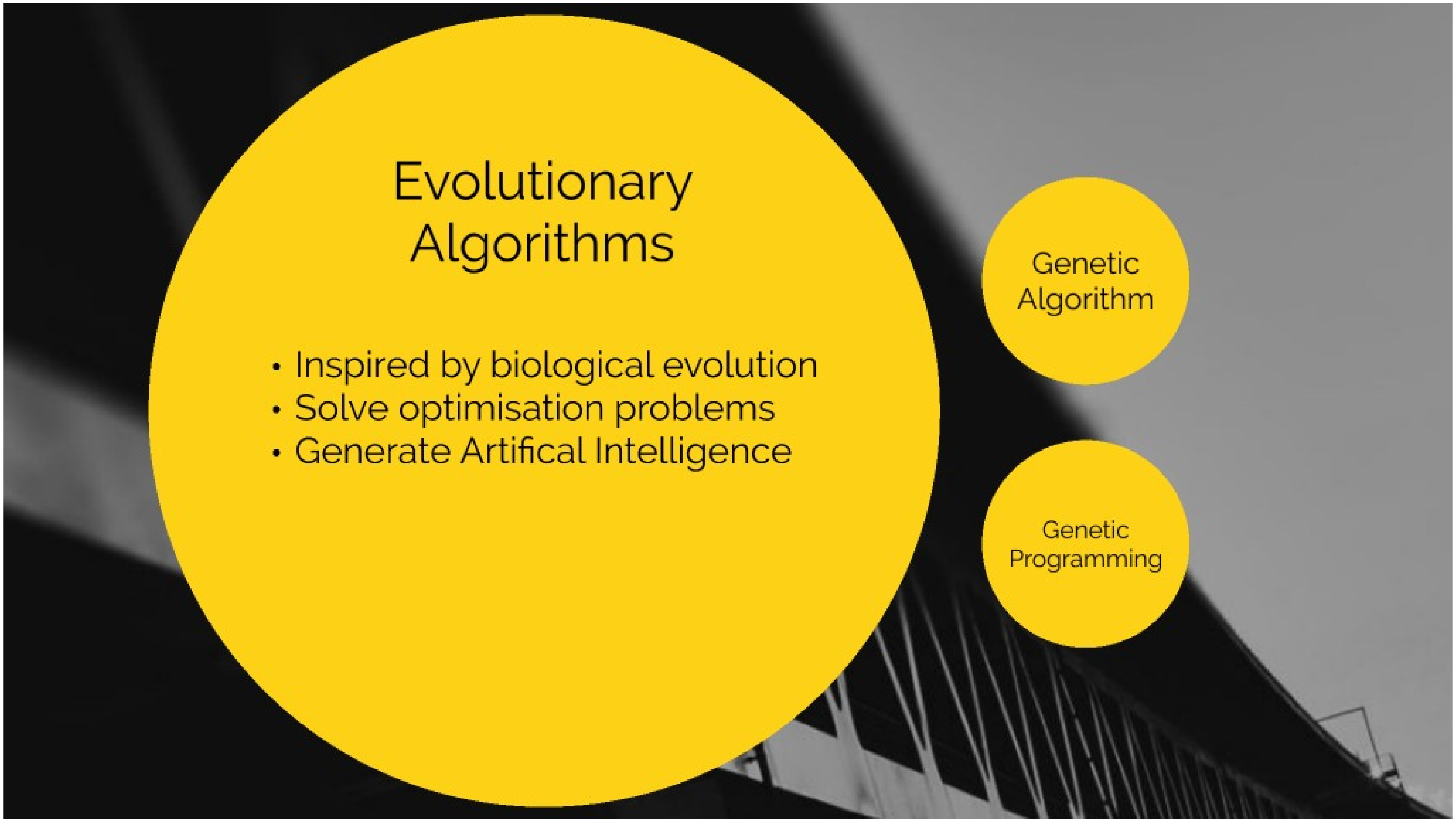
Evolutionary Programming

Gilgamesh Athoraya

Evolutionary Algorithms

Genetic operators

Implementation



Evolutionary Algorithms

- Inspired by biological evolution
- Solve optimisation problems
- Generate Artifical Intelligence

