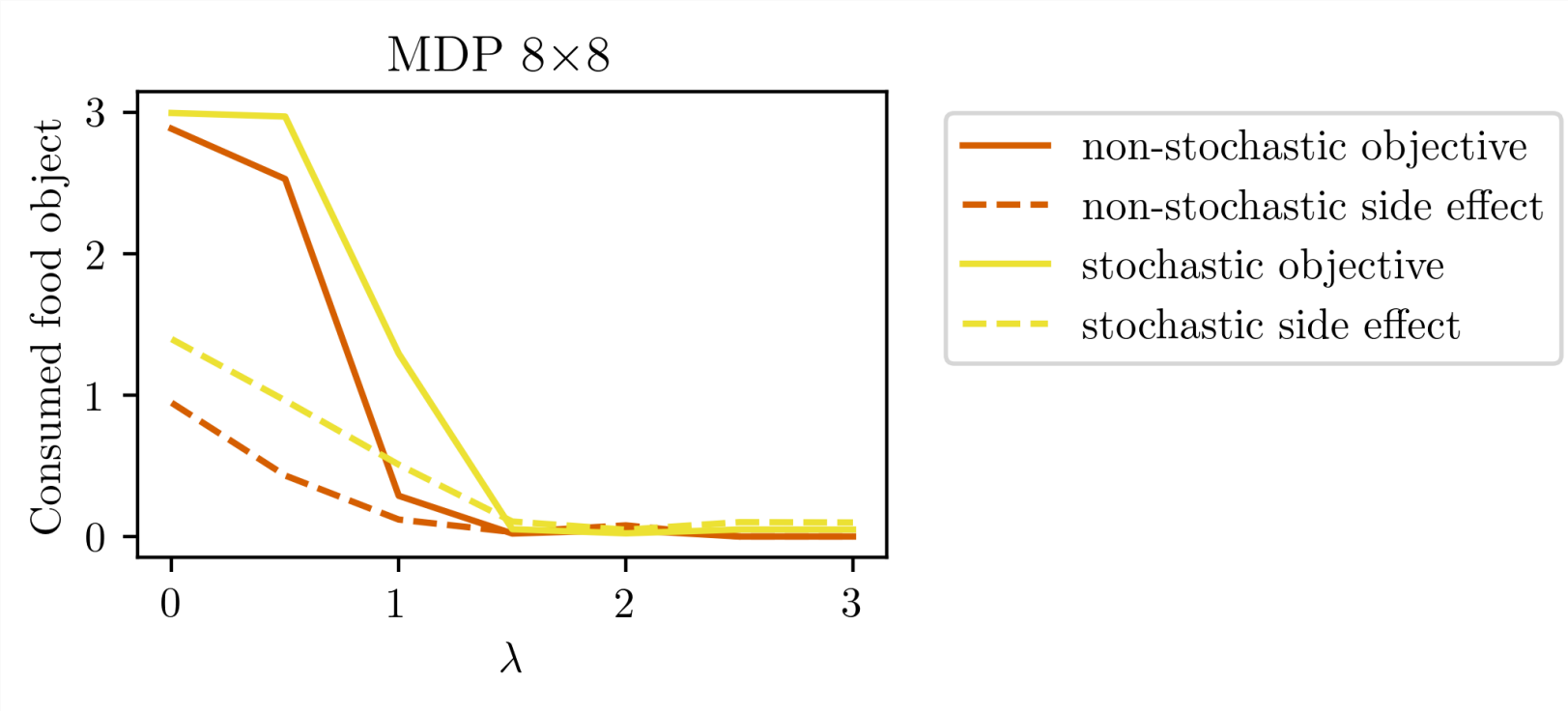
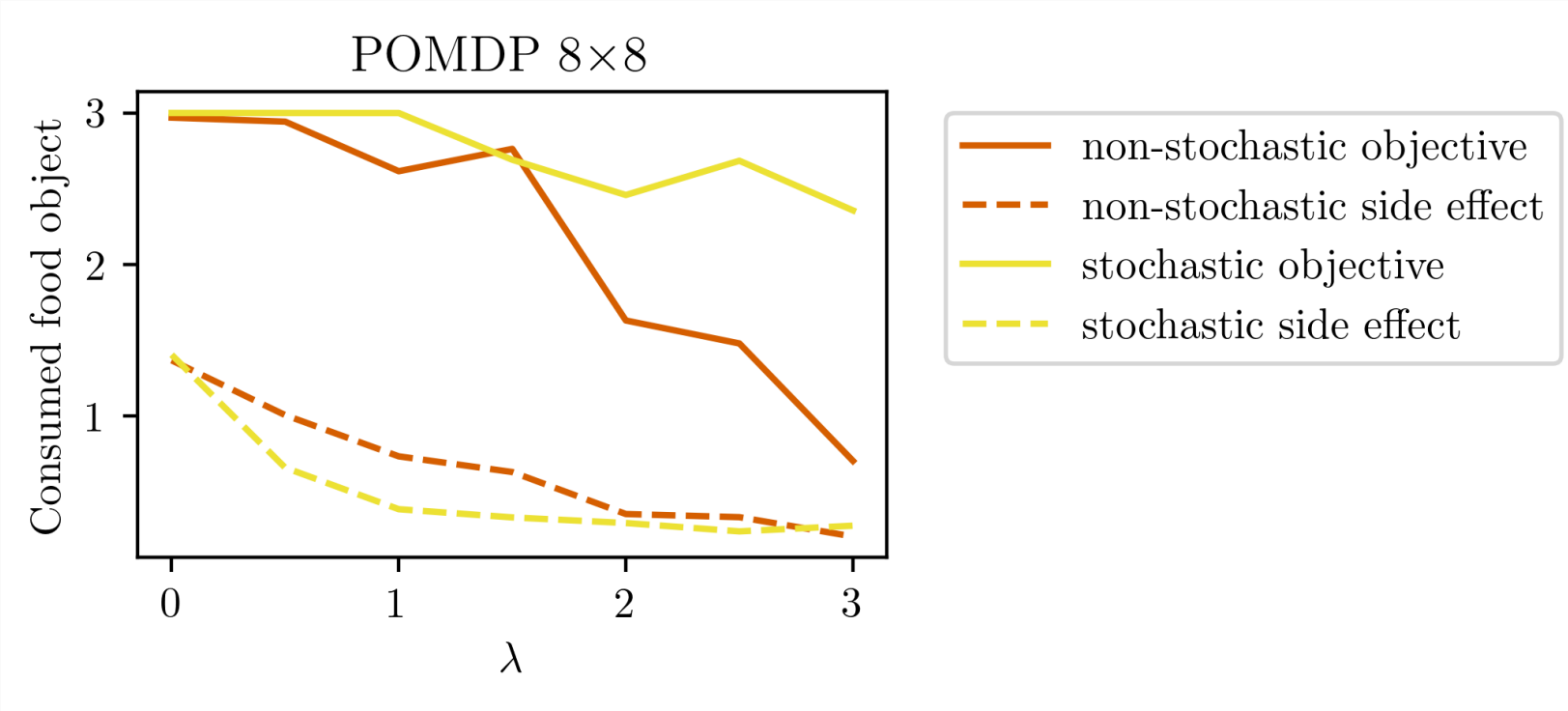
- Each with a stochastic and non-stochastic environment.
- Then evaluated using $\lambda \in \{0, 0.5, 1, 1.5, 2, 2.5, 3\}$

