AI Final project report AI angent for Catan

Oriane Louzoun   
the Hebrew university of Jerusalem

Amoss Dvir  
the Hebrew university of Jerusalem  
 Roy Suissa Sharon   
the Hebrew university of Jerusalem Boaz Bibi   
the Hebrew university of Jerusalem line

# Introduction

In this report we will present our finding about an AI agent for the game "Settlers of Catan".

The game is a multiplayer board game Players take on the roles of settlers, each attempting to build and develop holdings while trading and acquiring resources. Players gain points as their settlements grow; the first to reach a set number of points, typically 10, wins.

We chose to do some reduction to game eliminating the option to trade between players.

We used a platform called PyCatan to simulate the game, and chose to use the OOP approach, by using objects to represents the board, players, agents and game sessions. Also, we have a heuristics class.

We decided to have 4 kind of moves available for our agents:

### Move – to move the robber if the dice rolled 7

### Build – a road or a settlement or a city

### Buy – to buy a deveploment card

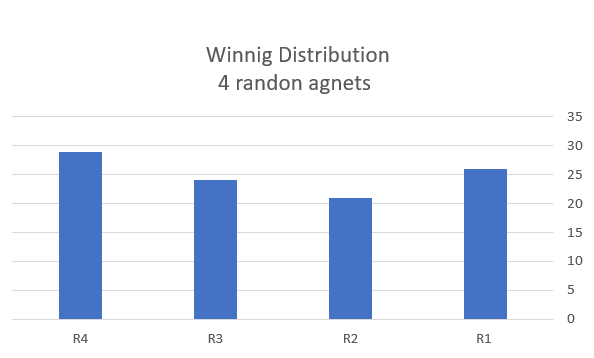
### Use – to activate a develepmont card

We used two ways to test our agent – the first way is to create many agents to compare with each other while using methods learned in class like ExpectiMax trees and Expected value. The second method we used is a neural network which we trained using game logs we have translated to an array of numbers.

# agents

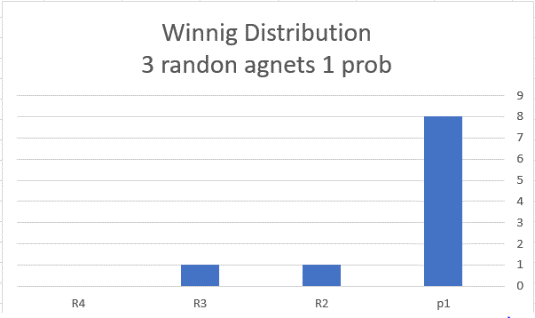
## random agents

The random agent chooses one move randomly from all the legal moves given to him.



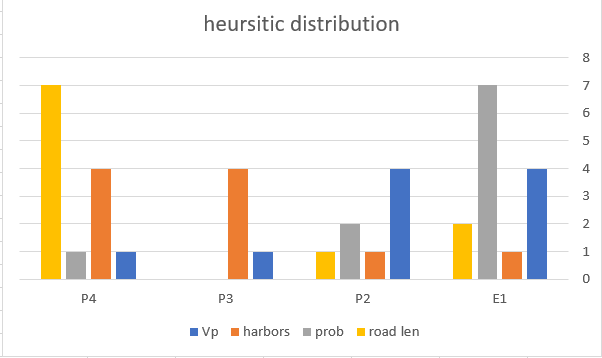
## Probability agent

This agent chooses the move with the highest heuristic value ai calculates which move will get him to the next state with the highest number of points



## One move agent and Expectimax agnet

Those agents calculate the best move to make according to a given heuristic.



While both agents can be given a heuristic the one move agent only simulate the state of the board in one move, the Expectimax agent creates a tree with a given depth.

