DEEP THREE MATCH: PROVIDING A POLICY FOR A MATCH THREE GAME THROUGH DEEP LEARNING

by

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MASTER OF SCIENCE

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Figure 1: The match three game: Gem Island

Aim

I aim to develop an optimal policy for a match three game to be utilized by an AI agent. The approach will be to use deep neural networks which will learn the policy from the experience of previous games. I will first implement a basic 'greedy' 1-step look ahead policy which will allow for naïve play and generate the training data.

Plan

The work I will undertake is outlined in this section. Tasks are further divided into sub-tasks. Also provided is a Gantt chart to show visually how the project will progress.

Task	1. Complete game
Due	13/06/2017
Objectives	To build a challenging game for an AI agent to solve.
Description	1.1 Make a simple game for proof of concept 1.2 Implement matches for gems 1.3 Implement removable ice 1.4 Implement 'gravity' to pull down gems 1.5 Implement animations 1.6 Implement scoring system 1.7 Implement bonus gems 1.8 Implement combination scoring
Milestones	1.1 Making a simple game 1.6 A fully working game without bonuses
Deliverable	A complete game for the AI to solve

Task	2. Set up game for AI
Due	19/6/2017
Objectives	To get the game in a state for the AI to control.
Description	2.1 Design the game state representation 2.2 Implement methods to get game state 2.3 Implement methods for AI to call
Milestones	2.3 Game can now be controlled by AI
Deliverable	A game designed so that an AI can control it.

Task	3. Build naïve AI version 1
Due	22/6/2017
Objectives	Proof of concept for getting an AI to control the game.
Description	3.1 Implement random policy/move selection 3.2 Connect AI to game 3.3 Collate training data from version 1
Milestones	3.3 Now have data that can be used for training
Deliverable	A working AI which can control the game.

Task	4. Build naïve AI version 2
Due	28/6/2017
Objectives	Proof of concept for using MCTS, evaluation function, and a policy
Description	4.1 Design search, policy, and evaluation function (s, p, e) 4.2 Implement s, p, e with 1-step look-ahead 4.3 Collate training data from version 2
Milestones	
Deliverable	A naïve version of the final design of the AI.

Task	5. Gather and collate training data
Due	27/6/2017
Objectives	To obtain the required training data for the neural networks.
Description	5.1 Set up game to output state to file 5.2 Set up game to distribute to users 5.3 Distribute game to users
Milestones	-
Deliverable	Game to distribute - 22/06/17 Collated training data 27/07/17

Task	6. Build Monte Carlo tree search program
Due	21/7/2017
Objectives	To build a tree search program to solve the game.
Description	6.1 Design and implement MCTS program with multi-step look-ahead 6.2 Connect MCTS program to AI
Milestones	-
Deliverable	A working AI similar in design to AlphaGo

Task	7. Build initial policy heuristic using hand chosen features
Due	28/06/2017
Objectives	Build a simple policy that assigns weights the features of different moves
Description	7.1 Select features to be used 7.2 Determine weights of features from training data 7.3 Connect policy to game
Milestones	-
Deliverable	A basic policy to evaluate actions

Task	8. Build policy neural network from whole game state
Due	4/7/2017
Objectives	Build a more complex policy to choose actions
Description	8.1 Build neural network 8.2 Train neural network with training data 8.3 Connect policy network to game
Milestones	-
Deliverable	A more complex policy to evaluate actions

Task	9. Build policy neural network from auto-encoder features
Due	14/07/2017
Objectives	Build a more intelligent policy which will be given the features of interest
Description	9.1 Build neural network 9.2 Train neural network with training data 9.3 Connect policy network to game 9.4 Compare results with those of previous NN
Milestones	-
Deliverable	A faster complex policy to evaluate actions

Task	10. Integration of work with Tom Brereton
Due	21/7/2017
Objectives	Integration of work to build AI which can solve the game.
Description	10.1 Integration of work
Milestones	-
Deliverable	A working AI similar in design to AlphaGo

Task	11. Write dissertation
Due	31/08/2017
Objectives	Write the dissertation for the whole project
Description	11.1 Complete literature review, 31/06/2017 11.1 Draft outline, 06/07/2017 11.3 Problem to be addressed, 10/07/2017 11.4 Work to be undertaken, 14/07/2017 11.5 Methodology for simple policy, 25/07/2017 11.6 Methodology for policy network one, 01/08/2017 11.7 Methodology for policy network two, 08/08/2017 11.8 Technical Implementation, 15/08/2017 11.9 Discussion of results, 22/08/2017 11.10 Conclusion, 24/08/2017 11.11 Completing Dissertation, 31/08/2017
Milestones	-
Deliverable	Complete dissertation

