

# DYNAMIC ALGORITHM CONFIGURATION: Foundation of a New Meta-Algorithmic Framework

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ECAI2020

# Motivation



0 Gold  
0 Silver  
0 Bronze



**Algorithm**

**Parameter**

**Instances**

**Objective**

Image sources given at the end of the presentation

# Algorithm Configuration

# Motivation



1 Gold  
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## **Per-Instance Algorithm Configuration**



# Motivation

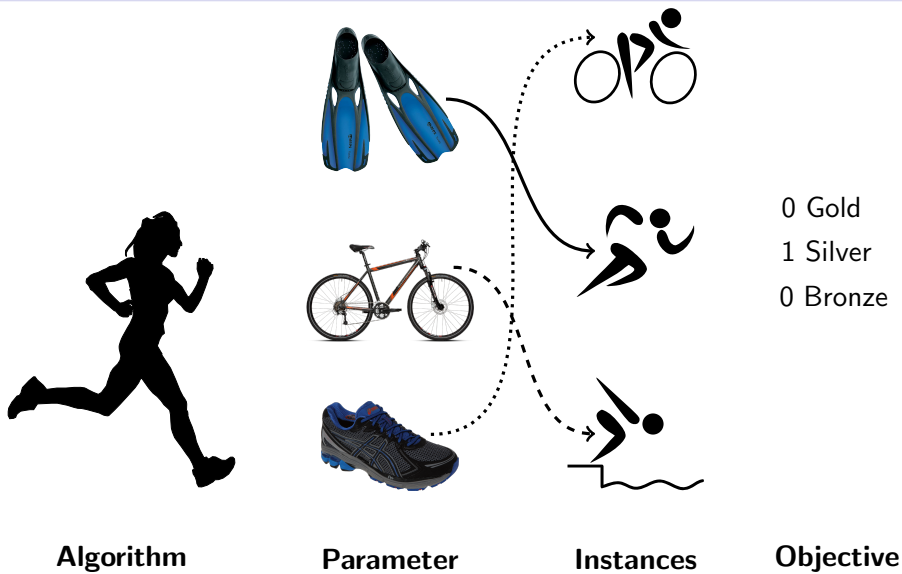


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# Motivation