Genetic Algorithm

Genetic Programming

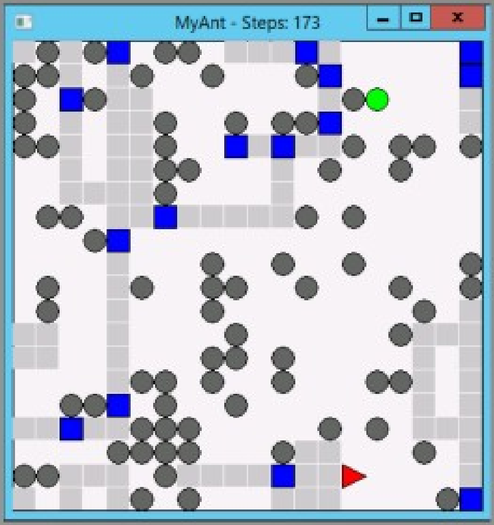
Genetic Algorithm

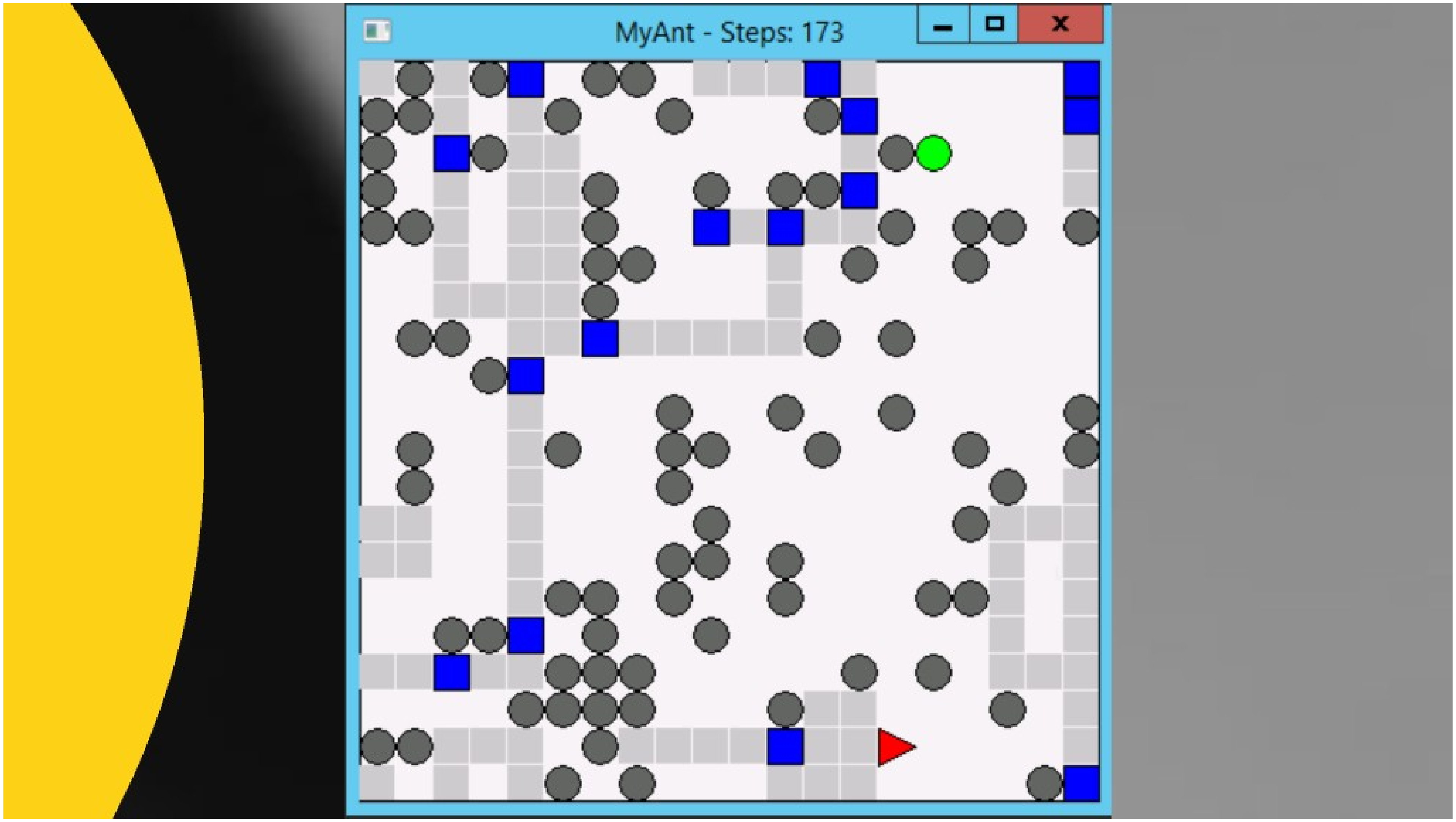
Seek the solution to a problem in the form of strings or numbers.

Program ***FIXED***
Parameters ***VARIABLE***

Sample implementation in APL using Artifical Neural Network as chromosomes:

https://github.com/e9gille/gpapl




MyAnt - Steps: 173

Genetic Programming

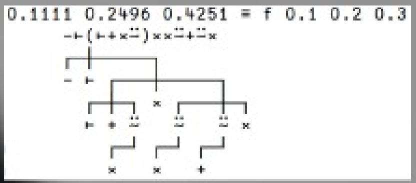
Space of solutions is computer programs.

Genes in chromosome are represented by operator functions.

Program ***VARIABLE***
Parameters ***FIXED***

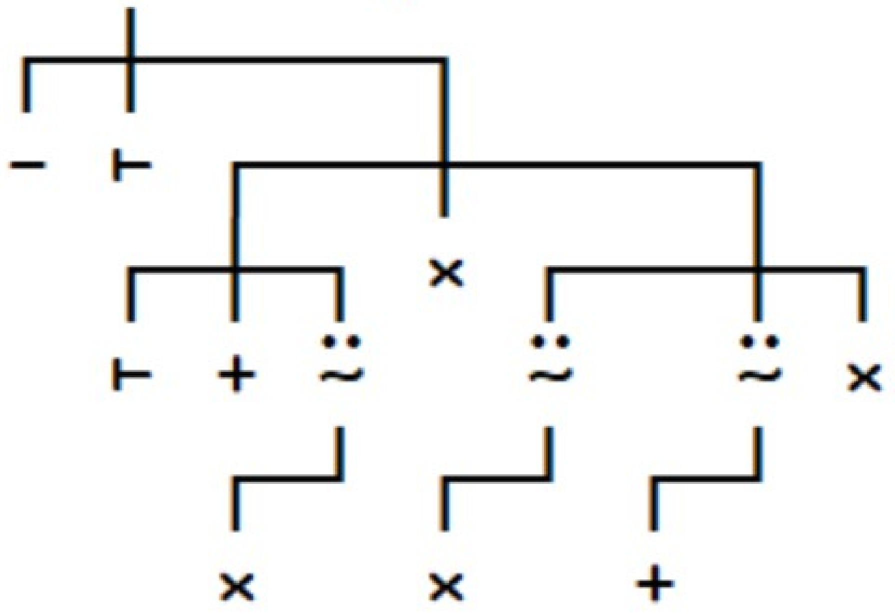
Sample implementation in APL using function trains as chromosomes:

https://github.com/e9gille/gpapl



```
0.1111 0.2496 0.4251 ≡ f 0.1 0.2 0.3
     -⊢(⊢+×⍨)××⍨+⍨×
```

```
0.1111 0.2496 0.4251 ≡ f 0.1 0.2 0.3
        -⊢(⊢+×⍨)××⍨+⍨×
```



