MIT Pokerbots 2017

Resources and Contact Info

Piazza – piazza.com/mit/spring2017/6176

Website – mitpokerbots.com

Email – pokerbots@mit.edu

Eligibility and Grading

- Register for 6.176 (6 units P/F or as a Listener) on WebSIS

- The IAP tournament is restricted to MIT students and cross-registered students from other universities

- To pass:
  - Submit a 2 page strategy report by the end of IAP
  - Submit your resume on our website (sponsors review resumes as they come in)
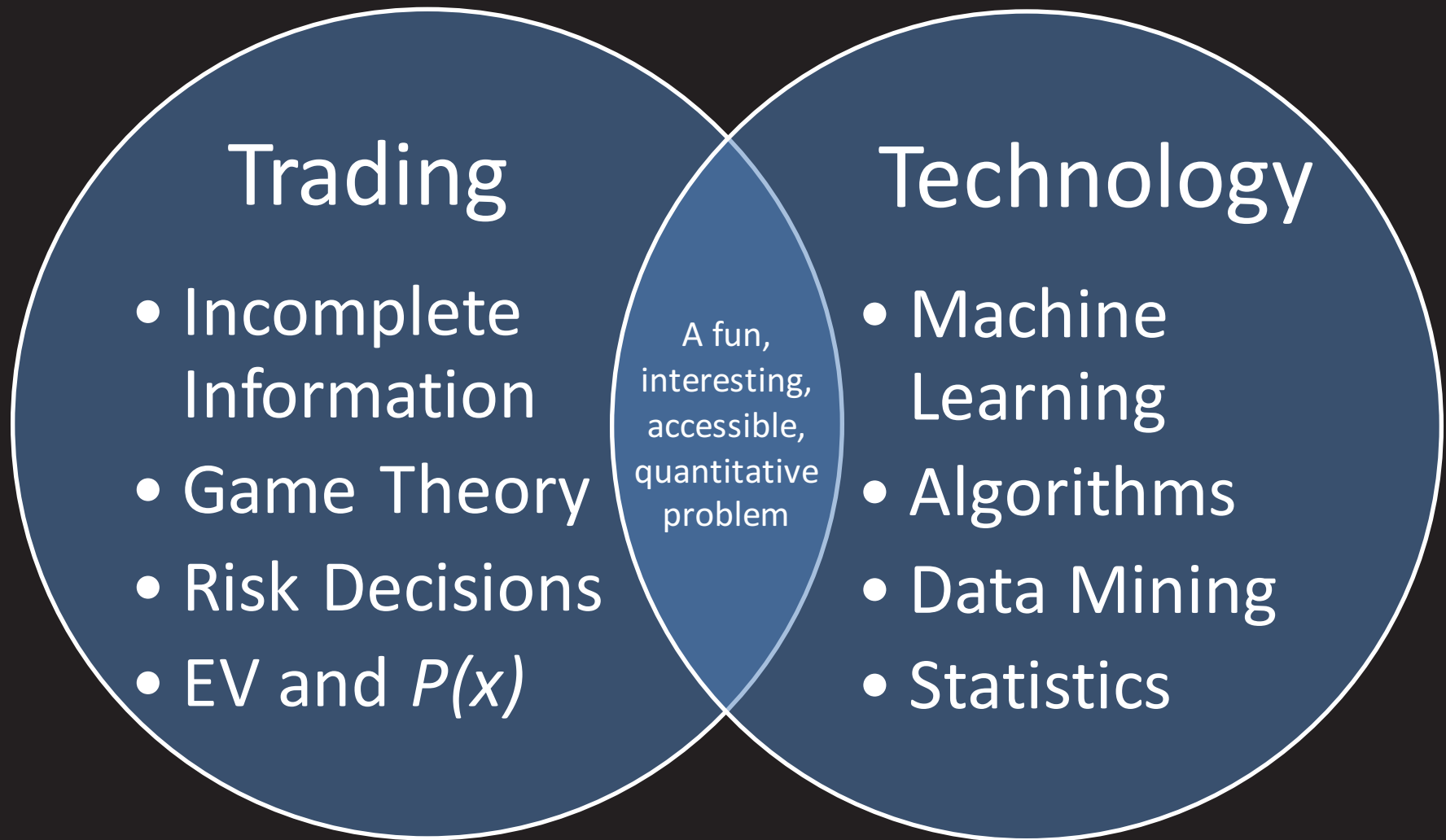 - Enter your bot to both our mini and final tournament