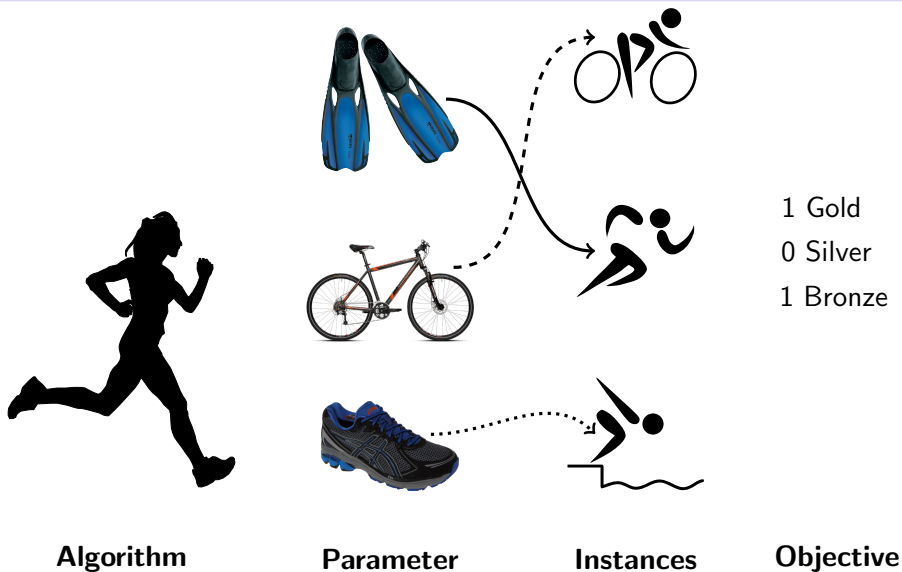


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# Motivation

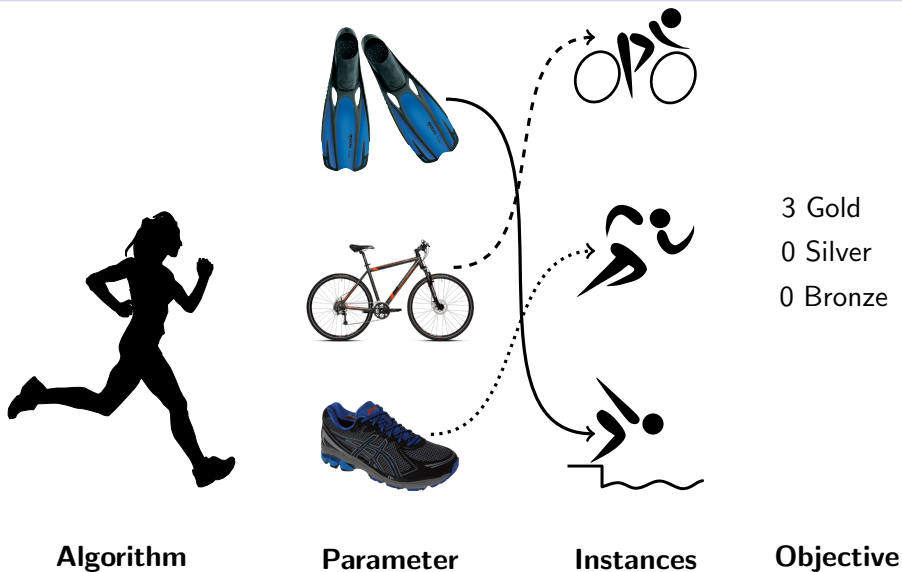
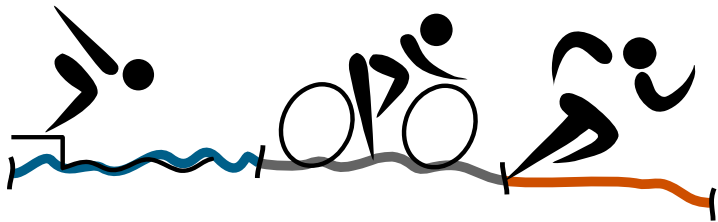


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**How can we solve such problem instances?**

## Dynamic Algorithm Configuration

# Dynamic Algorithm Configuration

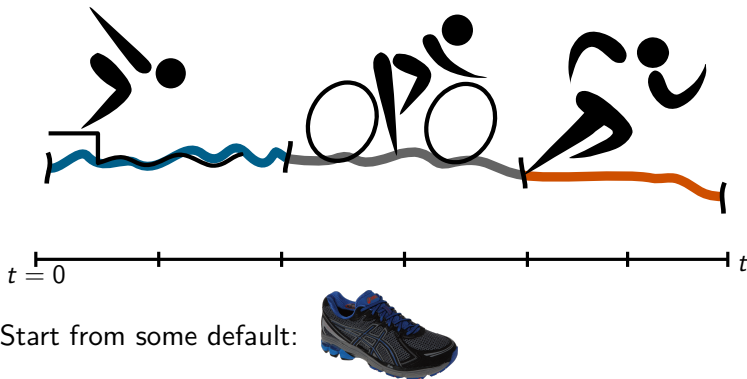
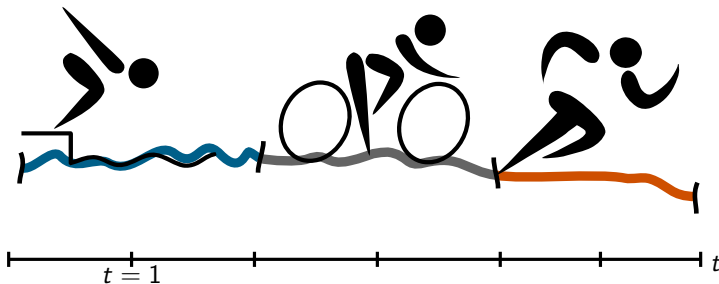


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# Dynamic Algorithm Configuration



