

[HOME](#) [CATEGORIES](#) [ARCHIVES](#) [LINKS](#) [SEARCH](#) [ABOUT ME](#)

## Reinforcement Learning

Published: 09 Oct 2015 Category: deep\_learning

### ABOUT ME



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### RECENT POSTS

- [Keep Up With New Trends](#)
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### LINKS

*Jump to...*

- Tutorials
  - Simple Reinforcement Learning with Tensorflow
- Courses
- Papers
  - Surveys
  - Playing Doom
- Projects
  - Play Flappy Bird
- Pong
- Tips and Tricks
- Library
- Blogs
  - Let's make a DQN
- Books
- Resources
- Reading and Questions

## Tutorials



### Demystifying Deep Reinforcement Learning (Part1)

<http://neuro.cs.ut.ee/demystifying-deep-reinforcement-learning/>

### Deep Reinforcement Learning With Neon (Part2)

<http://neuro.cs.ut.ee/deep-reinforcement-learning-with-neon/>

### Deep Reinforcement Learning

- intro: David Silver, Google DeepMind
- slides: <http://www.iclr.cc/lib/exe/fetch.php?media=iclr2015:silver-iclr2015.pdf>
- mirror: <http://pan.baidu.com/s/1qWBOJGo>

### Deep Reinforcement Learning

- intro: MLSS 2016. John Schulman[UC Berkeley]
- homepage: <http://rl-gym-doc.s3-website-us-west-2.amazonaws.com/mlss/index.html>
- slides: <http://pan.baidu.com/s/1jIatusA#path=%252F>

### Deep Reinforcement Learning: Pong from Pixels



- intro: Andrej Karpathy
- blog: <http://karpathy.github.io/2016/05/31/rl/>
- gist: <https://gist.github.com/karpathy/a4166c7fe253700972fc77e4ea32c5>

### Deep Reinforcement Learning

- instructor: David Silver. RLDM 2015
- video: [http://videlectures.net/rldm2015\\_silver\\_reinforcement\\_learning/](http://videlectures.net/rldm2015_silver_reinforcement_learning/)

### Deep Reinforcement Learning

- intro: David Silver [Google DeepMind]
- video: <http://techtalks.tv/talks/deep-reinforcement-learning/62360/>
- slides: [http://hunch.net/~beygel/deep\\_rl\\_tutorial.pdf](http://hunch.net/~beygel/deep_rl_tutorial.pdf)

### The Nuts and Bolts of Deep RL Research

- intro: NIPS 2016, John Schulman, OpenAI
- slides: <http://rll.berkeley.edu/deeprlcourse/docs/nuts-and-bolts.pdf>
- mirror: <https://pan.baidu.com/s/1kVkBLkF>

## Reinforcement learning explained

- blog: <https://www.oreilly.com/ideas/reinforcement-learning-explained>

## Beginner's guide to Reinforcement Learning & its implementation in Python

<https://www.analyticsvidhya.com/blog/2017/01/introduction-to-reinforcement-learning-implementation/>

## Reinforcement Learning on the Web

- intro: Andrej Karpathy
- slides: [https://docs.google.com/presentation/d/1lcYrN56V2\\_SuX1rSmpzOUeMnheF6Jsu33-MsvLW9O\\_4/edit#slide=id.p](https://docs.google.com/presentation/d/1lcYrN56V2_SuX1rSmpzOUeMnheF6Jsu33-MsvLW9O_4/edit#slide=id.p)
- slides: [http://alpha.openai.com/ak\\_rework\\_2017.pdf](http://alpha.openai.com/ak_rework_2017.pdf)

## Deep Q Learning with Keras and Gym

- blog: <https://keon.io/rl/deep-q-learning-with-keras-and-gym/>
- github: <https://github.com/keon/deep-q-learning>

## “Deep Reinforcement Learning, Decision Making, and Control

- intro: ICML 2017 Tutorial
- slides: <https://sites.google.com/view/icml17deeprl>

## Simple Reinforcement Learning with Tensorflow

**Part 0: Q-Learning with Tables and Neural Networks** <https://medium.com/emergent-future/simple-reinforcement-learning-with-tensorflow-part-0-q-learning-with-tables-and-neural-networks-d195264329d0#.oo105wa2t>

## Part 1 - Two-armed Bandit

<https://medium.com/@awjuliani/super-simple-reinforcement-learning-tutorial-part-1-fd544fab149#.tk89k51ob>

## Part 2 - Policy-based Agents

<https://medium.com/@awjuliani/super-simple-reinforcement-learning-tutorial-part-2-ded33892c724#.n2wytg9q0>

**Part 3 - Model-Based RL** <https://medium.com/@awjuliani/simple-reinforcement-learning-with-tensorflow-part-3-model-based-rl-9a6fe0cce99#.742i2yj6p>

**Part 4: Deep Q-Networks and Beyond** <https://medium.com/@awjuliani/simple-reinforcement-learning-with-tensorflow-part-4-deep-q-networks-and-beyond-8438a3e2b8df#.jox069crz>

**Part 5: Visualizing an Agent's Thoughts and Actions** <https://medium.com/@awjuliani/simple-reinforcement-learning-with-tensorflow-part-5-visualizing-an-agents-thoughts-and-actions-4f27b134bb2a#.pluh6cygm>

## Part 6: Partial Observability and Deep Recurrent Q-Networks

- **blog:** <https://medium.com/emergent-future/simple-reinforcement-learning-with-tensorflow-part-6-partial-observability-and-deep-recurrent-q-68463e9aeefc#.3se46qkzy>
- **github:** <https://gist.github.com/awjuliani/35d2ab3409fc818011b6519f0f1629df>

## Part 7: Action-Selection Strategies for Exploration

- **blog:** <https://medium.com/emergent-future/simple-reinforcement-learning-with-tensorflow-part-7-action-selection-strategies-for-exploration-d3a97b7cceaf#.8mcaa5nbe>
- **demo:** <https://awjuliani.github.io/exploration/index.html>

## Dissecting Reinforcement Learning

- **part 1:** <https://mpatacchiola.github.io/blog/2016/12/09/dissecting-reinforcement-learning.html>
- **part 2:** <https://mpatacchiola.github.io/blog/2017/01/15/dissecting-reinforcement-learning-2.html>

- part 3: <https://mpatacchiola.github.io/blog/2017/01/29/dissecting-reinforcement-learning-3.html>
- github: <https://github.com/mpatacchiola/dissecting-reinforcement-learning>

### REINFORCE tutorial

- intro: A small collection of code snippets and notes explaining the foundations of the REINFORCE algorithm.
- github: [https://github.com/mathias-madsen/reinforce\\_tutorial](https://github.com/mathias-madsen/reinforce_tutorial)

### Deep Q-Learning Recap

<http://blog.davidqu.com/Research/%5B%20Recap%20%5D%20Deep%20Q-Learning%20Recap/>

### Introduction to Reinforcement Learning

- intro: Joelle Pineau [McGill University]
- video: [http://videlectures.net/deeplearning2016\\_pineau\\_reinforcement\\_learning/](http://videlectures.net/deeplearning2016_pineau_reinforcement_learning/)
- slides:  
[http://videlectures.net/site/normal\\_dl/tag=1051677/deeplearning2016\\_pineau\\_reinforcement\\_learning\\_01.pdf](http://videlectures.net/site/normal_dl/tag=1051677/deeplearning2016_pineau_reinforcement_learning_01.pdf)

## Courses



### Advanced Topics: RL

#### UCL Course on RL

- instructors: David Silver (Google DeepMind, AlphaGo)
- homepage: <http://www0.cs.ucl.ac.uk/staff/d.silver/web/Teaching.html>
- youtube: [https://www.youtube.com/playlist?list=PL5X3mDkKaJrL42i\\_jhE4N-p6E2Ol62Ofa](https://www.youtube.com/playlist?list=PL5X3mDkKaJrL42i_jhE4N-p6E2Ol62Ofa)
- video: <http://pan.baidu.com/s/1bnWGuIz/>
- assignment: [http://www0.cs.ucl.ac.uk/staff/d.silver/web/Teaching\\_files/Easy21-Johannes.pdf](http://www0.cs.ucl.ac.uk/staff/d.silver/web/Teaching_files/Easy21-Johannes.pdf)

