Scaling

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Decision Making

Is about controlling linked variables:

- Learning correlation
- Optimize trajectories

Matematically:

- Manipulate Cartesian Product (Set Theory)
- Estimate functions
- Exploring large graph

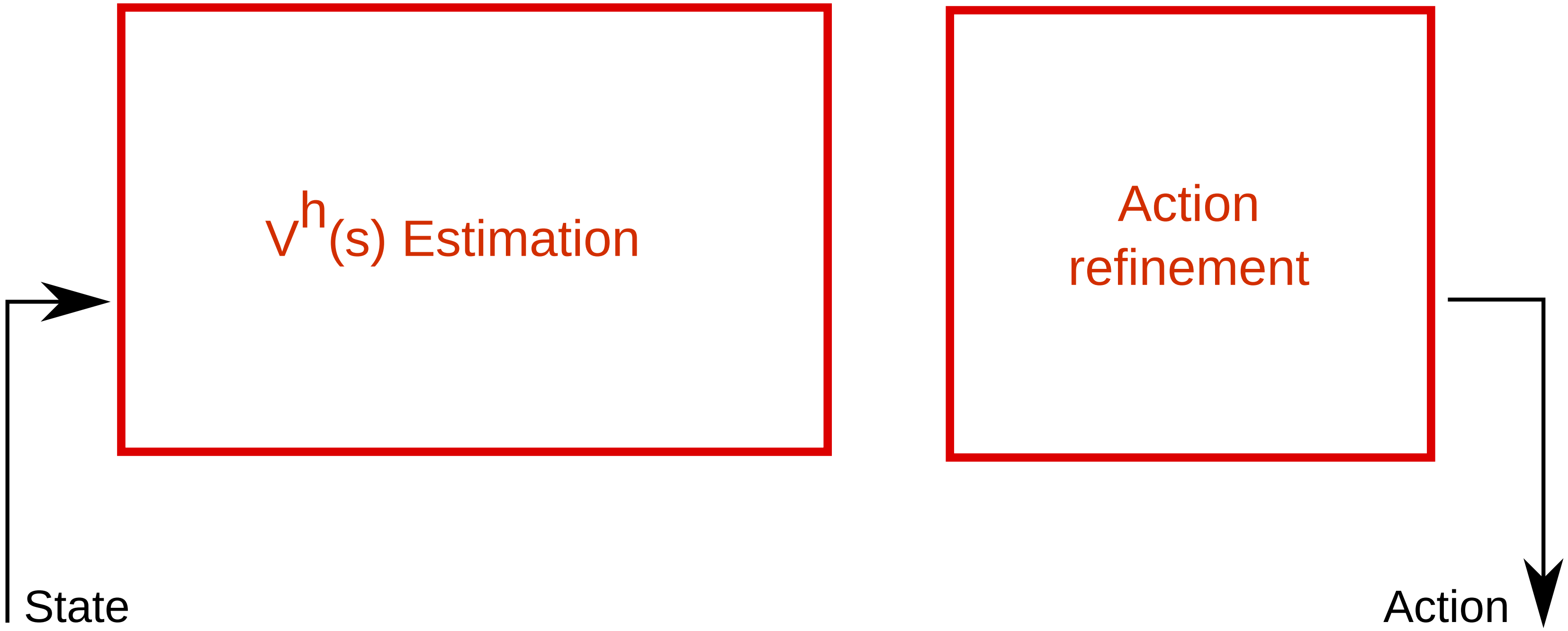
Dealing with large State Space

Reduce the state space