Observe state: Water

# Dynamic Algorithm Configuration

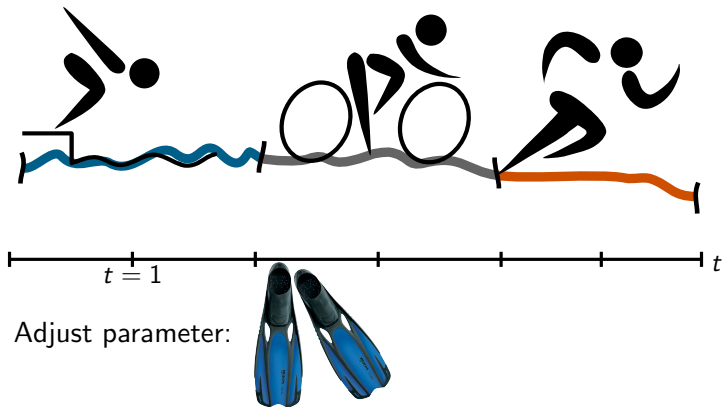
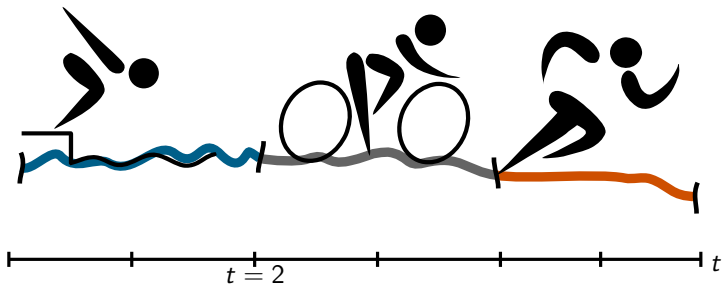


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# Dynamic Algorithm Configuration



Observe state: Bike Trail

# Dynamic Algorithm Configuration

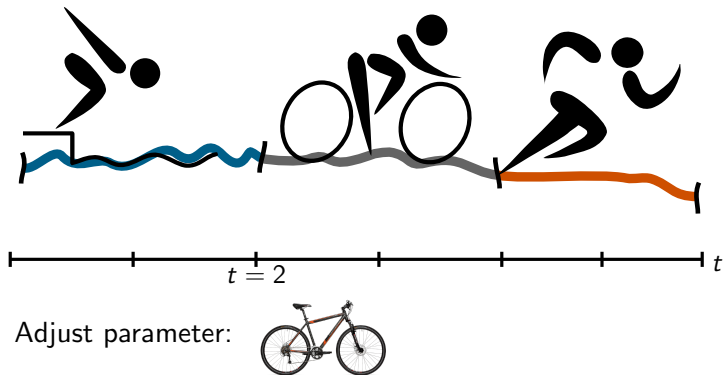


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# Dynamic Algorithm Configuration

