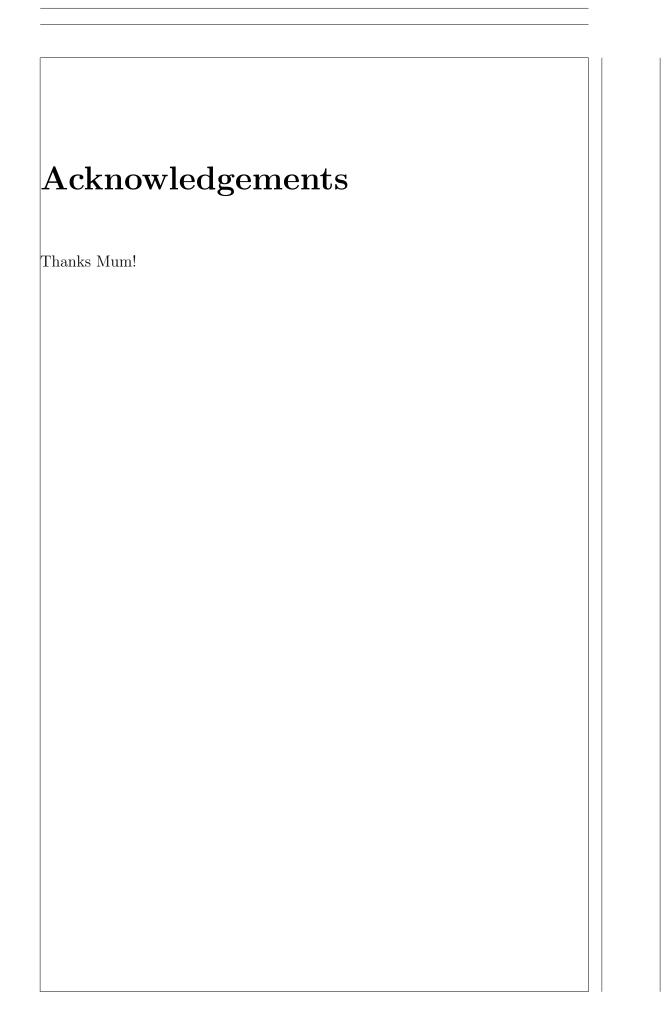


Abstract		
This is the paper's abstract		



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Nomenclature

3G Third Generation

4G Fourth Generation

AI Artificial Intelligence

DL Downlink

eNodeB Evolved Node B

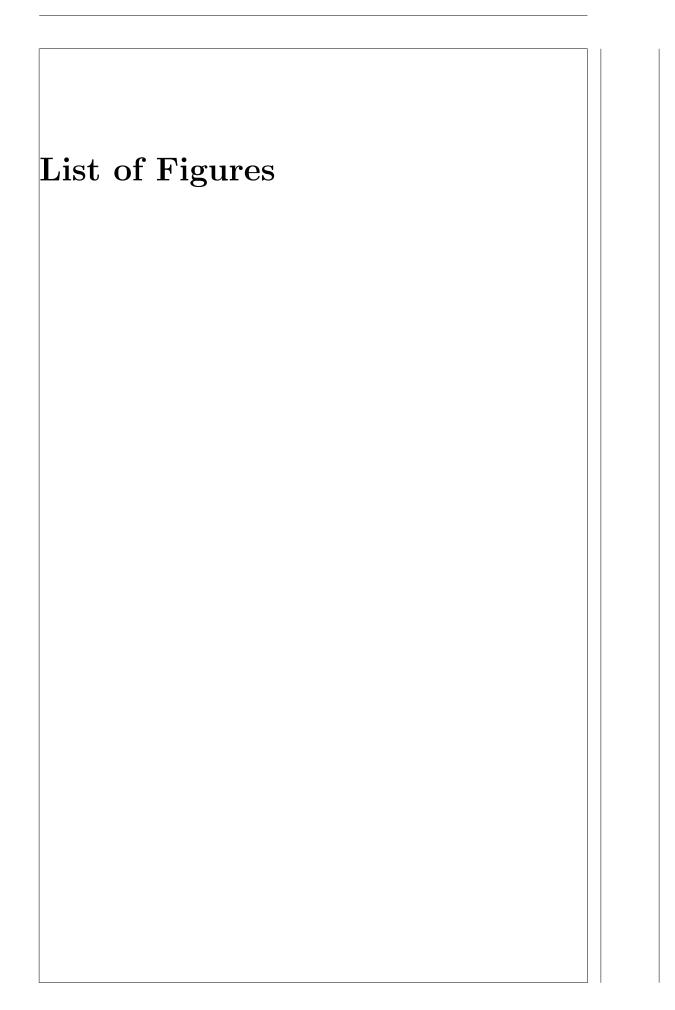
hys Hysteresis

LTE Long Term Evolution

MME Mobility Management Entity

TTT Time to Trigger

UL Uplink



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Chapter 2

\mathbf{LTE}

Mobile communications is on to its fourth generation of network infrastructure with LTE (Long Term Evolution) (4G). This network infrastructure is an improvement upon Universal Mobile Telecommunications System (UMTS), which is a third generation network (3G). LTE has downlink (DL) speeds of up to 300 Mbit/s and uplink (UL) speeds of 75 Mbit/s. This development was driven by the users want of faster download speeds for mobile services such as Video Streaming.

2.1 Self Organising Network

SON [1]

2.2 Handover Procedure

UE eNodeB MME

2.2.1 Handover Parameters

TTT hys

2.2.2 Handover Triggers

 $[2] \quad [3]$

Parameter	Value(dB)
hys	0.0
	0.0
	0.5
	1.0
	1.5
	2.0
	2.5
	3.0
	3.5
	4.0
	4.5
	5.0
	5.5
	6.0
	6.5
	7.0
	7.5
	8.0
	8.5
	9.0
	9.5
	10.0

Table 2.1: Table of the different LTE hys values.

Parameter	Value(s)
TTT	0.0
	0.04
	0.064
	0.08
	0.1
	0.128
	0.16
	0.256
	0.32
	0.48
	0.512
	0.64
	1.024
	1.280
	2.56
	5.12

Table 2.2: Table of the different LTE TTT values.

Event Type	Trigger Criteria
V 2	90
A1	Serving becomes better than a threshold.
A2	Serving becomes worse than a threshold.
A3	Neighbour becomes offset better than PCell.
A4	Neighbour becomes better than threshold.
A5	PCell becomes worse than threshold1 and neighbour becomes
	better than threshold2.
A6	Neighbour becomes offset better than SCell.
B1	Inter RAT neighbour becomes better than threshold.
B2	PCell becomes worse than threshold1 and inter RAT neigh-
	bour becomes better than threshold2.

Table 2.3: Table of the different LTE Trigger types and their criteria.

Chapter 3

Machine Learning