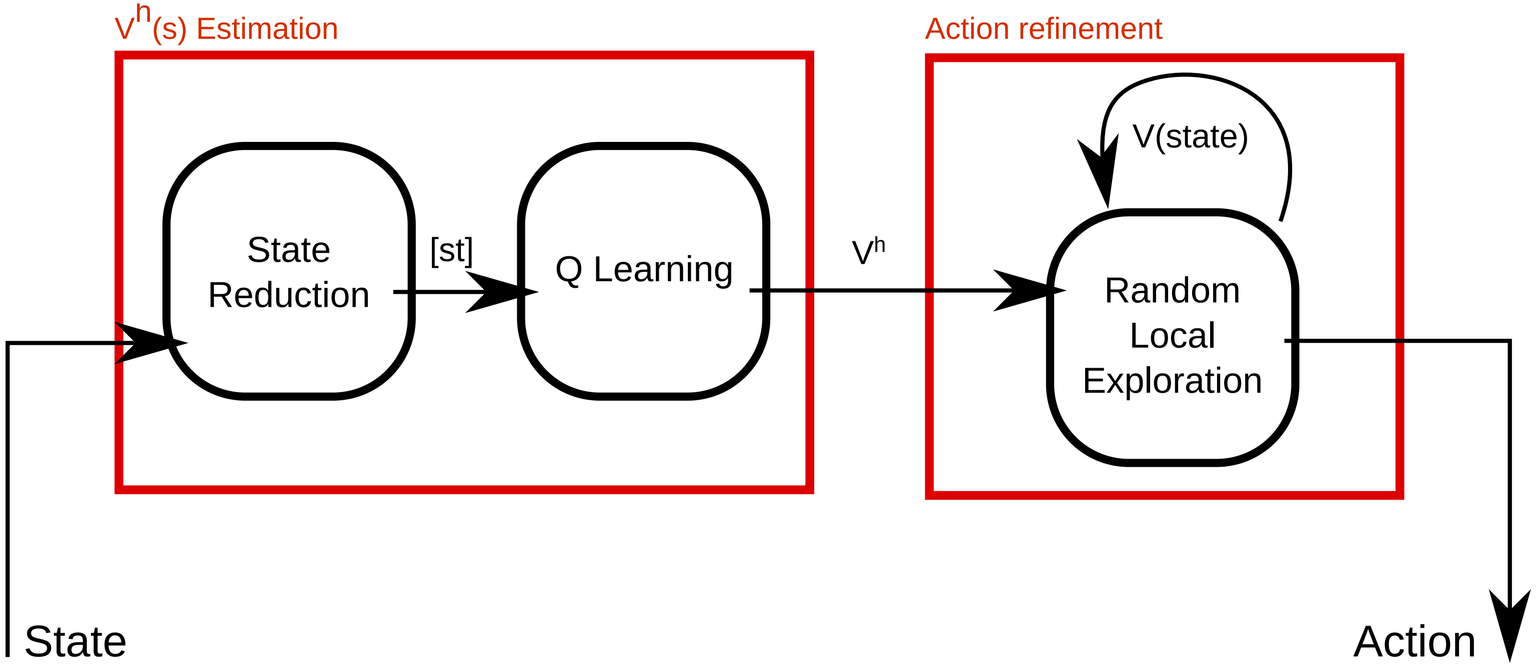
Work locally

A combination of these 2 solutions

A Complete Decision Architecture



A Complete Decision Architecture



State reduction (or identification)

Approach:

Distance based approach:

- Principal Component Analysis (**PCA**) (+ Discretization)
- Clustering: **k-means**, Simple Vector Machine (**SVM**)