Lectures and Office Hours

- E25-111 on WF from 4-5pm for the first two weeks of IAP

- Office Hours 3-5 on MR location TBD

- Lecture 1 is an introduction of the class and will feature Kevin Pang from Jump Trading. He was one of the founders of Pokerbots

- Lecture 2-3 will go more in-depth of the Pokerbot variation along with general poker strategy and explain the software

- Lecture 4 will be a guest lecture from Citadel

Pokerbots in a Nutshell…

Trading

- Incomplete Information
- Game Theory
- Risk Decisions
- EV and *P(x)*

A fun, interesting, accessible, quantitative problem

Technology

- Machine Learning
- Algorithms
- Data Mining
- Statistics

Our Goals

- Challenge you to combine programming ability and highly quantitative thinking

- Connect you with prestigious trading and tech sponsors looking for talent

Sponsors

The Challenge

- Conquer your opponents in…

Heads-up No-Limit Hold 'em With Discards

The Challenge

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- Discards: After the flop(the street where 3 cards are laid down) and the turn(where the 4th card is laid down), each player has the option to discard one of their two cards and draw another card.

The Challenge

- Heads-up: Play against one person at a time

- No-Limit: Your bet sizes can go up to your entire stack size.

- Discards: After the flop(the street where 3 cards are laid down) and the turn(where the 4th card is laid down), each player has the option to discard one of their two cards and draw another card.

- Cash Games: Bots ranked by final chips count

Logistics

- Check out mitpokerbots.com/docs for detailed documentation

- Post a note on Piazza if you can't request a password on mitpokerbots.com by midnight tonight

Final Competition

- The Final Competition will take place in on 2/6 from 6-8pm in room 10-250

- Gold and Platinum sponsors will be present

- Deadline for submitting your bot is 2/3

- Newbie teams will compete in an additional event (teams composed entirely of freshmen or sophomores with limited experience)

- Make sure to submit a bot to both events!

Prize Pool

- Over $40,000!

- Distribution will be announced when we have a more accurate idea of participation

- Lots of opportunities to win
  - We will reward creativity, effort, and excellence

Next Lecture

- We will talk more in-depth about how no limit hold 'em works and how the discard functionality will change the game.
- We will go over downloading the game engine and getting setup to start development.

Guest Lecture

- Kevin Pang
  - Algorithmic Trader at Jump Trading
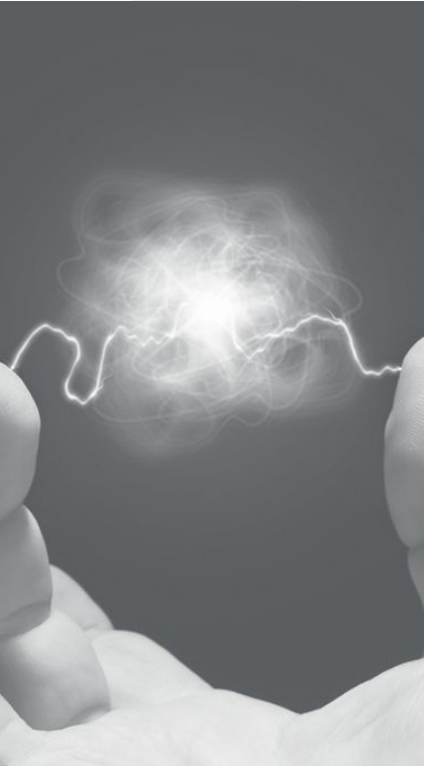 - Founder of Pokerbots
  - MIT B.S. Course 14 '11

