Computational Models of Decision Making

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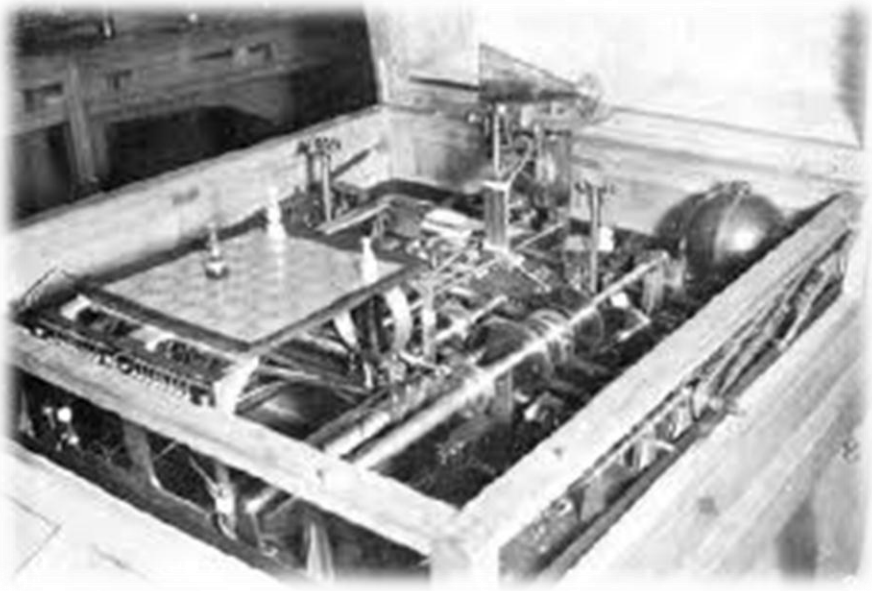
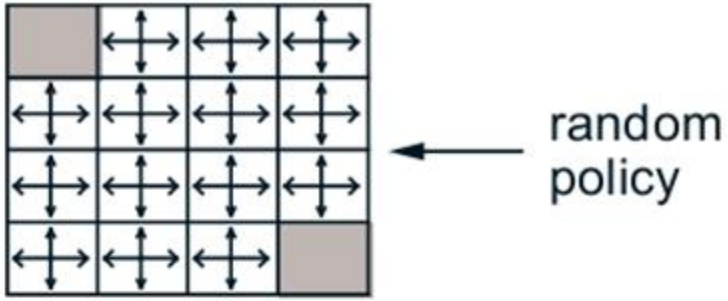
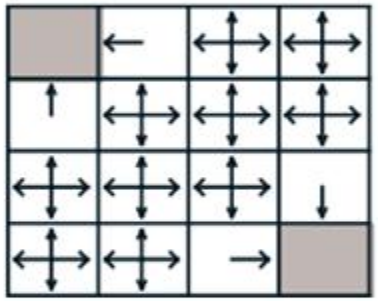
Original Motivation



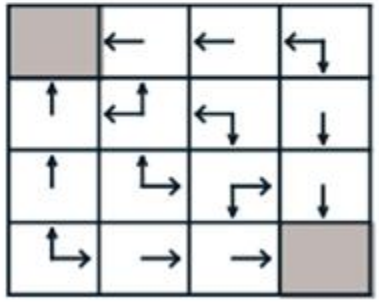
http://nathanbauman.com/seoulhero/nfblog/?p=317