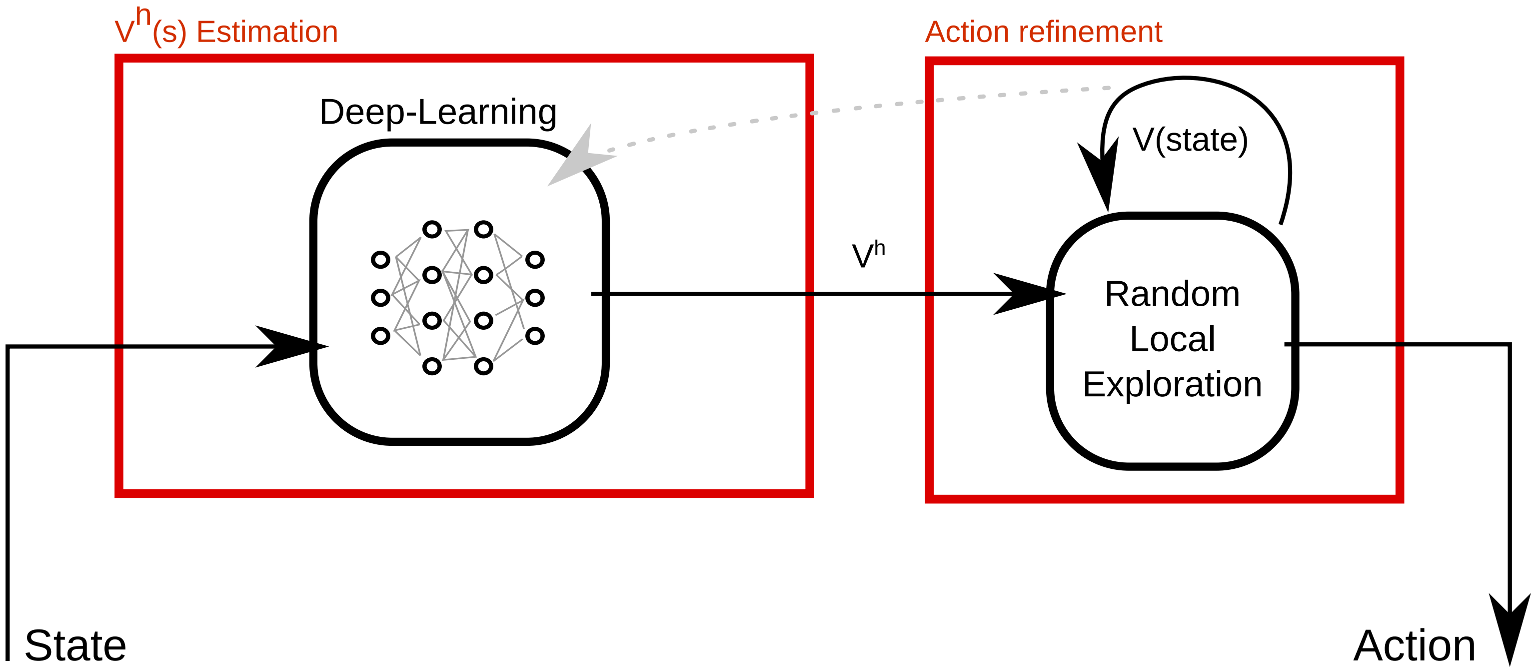
Discrete approach:

- Decision-Tree (ID3 algorithm family)

Goals:

Macro-States merge states with supposed similar values.

Deep-Learning-based Decision Architecture



Requirement:

Labeled data with valid *values*...

Action refinement at run time

Local computation of the Values and the policy from current state.

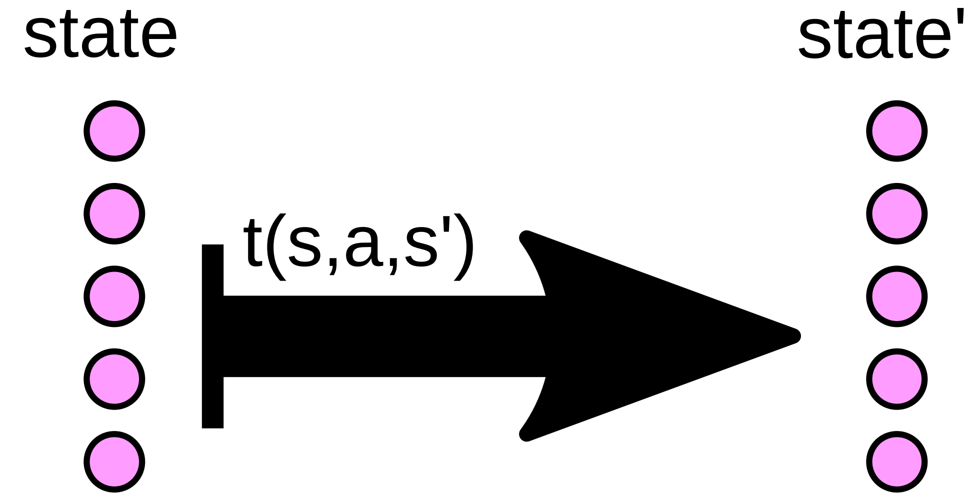
- Constrained Value Iteration (from the current state, with a limited horizon)
- Monte Carlo Approach (based on deep, but random trajectories)

