# BACKGROUND

This section will cover important theories and algorithms to help build a foundational understand on the topics that are relevant to this dissertation. This includes some of the definitions and terminology used in the field of research which encompasses the minimum spanning tree problem (MST). A variety of approaches to this problem will be highlighted, some of which include common deterministic methods and others utilise the swarm intelligence meta-heuristic. Next, a peek into the future of the MST problem before the evaluation of work presented throughout this section.

# Definitions:

Define graph and common phrases such as degree.

Define MST problem. Also define maximum spanning tree.

Define swarm intelligence meta-heuristic.

# Algorithms:

Common approach (Briefly cover Kruskal, Prims and Brukovsa) inc Yao a.c.c & Ackermann

# Swarm intelligence algorithms for MST:

GA approach

ICA approach

# NP-hard MST problems:

Define degree constrained DMST then cover paper

Define capacitated CMST then cover paper

# Review of Literature:

Compare and contrast different methods used against each other and my own

MST GA:

General overview of GA and (IN REF). Full explanation in algorithms section.

Explanation of purfer number – reword from paper (FIG)

The purfer number for graph representation is a good idea as a purfer number can only represent spanning trees due to the one to one relationship with the encoded spanning tree. The purfur number is used to represent the chromosomes in the GA approach.

This GA approach uses a uniform crossover crossover (figure).

explain the mutation technique.

This approach in non-determinist which much like the approach of this project, this is because the algorithm used is part of the swarm intelligence meta-heuristic. This approach is able to deal with any objective or constraint function. (compare and contrast)

There is no direct comparison of the weight the GA approach produced to the optimal weight return via deterministic algorithms which makes it difficult to tell whether the algorithm converges on the optimal solution or a local optima.

It is also not possible to tell what the ceiling of each spanning tree used in the graphs are. This makes it impossible to tell how bad the initial solutions are which makes it difficult to determine how good the convergence is. Visually the convergence of the graphs look good but without the minimum spanning tree and maximum spanning tree one cannot tell the size of the problem surface.

The fitness used if the total weight of the spanning tree, this means that the graphs can be compared in terms of convergence.

Imperialist competitive algorithm for EMST

This is for Euclidean MST problem however this can be seen as finding the MST of a complete undirected graph. To find a solution to the Euclidean MST problem vertices in the Euclidean space will be connected to each other. In order to create these connections in an optimal manor, a straight line is required due to the fact that it will be the fastest way to get from vertex A to vertex B. As the distance between two points in the Euclidean MST problem are constant, the distances can be used to represent a weight of an edge in a EWG. Another important factor is that a line can be created from any vertex to any other vertex. This property corresponds with that of a connected graph as all vertices are connected to all other vertices. The following figure will demonstrate these ideas:

(Figure)

The imperialist competitive algorithm population based algorithm which falls under the category of the swarm intelligence meta-heuristic, as such it is non-deterministic and requires multiple iterations to converge on a solution.

Generalise how ICA works by talking about the ideology behind it then ref the paper for deeper explanation (REF).

The graphs are represented as adjacency matrix (FIG)

Connectivity theorem

The implementation of ICA presented in this paper (REF) uses a formula to calculate the cost of an adjacency matrix using the connectivity theorem. The cost of any spanning tree will fit within the range of v – 1. Any cost that is larger than v-1 represents a graph with too many edges and any cost that is less than v-1 has too few edges. Costs outside the range of v-1 are heavily penalised thus becoming weaker countries.

Ackermann

The algorithm presented is the most asymptotically efficient algorithm for the MST problem. This is a non-greedy approach, but is still deterministic. *O* (*m α*(*m, n*)) time complexity where *α* is the functional inverse of Ackermann's functiondefined in Tarjan [1975]

This shows the range of time complexities that a MST algorithm can have.

Yao acc MST

This is one of the faster algorithmic approaches to the MST problem as it has a time complexity of *O* (|*E*|log log |*V*|). This is also a determinist algorithm.

Re-wright pseudo code for algorithm