Welcome to the Jet Age

How AI and DL Makes Online Shopping Smarter at Walmart

Today

1. GPU GA for Smart Merchant Selection
2. Deep Reinforcement Learning for Packing

Introduction

US eCommerce site dedicated to savings

Revolutionary pricing engine

Top technology and fulfillment platform

Acquired by Walmart in mid 2016

Introduction

QuantAlea

Machine learning and Cognitive computing

Numerical HPC algorithm design and implementation

Specialized in GPU computing and parallel algorithms

Creator of Alea GPU

Smart Merchant Selection

Jet Pricing Engine

Users shop for products

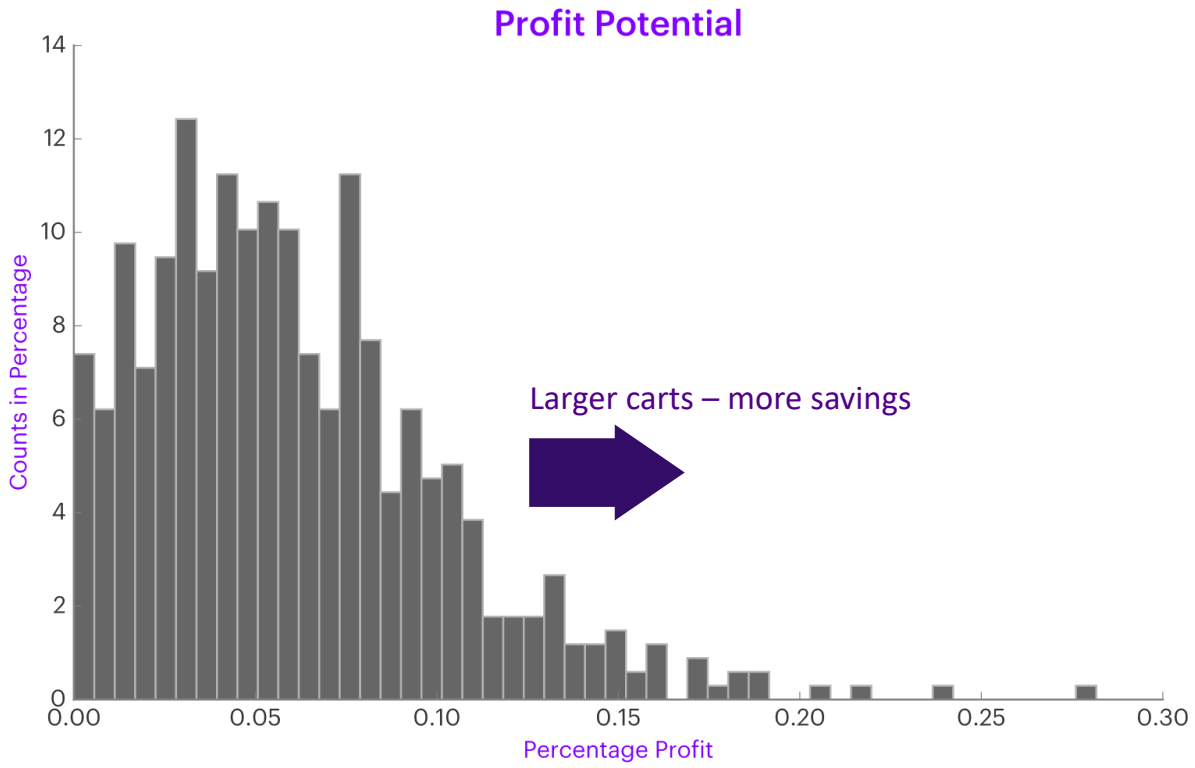
Platform decides about most optimal fulfillment during shopping and at checkout

Savings come from

- Cheapest net item prices
- Pack items together for fewer boxes to ship
- Conditions, merchant commission, basket rules
- More efficient fulfillment