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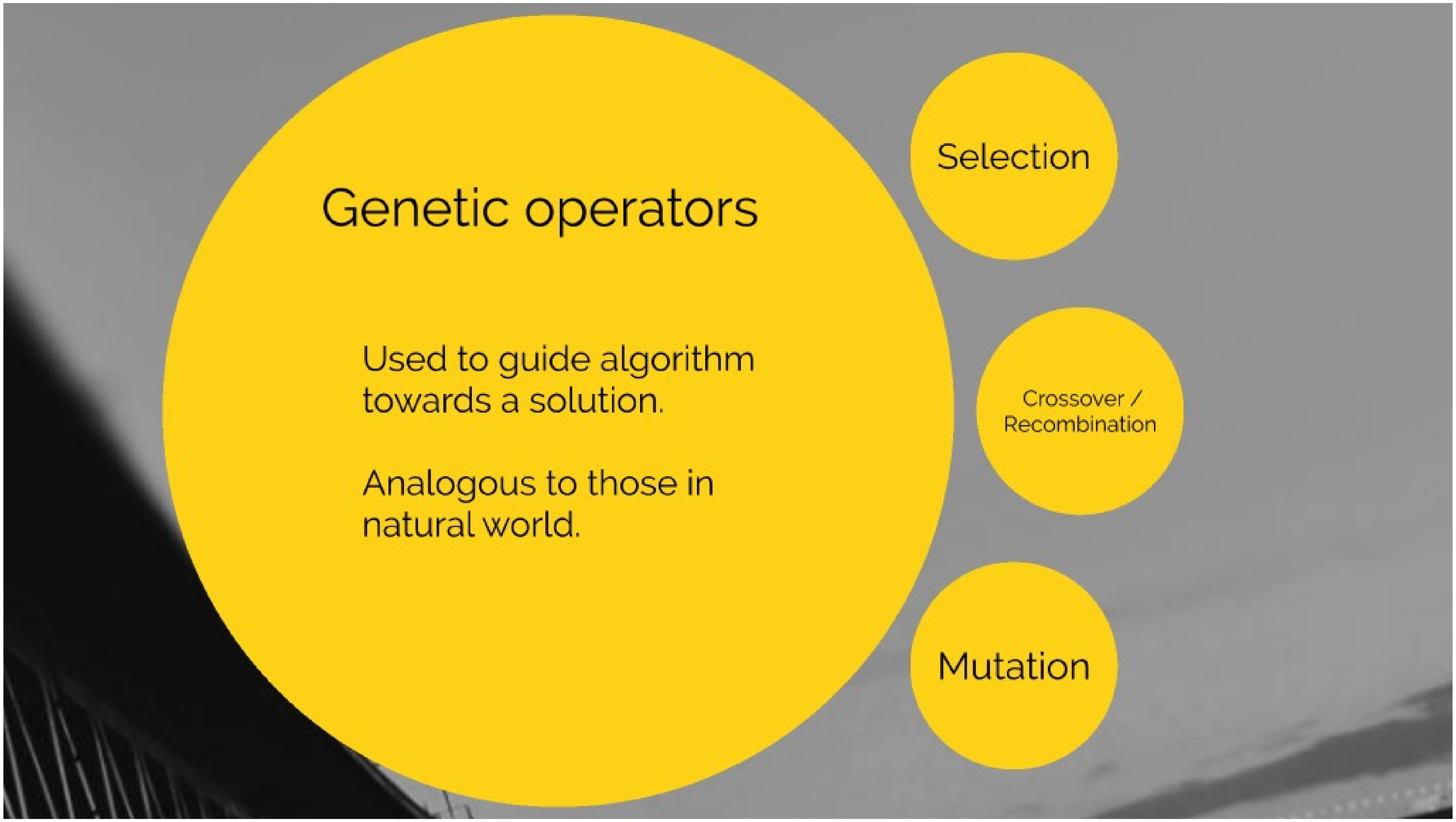


Genetic operators

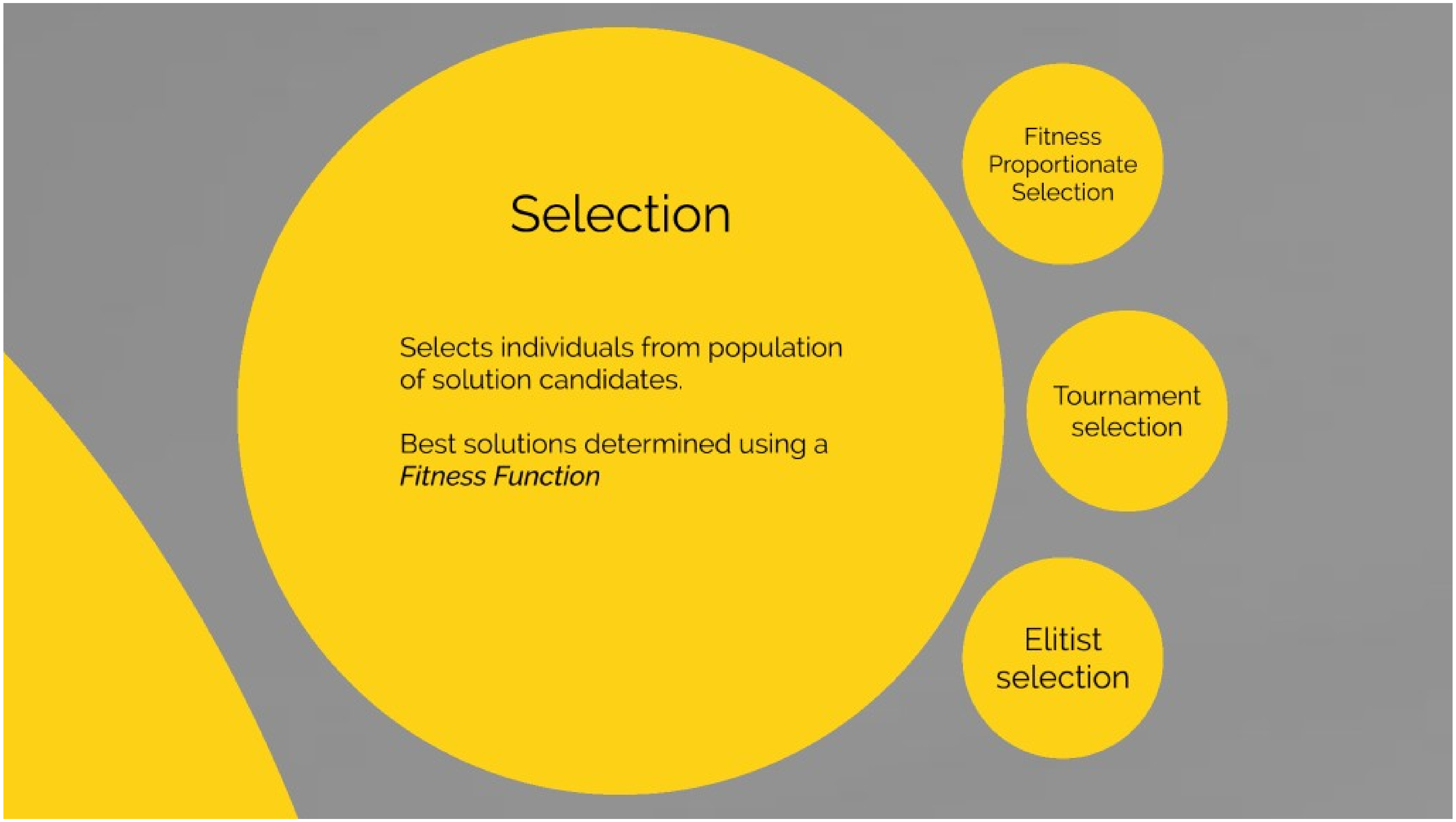
Used to guide algorithm towards a solution.