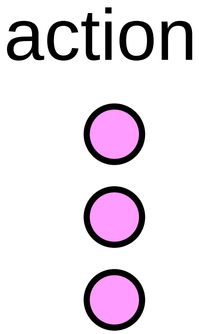
Requirement:

Simulation: a model of the controlled system

The Curse of Dimensionality in MDP

Fonction de Transition:



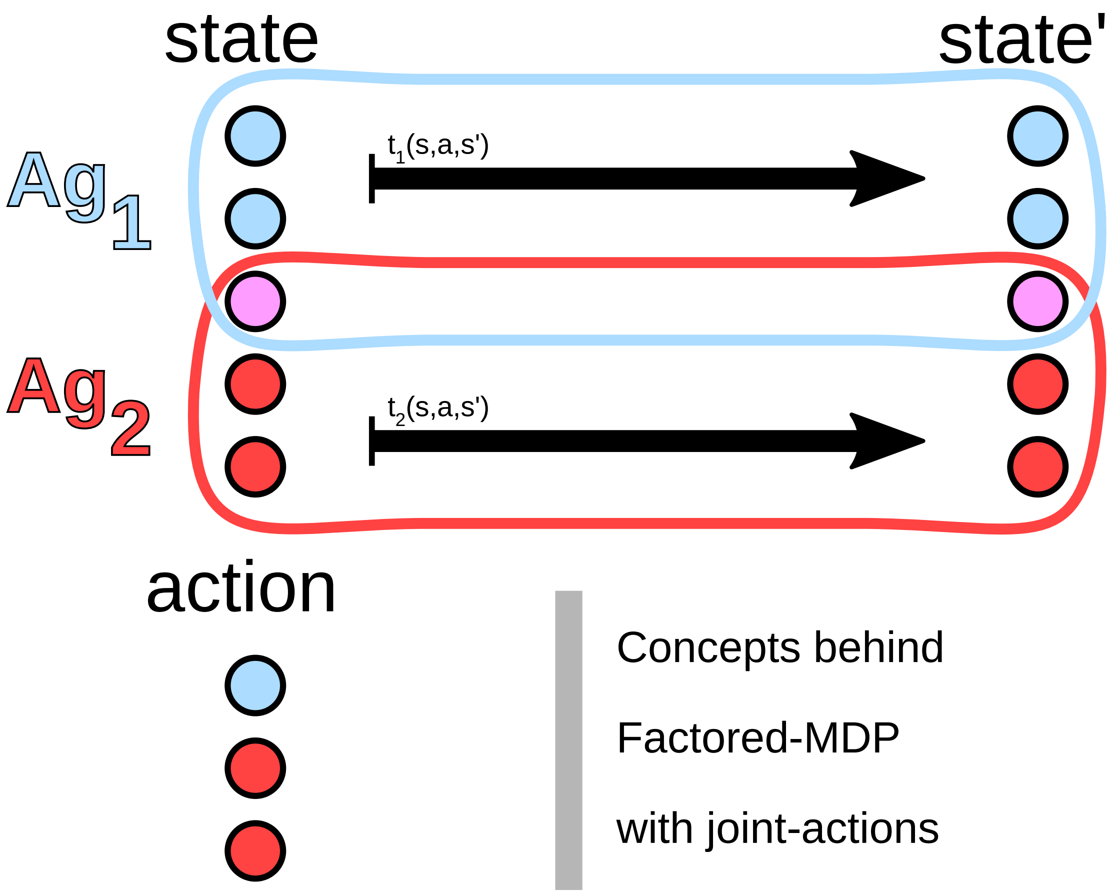


$t: |S|\times|A|\times|S| \rightarrow [0, 1]$

$\sim Dom(Vars)^{|Vars|\times 2}$

Factored Model:

Factored Transition function:



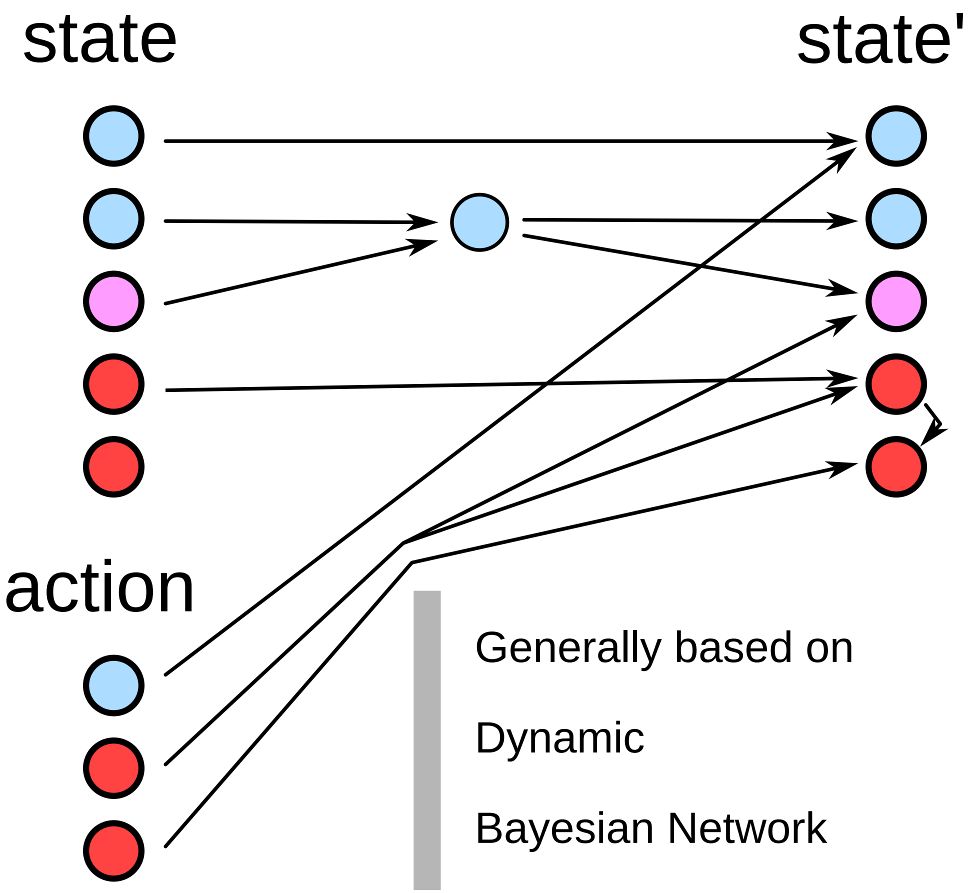
Concepts behind

Factored-MDP

with joint-actions

Factored Model:

Factored Transition function:



Generally based on

Dynamic

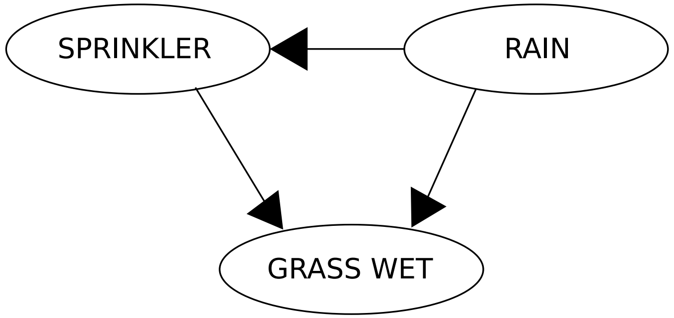
Bayesian Network

Bayesian Network:

Model complex system from local dependencies

Example: Rain, Sprinkler and Grass Wet:

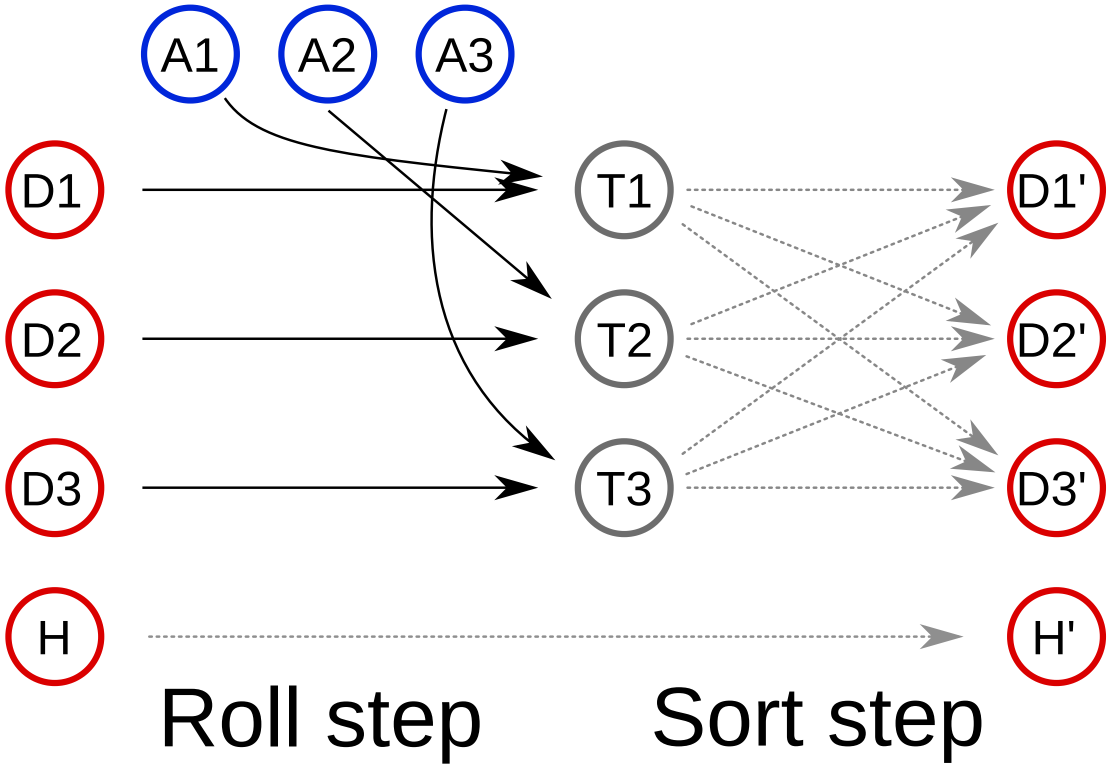
	SPRINKLER	
RAIN	T	F
F	0.4	0.6
T	0.01	0.99



RAIN	
T	F
0.2	0.8

		GRASS WET	
SPRINKLER	RAIN	T	F
F	F	0.0	1.0
F	T	0.8	0.2
T	F	0.9	0.1
T	T	0.99	0.01

Example: 421



Transition in two steps, but only the first isstokastic.