Savings Potential

Larger Carts – More Savings



Full Search

Embarrassingly Parallel

1

Large number of ways to fulfill a shopping cart

2

Cart pricing can be executed independently

Ideal problem to solve in parallel with GPUs

Full Search

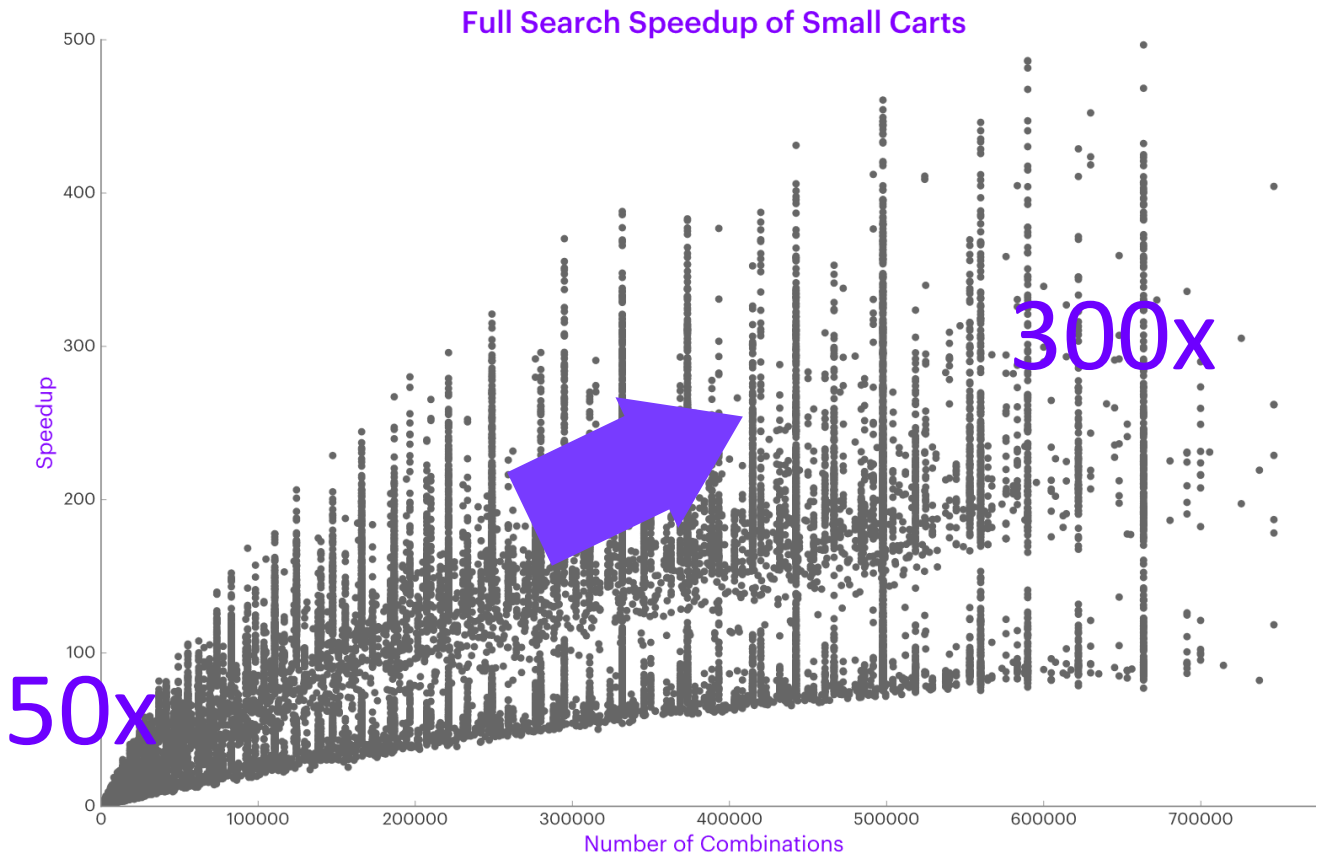
Exponential Complexity

Complexity =

Number of combinations =

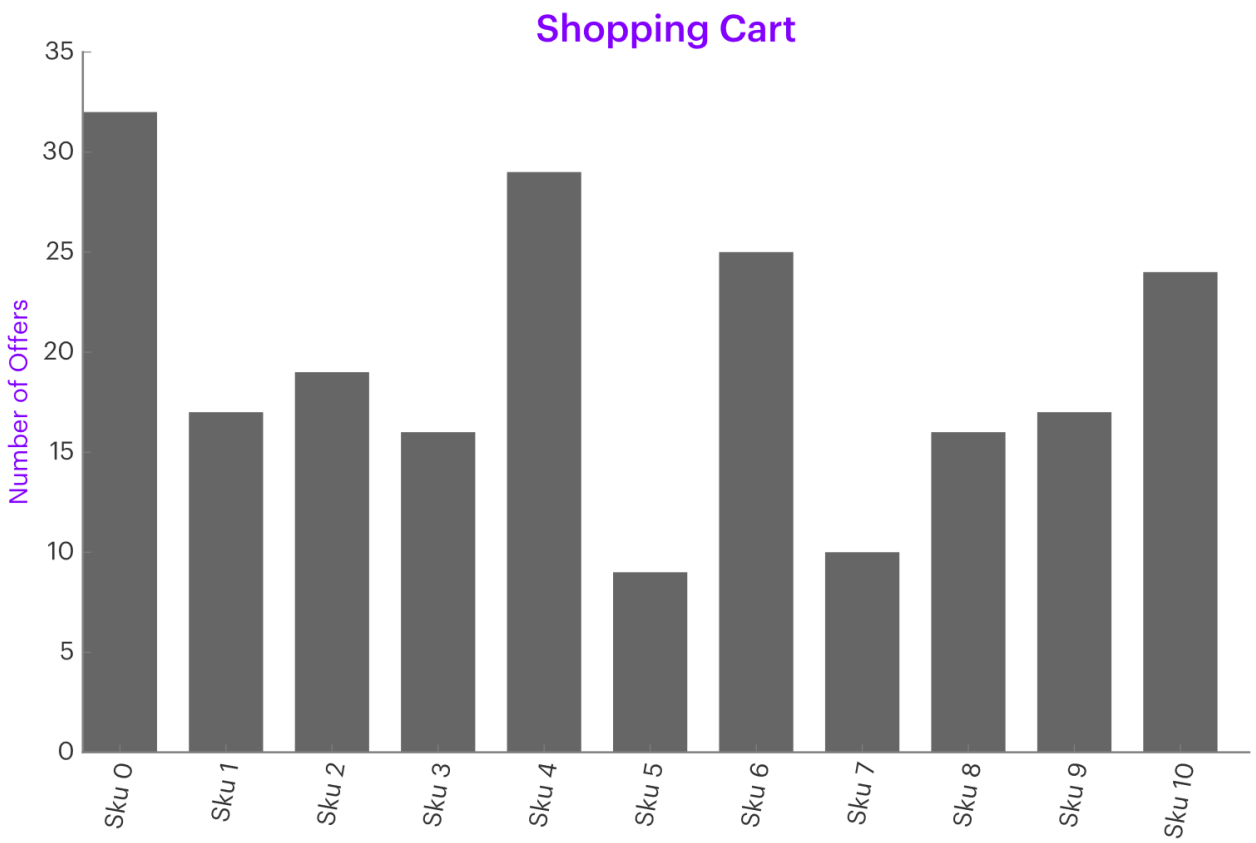
num offers for item 1 * . . . * num offers for item k