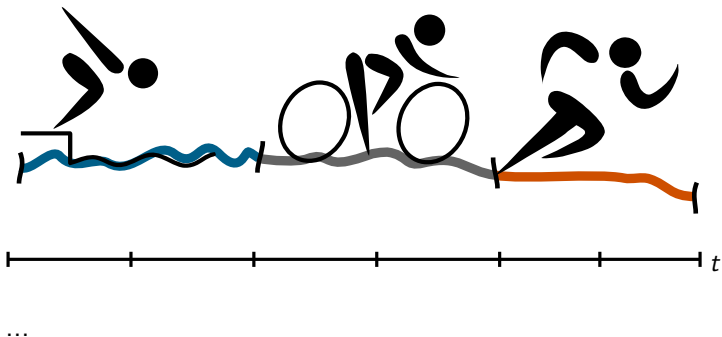


Image sources given at the end of the presentation

# Dynamic Algorithm Configuration

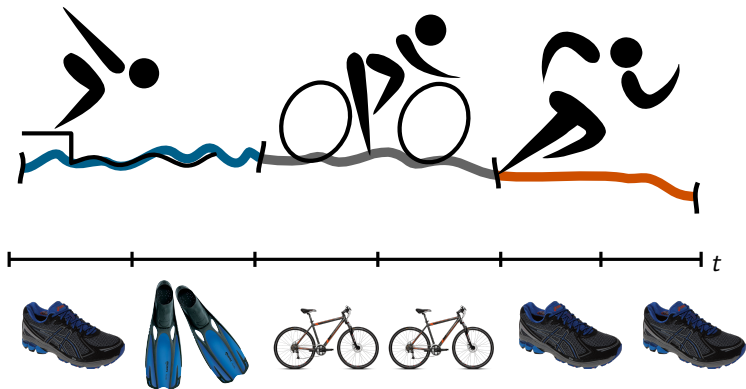


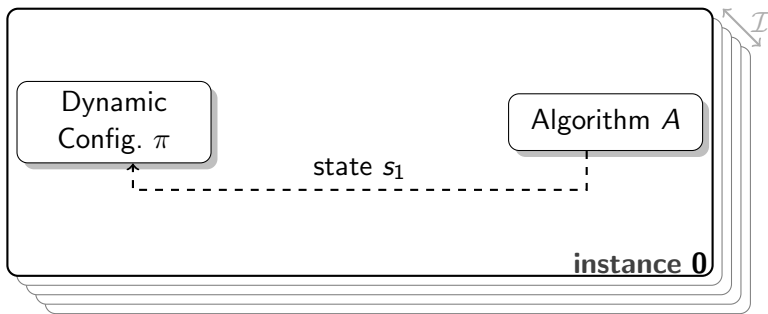
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Formalize optimization as MDP  $\mathcal{M} := (\mathcal{S}, \mathcal{A}, \mathcal{T}, \mathcal{R})$

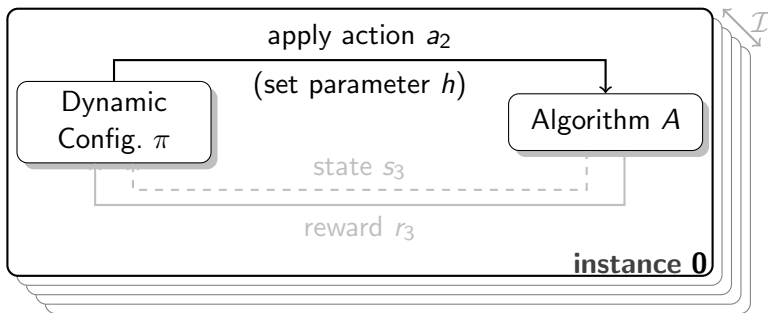
- State Space  $\mathcal{S}$
- Action Space  $\mathcal{A}$
- Transition Function  $\mathcal{T}$
- Reward Function  $\mathcal{R}$

- Instances as context
- Contextual-MDP:  $\mathcal{M}_{\mathcal{I}} := \{\mathcal{M}_i\}_{i \sim \mathcal{I}}$
- $\mathcal{M}_i := (\mathcal{S}, \mathcal{A}, \mathcal{T}_i, \mathcal{R}_i)$