## Berkeley CS 294: Deep Reinforcement Learning

- instructors: John Schulman, Pieter Abbeel
- homepage: <http://rll.berkeley.edu/deeprlcourse/>
- youtube: [https://www.youtube.com/playlist?list=PLkFD6\\_40KJIwTmSbCv9OVJB3YaO4sFwkX](https://www.youtube.com/playlist?list=PLkFD6_40KJIwTmSbCv9OVJB3YaO4sFwkX)
- mirror: <https://pan.baidu.com/s/1hsQcm1Y>

## (Udacity) Reinforcement Learning - Offered at Georgia Tech as CS 8803

- instructor: Charles Isbell, Michael Littman
- homepage: <https://www.udacity.com/course/reinforcement-learning-ud600>
- homepage: <https://classroom.udacity.com/courses/ud820/lessons/684808907/concepts/6512308530923>

## CS229 Lecture notes Part XIII: Reinforcement Learning and Control

- intro: Andrew Ng
- lecture notes: <http://cs229.stanford.edu/notes/cs229-notes12.pdf>

## Practical\_RL: A course in reinforcement learning in the wild

- github: [https://github.com/yandexdataschool/Practical\\_RL](https://github.com/yandexdataschool/Practical_RL)

## Reinforcement Learning (COMP-762) Winter 2017

- course page: <http://www.cs.mcgill.ca/~dprecup/courses/rl.html>
- lectures: <http://www.cs.mcgill.ca/~dprecup/courses/RL/lectures.html>

## Papers



## Playing Atari with Deep Reinforcement Learning

- intro: Google DeepMind. NIPS Deep Learning Workshop 2013
- arxiv: <http://arxiv.org/abs/1312.5602>

- github: <https://github.com/kristjankorjus/Replicating-DeepMind>
- demo: <http://cs.stanford.edu/people/karpathy/convnetjs/demo/rldemo.html>
- github: <https://github.com/Kaixhin/Atari>
- github(Tensorflow): [https://github.com/gliese581gg/DQN\\_tensorflow](https://github.com/gliese581gg/DQN_tensorflow)
- summary: [https://github.com/aleju/papers/blob/master/neural-nets/Playing\\_Atari\\_with\\_Deep\\_Reinforcement\\_Learning.md](https://github.com/aleju/papers/blob/master/neural-nets/Playing_Atari_with_Deep_Reinforcement_Learning.md)

### **Deep Learning for Real-Time Atari Game Play Using Offline Monte-Carlo Tree Search Planning**

- intro: NIPS 2014
- keywords: DQN, MCTS
- paper: <http://papers.nips.cc/paper/5421-scalable-inference-for-neuronal-connectivity-from-calcium-imaging>
- paper: <https://web.eecs.umich.edu/~baveja/Papers/UCTtoCNNsAtariGames-FinalVersion.pdf>

### **Replicating the Paper “Playing Atari with Deep Reinforcement Learning”**

- intro: University of Tartu
- technical report:  
[https://courses.cs.ut.ee/MTAT.03.291/2014\\_spring/uploads/Main/Replicating%20DeepMind.pdf](https://courses.cs.ut.ee/MTAT.03.291/2014_spring/uploads/Main/Replicating%20DeepMind.pdf)

### **A Tutorial for Reinforcement Learning**

- paper: <http://web.mst.edu/~gosavia/tutorial.pdf>
- code(C): <http://web.mst.edu/~gosavia/bookcodes.html>
- code(Matlab): [http://web.mst.edu/~gosavia/mrrl\\_website.html](http://web.mst.edu/~gosavia/mrrl_website.html)

### **Incentivizing Exploration In Reinforcement Learning With Deep Predictive Models**

- arxiv: <http://arxiv.org/abs/1507.00814>
- notes: <https://www.evernote.com/shard/s189/sh/a4262b84-a322-4f77-9a76-569278be84af/b8c3e146a76ca3853f560bb03b60a481>

### **Massively Parallel Methods for Deep Reinforcement Learning**



- intro: ICML 2015. DeepMind
- keywords: DQN, Gorila
- arxiv: <https://arxiv.org/abs/1507.04296>

### **Action-Conditional Video Prediction using Deep Networks in Atari Games**

- homepage: <https://sites.google.com/a/umich.edu/junhyuk-oh/action-conditional-video-prediction>
- arxiv: <http://arxiv.org/abs/1507.08750>
- github: <https://github.com/junhyukoh/nips2015-action-conditional-video-prediction>
- video: <http://video.weibo.com/show?fid=1034:98062f3d83e41da6faa99cde5aa1ac97>

### **Deep Recurrent Q-Learning for Partially Observable MDPs**

- intro: AAAI 2015
- arxiv: <https://arxiv.org/abs/1507.06527>

### **Continuous control with deep reinforcement learning**

- intro: Google DeepMind
- arxiv: <http://arxiv.org/abs/1509.02971>
- github: <https://github.com/iassael/torch-policy-gradient>
- github: <https://github.com/stevenpg/ddpg-aigym>
- github(TensorFlow + OpenAI Gym): <https://github.com/SimonRamstedt/ddpg>

### **Benchmarking for Bayesian Reinforcement Learning**

- arxiv: <http://arxiv.org/abs/1509.04064>
- code: <https://github.com/mcastron/BBRL/>
- reading: <http://blogs.ulg.ac.be/damien-ernst/benchmarking-for-bayesian-reinforcement-learning/>

### **Deep Reinforcement Learning with Double Q-learning**

- intro: AAAI 2016

- arxiv: <https://arxiv.org/abs/1509.06461>

### Giraffe: Using Deep Reinforcement Learning to Play Chess

- arxiv: <http://arxiv.org/abs/1509.01549>

### Human-level control through deep reinforcement learning



- intro: Google DeepMind. 2015 Nature
- paper: [http://www.readcube.com/articles/10.1038/nature14236?](http://www.readcube.com/articles/10.1038/nature14236?shared_access_token=Lo_2hFdW4MuqEcF3CVBZm9RgN0jAjWel9jnR3ZoTv0P5kedCCNjz3FJ2FhQCgXkApOr3ZSsJAldp-tw3IWgTseRnLpAc9xQq-vTA2Z5Ji9lg16_WvCy4SaOgpK5XXA6ecqo8d8J7l4EJsdjwai53GqKt-7JuioG0r3iV67MQIro74l6IxvmcVNKBgOwiMGi8U0izJStLpmQp6Vmi_8Lw_A%3D%3D)  
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7JuioG0r3iV67MQIro74l6IxvmcVNKBgOwiMGi8U0izJStLpmQp6Vmi\_8Lw\_A%3D%3D
- paper:  
<http://web.stanford.edu/class/psych209/Readings/MnihEtAlHassibis15NatureControlDeepRL.pdf>
- github(Lua/Torch): <https://github.com/deepmind/dqn>

- mirror: <http://pan.baidu.com/s/1kTiwzOF>
- code: <https://sites.google.com/a/deepmind.com/dqn/>
- youtube: [https://www.youtube.com/watch?v=V2wzkPmiB\\_A](https://www.youtube.com/watch?v=V2wzkPmiB_A)
- github: <https://github.com/kuz/DeepMind-Atari-Deep-Q-Learner>
- github: [https://github.com/tambetm/simple\\_dqn](https://github.com/tambetm/simple_dqn)
- github: <https://github.com/devsisters/DQN-tensorflow>
- reddit:  
[https://www.reddit.com/r/MachineLearning/comments/2x4yy1/google\\_deepmind\\_nature\\_paper\\_humanlevel\\_control](https://www.reddit.com/r/MachineLearning/comments/2x4yy1/google_deepmind_nature_paper_humanlevel_control)

### **Data-Efficient Learning of Feedback Policies from Image Pixels using Deep Dynamical Models**

- arxiv: <http://arxiv.org/abs/1510.02173>

### **Variational Information Maximisation for Intrinsically Motivated Reinforcement Learning**

- intro: Google DeepMind
- arxiv: <http://arxiv.org/abs/1509.08731>
- notes: <https://www.evernote.com/shard/s189/sh/8c7ff9d9-c321-4e83-a802-58f55ebed9ac/bfc614113180a5f4624390df56e73889>

### **Actor-Mimic: Deep Multitask and Transfer Reinforcement Learning**

- intro: ICLR 2016
- arxiv: <http://arxiv.org/abs/1511.06342>
- github: <https://github.com/eparisotto/ActorMimic>

### **MazeBase: A Sandbox for Learning from Games**

- intro: New York University & Facebook AI Research
- arxiv: <http://arxiv.org/abs/1511.07401>

### **Learning Simple Algorithms from Examples**

- intro: New York University & Facebook AI Research

- arxiv: <http://arxiv.org/abs/1511.07275>
- github: <https://github.com/wojzaremba/algorithm-learning>

