LunarLander GA

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1. Methods :

這次的 GA 我有嘗試比較不同種的方法應用在基因演算法中，並對 fitness value 做的比較。我最後的方法和參數設定為 ：

Crossover	Whole arithmetric crossover (alpha= 0.7)
Mutation	Gaussian mutation (sigma = 0.25)
Parent Selection	10 tournament selection
Simulation per evaluation	15
Population size	50
Generation	20
K_tournament	10
Crossover rate	0.7
Mutation rate	0.0005 (change with generation)

其中，我有另外加入 tune_rate 參數，由初始值 1 經過 20 次等比級數到 0.2。這個參數的設定最主要是想要讓 Mutation 隨著 generation 的上升，突變的機率會慢慢降低(發生突變的情況為 : random.random()<=Mutation_rate* tune_rate[i])。隨著 generation 的上升，Mutation 突變的機率會慢慢降低，到第 20 次 generation 時，tune_rate 末值為 0.2。

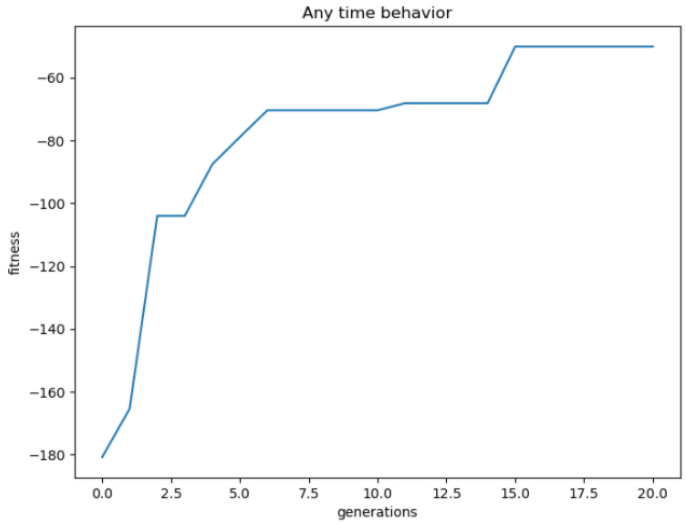
2. Experiment Results :

我使用 Simulation per evaluation = 15，跑出來的 best fitness 結果如下 ：

```
Generation    0, best fitness = -180.82
Generation    1, best fitness = -165.37
Generation    2, best fitness = -104.00
Generation    3, best fitness = -104.00
Generation    4, best fitness = -87.59
Generation    5, best fitness = -78.90
Generation    6, best fitness = -70.40
Generation    7, best fitness = -70.40
Generation    8, best fitness = -70.40
Generation    9, best fitness = -70.40
Generation   10, best fitness = -70.40
Generation   11, best fitness = -68.11
Generation   12, best fitness = -68.11
Generation   13, best fitness = -68.11
Generation   14, best fitness = -68.11
Generation   15, best fitness = -50.10
Generation   16, best fitness = -50.10
Generation   17, best fitness = -50.10
Generation   18, best fitness = -50.10
Generation   19, best fitness = -50.10
Generation   20, best fitness = -50.10
```

剛開始 best fitness value = -180.82。起初上升的幅度蠻大，但到後面上升的幅度相對小。
在第 20 次 generation 時，best fitness value = -50.10。

Draw Anytime Behavior :



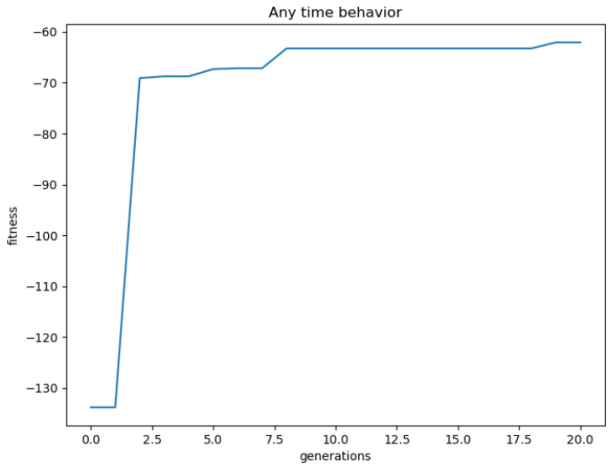
(20 次 generations)

3. Adjust parameter :

(1) 將 k = 10 改變為 k = 3 的 tournament selection :