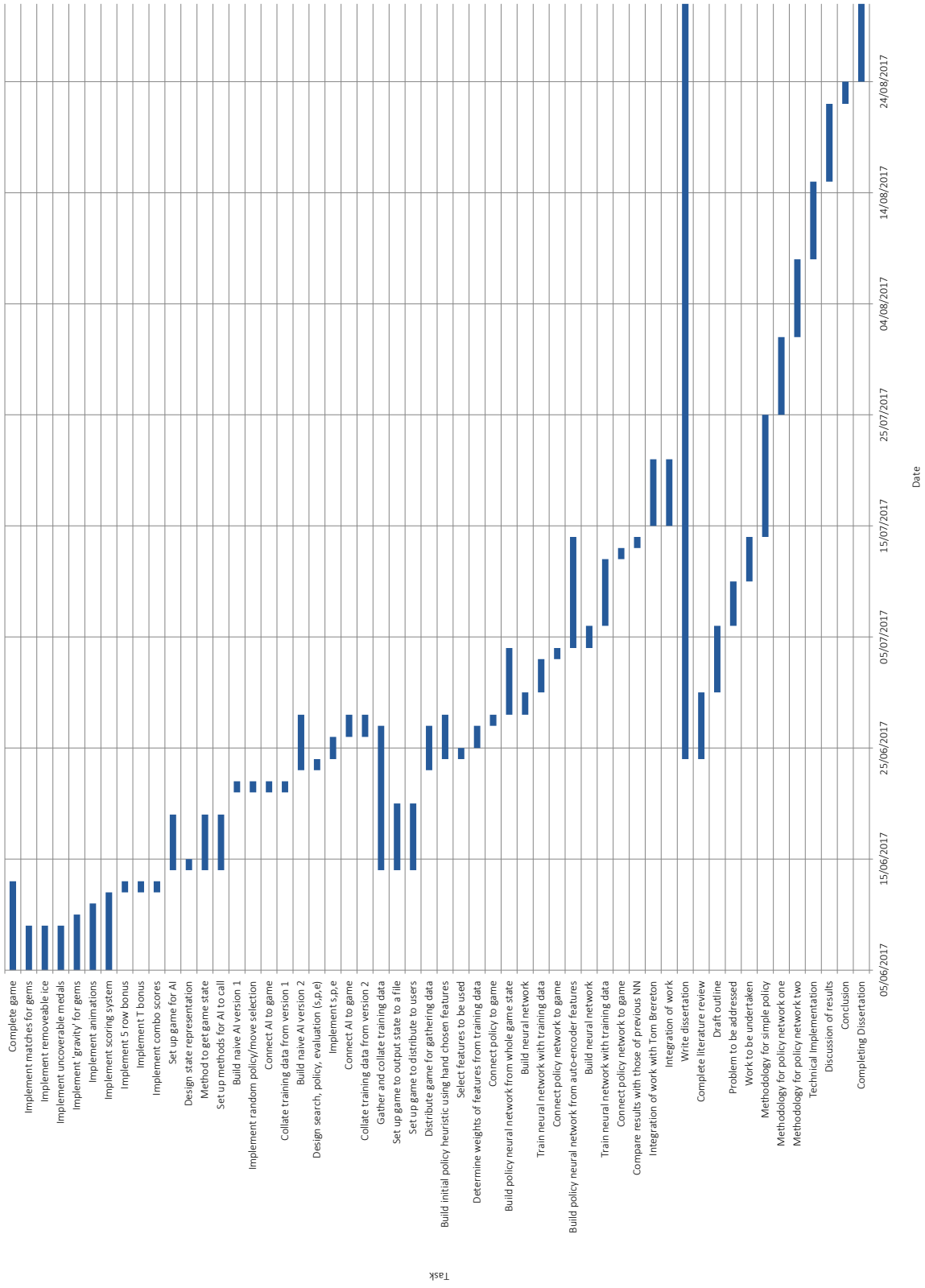

Figure 2: Gantt chart