Map States to Actions

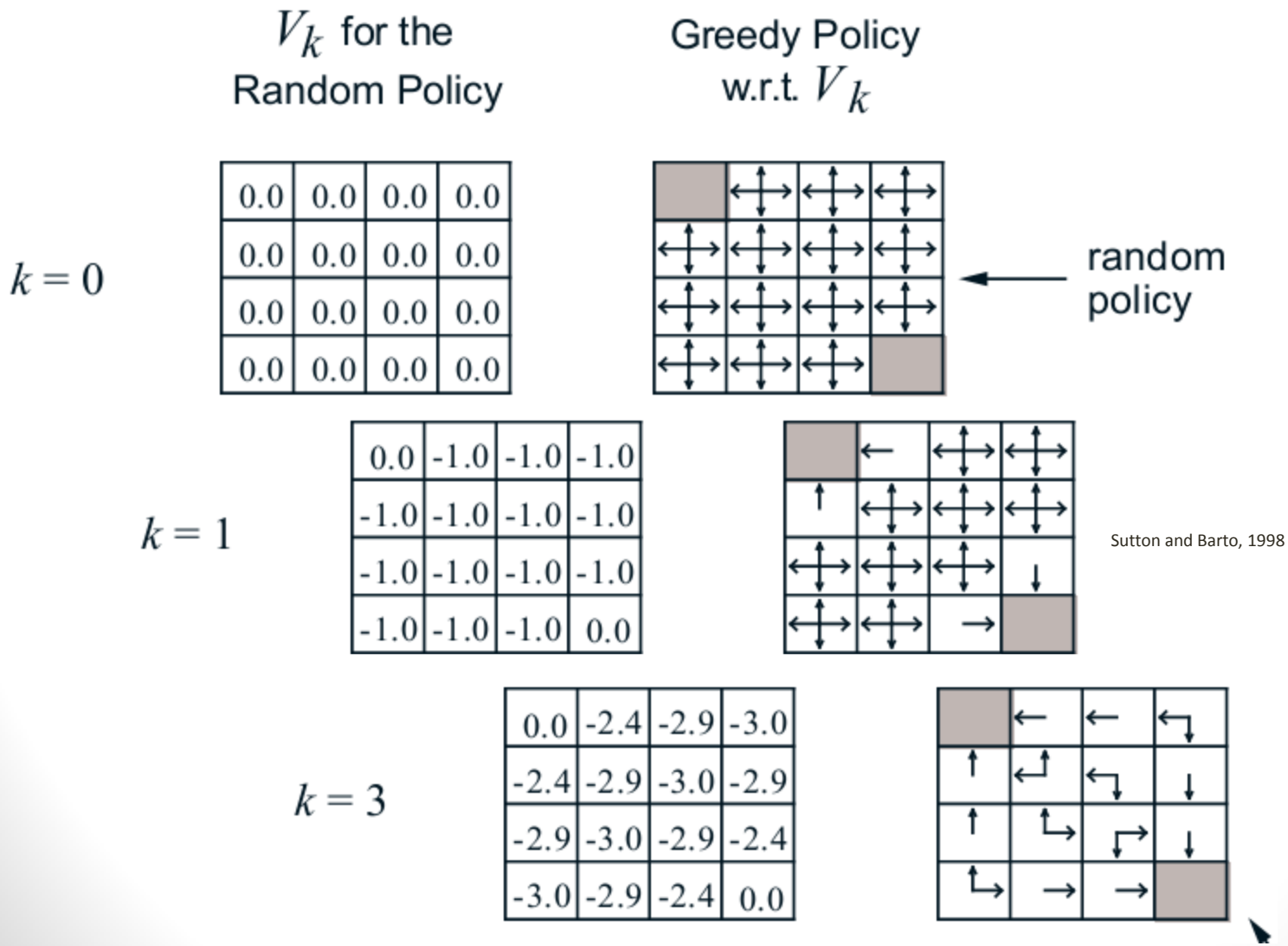




Sutton and Barto, 1998

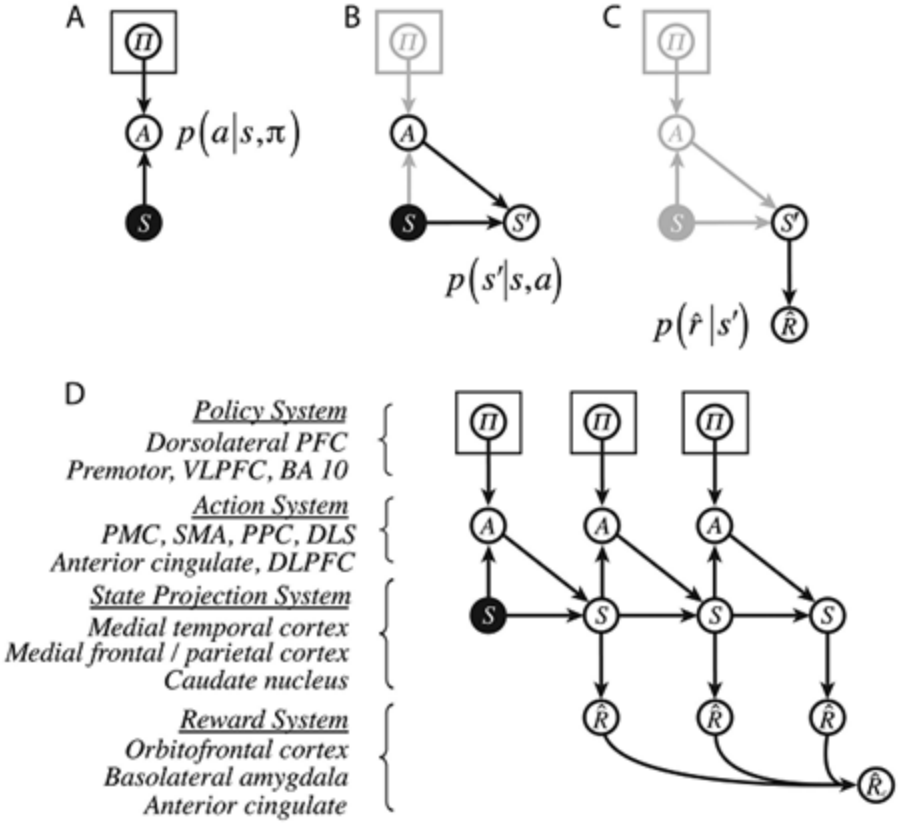


Map States to Values



Sutton and Barto, 1998

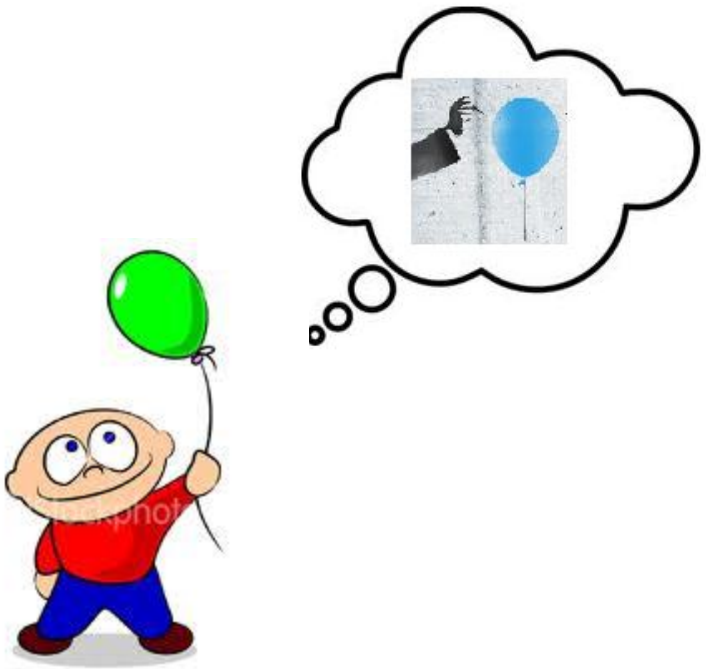
Model Based Learning



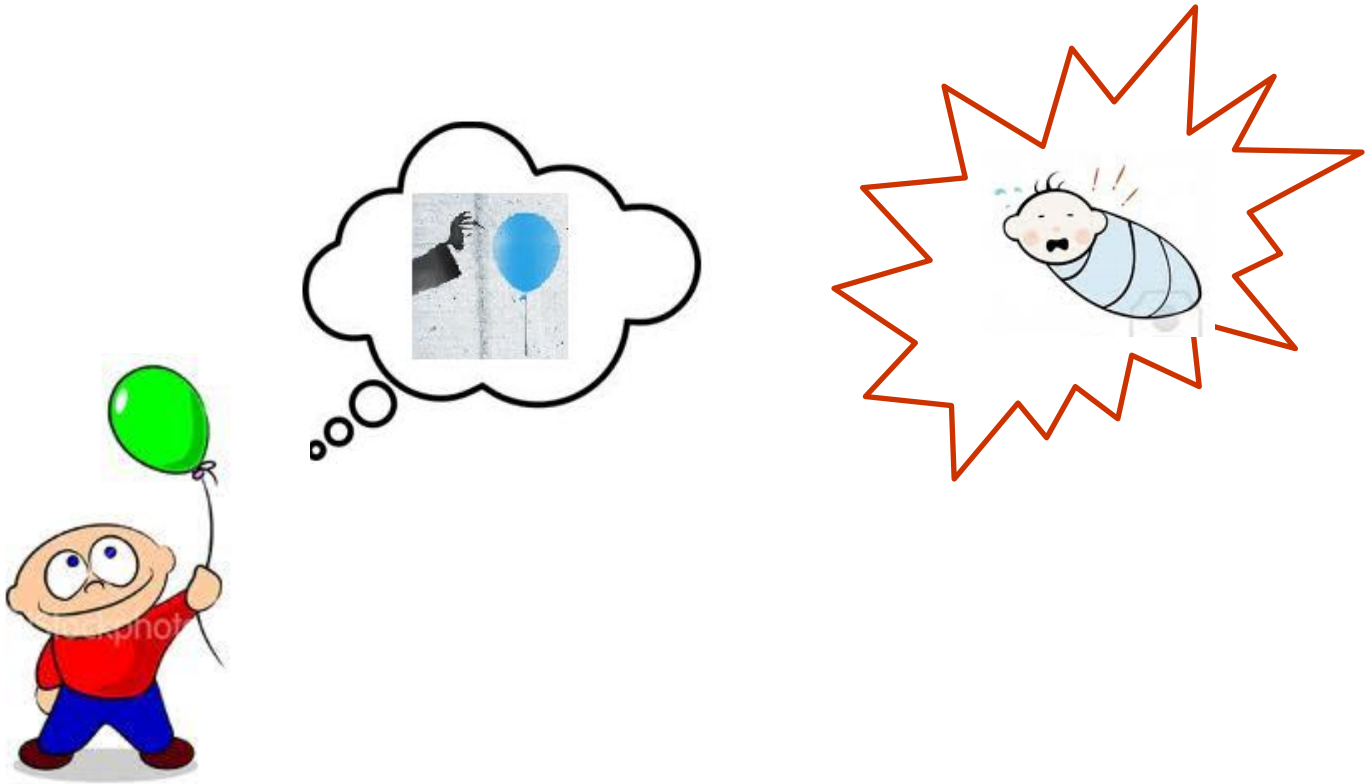
Sutton and Barto, 1998

Model Based

Model Based

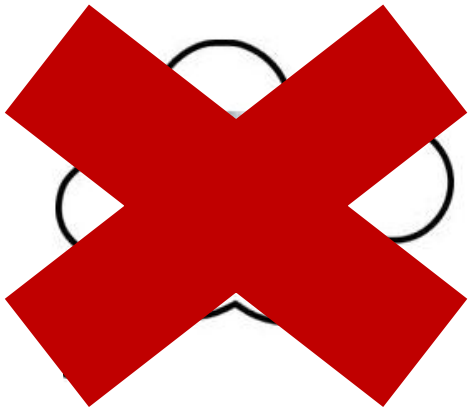


Model Based