Comparing results :

```
Generation   0, best fitness = -133.79
Generation   1, best fitness = -133.79
Generation   2, best fitness = -69.07
Generation   3, best fitness = -68.74
Generation   4, best fitness = -68.74
Generation   5, best fitness = -67.31
Generation   6, best fitness = -67.15
Generation   7, best fitness = -67.15
Generation   8, best fitness = -63.25
Generation   9, best fitness = -63.25
Generation  10, best fitness = -63.25
Generation  11, best fitness = -63.25
Generation  12, best fitness = -63.25
Generation  13, best fitness = -63.25
Generation  14, best fitness = -63.25
Generation  15, best fitness = -63.25
Generation  16, best fitness = -63.25
Generation  17, best fitness = -63.25
Generation  18, best fitness = -63.25
Generation  19, best fitness = -62.06
Generation  20, best fitness = -62.06
```

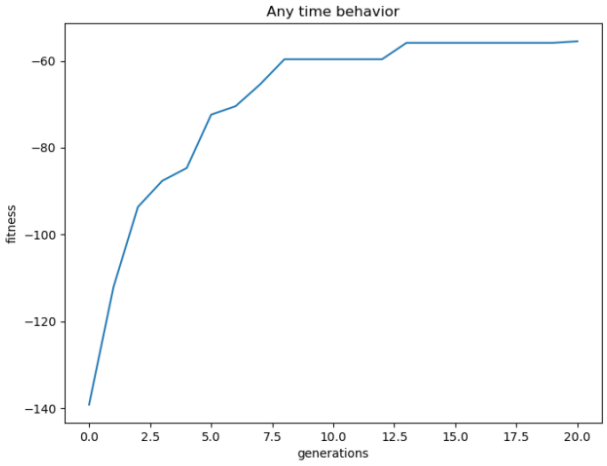


剛開始的 fitness value 有較大的改變，但後面改變的幅度較小。推測是因為隨機選 3 個個體比較難選擇到較好 fitness value 的個體，因此，成長的幅度較緩慢。可能需要更多次的 generations 次數方可達到較好的效果。

(2) 將 mutation rate 由 0.0005 改為 0.001 :

Comparing results :

```
Generation    0, best fitness = -139.13
Generation    1, best fitness = -112.06
Generation    2, best fitness = -93.64
Generation    3, best fitness = -87.60
Generation    4, best fitness = -84.67
Generation    5, best fitness = -72.39
Generation    6, best fitness = -70.45
Generation    7, best fitness = -65.45
Generation    8, best fitness = -59.65
Generation    9, best fitness = -59.65
Generation   10, best fitness = -59.65
Generation   11, best fitness = -59.65
Generation   12, best fitness = -59.65
Generation   13, best fitness = -55.87
Generation   14, best fitness = -55.87
Generation   15, best fitness = -55.87
Generation   16, best fitness = -55.87
Generation   17, best fitness = -55.87
Generation   18, best fitness = -55.87
Generation   19, best fitness = -55.87
Generation   20, best fitness = -55.52
```

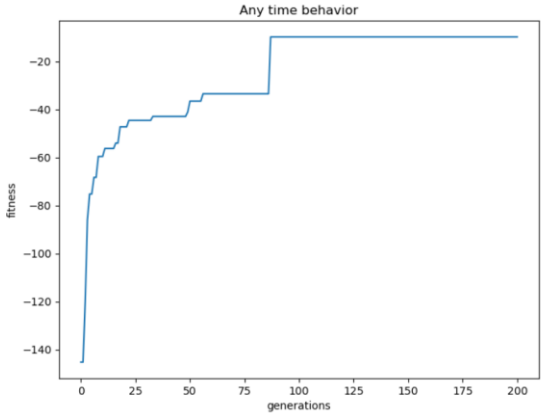


相較之下，將 Mutation rate 調高，則有較大的機率突變，表現上曲線較為陡峭，但最後的 fitness value 表現上是差不多的大概都收斂到 -50~-55。(GA 的隨機性很高，每次做出的結果不盡相同)

(3) 將 Generations 由 20 改為 200 :

Comparing results :

```
Generation   80, best fitness = -33.43
Generation   81, best fitness = -33.43
Generation   82, best fitness = -33.43
Generation   83, best fitness = -33.43
Generation   84, best fitness = -33.43
Generation   85, best fitness = -33.43
Generation   86, best fitness = -33.43
Generation   87, best fitness = -9.72
Generation   88, best fitness = -9.72
Generation   89, best fitness = -9.72
Generation   90, best fitness = -9.72
Generation   91, best fitness = -9.72
Generation   92, best fitness = -9.72
Generation   93, best fitness = -9.72
Generation   94, best fitness = -9.72
Generation   95, best fitness = -9.72
Generation   96, best fitness = -9.72
```



Fitness value 有越來越好的趨勢，但整體而言，最後只有收斂到 -9.72，有點可惜。我認為如果將 population size 調大一點，可能有機會收斂到較好的值。