Full Search on GPU



Example

Somebody wanted to build a computer



Exponential Complexity

Number of combinations =

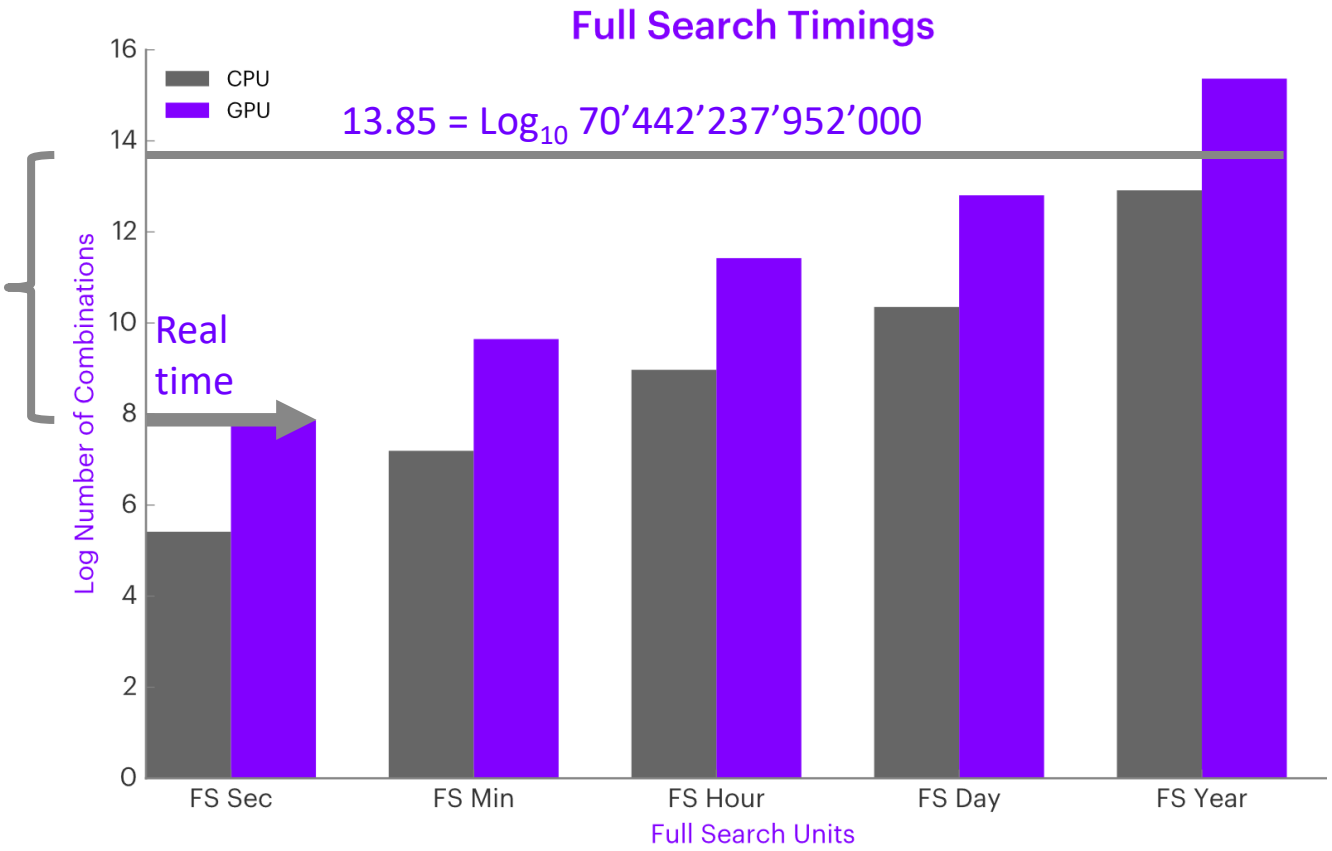
Offers for item 1 * Offers for item 2 * . . . . * Offers for item 10