JUMP TRADING

ESTABLISHED
2000

HEADQUARTERS
CHICAGO, IL

EMPLOYEES
550+

LOCATIONS
CHICAGO, NEW YORK, CHAMPAIGN, LONDON, SINGAPORE

WHAT WE TRADE
FUTURES, CASH (EQUITIES, FX, TREASURIES), OPTIONS

EXCHANGES
75+ IN AMERICAS, ASIA, EUROPE AND AUSTRALIA

JUMP CULTURE

- Small, dynamic and fast-paced teams

- Flat organizational structure

- Diverse trading community and strategies

- Shared core infrastructure and software

- Casual atmosphere

HQ
CHICAGO

600 West Chicago
Chicago, IL 60654
p: 312.205.8900

CHAMPAIGN

2100 S. Oak Street
Champaign, IL 61820
p: 312.205.8900

NEW YORK

15 East 26th Street
New York, NY 10010
p: 646.843.7400

LONDON

One London Wall
London EC2Y 5EA
p: 44.207.382.4350

SINGAPORE

8 Marina View
Asia Square Tower 1, #38-01
Singapore 018960
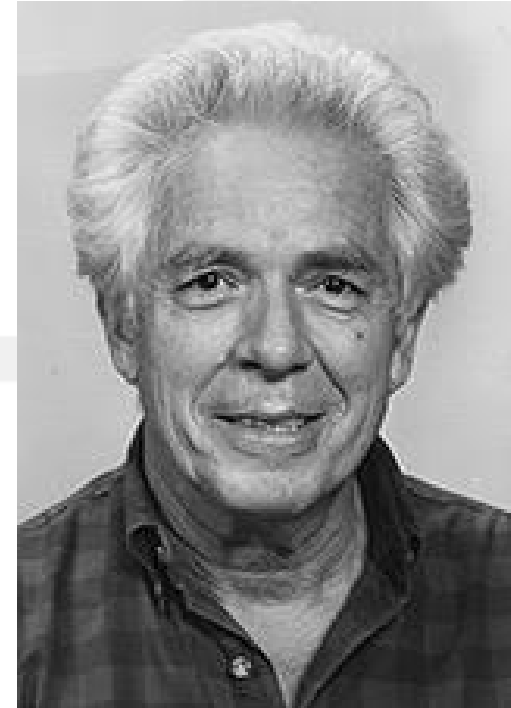p: 65.6240.6266

Kevin Pang

MIT '11
Pokerbots Co-Founder

Overview

- Mathematically formalizing poker
- Nash Equilibrium
- Counterfactual Regret Minimization
- State of the art bots (Cepheus, Claudico, Libratus, DeepStack)
-