### **Learning Algorithms from Data**

- PhD thesis: [http://www.cs.nyu.edu/media/publications/zaremba\\_wojciech.pdf](http://www.cs.nyu.edu/media/publications/zaremba_wojciech.pdf)
- github: <https://github.com/wojzaremba/algorithm-learning>

### **Multiagent Cooperation and Competition with Deep Reinforcement Learning**

- arxiv: <http://arxiv.org/abs/1511.08779>
- github: <https://github.com/NeuroCSUT/DeepMind-Atari-Deep-Q-Learner-2Player>

### **Active Object Localization with Deep Reinforcement Learning**

- arxiv: <http://arxiv.org/abs/1511.06015>

### **Deep Reinforcement Learning with Attention for Slate Markov Decision Processes with High-Dimensional States and Actions**

- arxiv: <http://arxiv.org/abs/1512.01124>

### **How to Discount Deep Reinforcement Learning: Towards New Dynamic Strategies**

- arxiv: <http://arxiv.org/abs/1512.02011>

### **State of the Art Control of Atari Games Using Shallow Reinforcement Learning**

- arxiv: <http://arxiv.org/abs/1512.01563>

### **Angrier Birds: Bayesian reinforcement learning**

- arxiv: <http://arxiv.org/abs/1601.01297>
- github: <https://github.com/imanolarrieta/angrybirds>
- gitxiv: <http://gitxiv.com/posts/Nr2N7j4YrR4gnCYK9/angrier-birds-bayesian-reinforcement-learning>

### **Prioritized Experience Replay**

- arxiv: <http://arxiv.org/abs/1511.05952>

### **Dueling Network Architectures for Deep Reinforcement Learning**

- intro: ICML 2016 best paper
- arxiv: <http://arxiv.org/abs/1511.06581>
- notes: <https://hadovanhasselt.wordpress.com/2016/06/20/best-paper-at-icml-dueling-network-architectures-for-deep-reinforcement-learning/>

### **Asynchronous Methods for Deep Reinforcement Learning**

- arxiv: <http://arxiv.org/abs/1602.01783>
- github(Tensorflow): <https://github.com/traai/async-deep-rl>
- github(Tensorflow+Keras+OpenAI Gym): <https://github.com/coreylynch/async-rl>
- github(Tensorflow): <https://github.com/devsisters/async-rl-tensorflow>
- github(PyTorch): <https://github.com/ikostrikov/pytorch-a3c>
- notes: <https://blog.acolyer.org/2016/10/10/asynchronous-methods-for-deep-reinforcement-learning/>

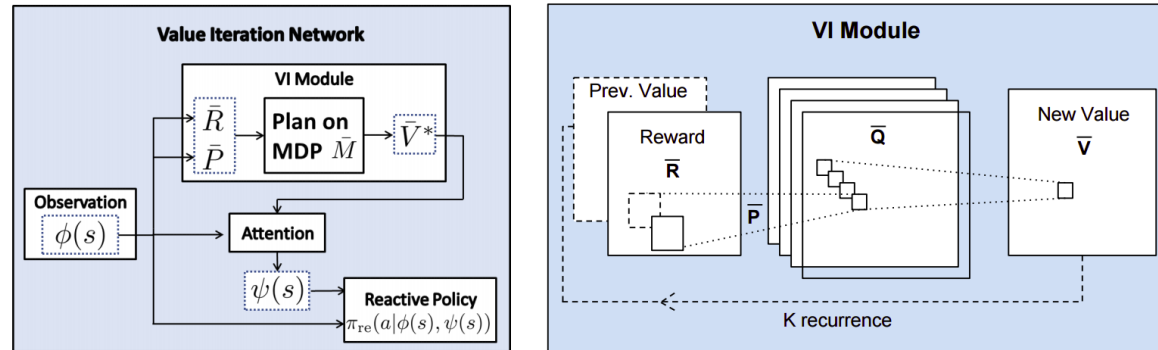
### **Graying the black box: Understanding DQNs**

- arxiv: <http://arxiv.org/abs/1602.02658>

### **Learning to Communicate to Solve Riddles with Deep Distributed Recurrent Q-Networks**

- arxiv: <http://arxiv.org/abs/1602.02672>

### **Value Iteration Networks**



- intro: NIPS 2016, Best Paper Award. University of California, Berkeley
- arxiv: <http://arxiv.org/abs/1602.02867>
- github(official, Theano): <https://github.com/avivt/VIN>
- github: <https://github.com/TheAbhiKumar/tensorflow-value-iteration-networks>
- github: <https://github.com/onlytailei/PyTorch-value-iteration-networks>
- github: <https://github.com/kentsommer/pytorch-value-iteration-networks>
- github: <https://github.com/neka-nat/vin-keras>
- notes(by Andrej Karpathy): <https://github.com/karpathy/paper-notes/blob/master/vin.md>

### Insights in Reinforcement Learning

- intro: MSc thesis
- mirror: <http://pan.baidu.com/s/1bn51BYJ>

### Using Deep Q-Learning to Control Optimization Hyperparameters

- arxiv: <http://arxiv.org/abs/1602.04062>

### Continuous Deep Q-Learning with Model-based Acceleration

- arxiv: <http://arxiv.org/abs/1603.00748>

### Deep Reinforcement Learning from Self-Play in Imperfect-Information Games

- arxiv: <http://arxiv.org/abs/1603.01121>

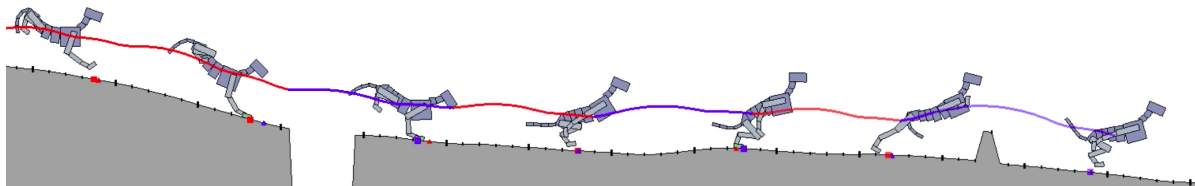
### **Hierarchical Deep Reinforcement Learning: Integrating Temporal Abstraction and Intrinsic Motivation**

- intro: MIT
- arxiv: <https://arxiv.org/abs/1604.06057>
- github: <https://github.com/EthanMacdonald/h-DQN>

### **Benchmarking Deep Reinforcement Learning for Continuous Control**

- arxiv: <http://arxiv.org/abs/1604.06778>
- github: <https://github.com/rllab/rllab>
- doc: <https://rllab.readthedocs.org/en/latest/>

### **Terrain-Adaptive Locomotion Skills Using Deep Reinforcement Learning**



- homepage: <http://www.cs.ubc.ca/~van/papers/2016-TOG-deepRL/index.html>
- paper: <http://www.cs.ubc.ca/~van/papers/2016-TOG-deepRL/2016-TOG-deepRL.pdf>
- github: <https://github.com/xbpeng/DeepTerrainRL>

### **Hierarchical Reinforcement Learning using Spatio-Temporal Abstractions and Deep Neural Networks**

- arxiv: <http://arxiv.org/abs/1605.05359>

### **Deep Successor Reinforcement Learning (MIT)**

- arxiv: <http://arxiv.org/abs/1606.02396>

- github: <https://github.com/Ardavans/DSR>

### **Learning to Communicate with Deep Multi-Agent Reinforcement Learning**

- arxiv: <https://arxiv.org/abs/1605.06676>
- github: <https://github.com/iassael/learning-to-communicate>

### **Deep Reinforcement Learning with Regularized Convolutional Neural Fitted Q Iteration RC-NFQ: Regularized Convolutional Neural Fitted Q Iteration**

- intro: A batch algorithm for deep reinforcement learning. Incorporates dropout regularization and convolutional neural networks with a separate target Q network.
- paper: <http://machineintelligence.org/papers/rc-nfq.pdf>
- github: <https://github.com/cosmoharrigan/rc-nfq>

### **Episodic Exploration for Deep Deterministic Policies: An Application to StarCraft Micromanagement Tasks**

- intro: Facebook AI Research
- arxiv: <http://arxiv.org/abs/1609.02993>

### **Bayesian Reinforcement Learning: A Survey**

- arxiv: <http://arxiv.org/abs/1609.04436>

### **Playing FPS Games with Deep Reinforcement Learning**

- arxiv: <http://arxiv.org/abs/1609.05521>
- demo: <https://www.youtube.com/playlist?list=PLduGZax9wmiHg-XPFSgqGg8PEAV51q1FT>
- notes: <https://blog.acolyer.org/2016/11/23/playing-fps-games-with-deep-reinforcement-learning/>