Analogous to those in natural world.

Selection

Crossover / Recombination

Mutation

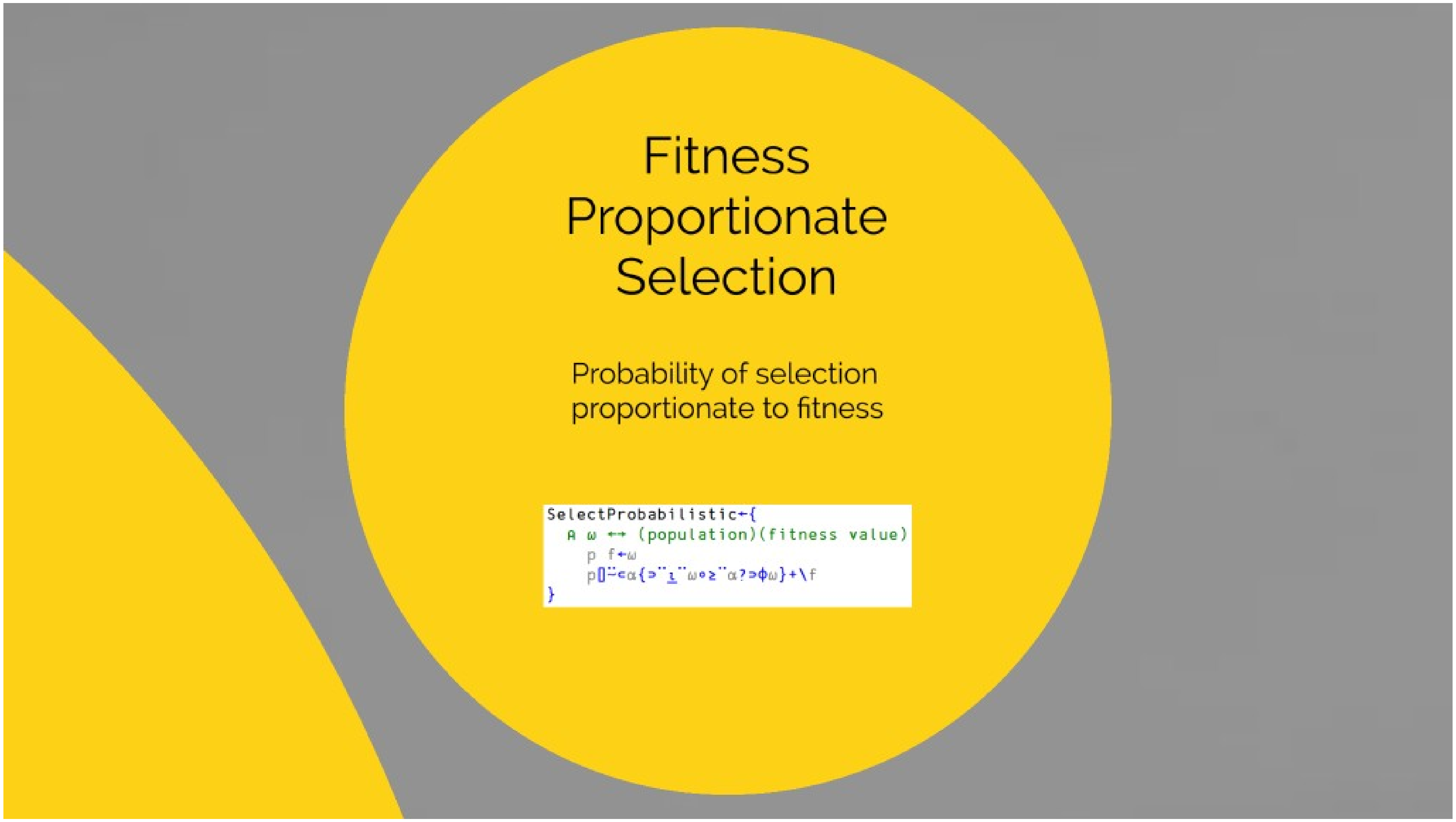


Selection

Selects individuals from population of solution candidates.