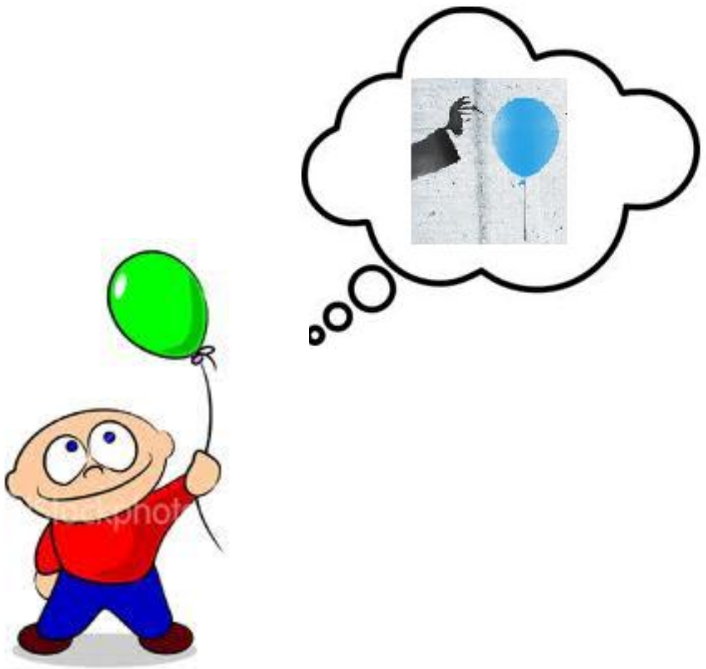
Model Based

Model Based

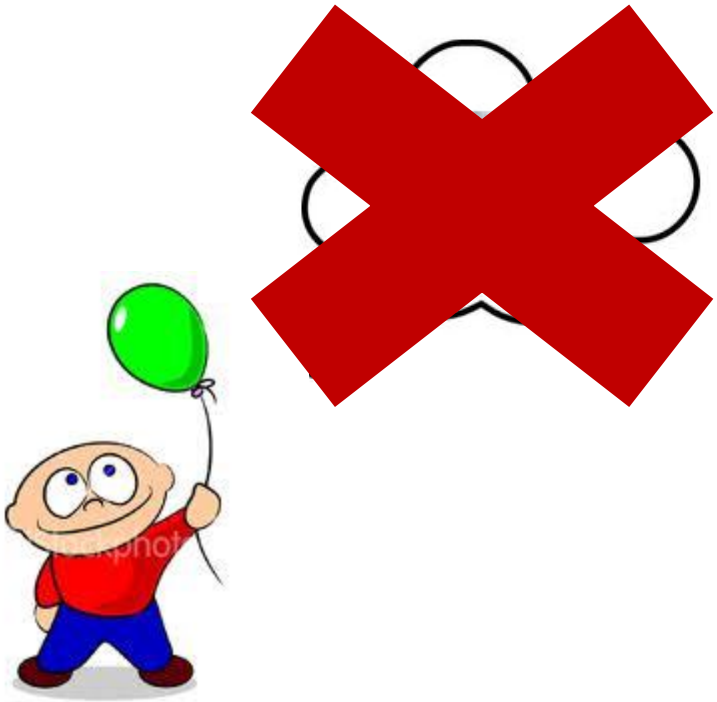


Model Free

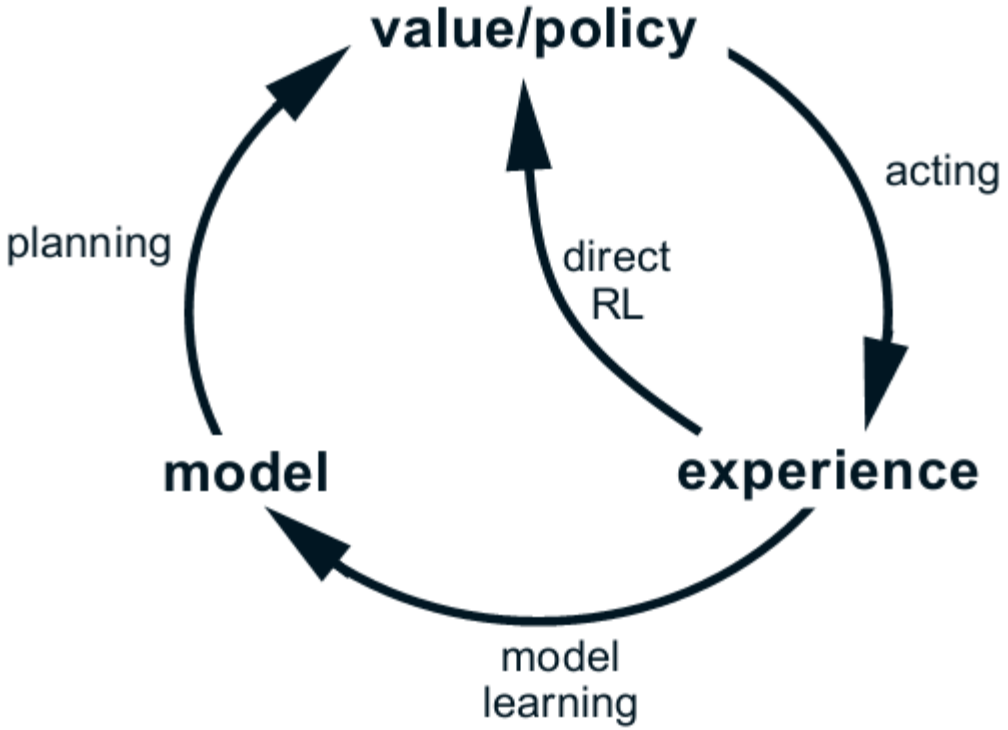
Model Free



Model Free

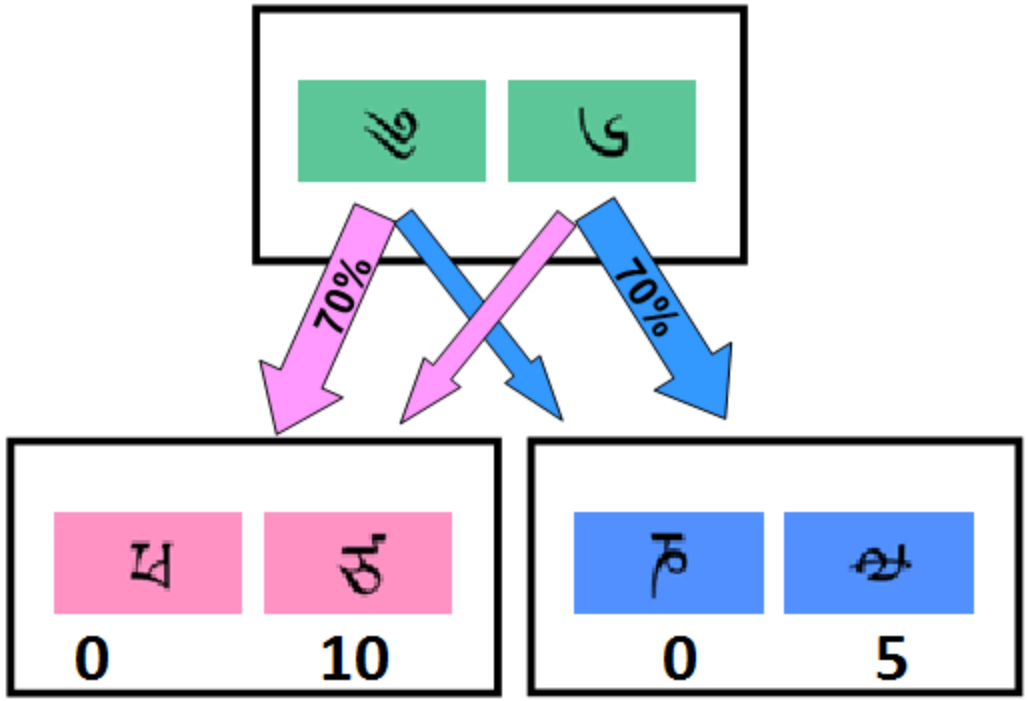


Model Free Vs. Model Based



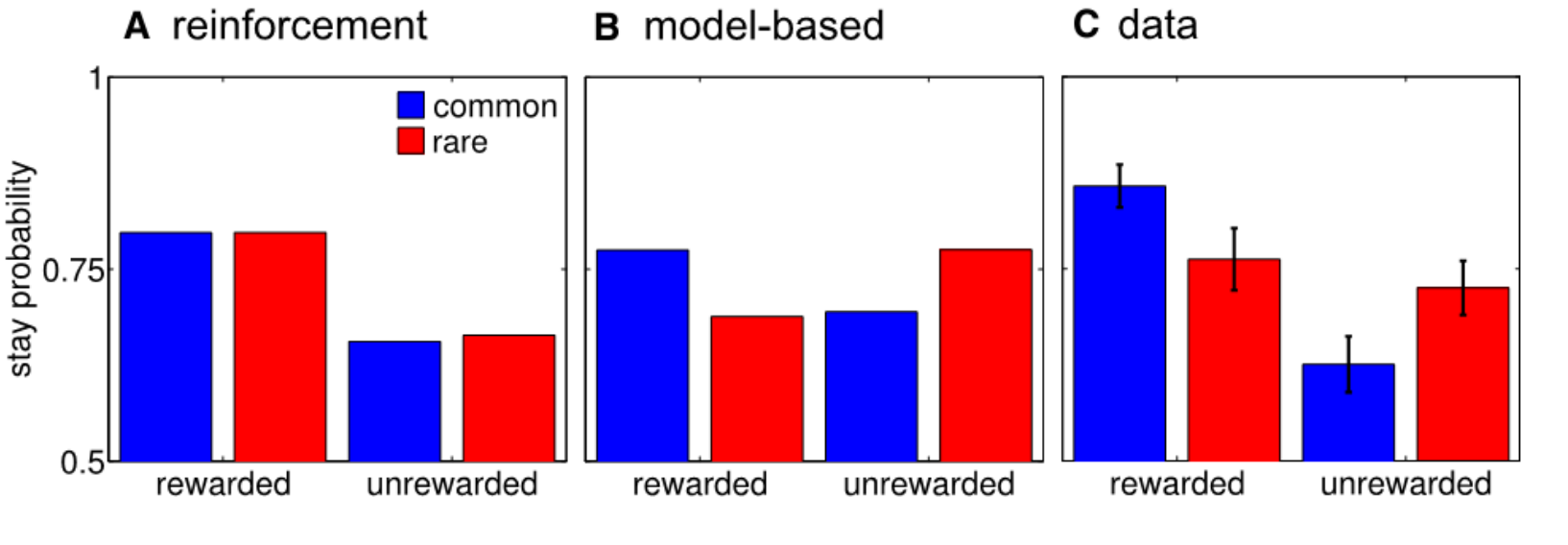
Sutton and Barto, 1998

Daw's Study



Daw et al, 2011

Daw's Study



Daw et al, 2011

