**Dissertation Project plan, Jacob Howes**

An investigation into and creation of a discretization for cuckoo search/optimisation to solve the graph colouring problem.

**Description:**

Much work has been done surrounding the efficient solving of NP-hard problems such as graph colouring. Recently, the bulk of this research has been focused on developing efficient metaheuristic algorithms to obtain approximate solutions quickly. The focus of this project will be the investigation of such algorithms to tackle graph colouring, specifically focusing on the population-based metaheuristic algorithms cuckoo search and cuckoo optimisation with the main goal being to develop my own discretization to solve the graph colouring problem.

**Preliminary preparation:**

* A strong understanding of graph theory and specifically of the graph colouring problem
* A strong understanding of some metaheuristic algorithms
* A basic understanding of reconfiguration problems specifically surrounding graph colouring

**Objectives:**

**Minimum:**

* Implementation of continuous cuckoo search (CS) and cuckoo optimisation (CO)
* Implementation of 2017 CS colouring
* Implementation of 2014 CS colouring
* Some elementary experimentation surrounding graph colouring discretisation

**Intermediate:**

* Implementation of 2015 CO colouring
* Implementation of at least two other metaheuristic algorithms for graph colouring, e.g.:
  + PSO for graph colouring
  + BEECOL
  + TABUCOL
  + GA
* Create my own discretisation for graph colouring (specifically to solve the problems in the 2015 CO paper)

**Advanced:**

* Create my own hybridisations of the above algorithms
  + E.g. improve CS or CO with the addition of some other algorithm/heuristic for local search
* Create a novel cuckoo algorithm for graph colouring
  + E.g. a modified version of cuckoo search for the graph colouring problem or perhaps a combination of cuckoo search and cuckoo optimisation
* Consider discretisations of other NP-hard problems (beyond graph colouring)

**Project Plan**

The minimum objectives focus primarily on background work relating to the project. I believe the implementations of the continuous algorithms is necessary to gain a deeper understanding of the algorithms’ strengths and weaknesses. Once the continuous cuckoo search is implemented, the implementations of the two cuckoo search graph colouring algorithms will (hopefully) not present with too much challenge but this will be important as not only will it give me experience with implementing metaheuristic algorithms for graph colouring but also it will be good to compare these algorithms with my own future discretisation. Beyond implementing these algorithms, before I start considering my own discretisation I feel it necessary to do more background research and experimentation surrounding the topic (hence the final minimum objective).

Although the 2016 cuckoo optimisation algorithm has many issues, it will probably still form some basis of foundation for my own algorithm. Furthermore, given that my aim is to solve the problems with this algorithm, it will be necessary to implement it to see if these problems are solved by my own. Beyond cuckoo search and cuckoo optimisation, any algorithm should be compared and benchmarked against other common algorithms in the domain so for my results and analysis it will be necessary for me to implement a few other metaheuristic algorithms for graph colouring.

Once the minimum and intermediate objectives are complete, I am free to experiment with and improve my algorithm with hybridisations or the inclusion of heuristics for graph colouring. It’s difficult to say at this stage what exactly this stage will entail but given any metaheuristic algorithm there are many problem-specific ways in which it can be fine-tuned. Finally, if I’m satisfied with my algorithm and still have time I may consider tackling some other NP-hard combinatorial optimisation problems such as the travelling salesman problem, the knapsack problem, the dominating set problem, etc.

**Gantt Chart**