### **Reset-Free Guided Policy Search: Efficient Deep Reinforcement Learning with Stochastic Initial States**

- intro: University of Washington & UC Berkeley



- arxiv: <https://arxiv.org/abs/1610.01112>

### **Utilization of Deep Reinforcement Learning for saccadic-based object visual search**

- arxiv: <https://arxiv.org/abs/1610.06492>

### **Learning to Navigate in Complex Environments**

- intro: Google DeepMind
- arxiv: <https://arxiv.org/abs/1611.03673>
- github: <https://github.com/deepmind/lab>
- youtube: <https://www.youtube.com/watch?v=lNoaTyMZsWI>

### **Reinforcement Learning with Unsupervised Auxiliary Tasks**

- intro: DeepMind. ICLR 2017 oral
- arxiv: <https://arxiv.org/abs/1611.05397>

### **Learning to reinforcement learn**

- intro: DeepMind
- arxiv: <https://arxiv.org/abs/1611.05763>

### **A Deep Learning Approach for Joint Video Frame and Reward Prediction in Atari Games**

- intro: Graduate Training Center of Neuroscience & MSR
- arxiv: <https://arxiv.org/abs/1611.07078>

### **Exploration for Multi-task Reinforcement Learning with Deep Generative Models**

- intro: NIPS Deep Reinforcement Learning Workshop 2016
- arxiv: <https://arxiv.org/abs/1611.09894>

### **Neural Combinatorial Optimization with Reinforcement Learning**

- intro: Google Brain

- keywords: traveling salesman problem (TSP)
- arxiv: <https://arxiv.org/abs/1611.09940>

### **Loss is its own Reward: Self-Supervision for Reinforcement Learning**

- arxiv: <https://arxiv.org/abs/1612.07307>

### **Reinforcement Learning Using Quantum Boltzmann Machines**

- intro: 1QB Information Technologies (1QBit)
- arxiv: <https://arxiv.org/abs/1612.05695>

### **Deep Reinforcement Learning applied to the game Bubble Shooter**

- bachelor thesis: <https://staff.fnwi.uva.nl/b.bredeweg/pdf/BSc/20152016/Samson.pdf>
- github: <https://github.com/laurensam/AlphaBubble>
- demo: <https://www.youtube.com/watch?v=DPAKFenNgbs>

### **Deep Reinforcement Learning: An Overview**

- arxiv: <https://arxiv.org/abs/1701.07274>

### **Robust Adversarial Reinforcement Learning**

- intro: CMU & Google Brain & Google Research
- arxiv: <https://arxiv.org/abs/1703.02702>

### **Beating Atari with Natural Language Guided Reinforcement Learning**

- intro: Stanford University
- arxiv: <https://arxiv.org/abs/1704.05539>

### **Feature Control as Intrinsic Motivation for Hierarchical Reinforcement Learning**

- intro: Imperial College London
- arxiv: <https://arxiv.org/abs/1705.06769>

- github: <https://github.com/Nat-D/FeatureControlHRL>

### **Distral: Robust Multitask Reinforcement Learning**

- intro: DeepMind
- keywords: Distill, transfer learning
- arxiv: <https://arxiv.org/abs/1707.04175>

## **Surveys**

### **Reinforcement Learning: A Survey**

- intro: JAIR 1996
- project page: <http://www.cs.cmu.edu/afs/cs/project/jair/pub/volume4/kaelbling96a-html/rl-survey.html>
- arxiv: <http://arxiv.org/abs/cs/9605103>

### **A Brief Survey of Deep Reinforcement Learning**

- intro: IEEE Signal Processing Magazine, Special Issue on Deep Learning for Image Understanding
- intro: Imperial College London & Arizona State University
- arxiv: <https://arxiv.org/abs/1708.05866>

## **Playing Doom**

### **ViZDoom: A Doom-based AI Research Platform for Visual Reinforcement Learning**



- arxiv: <http://arxiv.org/abs/1605.02097>
- github: <https://github.com/Marqt/ViZDoom>
- homepage: <http://vizdoom.cs.put.edu.pl/>
- tutorial: <http://vizdoom.cs.put.edu.pl/tutorial>

### Deep Reinforcement Learning From Raw Pixels in Doom

- intro: Bachelor's thesis
- arxiv: <https://arxiv.org/abs/1610.02164>

### Playing Doom with SLAM-Augmented Deep Reinforcement Learning

- intro: University of Oxford
- arxiv: <https://arxiv.org/abs/1612.00380>

### **Reinforcement Learning via Recurrent Convolutional Neural Networks**

- intro: ICPR 2016
- arxiv: <https://arxiv.org/abs/1701.02392>
- github: [https://github.com/tanmayshankar/RCNN\\_MDP](https://github.com/tanmayshankar/RCNN_MDP)

### **Shallow Updates for Deep Reinforcement Learning**

- intro: The Technion & UC Berkeley
- arxiv: <https://arxiv.org/abs/1705.07461>
- github(Official): [https://github.com/Shallow-Updates-for-Deep-RL/Shallow\\_Updates\\_for\\_Deep\\_RL](https://github.com/Shallow-Updates-for-Deep-RL/Shallow_Updates_for_Deep_RL)

## **Projects**



### **TorchQLearning**

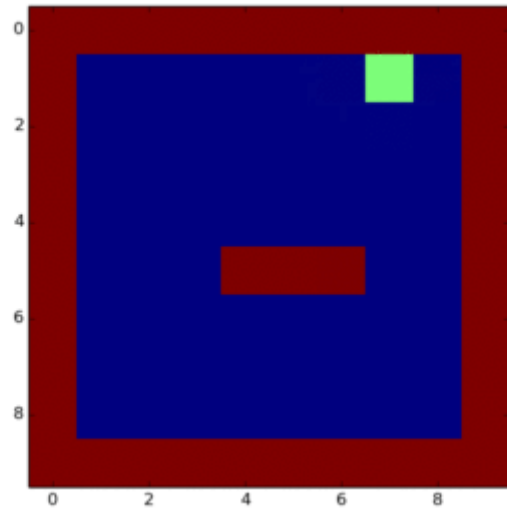


- github: <https://github.com/SeanNaren/TorchQLearningExample>

#### **General\_Deep\_Q\_RL: General deep Q learning framework**

- github: [https://github.com/VinF/General\\_Deep\\_Q\\_RL](https://github.com/VinF/General_Deep_Q_RL)
- wiki: [https://github.com/VinF/General\\_Deep\\_Q\\_RL/wiki](https://github.com/VinF/General_Deep_Q_RL/wiki)

#### **Snake: Toy example of deep reinforcement model playing the game of snake**

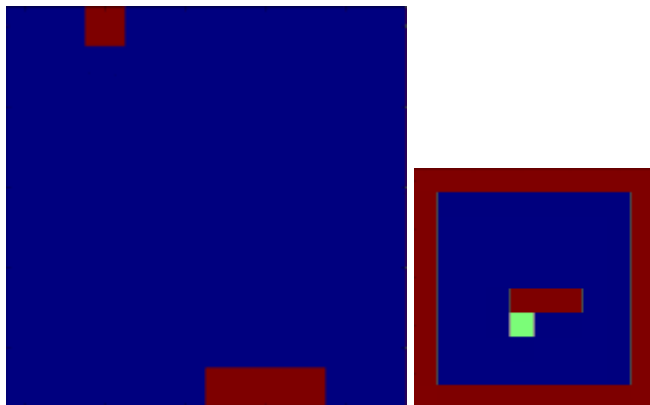


- github: <https://github.com/bitwise-ben/Snake>

### Using Deep Q Networks to Learn Video Game Strategies

- github: <https://github.com/asrivat1/DeepLearningVideoGames>

### qlearning4k: Q-learning for Keras



- intro: “Qlearning4k is a reinforcement learning add-on for the python deep learning library Keras. Its simple, and is ideal for rapid prototyping.”
- github: <https://github.com/farizrahman4u/qlearning4k>

#### **rlenvs: Reinforcement learning environments for Torch7, inspired by RL-Glue**

- github: <https://github.com/Kaixhin/rlenvs>

#### **deep\_rl\_ale: An implementation of Deep Reinforcement Learning / Deep Q-Networks for Atari games in TensorFlow**

- github: [https://github.com/Jabberwockyll/deep\\_rl\\_ale](https://github.com/Jabberwockyll/deep_rl_ale)