Kuhn Poker

- Stack size: 2 chips
- Ante: 1 chip
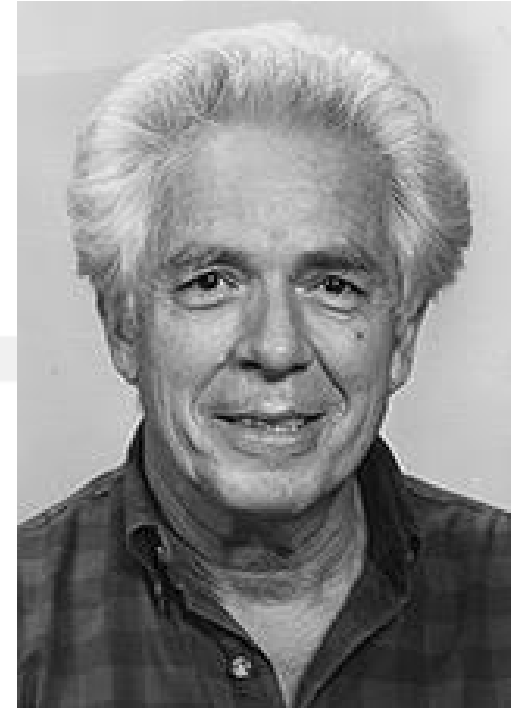- 3 card deck {A, K, Q}
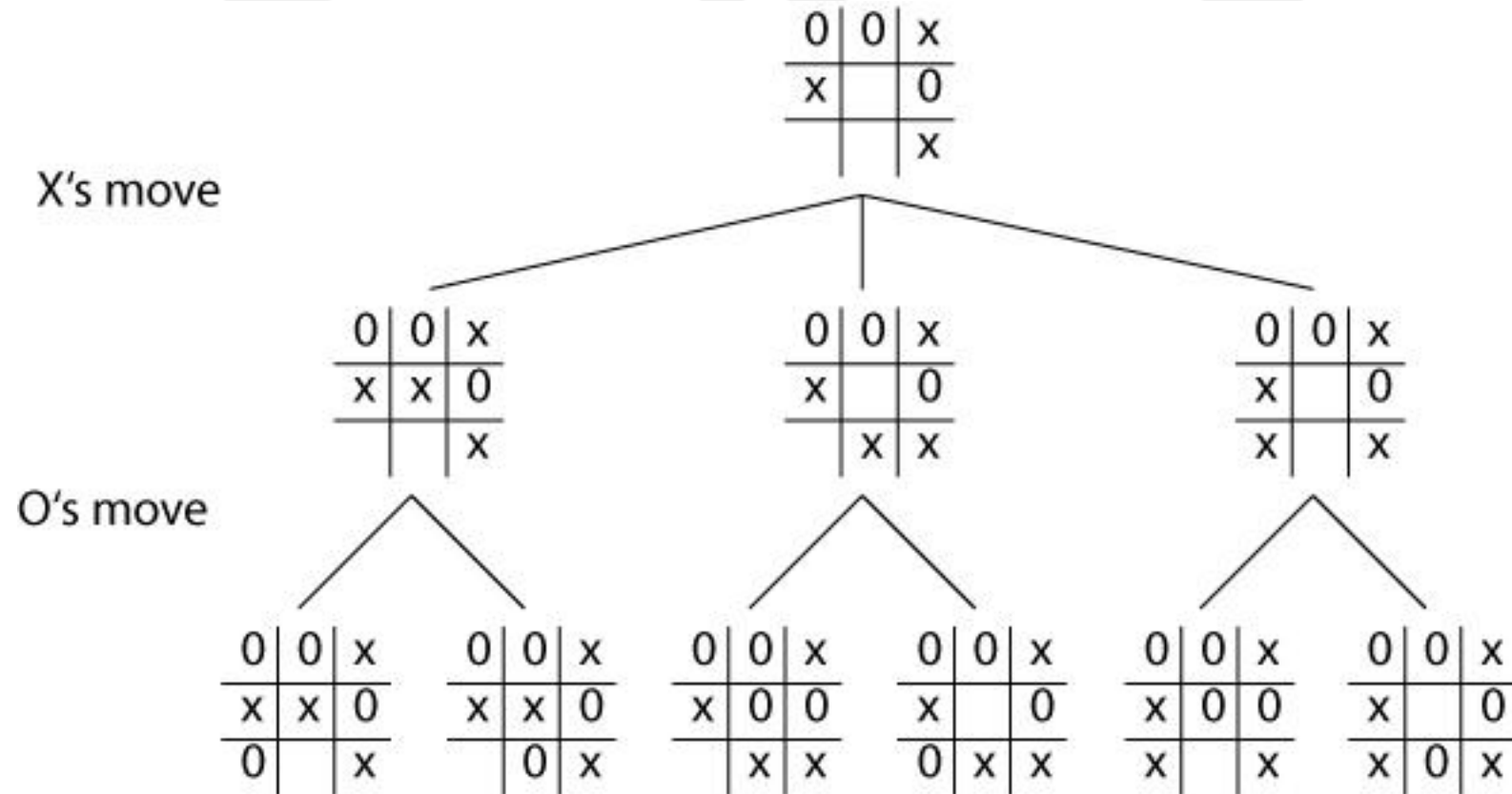- Button cannot bet
-