= 32 * 17 * 19 * 16 * 29 * 9 * 25 * 10 * 16 * 17 * 24

= 70’442’237’952’000 combinations

= $10^{13.85}$ combinations

Performance Gap

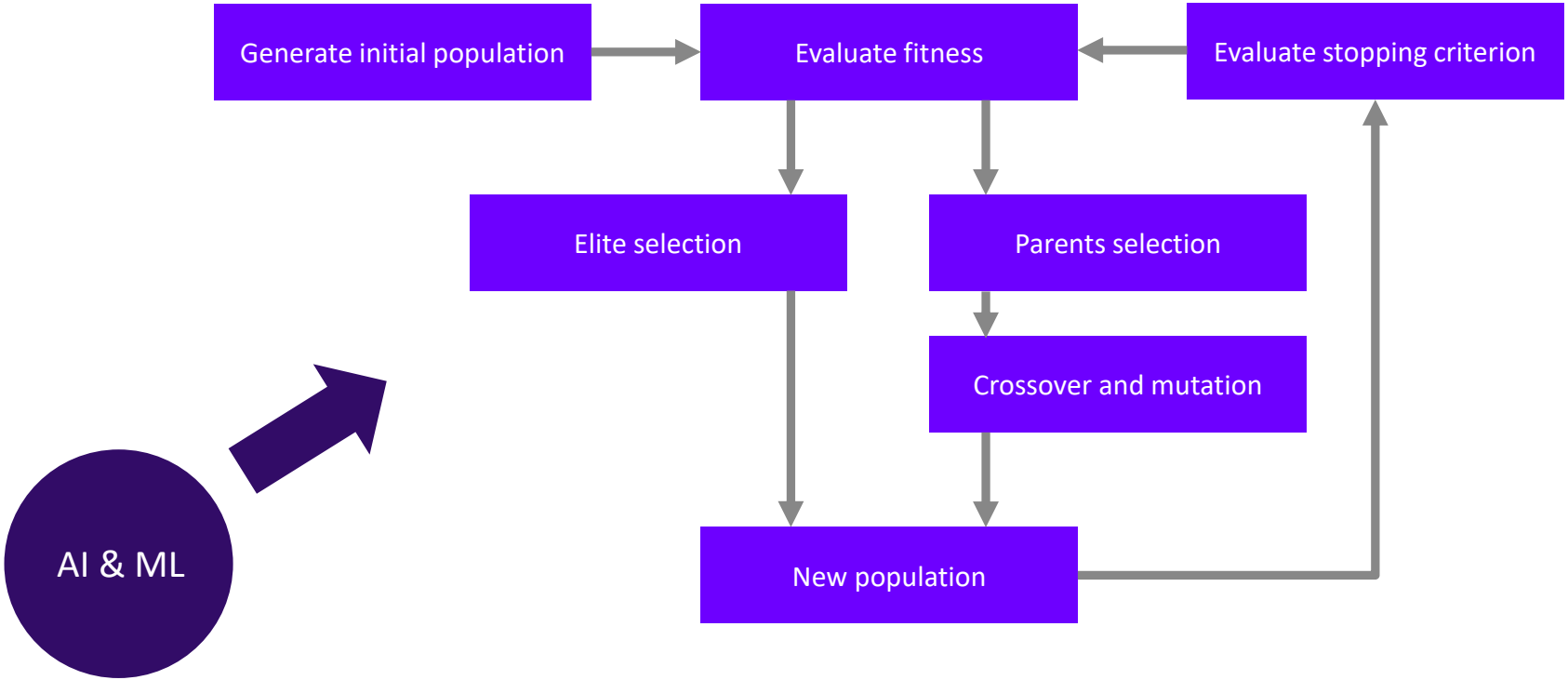


Genetic Algorithm

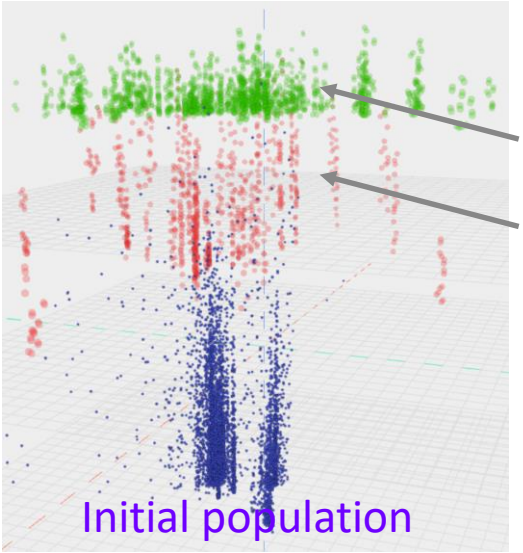
Apply Genetic Algorithms to solve the problem

- Standard GA does not work
  - Search space is astronomically large
  - Need a reliable high quality approx. solution
  - Calculations in near real-time
- Rely on AI & ML to choose GA configuration
- Generation iteration is serial, extending the population size dramatically allows to reduce iterations