Machine learning is a form of artificial intelligence (AI) that involves designing and studying systems and algorithms with the ability to learn from data. This field of AI has many applications within research (such as system optimisation), products (such as image recognition) and advertising (such as adverts that use a users browsing history). There are many different paradigms that machine learning algorithms use. Algorithms can use training sets to train an algorithm to give appropriate outputs; other algorithms look for patterns in data; while others use the notion of rewards to find out if an action could be considered correct or not. [4] Three of the most popular types of machine learning algorithms are:

- Supervised learning is where an algorithm is trained using a training set of data. This set of data includes inputs and the known outputs for those inputs. The training set is used to fine-tune the parameters in the algorithm. The purpose of this kind of algorithm is to learn a general mapping between inputs and outputs so that the algorithm can give an accurate output for an unknown input. This type of algorithm is generally used in classifier systems.
- Unsupervised learning algorithms only know about the inputs they are given. The goal of such an algorithm is to try and find patterns or structure within the input data. Such algorithm would be given inputs and any patterns that are contained would become more and more common the more inputs the algorithm is given.
- Reinforcement learning uses an intelligent agent to perform actions within an environment. Any such action will yield a reward to the agent and the agents goal is to learn about how the environment reacts to any given action. The agent then uses this knowledge to try and maximise its reward gains.

The chosen type of machine learning chosen for the project is Reinforcement learning due to its ability to use the notion of states and rewards. These notions can be mapped to a set of TTT and hys values as well as the performance of that set respectively.

3.1 Reinforcement Learning

[5]

3.2 Q-Learning

In Q-Learning an agent tries to discover an optimal policy from its history of interactions with the environment.