Harold Kuhn
1925-2014

Kuhn Poker

- Stack size: 2 chips
- Ante: 1 chip
- 3 card deck {A, K, Q}
- Button cannot bet
- A: always bet, always call
- K: never bet, sometimes call
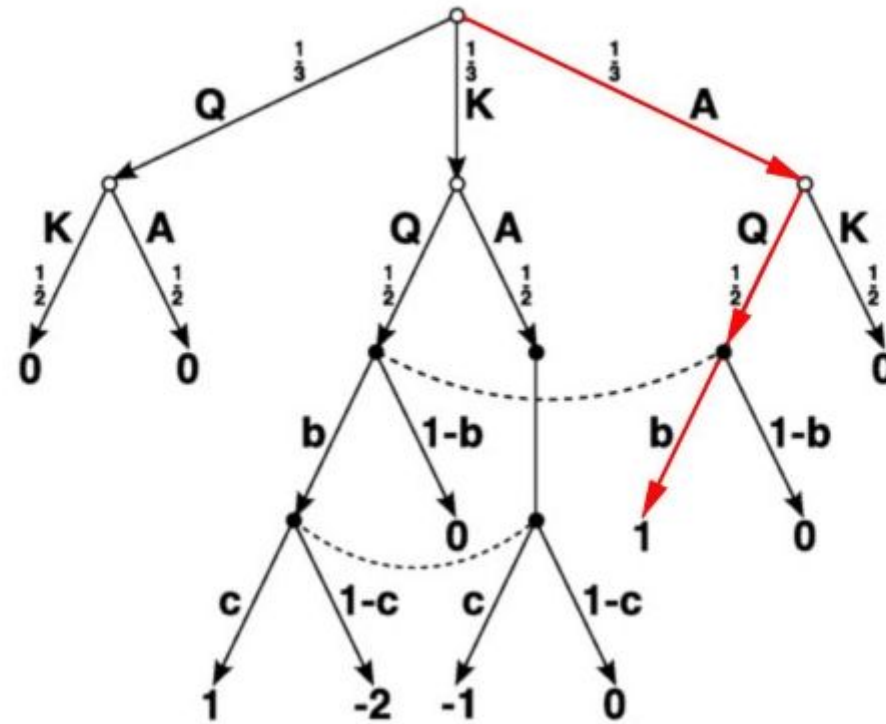- Q: sometimes bet, never call

Harold Kuhn
1925-2014

Perfect Information Games

Imperfect Information Games

Poker Abstractified

- **Information set**: set of game states that are indistinguishable from player i's point of view
- **Poker**:
  - Game tree with information sets
  - Leaf nodes have associated payouts
  - Each player seeks to maximize their expected payout

Strategies

- Finite set of information sets, I
- Finite set of possible actions, A
- $P(A)$: set of probability distributions over A
- **Strategy**: function mapping I to $P(A)$

Normal form

- $\min\limits_{x} \max\limits_{y} xAy$

- A: payout matrix (encodes poker rules)

- x, y: strategies represented by probabilities of individual moves

Normal form

- $\min\limits_{x} \max\limits_{y} xAy$

- A: payout matrix (encodes poker rules)

- x, y: strategies represented by probabilities of individual moves

- Problem: A is exponential in game tree size

Sequence form

- $\min\limits_{x} \max\limits_{y} xAy$

- A: payout matrix (encodes poker rules)

- x, y: strategies represented by probabilities of **sequences of moves**

- Avoids exponential blow-up!

