

# Wishlist: Interesting Problems

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## Abstract

These are problems I would be interested in working on and/or knowing more about. If you have ideas and want to work together, contact me! I enjoy collaboration. My email address is [marvel@berkeley.edu](mailto:marvel@berkeley.edu).

## 1 Learning

### 1.1 Explainable Learning: RL for Hanabi

A classic challenge in RL is creating an agent which acts in an explainable way. The idea of this project would be to try to create a training regime where the interaction between agents forces them to play a simple, common strategy.

Hanabi is a great example of a game where two RL agents would end up developing an esoteric system that is totally incomprehensible. To break this, you could train two agents together (A and B) and another two agents (C and D), then have them play together across the pairs (AC, AD, BC, BD). This would force the pairs to learn a strategy that generalizes well.

### 1.2 Neural Recommendation Systems

Think about the way you recommend movies to someone. You typically have a sense of their tastes, especially which popular items they most enjoy. You make deep conclusions based on a few popular items. Maybe the key to good recommendations is to train NNs to predict the user ratings based on their opinion of a small set of popular movies.

## 2 Graphs

### 2.1 Subgraph Removal Game

Given a graph  $G$  given a collection of graphs  $H$ , we play the following game. On their turn, a player may remove any subgraph from  $G$  if it is in  $H$  (meaning, remove all the nodes corresponding to the subgraph). The first player unable to do so loses.

Interesting cases:

- It is hard to even compute if a player has lost (subgraph isomorphism).
- Special case: remove any  $k$  nodes at a time. Easy.
- Special case: remove any  $k$  connected nodes at a time. Difficult to compute the winning strategy even when  $G$  is a line graph and  $k$  is 2. Can we formalize this?
- How about trees and bipartite graphs? Anything special about those?
- Are there connections to automorphisms?

### 3 Others

#### 3.1 Learning

- Neural Combinatorial Optimization

#### 3.2 Graphs

- The Quadratic Assignment Problem ( $\min c_{ij}x_{ij}^2$  subject to assignment polytope)
- Inverse Shortest Path
- Inverse Minimum Spanning Tree
- Maximum Cut
- Streaming Medians Problem
- Influence Maximization
- Community Detection