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Pruning Neural Networks with Lottery Tickets in a MDP Approach

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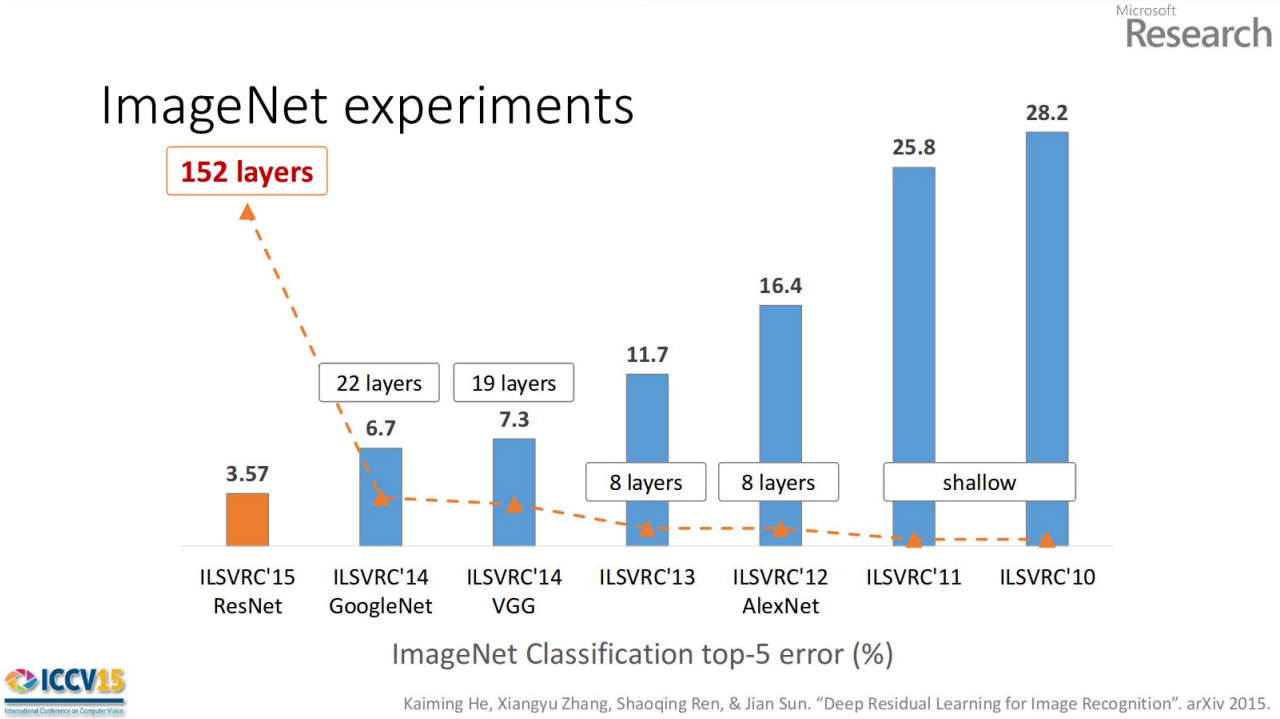
The Problem

Neural networks have increased their performance in Computer Vision tasks, but their large storage size/number of operations makes them impractical to run on CPU/mobile devices/embedded devices.

The Problem



Source: slide presentation from Kaiming He

http://kaiminghe.com/ilsvrc15/ilsvrc2015_deep_residual_learning_kaiminghe.pdf

A Solution in the Literature

The Lottery Tickets Hypothesis.

Algorithm 1 Iterative Magnitude Pruning (IMP) with rewinding to iteration k.

1: Randomly initialize a neural network $f(x; m \odot W_0)$ with initial trivial pruning mask $m = 1^{|W_0|}$.
2: Train the network for k iterations, producing network $f(x; m \odot W_k)$.
3: Train the network for $T - k$ further iterations, producing network $f(x; m \odot W_t)$.
4: Prune the remaining entries with the lowest magnitudes from W_T. That is, let $m[i] = 0$ if $W_T[i]$ is pruned.
5: If satisfied, the resulting network is $f(x; m \odot W_T)$.
6: Otherwise, reset W to W_k and repeat steps 3-5 iteratively, gradually removing more of the network.