# Taking Instances Into Account

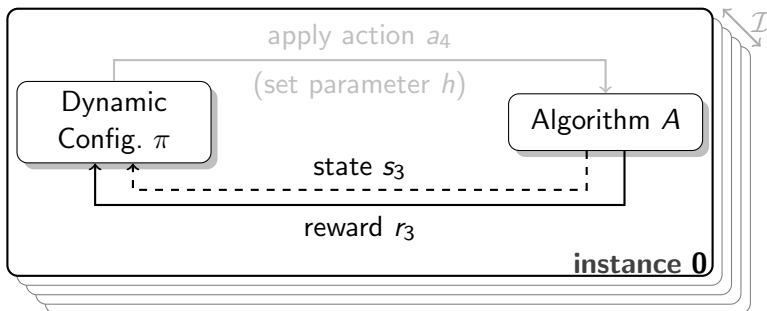


# Taking Instances Into Account

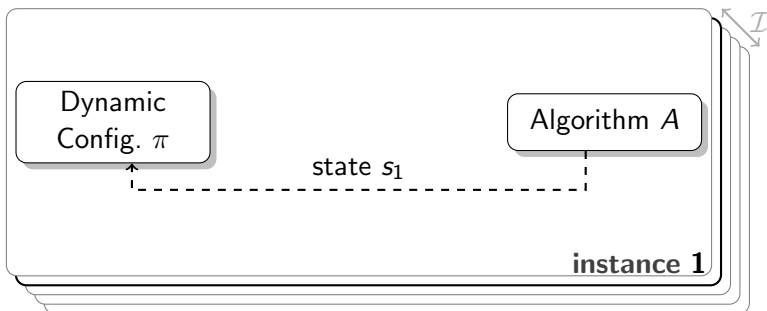




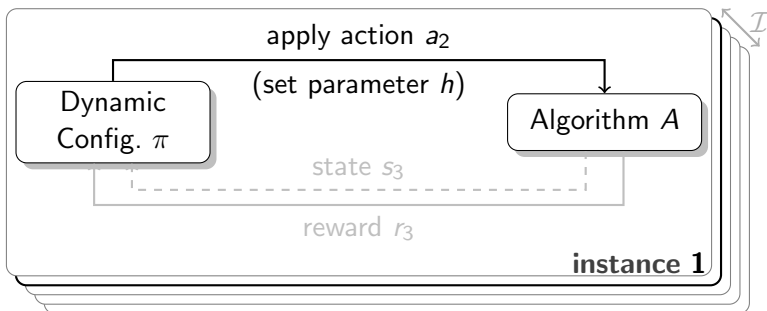
# Taking Instances Into Account



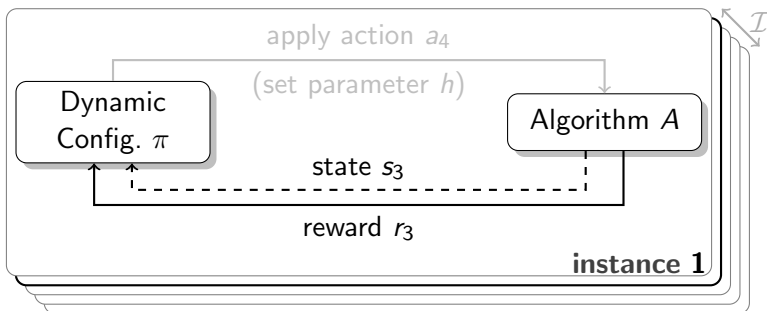
# Taking Instances Into Account



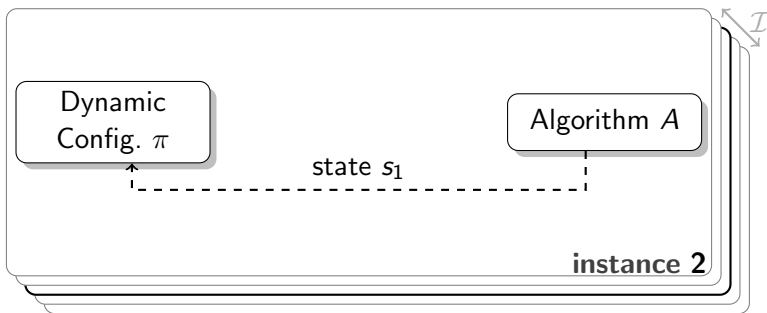
# Taking Instances Into Account



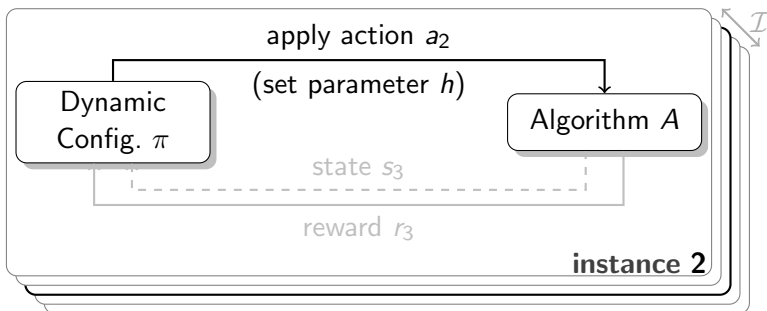
# Taking Instances Into Account



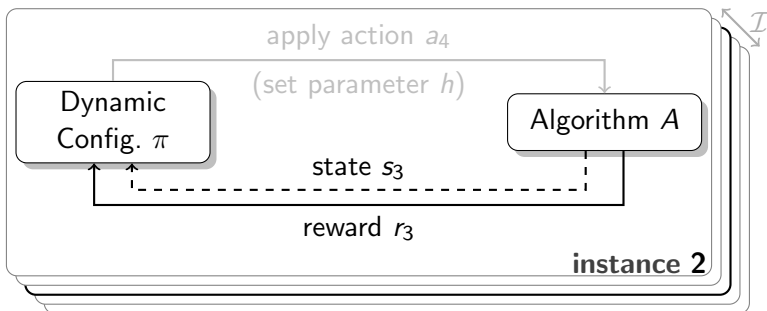
# Taking Instances Into Account



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# Taking Instances Into Account