Current State

- Machine Learning, Sutton and Barto 1998
- *Model-Based Influences on Humans' Choices and Striatal Prediction Errors*, Daw et al 2011
- Goal-Directed Decision Making as Probabilistic Inference:A Computational Framework and Potential Neural Correlates, Solway and Botvinick 2012
- Preliminary Data Analysis

To Do Next

- **Two Weeks**
  - Increase familiarity with SARSA (model based learning) and hybrid algorithms
  - Continue writing code to construct models
  - Tweak code to optimize models
- **Four Weeks**
  - Determine contribution of model-free and model-based agents
  - Analyze correlation with reaction times
- **Long Term**
  - Use reaction times as constraints to build more accurate computational models
  - Examine distribution of reaction using drift diffusion models to determine which of many model-based learning algorithms the subject used

Success Criteria

- Model accurately and consistently predicts actual subject's patterns of decision making
- Correlation found between model-based decision making and reaction time
- New model, with RT's as constraint
- Use of drift diffusion model to predict specific learning algorithm

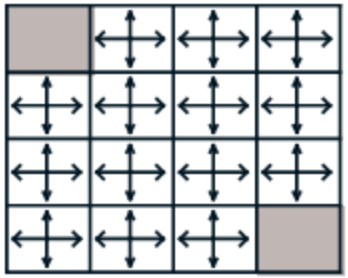
Conclusion: Reinforcement Learning

V_k for the Random Policy

Greedy Policy w.r.t. V_k

$k = 0$

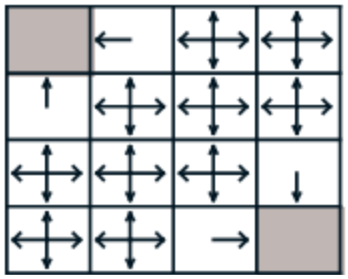
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0



random policy

$k = 1$

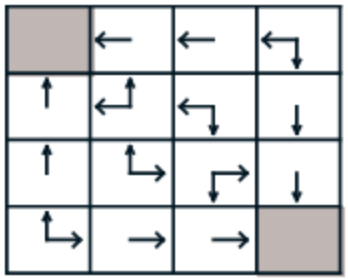
0.0	-1.0	-1.0	-1.0
-1.0	-1.0	-1.0	-1.0
-1.0	-1.0	-1.0	-1.0
-1.0	-1.0	-1.0	0.0



