Title: *From Scramble to Solution: Harnessing Genetic Algorithms for Rubik's Cube*

Team Members:

Student ID	Name	Email
110550091	吳承瑀	20021212lilywu@gmail.com
110550126	曾家祐	buszter0403@gmail.com
110550087	俞柏帆	mfpss98399@gmail.com
110550035	陳奎元	kono.c@nycu.edu.tw

Type: Evolutionary Computation Application

Objectives:

The primary objective of this project is to develop a genetic algorithm capable of efficiently solving a standard 3x3 Rubik's Cube. To achieve this, we aim to implement a genetic algorithm framework specifically tailored to the problem, allowing for the exploration of various genetic operators, including selection, crossover, and mutation, to assess their effectiveness in finding optimal solutions. Additionally, we plan to compare the performance of our genetic algorithm against traditional solving methods to evaluate its efficiency and robustness.

Methodology:

To achieve our objectives, we will follow these steps:

1. **Literature Review:**

   Conduct a review of existing algorithms and read published papers for solving Rubik's Cubes, particularly those utilizing genetic algorithms. Identify key performance metrics and benchmarks.

2. **Algorithm Design:**
   - Establish a representation of a solution within the genetic algorithm as a sequence of moves, utilizing a total of 12 possible move options.
     1. These options correspond to the six faces of the Rubik's Cube, with each face capable of rotating either clockwise or counterclockwise.
     2. Consequently, the sequence will be represented using a duodecimal (12-ary) string.
   - Formulate a fitness function to assess the proximity of a given solution to achieving a complete configuration of the cube.
     1. This will be determined by evaluating the completeness of each face after *n* moves.

3. **Genetic Operators:**
   - **Selection:** Implement techniques such as tournament selection, roulette wheel selection, or other relevant selection methods.
   - **Crossover:** Design crossover methods that combine sequences of moves from parent solutions.
   - **Mutation:** Introduce random changes to a solution to promote genetic diversity.

4. **Parameter Optimization:**
   Experiment with various parameters, such as population size, mutation rate, and crossover rate, to determine their effects on the algorithm's performance.

5. **Testing and Evaluation:**
   Test the algorithm on various Rubik's Cube configurations and evaluate the solution quality and convergence time. Compare the results with existing solving methods.

Contributions:

If successful, this project will contribute to the field of evolutionary computation by demonstrating the application of genetic algorithms in solving complex combinatorial problems like the Rubik's Cube. It will provide insights into the efficiency of genetic algorithms compared to traditional methods and could serve as a foundation for future work in evolutionary problem-solving techniques.