- Koller et al [1994]

Solving optimization problem

- Reduce size by merging similar information states
- Two approaches to solve optimization:
  - Linear programming
  - Counterfactual regret minimization (Johanson et al. [2007])

Counterfactual Regret Minimization (CFR)

- Initialize strategy x randomly

- Play x against itself

- For each node of game tree, compare what x did, against what x **should** have done.

- Update x based on difference

Counterfactual Regret Minimization (CFR)

- Generates sequence of strategies $x_1, x_2, \ldots$
- Provably converges to Nash Equilibrium!
- Small memory requirement, parallelizable

Fixed Limit Hold'em (FLHE)

- About 3.2e14 information sets
- Brute force with hardware + time + coding skillz
- 2008: bots defeat best humans
- 2015: FLHE "weakly solved" (Cepheus)

No Limit Hold'em (NLHE)

- ~1.0e50 information sets for 100BB stacks
- Information sets must be merged
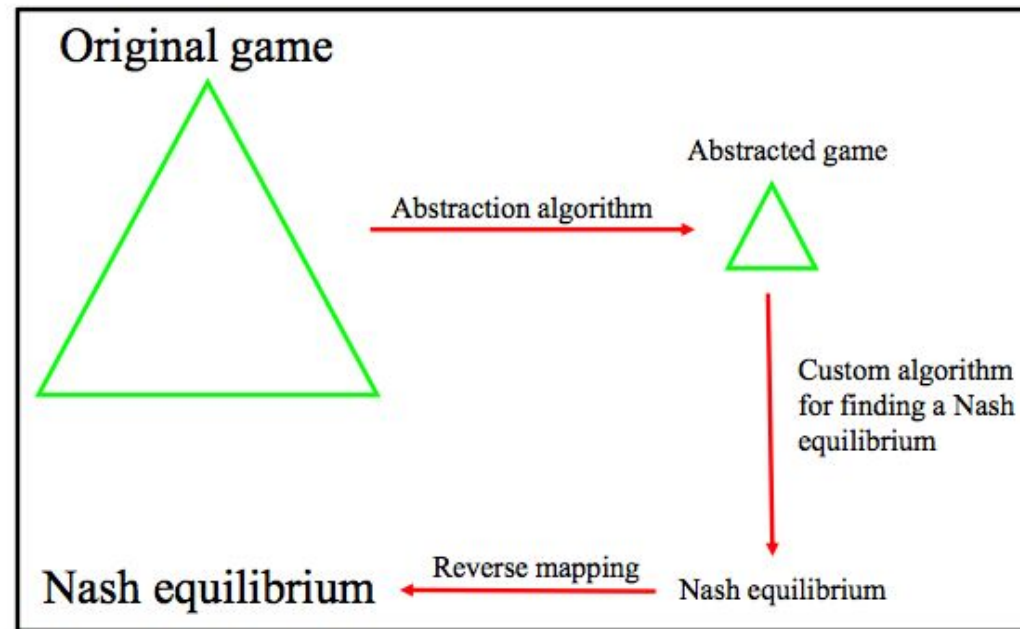
Abstraction

- **Hand bucketing**
  - "on AhKcQd board, 22 and 33 can be treated as the same hand"
- **Action translation**
  - "a $49 bet into a $100 pot can be treated the same as a $50 bet"
  - Bet sizes: {¼ pot, ½ pot, pot, 3x, all-in}

Action Translation

- Difference between **actual** pot size and **abstract** (implicit) pot size can diverge
- Alberta guys tried to use bet sizes that would correct for divergence
- Claudico, on the river, would:
  - Recalibrate its view of pot size
  - Perform expensive Nash Equilibrium approximation on subtree (~2 minutes)

Existing Literature

- Cepheus
  - http://science.sciencemag.org/content/347/6218/145.full.pdf
- Claudico
  - https://www.cs.cmu.edu/~sganzfri/Claudico15.pdf
- DeepStack
  - https://arxiv.org/pdf/1701.01724v1.pdf