#### **Chimp: General purpose framework for deep reinforcement learning**

- github: <https://github.com/sisl/Chimp>

#### **Deep Q Learning for ATARI using Tensorflow**

- github: [https://github.com/mrkulk/deepQN\\_tensorflow](https://github.com/mrkulk/deepQN_tensorflow)

#### **DeepQLearning: A powerful machine learning algorithm utilizing Q-Learning and Neural Networks, implemented using Torch and Lua.**

- github: <https://github.com/blakeMilner/DeepQLearning>

#### **OpenAI Gym: A toolkit for developing and comparing reinforcement learning algorithms**

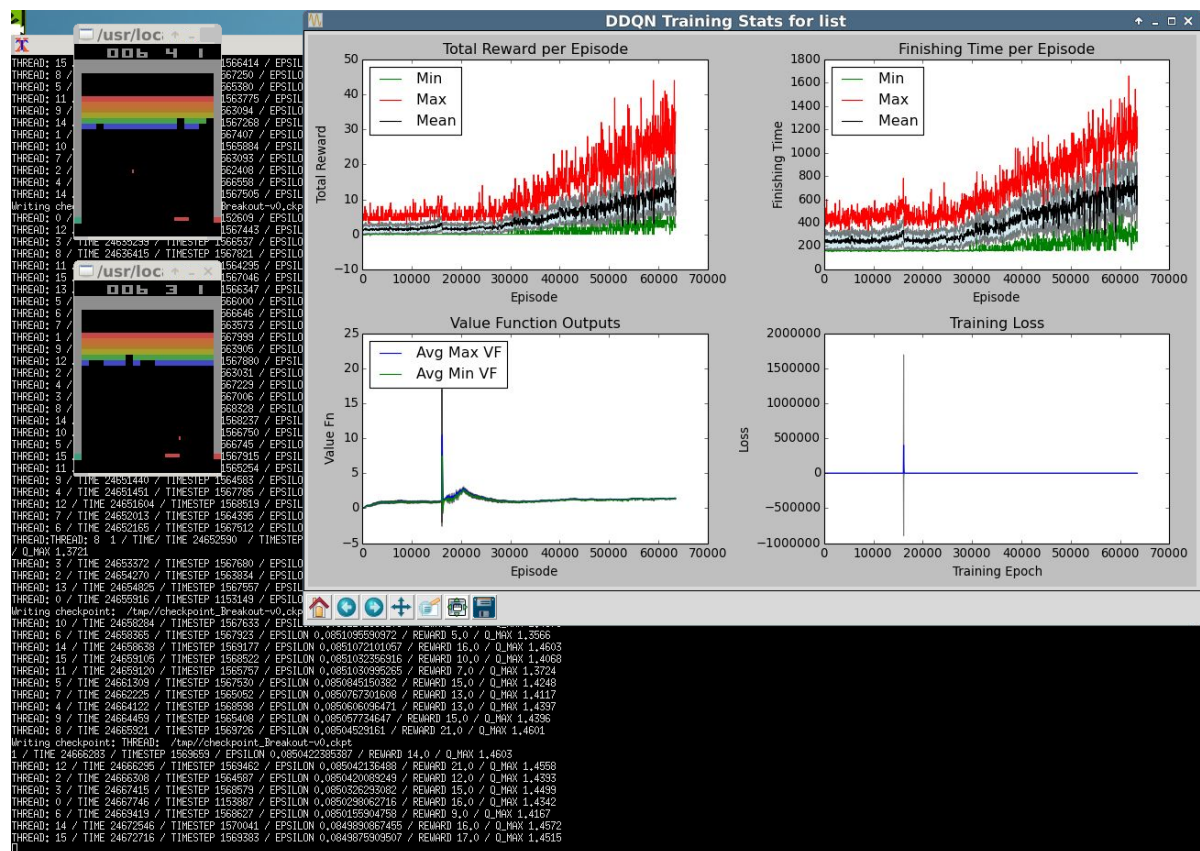
- homepage: <https://gym.openai.com/>
- github: <https://github.com/openai/gym>

#### **DeeR: DEEp Reinforcement learning framework**

- github: <https://github.com/VinF/deer/>
- docs: <http://deer.readthedocs.io/en/latest/>



## KeRLym: A Deep Reinforcement Learning Toolbox in Keras



- homepage: <https://oshearesearch.com/index.php/2016/06/14/kerlym-a-deep-reinforcement-learning-toolbox-in-keras/>
- github: <https://github.com/osh/kerlym>

## Pack of Drones: Layered reinforcement learning for complex behaviors

- github: <https://github.com/MickyDowns/deep-theano-rnn-lstm-car>
- youtube: <https://www.youtube.com/watch?v=WtLRGzbfeZc>

## RL Helicopter Game: Q-Learning and DQN Reinforcement Learning to play the Helicopter Game - Keras based!

- project page: [http://dandxy89.github.io/rf\\_helicopter/](http://dandxy89.github.io/rf_helicopter/)
- github: [https://github.com/dandxy89/rf\\_helicopter](https://github.com/dandxy89/rf_helicopter)

### **Playing Mario with Deep Reinforcement Learning**

- github: <https://github.com/aleju/mario-ai>

### **Deep Attention Recurrent Q-Network**

- intro: Deep Reinforcement Learning Workshop, NIPS 2015. DeepHack Game
- arxiv: <https://arxiv.org/abs/1512.01693>
- github: <https://github.com/5vision/DARQN>

### **Deep Reinforcement Learning in TensorFlow**

- intro: TensorFlow implementation of Deep Reinforcement Learning papers
- github: <https://github.com/carpedm20/deep-rl-tensorflow>

### **rltorch: A RL package for Torch that can also be used with openai gym**

- github: <https://github.com/ludc/rltorch>

### **deep\_q\_rl: Theano-based implementation of Deep Q-learning**

- github: [https://github.com/spragunr/deep\\_q\\_rl](https://github.com/spragunr/deep_q_rl)

### **Reinforcement-trading**

- intro: This project uses reinforcement learning on stock market and agent tries to learn trading. The goal is to check if the agent can learn to read tape. The project is dedicated to hero in life great Jesse Livermore.
- github: [https://github.com/deependersingla/deep\\_trader](https://github.com/deependersingla/deep_trader)

### **dist-dqn : Distributed Reinforcement Learning using Deep Q-Network in TensorFlow**

- github: <https://github.com/viswanathgs/dist-dqn>

## Deep Reinforcement Learning for Keras

- github: <https://github.com/matthiasplappert/keras-rl>

## RL4J: Reinforcement Learning for the JVM

- intro: Reinforcement learning framework integrated with deeplearning4j.
- github: <https://github.com/deeplearning4j/rl4j>

## Teaching Your Computer To Play Super Mario Bros. – A Fork of the Google DeepMind Atari Machine Learning Project

- blog: <http://www.ehrenbrav.com/2016/08/teaching-your-computer-to-play-super-mario-bros-a-fork-of-the-google-deepmind-atari-machine-learning-project/>
- github: <https://github.com/ehrenbrav/DeepQNetwork>

## dpri: Deep reinforcement learning package for torch7

- github: <https://github.com/PoHsunSu/dpri>

## Reinforcement Learning for Torch: Introducing torch-twrl

- blog: <https://blog.twitter.com/2016/reinforcement-learning-for-torch-introducing-torch-twrl>
- github: <https://github.com/twitter/torch-twrl>

## Alpha Toe - Using Deep learning to master Tic-Tac-Toe - Daniel Slater

- blog: <http://www.danielslater.net/2016/10/alphatoe.html>
- youtube: <https://www.youtube.com/watch?v=Meb5hApAnj4>
- github: <https://github.com/DanielSlater/AlphaToe>

## Tensorflow-Reinforce: Implementation of Reinforcement Learning Models in Tensorflow

- github: <https://github.com/yukezhu/tensorflow-reinforce>

## deep RL hacking on minecraft with malmo

- github: <https://github.com/matpalm/malmomo>

### **Reinforcement Learning**

- intro: MC control, Q-learning, SARSA, Cross Entropy Method
- github: <https://github.com/janivanecky/ReinforcementLearning>

### **markovjs: Reinforcement Learning in JavaScript**

- github: <https://github.com/lsumsi/markovjs>

### **Deep Q: Deep reinforcement learning with TensorFlow**

- github: [https://github.com/tobegit3hub/deep\\_q](https://github.com/tobegit3hub/deep_q)