Example: Zombie Dice

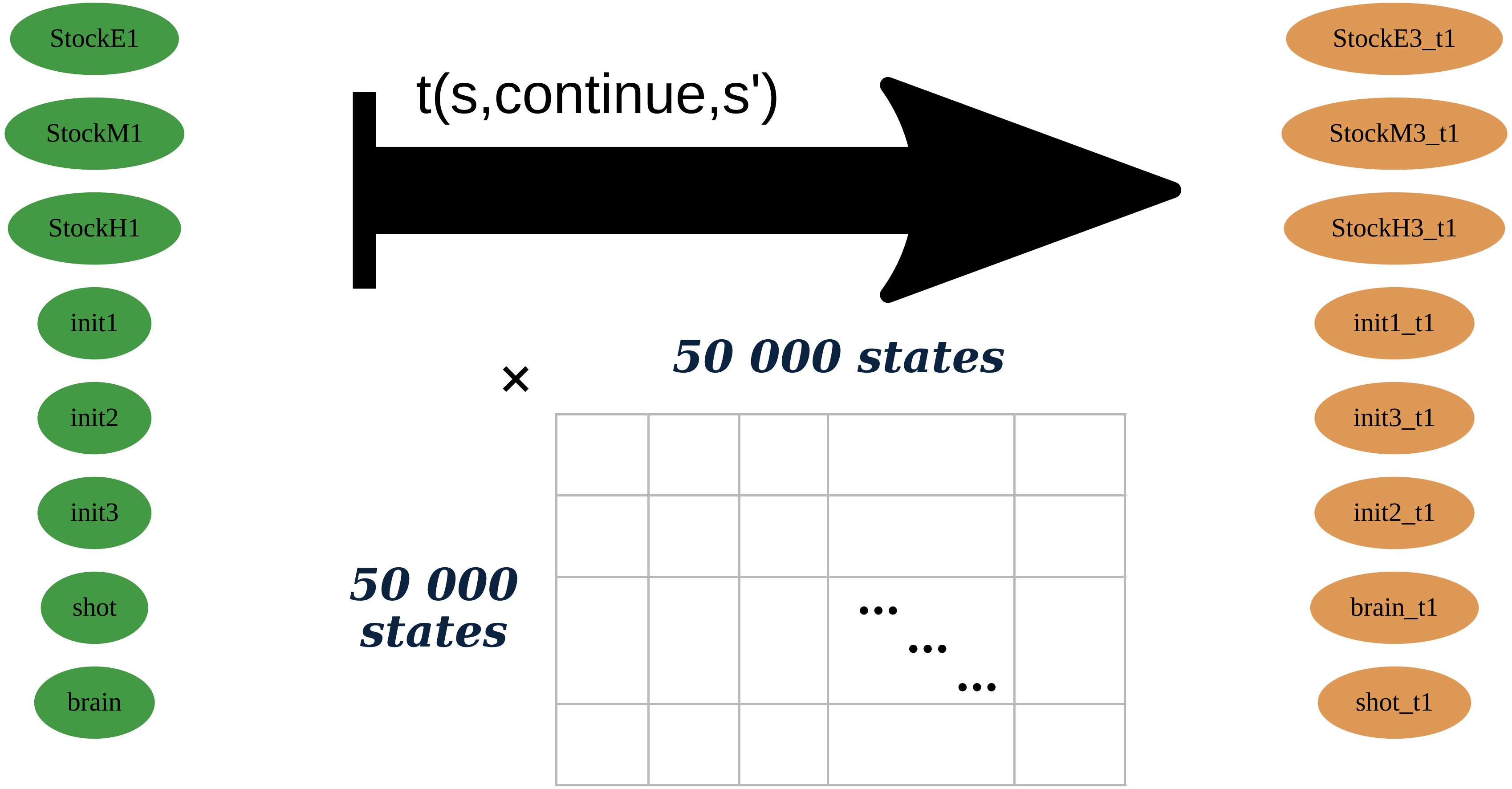
Eat maximum brains

without dying (3 damages)

- Players are zombies.
- They try to catch humans three at a time.
- Humans are dice with probability to fight back.

