Memory-based exploratory online learning of simple object manipulation

Master thesis

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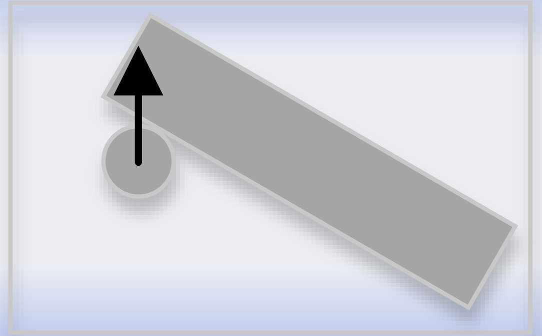
Outline

1. Task
2. Current Results
3. Methods
4. Issues
5. Technologies
6. Evaluation

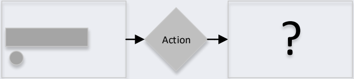
Scenario



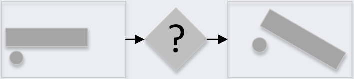
Task

Given an environment and a set of action primitives to control some actuator, incrementally and interactively learn a

Forward Model



Inverse Model



Current Results

Video(s)

Methods

Created two models

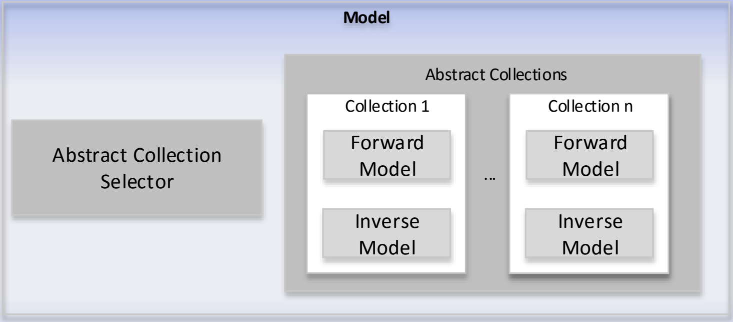
Interactions

- Represent interaction states
- Split space into subspaces along different interactions

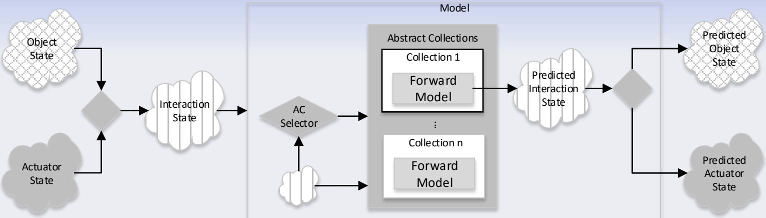
Objects with gate

- Represent individual object states
- Introduce gate, distinguishing interaction from no interaction

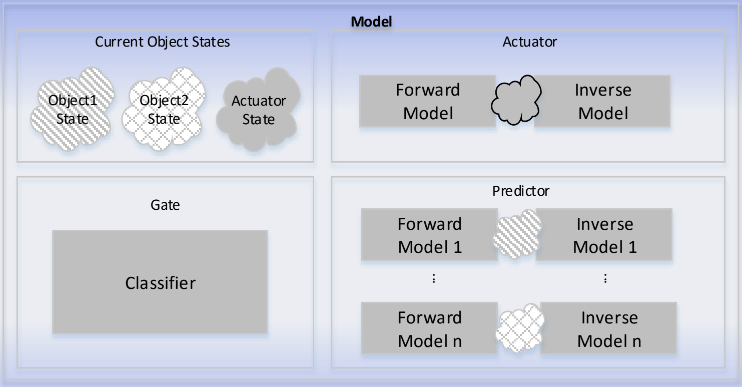
Method - Interactions



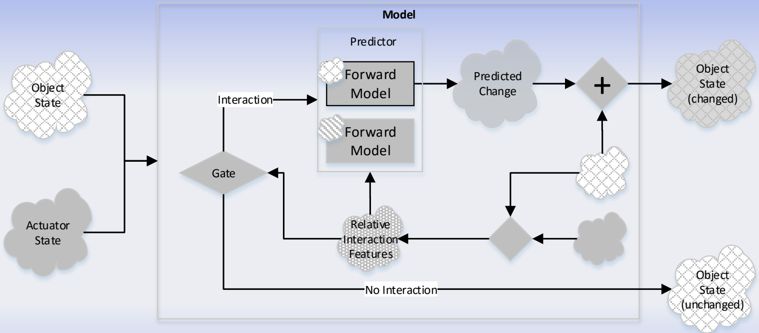
Method - Interactions Prediction



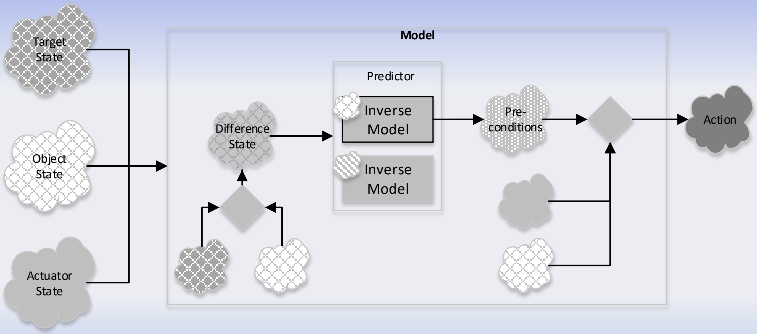
Method - Gate


Model
Current Object States
Object1 State
Object2 State
Actuator State
Actuator
Forward Model
Inverse Model
Gate
Classifier
Predictor
Forward Model 1
Inverse Model 1
⋮
⋮
Forward Model n
Inverse Model n

Method - Gate Prediction



Method - Gate Planning



Issues

- Incremental update
- Time constraints for updates and queries due to environment loop
- Metric problem
  - Features may have different orders of magnitudes (e.g. orientation/position)
  - Features may have different importances

Technologies

- Regression and classification models are memory/instance based
- Adapted the instantaneous topological map (ITM) as main model
- Developed abstract inverse model to avoid extrapolation and metric problems

Technology - ITM

Technology - Inverse Model

Inhalt...

Evaluation

Two main tasks in order to test forward and inverse model

PushTaskSimulation (Video 1)

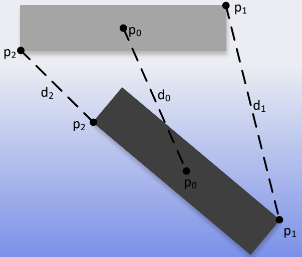
- Train at different starting positions and push the object
- Use previous prediction as input when testing
  → No environment feedback

MoveToTarget (Video 2)

- Show all feature changes during training
- Give fixed target position for one object
- Operate in open loop → Constant environment feedback

Evaluation - PushTaskSimulation

- A run is defined as the number of frames until the actuator traveled a certain distance
- Testruns start at varying starting points
- Calculate difference to actual object at end of each run
- Difference defined over keypoints in order to combine position and orientation
- Test against different number of training runs



Evaluation - MoveToTarget

Multiple possibilities

- Measure number of frames/actions required to reach target
- Measure distance after fixed number of allowed actions
- Measure average distance reduction per action
- Try reduced number of training examples/interactions
  - e.g. only show position change and no orientation

Further Evaluations and further features

- Evaluate subparts by swapping them out where possible
    - E.g. gate classifier/actuator forward model
- Distinguish testpositions that were not included in trainset and those that are
- Multiple objects
- Self-exploration

Thank you for your attention!