We designed benchmarks to gain insights into the following settings:

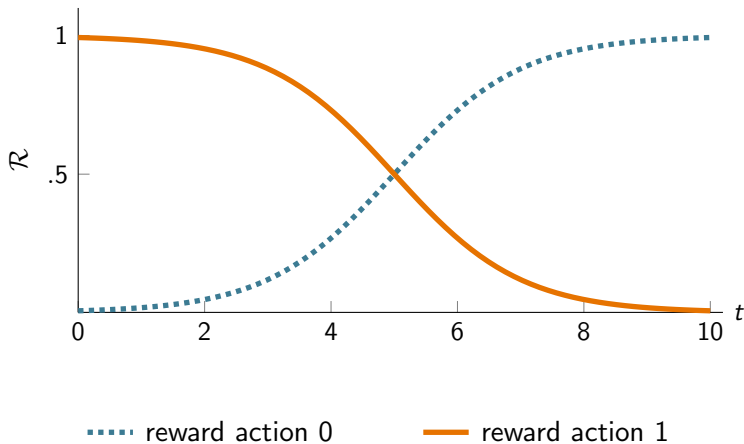
- Effect of Short Effective Sequence Length
- Stochasticity of Reward Signal
- Homogeneity of Instances
- Generalization
- Scaling with the Number of Parameters
- Effect of Self-Paced Learning

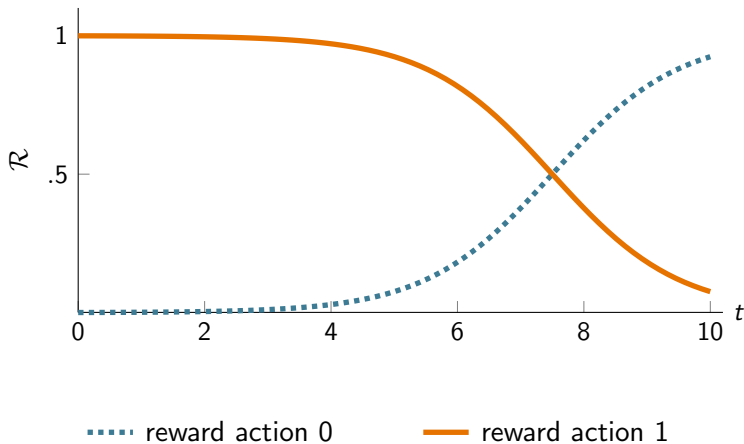


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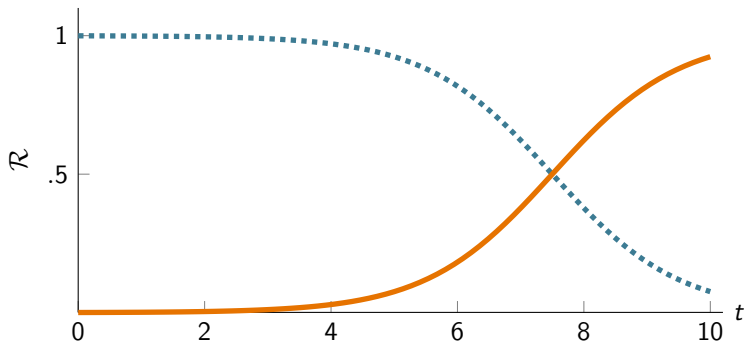
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# Experimental Design