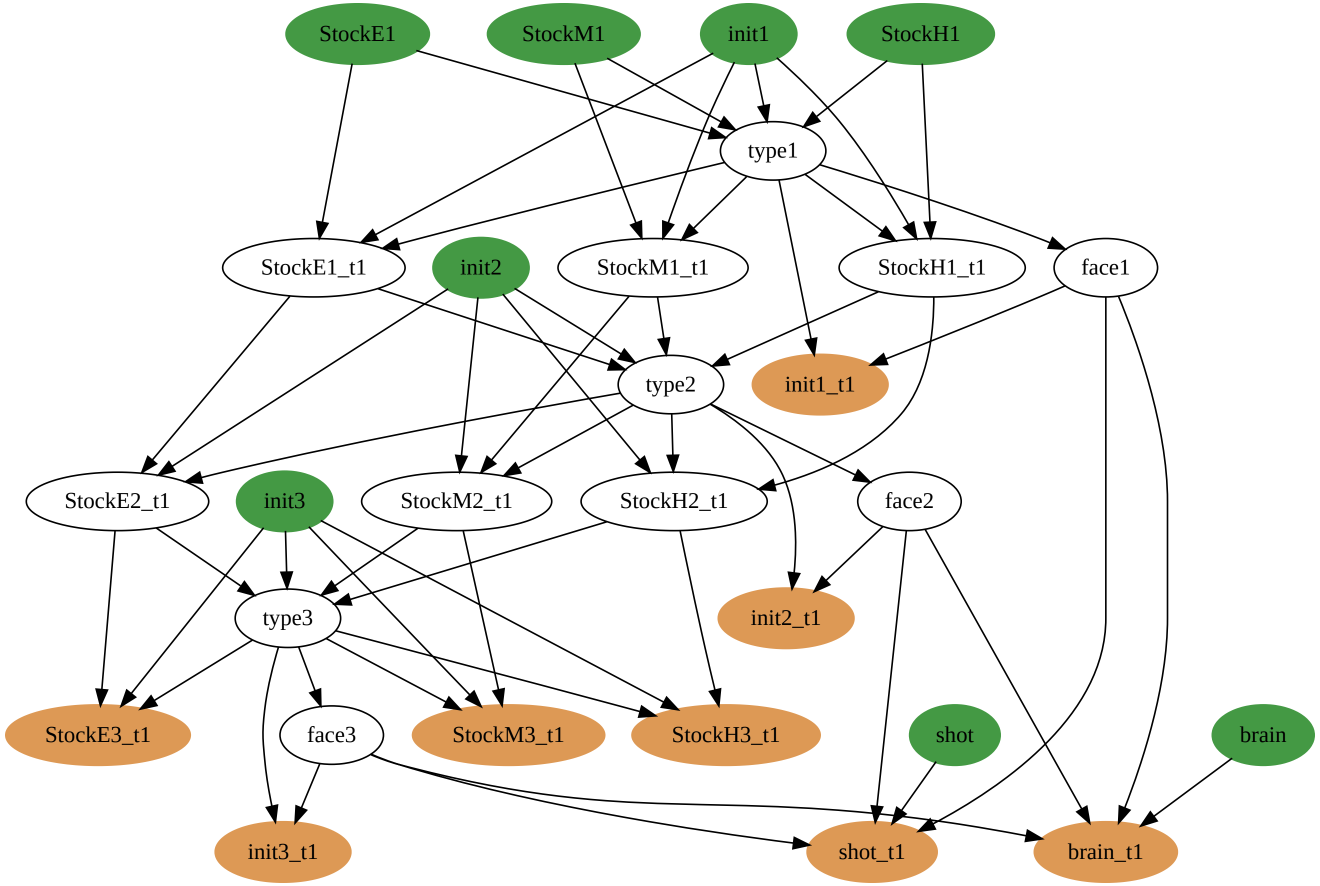
Example: Zombie Dice

Matrice complète



Example: Zombie Dice

Dynamic Bayesian Network:



Model-Based Learning:

It’s more about estimate variable correlations than transition probabilities.

- Determines variable dependencies (ie. Bayesian Network)
- Learn conditional probabilities (Gaussian Noise, Poisson’s law)
- Validate the model regarding it entropy

Then decide from exploring limited search spaces

- Limited horizon Value or Policy Iteration
- random trajectories: Algorythm Monte-Carlo

To conclude

Conclusion

- Problem: Control Dynamic System
- Hypothesis: Markov Decision Process (but unknown)
- Reinforcement Learning:
  - Model-free: QLearning
  - Model-based: Bellman Values function
- The root difficulty: the curse of dimensionality
  - Use factored model
- The solution requires to:
  - identify the model structure
  - have a lot of data
- Optimasation from an iterative/incremental process