Best solutions determined using a *Fitness Function*

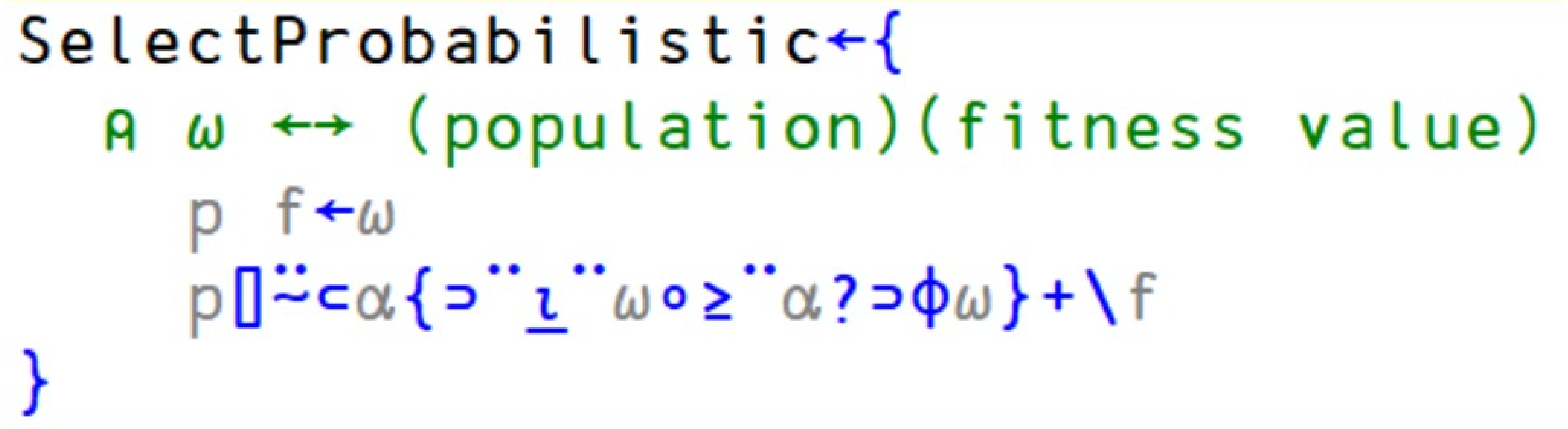
Fitness Proportionate Selection
Tournament selection
Elitist selection



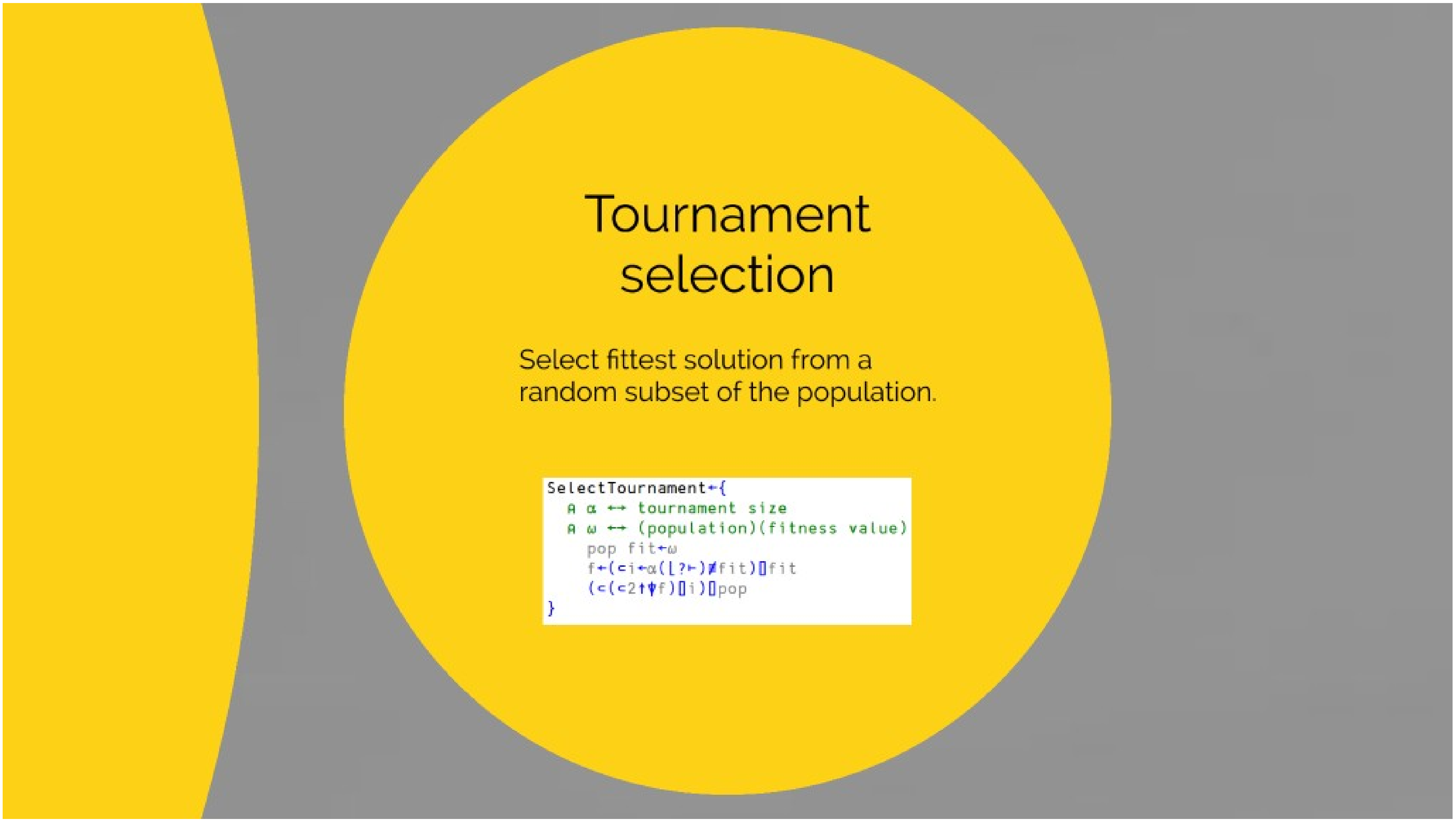
Fitness Proportionate Selection

Probability of selection proportionate to fitness

```
SelectProbabilistic←{
  ⍝ ⍵ ←→ (population)(fitness value)
    p f←⍵
    p⌷⍨⊂⍺{⊃¨⍸¨⍵∘≥¨⍺?⊃⌽⍵}+\f
}
```