### **Deep Q-Learning Network in pytorch**

<https://github.com/transedward/pytorch-dqn>

### **Tensorflow-RL: Implementations of deep RL papers and random experimentation**

<https://github.com/steveKapturowski/tensorflow-rl>

### **Minimal and Clean Reinforcement Learning Examples**

<https://github.com/rlcode/reinforcement-learning>

### **DeepRL: Highly modularized implementation of popular deep RL algorithms by PyTorch**

<https://github.com/ShangtongZhang/DeepRL>

## **Play Flappy Bird**

### **Using Deep Q-Network to Learn How To Play Flappy Bird**

- github: <https://github.com/yenchenlin/DeepLearningFlappyBird>

## Playing Flappy Bird Using Deep Reinforcement Learning (Based on Deep Q Learning DQN using Tensorflow)

- blog: <http://blog.csdn.net/songrotek/article/details/50951537>
- github: <https://github.com/songrotek/DRL-FlappyBird>

## Playing Flappy Bird Using Deep Reinforcement Learning (Based on Deep Q Learning DQN)

- github: <https://github.com/li-haoran/DRL-FlappyBird>

## MXNET-Scala Playing Flappy Bird Using Deep Reinforcement Learning

- github: <https://github.com/Ldpe2G/DeepLearningForFun/tree/master/Mxnet-Scala/DRLFlappyBird>

## Flappy Bird Bot using Reinforcement Learning in Python

- github: <https://github.com/chncyhn/flappybird-qlearning-bot>

## Using Keras and Deep Q-Network to Play FlappyBird

- blog: <https://yanpanlau.github.io/2016/07/10/FlappyBird-Keras.html>
- github: <https://github.com/yanpanlau/Keras-FlappyBird>

# Pong



## Building a Pong playing AI in just 1 hour(plus 4 days training...)

- slides: <https://speakerdeck.com/danielslater/building-a-pong-ai>
- github: <https://github.com/DanielSlater/PyDataLondon2016>
- youtube: [https://www.youtube.com/watch?v=n8NdT\\_3y9oY](https://www.youtube.com/watch?v=n8NdT_3y9oY)

## Pong Neural Network(LIVE)

- youtube: [https://www.youtube.com/watch?v=Hqf\\_\\_FIRlzg](https://www.youtube.com/watch?v=Hqf__FIRlzg)

- github: [https://github.com/llSourcell/pong\\_neural\\_network\\_live](https://github.com/llSourcell/pong_neural_network_live)

## Tips and Tricks



### DeepRLHacks

- intro: The Nuts and Bolts of Deep RL Research
- github: <https://github.com/williamFalcon/DeepRLHacks>

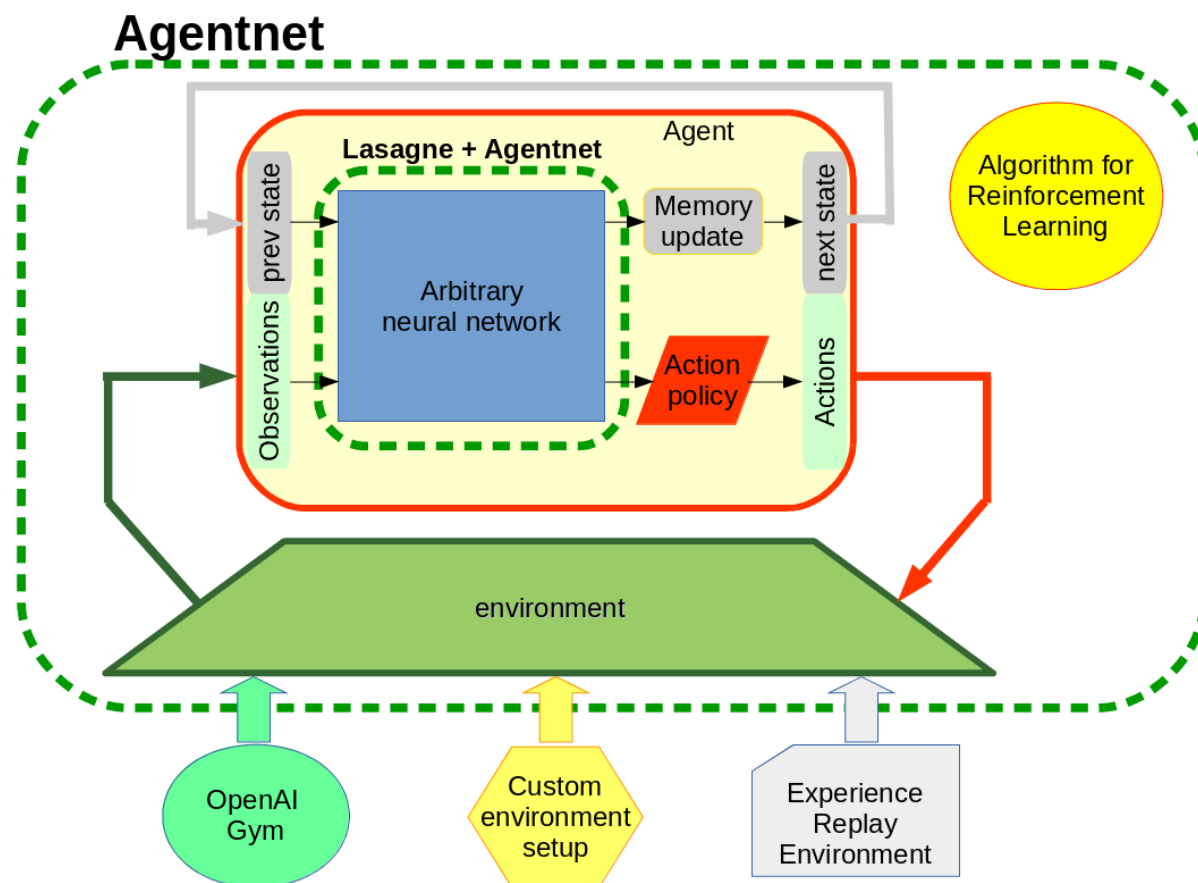
## Library



### BURLAP: Brown-UMBC Reinforcement Learning and Planning (BURLAP) java code library

- intro: for the use and development of single or multi-agent planning and learning algorithms and domains to accompany them
- homepage: <http://burlap.cs.brown.edu/>

### AgentNet: Deep Reinforcement Learning library for humans



- intro: A lightweight library to build and train deep reinforcement learning and custom recurrent networks using Theano+Lasagne
- github: <https://github.com/yandexdataschool/AgentNet>

### Atari Multitask & Transfer Learning Benchmark (AMTLB)

- intro: Atari gauntlet for RL agents
- project page: <http://ai-on.org/projects/multitask-and-transfer-learning.html>
- github: [https://github.com/deontologician/atari\\_multitask](https://github.com/deontologician/atari_multitask)

## Blogs



### **A Short Introduction To Some Reinforcement Learning Algorithms**

[http://webdocs.cs.ualberta.ca/~vanhasse/rl\\_algs/rl\\_algs.html](http://webdocs.cs.ualberta.ca/~vanhasse/rl_algs/rl_algs.html)

### **A Painless Q-Learning Tutorial**

<http://mnemstudio.org/path-finding-q-learning-tutorial.htm>

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### **Reinforcement Learning - Part 1**

<http://outlace.com/Reinforcement-Learning-Part-1/>

### **Reinforcement Learning - Monte Carlo Methods**

<http://outlace.com/Reinforcement-Learning-Part-2/>

### **Q-learning with Neural Networks**

<http://outlace.com/Reinforcement-Learning-Part-3/>

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### **Guest Post (Part I): Demystifying Deep Reinforcement Learning**

<http://www.nervanasys.com/demystifying-deep-reinforcement-learning/>

**Using reinforcement learning in Python to teach a virtual car to avoid obstacles: An experiment in Q-learning, neural networks and Pygame.**



- blog: <https://medium.com/@harvitronix/using-reinforcement-learning-in-python-to-teach-a-virtual-car-to-avoid-obstacles-6e782cc7d4c6#.p8ug6snri>
- github: <https://github.com/harvitronix/reinforcement-learning-car>