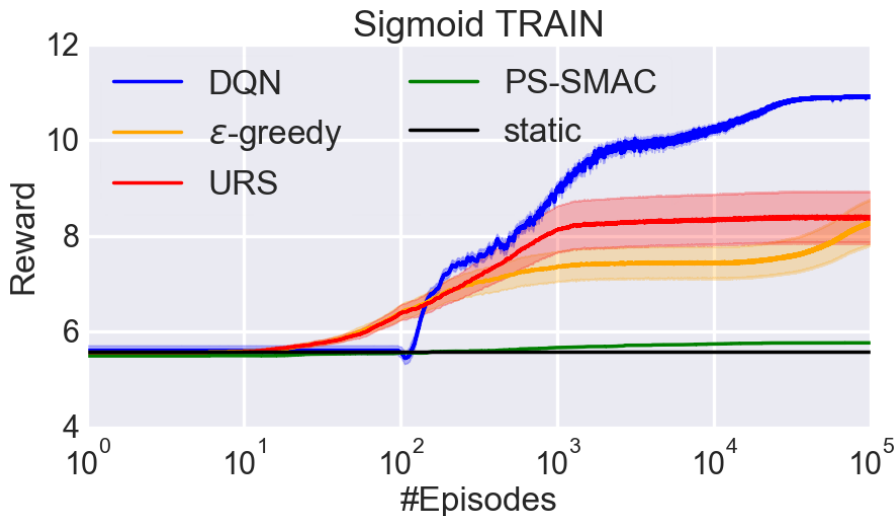
# Experimental Design

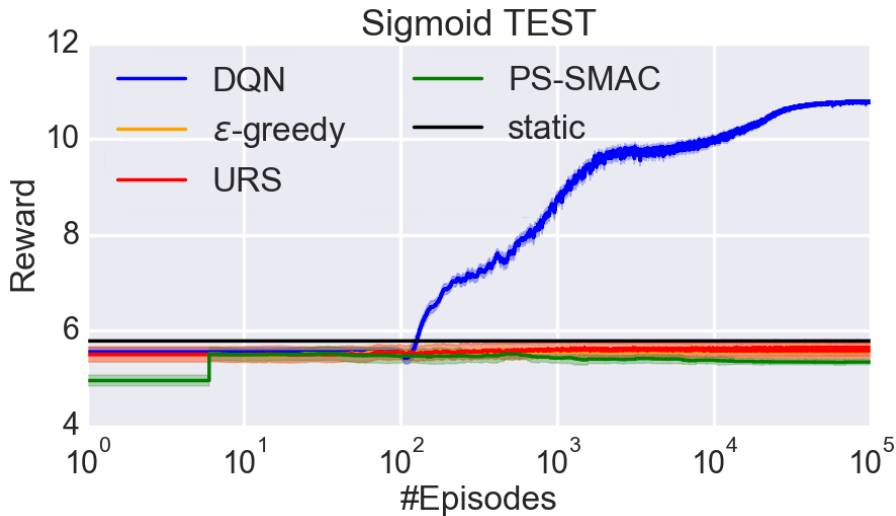


..... reward action 0

— reward action 1

# Sigmoid: Instance sets





- We presented a new meta-algorithmic framework
- We demonstrated that the framework is a generalisation of prior frameworks
- Finally we demonstrated the effectiveness of the framework
  - Effect of Short Effective Sequence Length
  - Stochasticity of Reward Signal
  - Homogeneity of Instances
  - Generalization
  - Scaling with the Number of Parameters
  - Effect of Self-Paced Learning

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- Flippers (under [CC BY-NC 4.0](#))
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(by [Parutakupiu](#) & [Thadius856](#) under public domain)
- Athletics Pictogram  
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- Swimming Pictogram  
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- The above images were flipped/rotated or scaled and used to depict abstract representations of Algorithm Configuration