Sutton and Barto, 1998

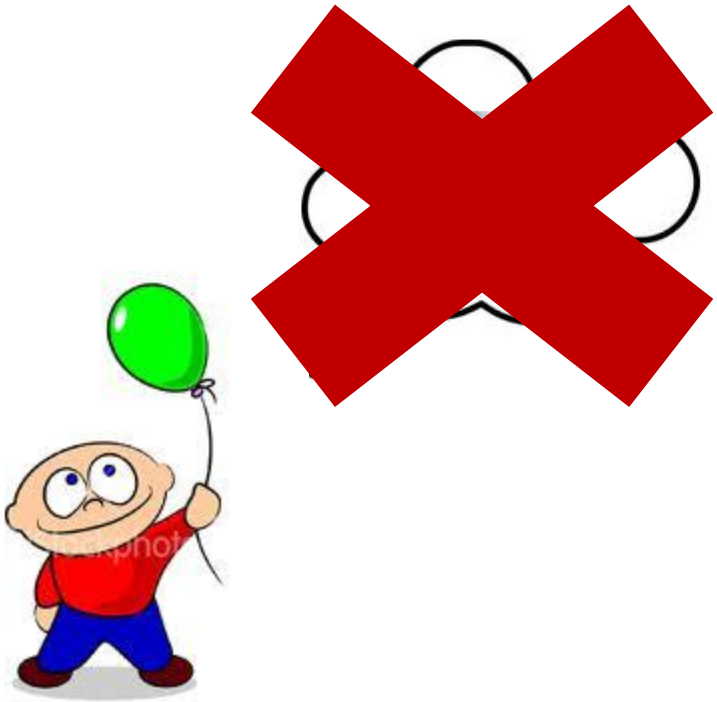
$k = 3$

0.0	-2.4	-2.9	-3.0
-2.4	-2.9	-3.0	-2.9
-2.9	-3.0	-2.9	-2.4
-3.0	-2.9	-2.4	0.0

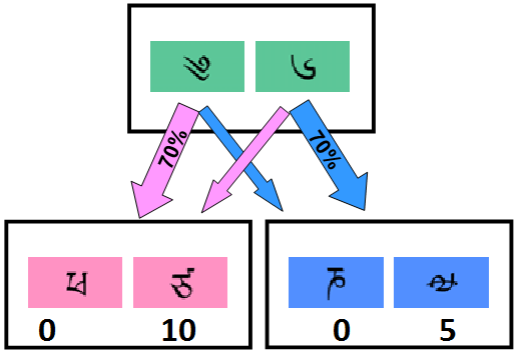


Conclusion :Model Based

Conclusion: Model Free



Conclusion: Daw's Study



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1	4	1	1	3	0	NaN	677	1517	1	1
1	5	2	2	3	0	3899	1093	1279	0	1
1	6	2	2	3	1	2550	743	1737	0	0
1	7	2	1	3	1	2460	726	912	0	1
1	8	2	1	3	1	2910	505	1081	0	0
1	9	2	1	3	1	4800	930	980	0	1
1	10	2	1	3	0	3720	706	865	1	0
1	11	1	2	2	1	2730	591	1442	0	1
1	12	1	1	2	0	1111	690	988	1	1
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1	14	2	1	3	0	1740	1084	1055	1	1
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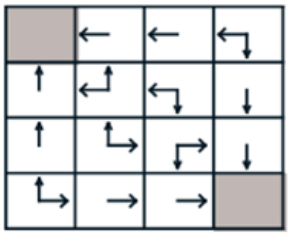

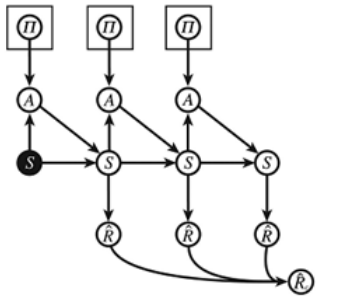

References

- Daw, Nathaniel D., Samuel J. Gershman, Ben Seymour, Peter Dayan, and Raymond J. Dolan. "Model-Based Influences on Humans' Choices and Striatal Prediction Errors." Neuron 69.6 (2011): 1204-215.

- Botvinick, Matthew and Solway, Alec. "Goal-Directed Decision Making as Probabilistic Inference: A Computational Framework and Potential Neural Correlates." Psychological Review 119.1 (2012): 120-54.

- Sutton, R.S., and A.G. Barto. "Reinforcement Learning: An Introduction." IEEE Transactions on Neural Networks 9.5 (1998): 1054.