$$< s_0, a_0, r_1, s_1, a_1, r_2, s_2, a_2... >$$
 $< s, a, r, s' >$

$$Q[s, a] = (1 - \alpha)Q[s, a] + \alpha(r + \gamma \max_{a'} Q[s', a']).$$

$$Q[s, a] = Q[s, a] + \alpha(r + \gamma \max_{a'} Q[s', a'] - Q[s, a])$$

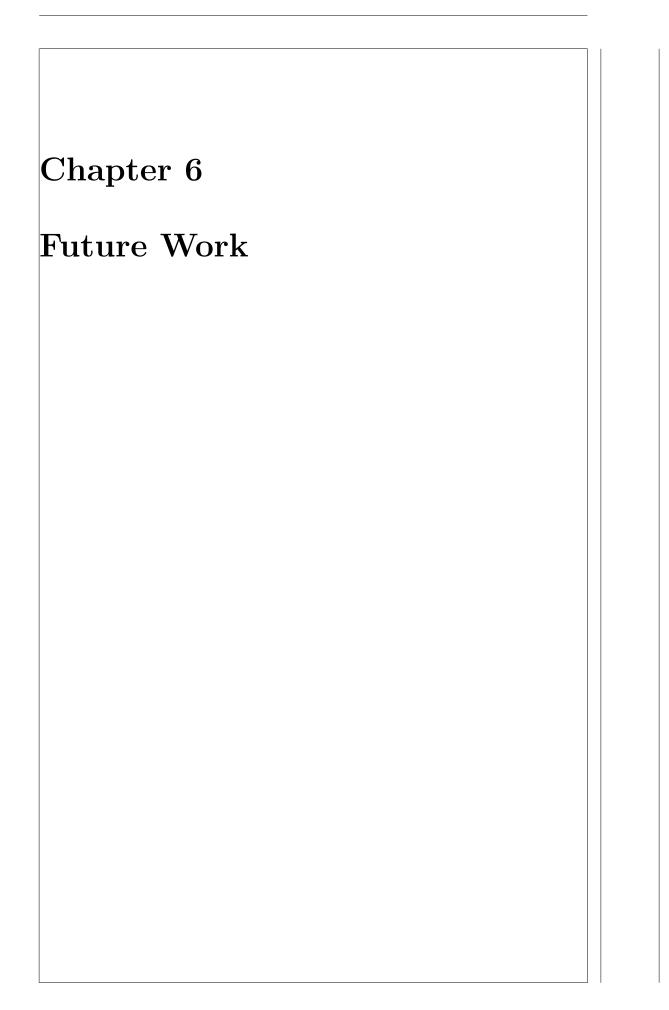
[6]

Chapter 4 Simulation Design 4.1 **Simulation Parameters** 4.2 Simulation Testing

Chapter 5

Handover Parameter Optimisation

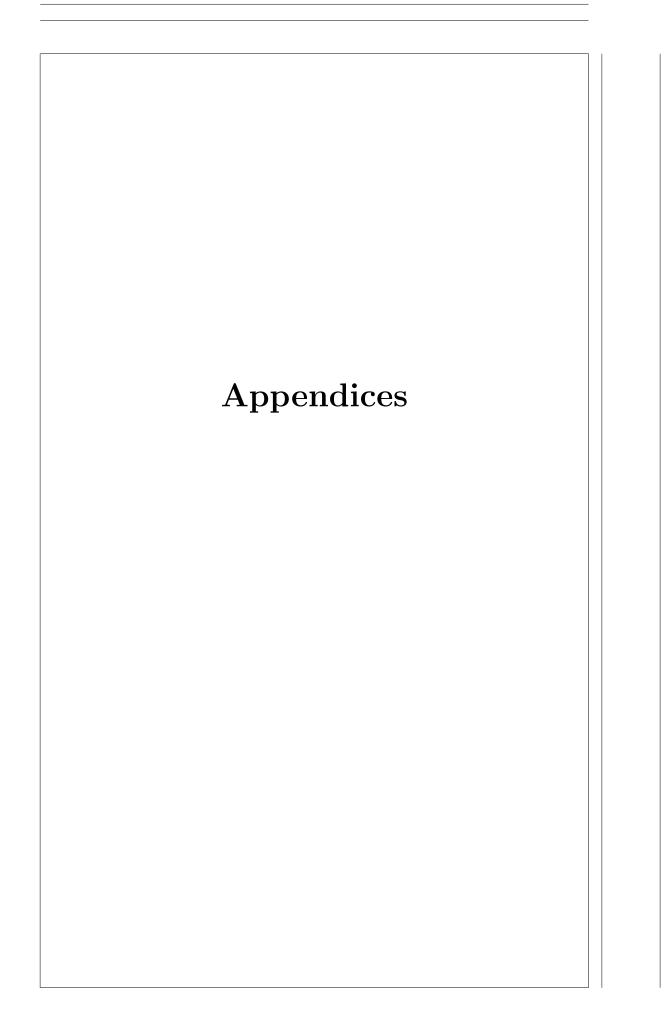
- 5.1 Approach 1
- 5.2 Approach 2
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- 5.4 Comparisons and Results



Chapter 7	
Conclusions	
We worked hard, and achieved very little.	

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Appendix A System Design and Evaluation The contents...