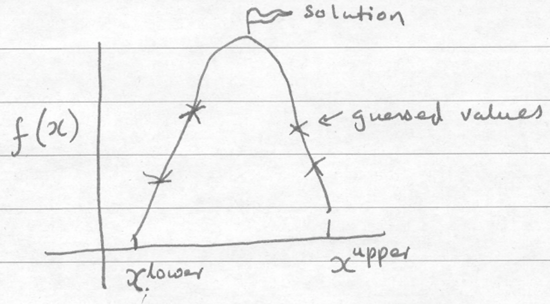
Genetic Algorithms - Lecture 2

How do we create a population?

x_3 x_2 x_1

Random {
1 0 0 1 0 1 0 0 1
1 0 0 1 0 1 0 0 1
⋮

While calculating, using the binary sequence, neglect the boundaries between the variables.



To assess individuals, we have to assign a "fitness"
Our task is to find the maximum value of function.

Therefore, the larger the value of $f(x)$, the more fitness that individual is. ∴ In a maximisation proplem, fitness = function value.

In a minimisation problem, we convert the minimisation problem into a pseudo maximising problem

e.g. minimize $G \Rightarrow$ maximise $-G$

" " $\Rightarrow$ " $\frac{1}{1+G}$.

- What population size should we choose?
  Suppose there are L bits in each individual, the population size $\simeq L$. but not much bigger than L

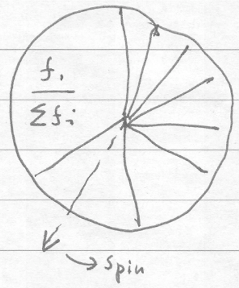
- Nature conducts selection, crossover and mutation

- Selection: Not all individuals survive to propagate.
  The chance of survival depends on "fitness".

	fitness	
population — — — — — —	20	
— — — — — —	30.5	← greater chance of survival. Let this propagate
— — — — —	11.07	
— — — —	2.2	← minimal chance of survival. Let this die.
⋮	⋮	

All the initial guesses belong to generation 1
Some of these survive but I want generation 2 to be of the same size as generation 1 ∴ Therefore surviving individuals will have ~~more than one copy~~. to be "copied"

- Roulette wheel method of selection. Suppose f_i is the fitness value of the i th individual.
  Relative fitness $= f_i / \sum_i f_i$



Simulate the spinning of roulette wheel (generate random number between $0 \to 1$, which defines the spin of the wheel). Where the arrow stops defines the individual copied to the next step.
The wheel is spinned the same number of times as the size of the population.

- Clearly, if the solution is not in the population then selection ~~along~~ alone will never obtain it.

- Tournament Selection (Less Jerky)

  Population

  → Shuffle to remove any preference for neighbour.

  Then decide on "tournament size", with a minimum value of 2.

  For a size of 2, 2 play a "game" and the player with the highest fitness survives. Continue this. The shuffle again and repeat to generate the same population size.

- ~~Mutation~~ Cross-over: e.g. some of the genes from ~~father~~ or mother inherited

  Random ~~crossing site~~ crossing site

  ```
  1 0 0 0 | 1 1 0                  1 0 0 0 1 0 0 }
  1 1 0 1 | 1 0 0        →         1 1 0 1 1 1 0 } new children
  ```

  $\text{Parent}_1 \otimes \text{Parent}_2 \Rightarrow \text{Child}_1 + \text{Child}_2$

This is known as single-point crossover.
In a two point crossover

```
1 0 0 | 0 1 1 | 0
1 1 0 | 0 0 1 | 1
```

swap here

Crossover has a probability p_{cross} is assigned.
If p_{cross} > random number between 0 and 1, then allow crossover. Helps preserve population diversity.

- Uniform Crossover

1001 01   Select a <u>small</u> p_{cross}

101 1 10   Then examine bit

↑ "a"   by bit, and only

change if random number < p_{cross}. Because of bit by bit, the parent may not change, e.g. at "a"