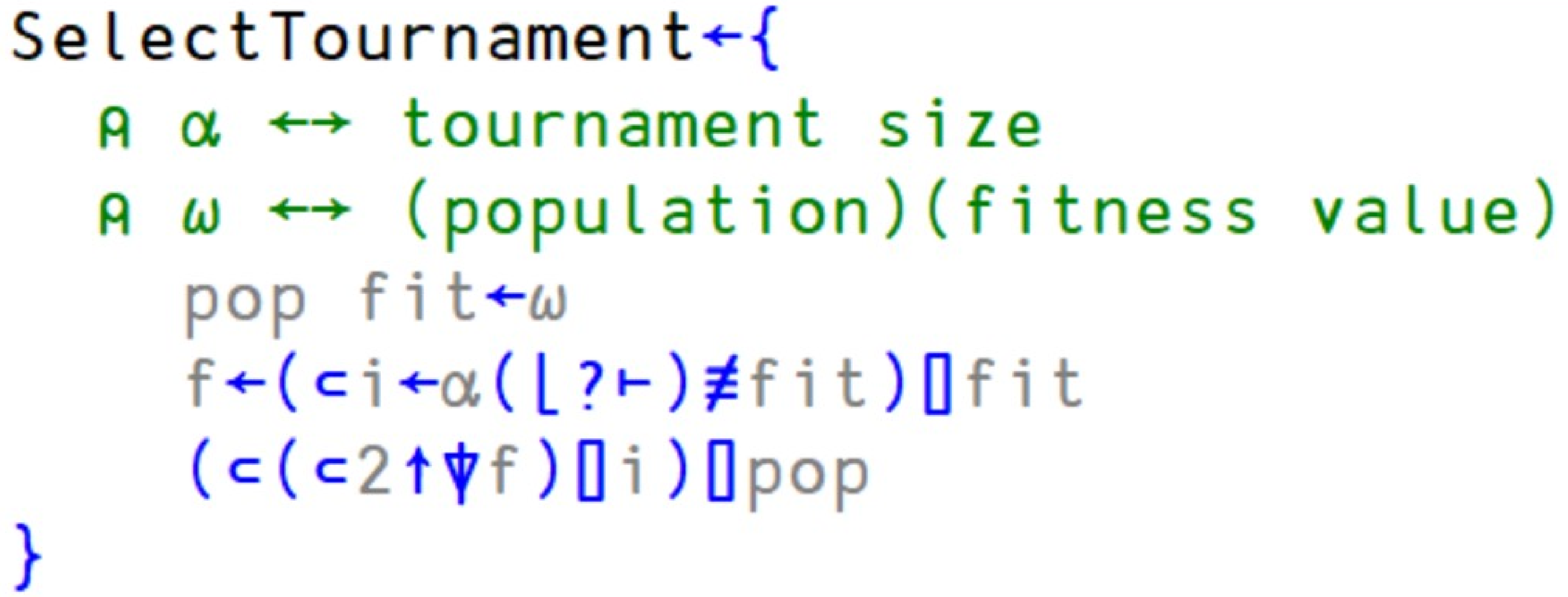
```
SelectProbabilistic←{
   ⍝ ω ↔ (population)(fitness value)
     p f←ω
     p⌷⍨⊂α{⊃¨⍸¨ω∘≥¨α?⊃⌽ω}+\f
}
```



Tournament selection

Select fittest solution from a random subset of the population.

```
SelectTournament←{
  ⍝ α ←→ tournament size
  ⍝ ω ←→ (population)(fitness value)
    pop fit←ω
    f←(⊂i←α(⌊?⊢)≢fit)⌷fit
    (⊂(⊂2↑⍒f)⌷i)⌷pop
}
```