Source: Frankle, J., Dziugaite, G.K., Roy, D.M., & Carbin, M. (2019). Stabilizing the Lottery Ticket Hypothesis

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Proposal

Change line 4 by a Markov Decision Process with Q-Learning.

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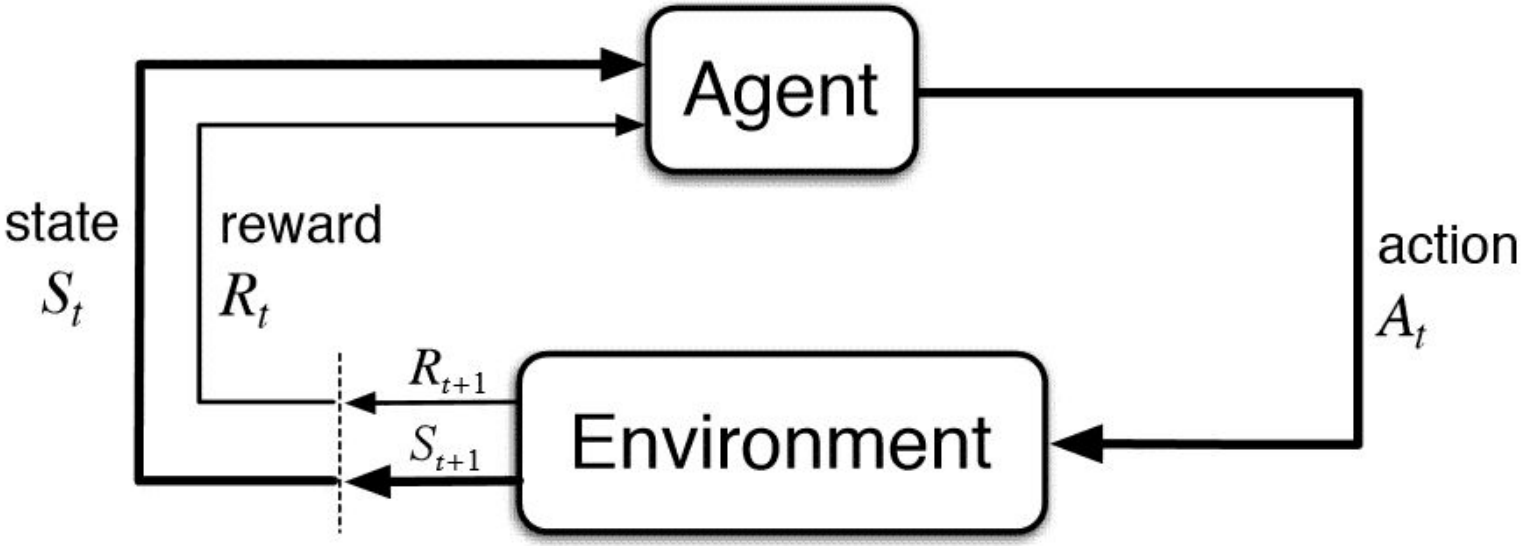
Markov Decision Process



Source: Sutton, R. S., Barto, A. G., & Bach, F. (1998). Reinforcement learning: An introduction

Q-Learning

Q-learning
  loop
    $a \leftarrow \text{Select}_a\{Q(s,a)\}$
    apply action a
    observe resulting reward $r(s,a)$ and next state s'
    $Q(s,a) \leftarrow Q(s,a) + \alpha[r(s,a) + \max_{a'}\{Q(s',a')\} - Q(s,a)]$ *(i)*
    $s \leftarrow s'$
  until termination condition

Source: Ghallab, M., Nau, D., & Traverso, P. (2016). Automated planning and acting

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Project Management

- Week 1 - The implementation of MDP will be completed (now we are in the final stages of debugging).
- Week 2 - Execute the MDP making a grid searching to find the better hyperparameter combination
- Week 3 - Even performing the tests.
- Week 4 - With the tests completed, we will compare the results with the original Lottery Tickets.
- Week 5 - Write the final paper and the presentation slides.

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Thank you!

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