### **Reinforcement learning in Python to teach a virtual car to avoid obstacles—part 2**



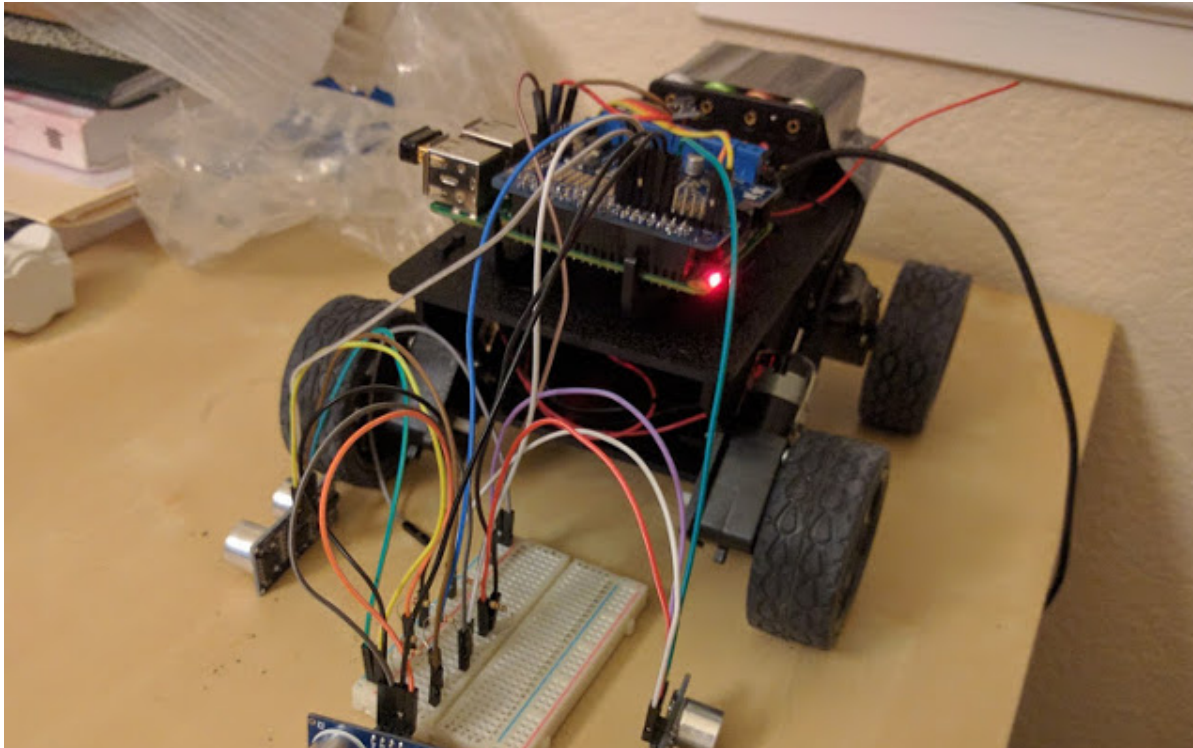
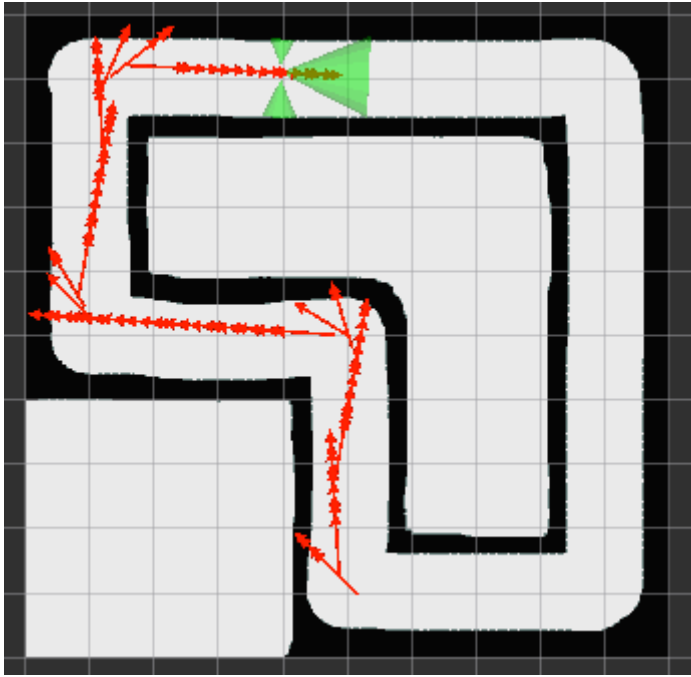
<https://medium.com/@harvitronix/reinforcement-learning-in-python-to-teach-a-virtual-car-to-avoid-obstacles-part-2-93e614fcd238#.i0o643m1h>

### **Some Reinforcement Learning Algorithms in Python, C++**

- pan:

<http://pan.baidu.com/s/1mhcYf3M#path=%252FImplementations%2520of%2520Some%2520Reinforcement%2520Learning%2520Algorithms>

**learning to do laps with reinforcement learning and neural nets**





- blog: <http://matpalm.com/blog/drivebot/>
- github: <https://github.com/matpalm/drivebot>

### Get a taste of reinforcement learning—implement a tic tac toe agent



<https://medium.com/@shiyang/get-a-taste-of-reinforcement-learning-implement-a-tic-tac-toe-agent-deda5617b2e4#.59bx71a2h>

### Best reinforcement learning libraries?

- reddit:  
[https://www.reddit.com/r/MachineLearning/comments/4b2ugc/best\\_reinforcement\\_learning\\_libraries/](https://www.reddit.com/r/MachineLearning/comments/4b2ugc/best_reinforcement_learning_libraries/)

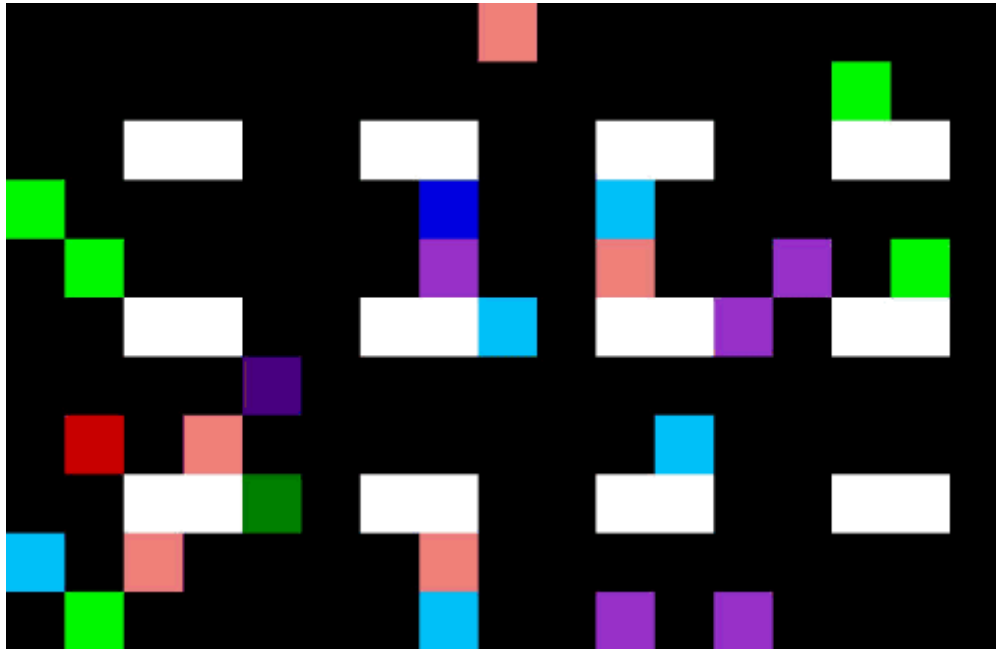
### Super Simple Reinforcement Learning Tutorial

- part 1: <https://medium.com/@awjuliani/super-simple-reinforcement-learning-tutorial-part-1-fd544fab149>
- part 2: <https://medium.com/@awjuliani/super-simple-reinforcement-learning-tutorial-part-2-ded33892c724#.dyhxxw1u6>
- part 3: <https://medium.com/@awjuliani/simple-reinforcement-learning-with-tensorflow-part-3-model-based-rl-9a6fe0cce99#.r4c7i7tjq>
- gist: <https://gist.github.com/awjuliani/16608e1c4968baaa692b9b8c7dd94d04>