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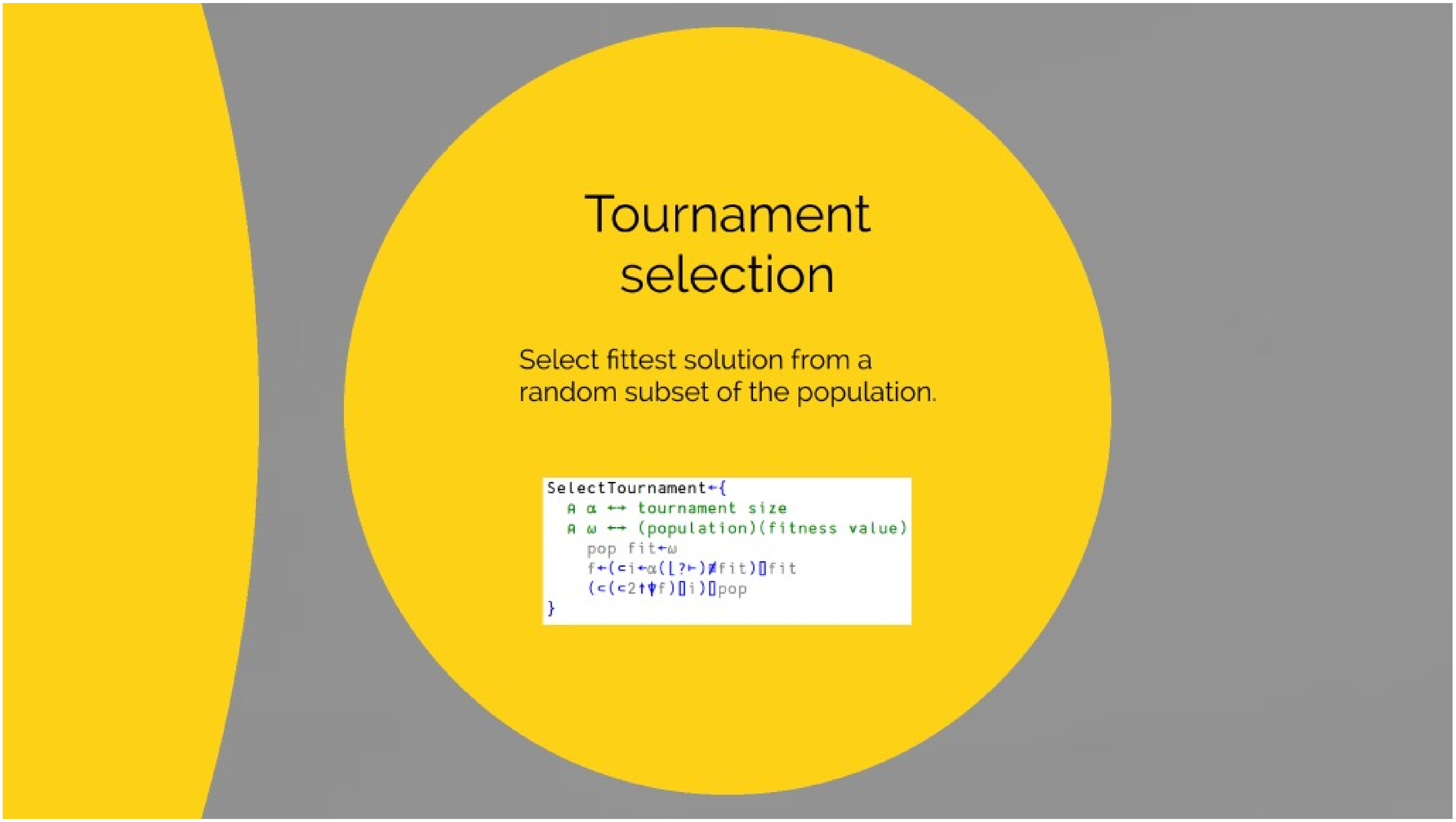
    (⊂(⊂2↑⍒f)⌷i)⌷pop
}
```



Tournament selection

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    pop fit←ω
    f←(⊂i←α(⌊?⊢)≢fit)⌷fit
    (⊂(⊂2↑⍒f)⌷i)⌷pop
}
```

Elitist selection

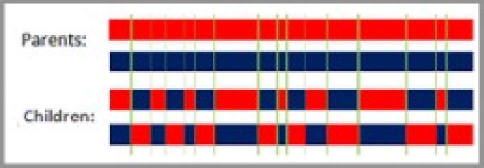
Fittest solution selected.

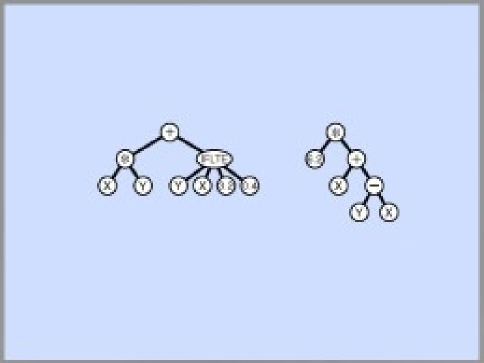
Crossover / Recombination

(sexy time)

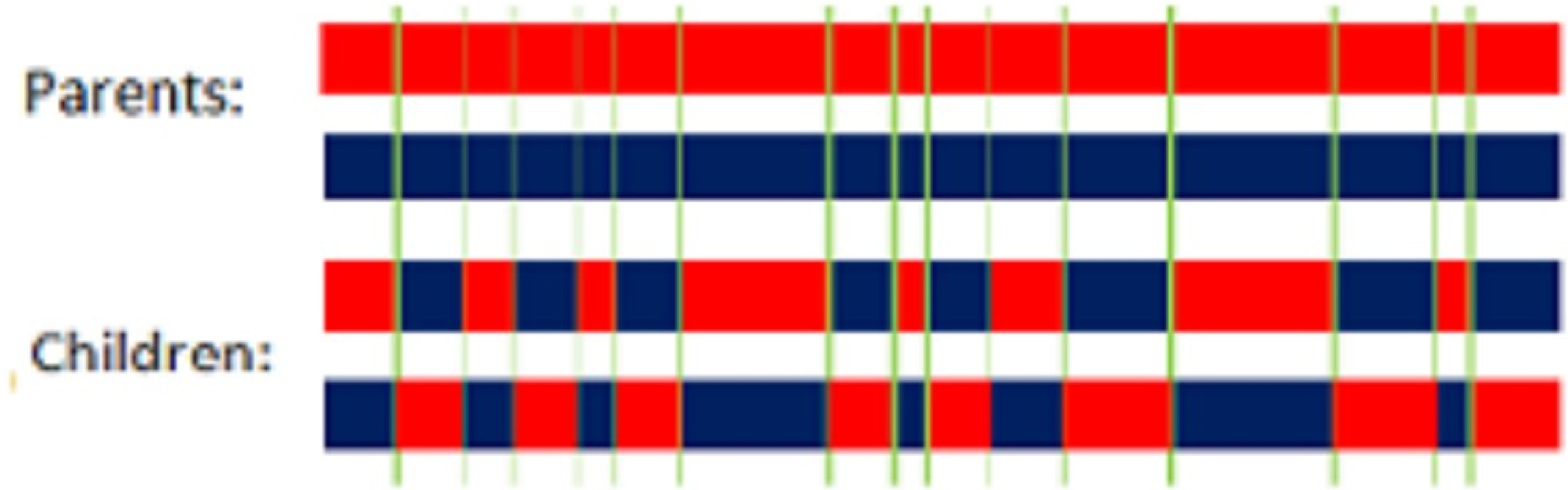
Recombines genetic code from 2 (or more) parent solutions to generate a child solution.

Method selected based on the chromosome's representation of solution.