Genetic Algorithm
Schematic Description



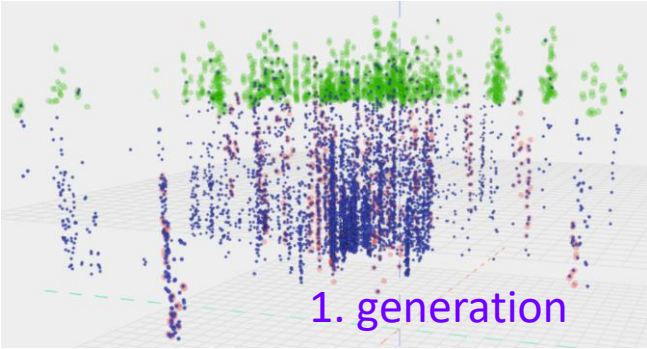
Convergence
Embedding with TSNE

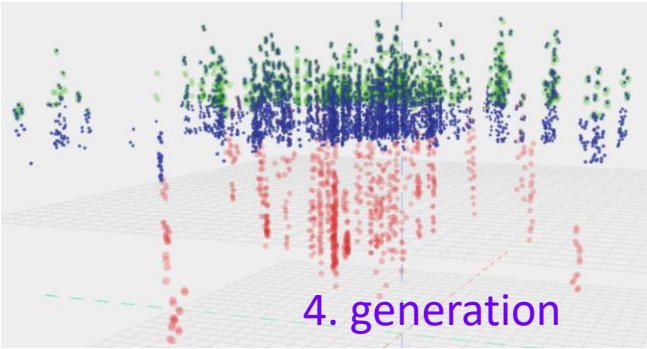


Best part from full search

Special greedy
«boundary» points

Score rapidly improves
Catches best points
found by full search





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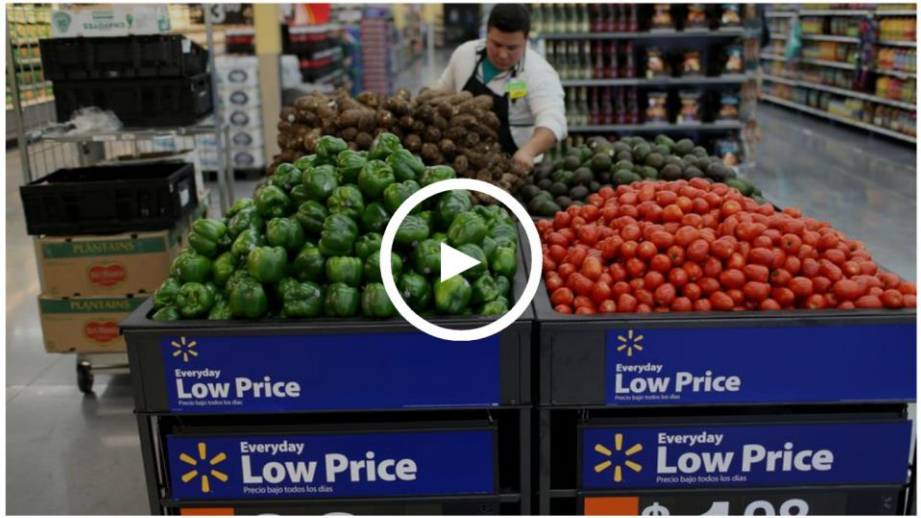
By **Matthew Boyle**