We have tested the next heuristics on both agents:

### Harbors – an agent using this heuristic will choose moves that will get him as many harbors as possible

### Prefer resources – an agent using this heuristic will prefer different resources at any given time in the game according to the progress of the game

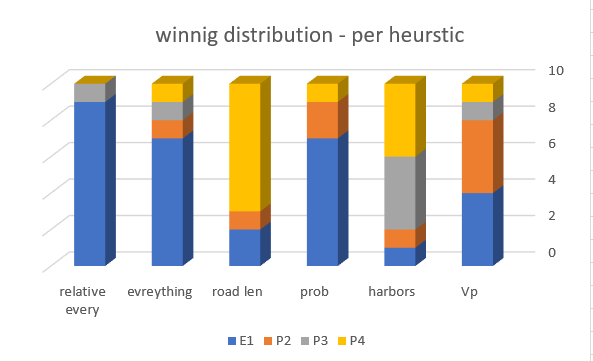
### Roads – an agent using this heuristic will try to build as many roads as possible

### Settelments – an agent using this heuristic will try to build as many settelments as possible

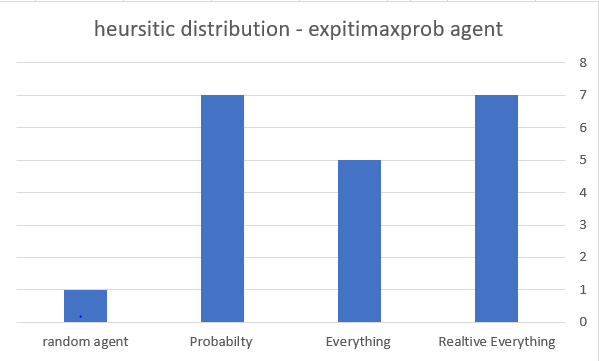
### Vp – the victory points heuristic

### Everithing heuristic – this heuristic calucaltes a sum of all the previous heuristic with a given weight function

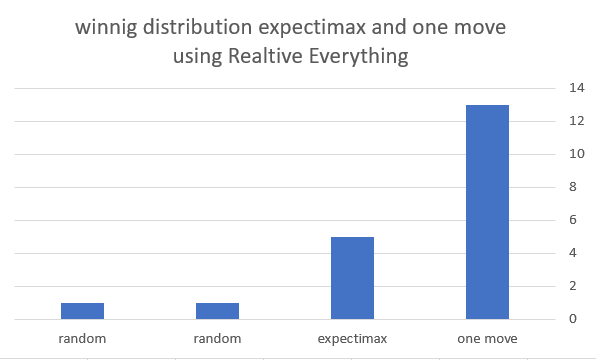
### Relative – this heuristic calculates the heuristic value of the given player and the heuristic value of all the other players and return the heuristic value of the player divided by the avarage of the heuristic value of all the other players.



After testing all the heuristic on both the agents we have concluded that the "Relative everything" heuristic gives us the best result on both agents.



After finding the best heuristic we tested the agents against each other using "relative everything" the findings are shown in the next figure:

the findings clearly shows that the one move agent gives us the best result.

Weve tested the agent agaisnt human players

# value iteration with neural network

Seeing AlphaGo Zero and other state-of-the-art AIs, we wanted to try and write an agent that uses learning and neural networks evaluate boards and moves.

We started by representing the state of the game as vector, with all the information available to the current player (not including of course information he doesn’t know like development cards in the hand of other players), and also basic calculated features (like victory points).

For the network we chose a basic architecture featuring two dense layers after the input, and finally a size-4 output, representing the chance of every player to win the game.

Our network tried to simulate value function, it was meant to be given a state and to return how good it is for each player.

This ultimately failed. Our biggest problem was the fact that in Catan the players doesn’t have the same information as the other players, which was problematic since the Value Iteration algorithm requires us to iterate through all the moves, but for every move done the information the available to the agent is different. We tried to pretend that this wasn’t the case (and calculate the next state after passing as identical to the current one) and see what happens, but this proved futile since the network was never even exposed to losing game states – since this happens only on other players turn.

If we had more time, we would probably have tried to train a different network, one that have full information about the game in any given moment. This of course is not good as an agent, so after we have the first network fully trained we would have trained a different network without full information to try and imitate the first network.

# genetic algorithm

After our effort with the neural network failed, we decided to try and utilize learning again, but this time using a simpler task. One of the problems that we were facing was how find the optimal blend of heuristics – every heuristic returned a value, and the final heuristic was a linear combination of all these values, but it wasn’t clear how find the optimal values for the linear combination.

We decided to try and use Genetic Algorithm, when the ‘fitness function’ is simply the result of games we ran (this is the ‘learning’ part). Every agent was represented by a vector telling how much to multiply each heuristic. We took 4 agents (at the start randomly spawned near already known decent vector), and for every iteration ran 10 games. We removed the worst vector, and replaced with a vector created from the combination of the two best vectors. The third vector we mutated a little.

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