Results

MDP


MDP 8×8
Consumed food object
3
2
1
0
0
1
2
3
λ
non-stochastic objective
non-stochastic side effect
stochastic objective
stochastic side effect

POMPD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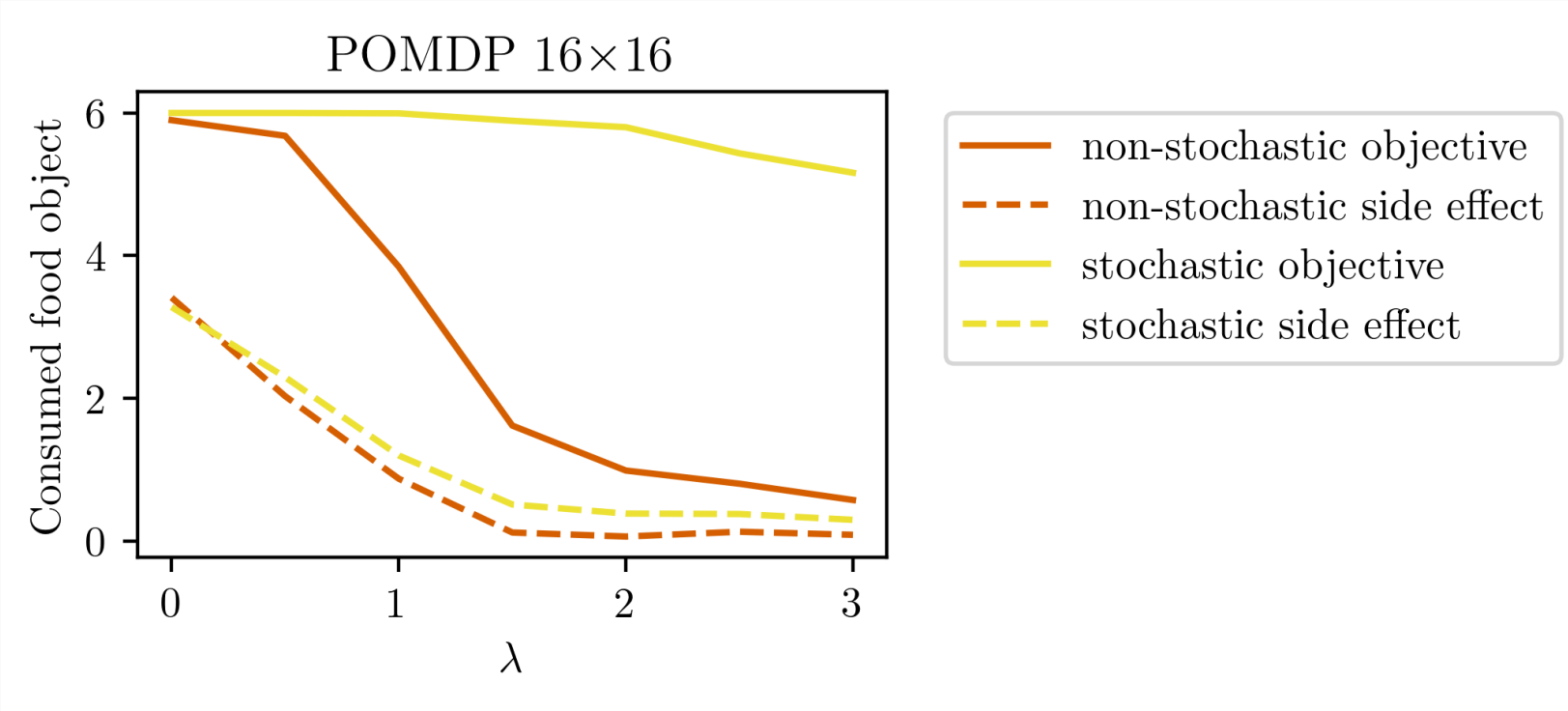
POMDP 16×16
Consumed food object
6
4
2
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1
2
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non-stochastic objective
non-stochastic side effect
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Conclusion

Summary

End note

Questions?

References

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