October 10, 2017 4:35 PM CEST

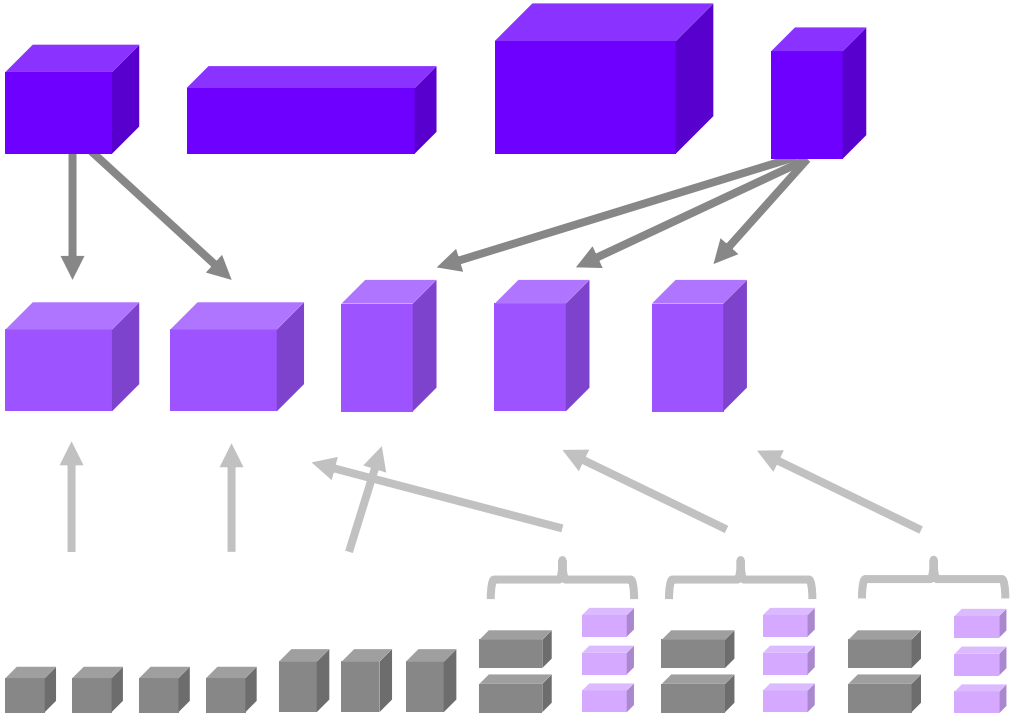


Wal-Mart Expects a 40% Surge in Online Sales

Deep Reinforcement Learning for Packing

Optimal Packing

Non-standard Multi-container Loading Problem



30 – 40 different container types

Choose the best containers
to pack in as few containers
as possible

Respect many constraints
Add optional coolant for fresh
Minimize waste volume

Learning Approach

GA is powerful but

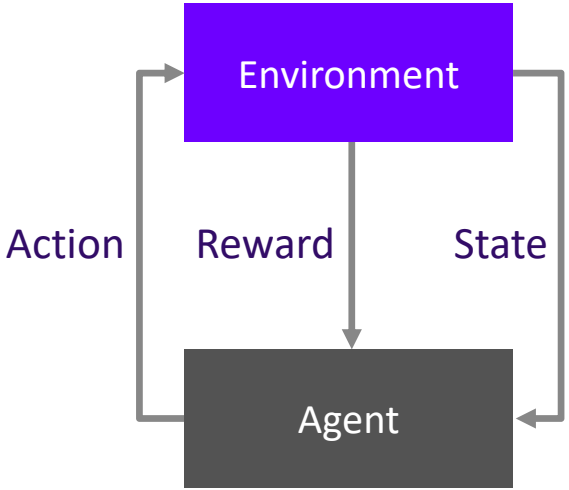
- Slow (complex constraints)
- Hard to move to GPU (constraints, placement heuristics)

Deep Reinforcement Learning

- More natural (cost resp. reward based)
- More flexible
- Bootstrapping with solutions from GA
- Requires retraining when container types change

Deep Reinforcement Learning

Learning a behavioral strategy which maximizes long term sum of rewards by a direct interaction with an unknown and uncertain environment

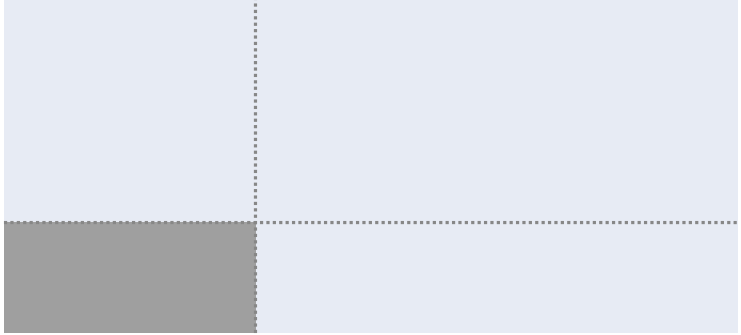


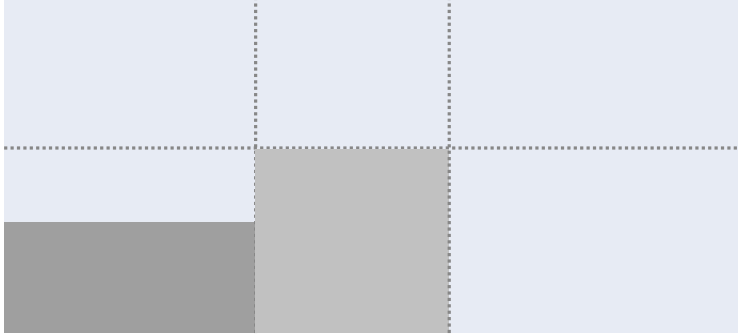
While not terminal do:

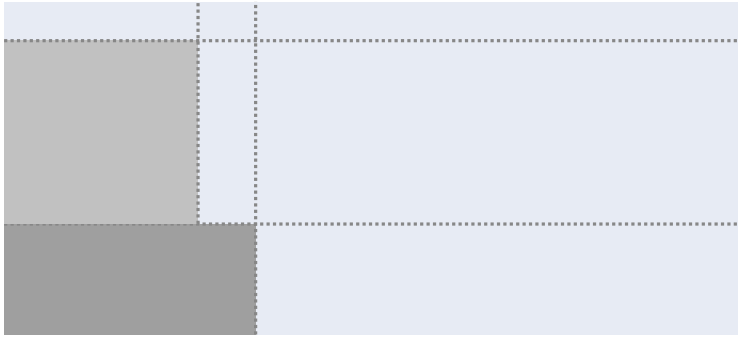
- Agent perceives state s_t
- Agent performs action a_t
- Agent receives reward r_t
- Environment evolves to state s_{t+1}

Placements in Containers

Free subspaces keep track of potential placements







Reinforcement Learning Setup

States
- Opened containers
- Free subspaces of each opened container
- Remaining boxes to pack

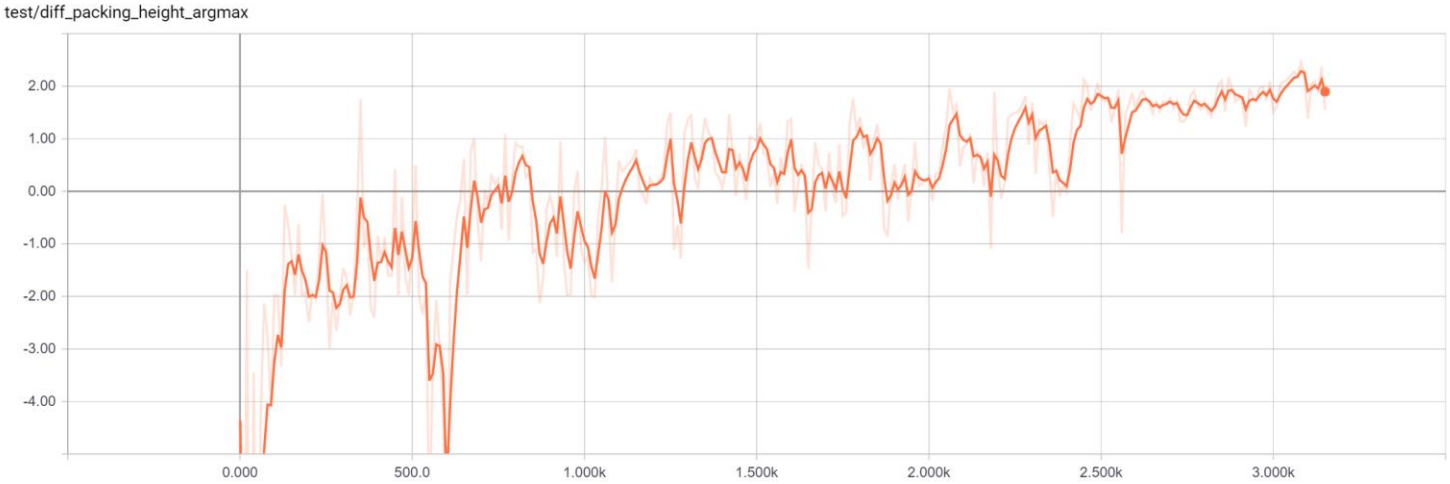
Action
- Option to open new container
- Choose an orientation of the box
- Choose a free subspace in a container to place the box

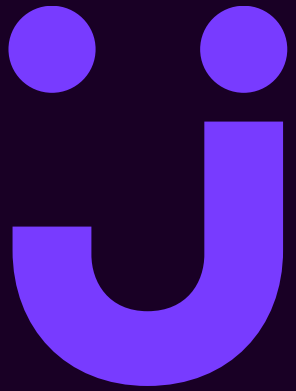
Immediate reward
- Number of containers used so far
- Waste volume
- Constraints violations

Final reward
- Total shipping costs

Reinforcement Learning Performance

Compare to baseline random search





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Questions?