### Reinforcement Learning in Python

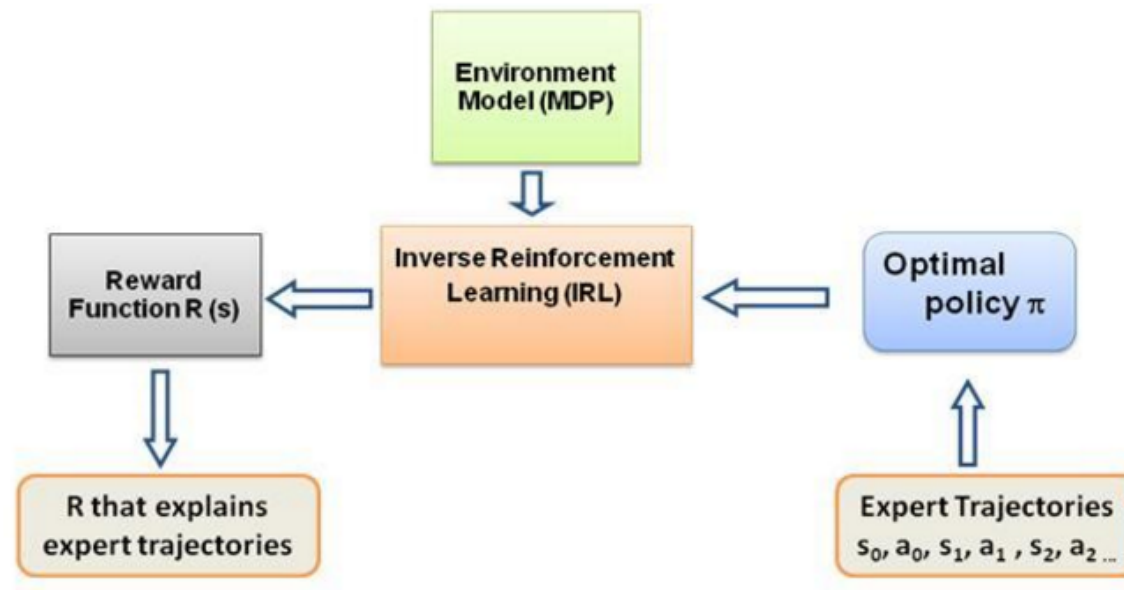
- github: <https://github.com/NathanEpstein/pydata-reinforce>

### The Skynet Salesman



- keywords: traveling salesman problem (TSP), deep Q learning
- blog: <http://multithreaded.stitchfix.com/blog/2016/07/21/skynet-salesman/>
- github: <https://github.com/jn2clark/ReinforcementLearning/tree/master/DeepQ>

### Apprenticeship learning using Inverse Reinforcement Learning



- blog: <https://jangirishabh.github.io/2016/07/09/virtual-car-IRL/>
- github: <https://github.com/jangirishabh/toyCarIRL>

### Reinforcement Learning and DQN, learning to play from pixels

- blog: <https://rubenfiszel.github.io/posts/rl4j/2016-08-24-Reinforcement-Learning-and-DQN.html>

### Deep Learning in a Nutshell: Reinforcement Learning

<https://devblogs.nvidia.com/parallelforall/deep-learning-nutshell-reinforcement-learning/>

### Write an AI to win at Pong from scratch with Reinforcement Learning

<https://medium.com/@dhrupv/how-to-write-a-neural-network-to-play-pong-from-scratch-956b57d4f6e0#.n1pgn9chr>

### Learning Reinforcement Learning (with Code, Exercises and Solutions)

- blog: <http://www.wildml.com/2016/10/learning-reinforcement-learning/>

- github: <https://github.com/dennybritz/reinforcement-learning>

### **Deep Reinforcement Learning: Playing a Racing Game**

[https://lopespm.github.io/machine\\_learning/2016/10/06/deep-reinforcement-learning-racing-game.html](https://lopespm.github.io/machine_learning/2016/10/06/deep-reinforcement-learning-racing-game.html)

### **Experimenting with Reinforcement Learning and Active Inference**

- blog: <http://www.araya.org/archives/955>
- github: <https://github.com/arrayabrain/BinarySearchLSTM>

### **Deep reinforcement learning, battleship**

- blog: <http://efavdb.com/battleship/>
- github: <https://github.com/EFavDB/battleship>

### **Deep Learning Research Review Week 2: Reinforcement Learning**

<https://adeshpande3.github.io/adeshpande3.github.io/Deep-Learning-Research-Review-Week-2-Reinforcement-Learning>

### **Reinforcement Learning: Artificial Intelligence in Game Playing**

<https://medium.com/@pavelkordik/reinforcement-learning-the-hardest-part-of-machine-learning-b667a22995ca#.jjiitflok>

### **Artificial Intelligence's Next Big Step: Reinforcement Learning**

<http://thenewstack.io/reinforcement-learning-ready-real-world/>

## **Let's make a DQN**

### **Let's make a DQN**

- Theory: <https://jaromiru.com/2016/09/27/lets-make-a-dqn-theory/>
- Implementation: <https://jaromiru.com/2016/10/03/lets-make-a-dqn-implementation/>

- Debugging: <https://jaromiru.com/2016/10/12/lets-make-a-dqn-debugging/>
- Full DQN: <https://jaromiru.com/2016/10/21/lets-make-a-dqn-full-dqn/>
- github: <https://github.com/jaara/AI-blog/blob/master/CartPole-basic.py>

## Books



### Reinforcement Learning: State-of-the-Art

- intro: “The main goal of this book is to present an up-to-date series of survey articles on the main contemporary sub-fields of reinforcement learning. This includes surveys on partially observable environments, hierarchical task decompositions, relational knowledge representation and predictive state representations. Furthermore, topics such as transfer, evolutionary methods and continuous spaces in reinforcement learning are surveyed. In addition, several chapters review reinforcement learning methods in robotics, in games, and in computational neuroscience. In total seventeen different subfields are presented by mostly young experts in those areas, and together they truly represent a state-of-the-art of current reinforcement learning research.”
- book: <http://www.springer.com/gp/book/9783642276446#>

### Reinforcement Learning: An Introduction

- github: <https://github.com/Mononofu/reinforcement-learning>
- homepage: <http://webdocs.cs.ualberta.ca/~sutton/book/the-book.html>
- course: <http://incompleteideas.net/rlai.cs.ualberta.ca/RLAI/RLAICourse/2010.html>
- book(1st edition): <http://pan.baidu.com/s/1jkaMq>
- book(2nd edition): <http://pan.baidu.com/s/1dDnNEnR>

### Reinforcement Learning: An Introduction (Second edition, Draft)

- book: <https://webdocs.cs.ualberta.ca/~sutton/book/bookdraft2016sep.pdf>
- mirror: <http://pan.baidu.com/s/1slrMYkP>

- github: <https://github.com/ShangtongZhang/reinforcement-learning-an-introduction>

### The Self Learning Quant

- intro: explain and show the concept of self reinforcement learning combined with a neural network
- blog: <https://medium.com/@danielzakrisson/the-self-learning-quant-d3329fcc9915#.9lsa5rh3e>
- gihtub: <https://github.com/danielzak/sl-quant>

### Reinforcement Learning: An Introduction

- author: Richard S. Sutton and Andrew G. Barto
- book: <https://webdocs.cs.ualberta.ca/~sutton/book/ebook/the-book.html>
- solutions: <https://github.com/btaba/intro-to-rl>

## Resources



### Deep Reinforcement Learning Papers

<https://github.com/junhyukoh/deep-reinforcement-learning-papers>

### Awesome Reinforcement Learning

- website: [http://aikorea.org/awesome-rl/?utm\\_content=buffer5d0f3&utm\\_medium=social&utm\\_source=plus.google.com&utm\\_campaign=buffer#online-demos](http://aikorea.org/awesome-rl/?utm_content=buffer5d0f3&utm_medium=social&utm_source=plus.google.com&utm_campaign=buffer#online-demos)
- github: <https://github.com/aikorea/awesome-rl>

### Deep Reinforcement Learning Papers

- github: <https://github.com/muupan/deep-reinforcement-learning-papers>

### Deep Reinforcement Learning 深度增强学习资源



- blog: <https://zhuanlan.zhihu.com/p/20885568>

### **deep-reinforcement-learning-networks: A list of deep neural network architectures for reinforcement learning tasks**

- github: <https://github.com/5vision/deep-reinforcement-learning-networks>

### **Deep Reinforcement Learning survey**

- github: <https://github.com/andrewliao11/Deep-Reinforcement-Learning-Survey>

### **Studying Reinforcement Learning Guide**

- github: <https://github.com/Observer07/Study-Reinforcement-Learning>

## **Reading and Questions**



### **What are the best books about reinforcement learning?**

<https://www.quora.com/What-are-the-best-books-about-reinforcement-learning>

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« Recommendation System

Image Retrieval »

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