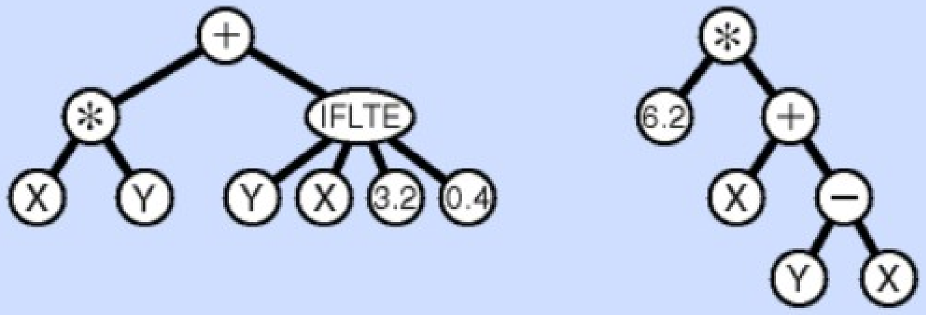




[redacted]



[redacted]


+
*
IFLTE
X
Y
Y
X
3.2
0.4
*
6.2
+
X
−
Y
X

Crossover / Recombination

(sexy time)

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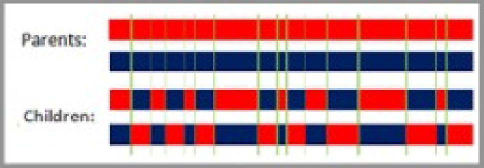

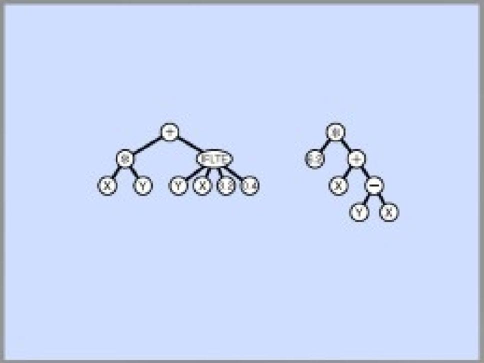

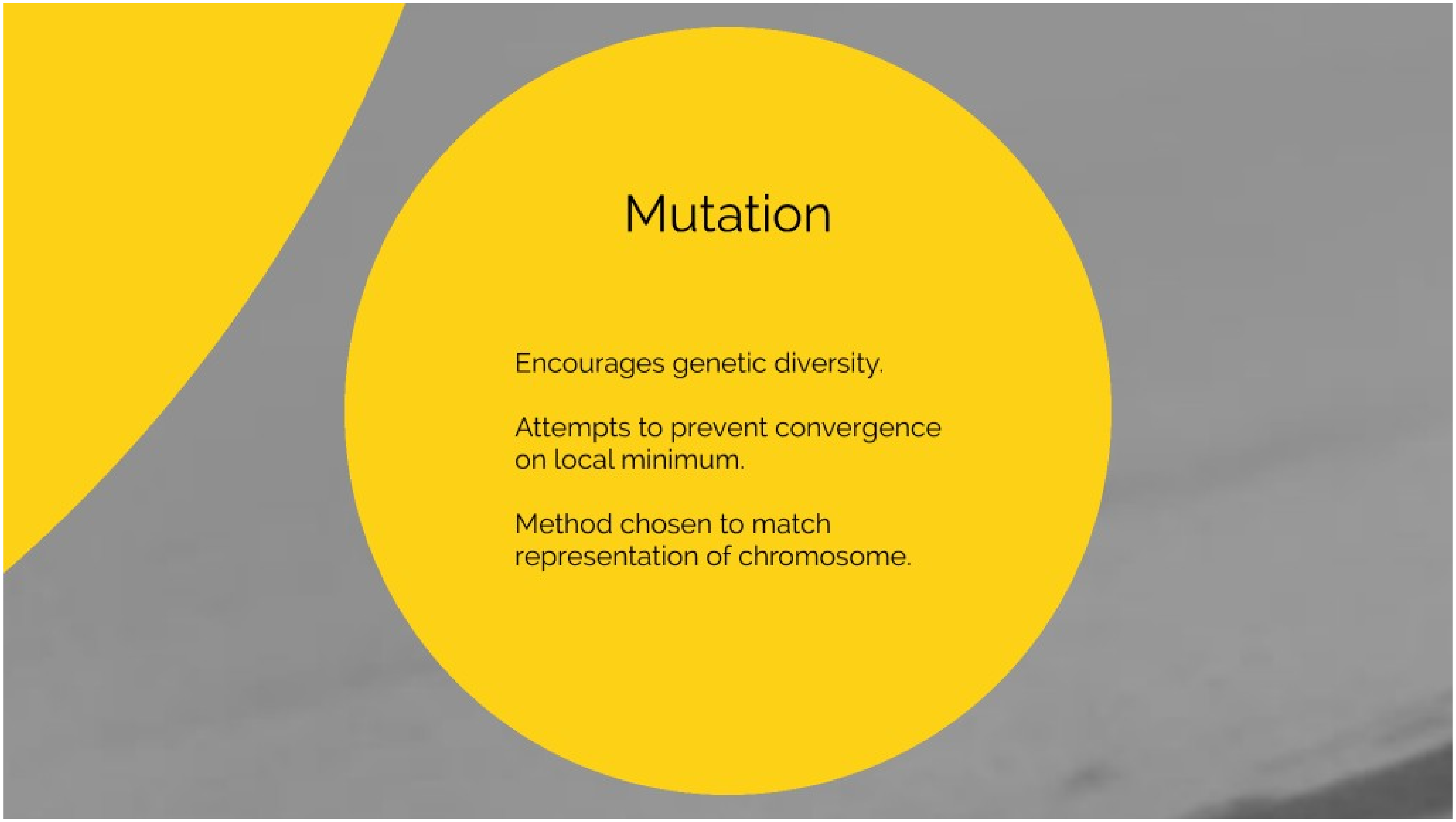

Mutation

Encourages genetic diversity.

Attempts to prevent convergence on local minimum.

Method chosen to match representation of chromosome.

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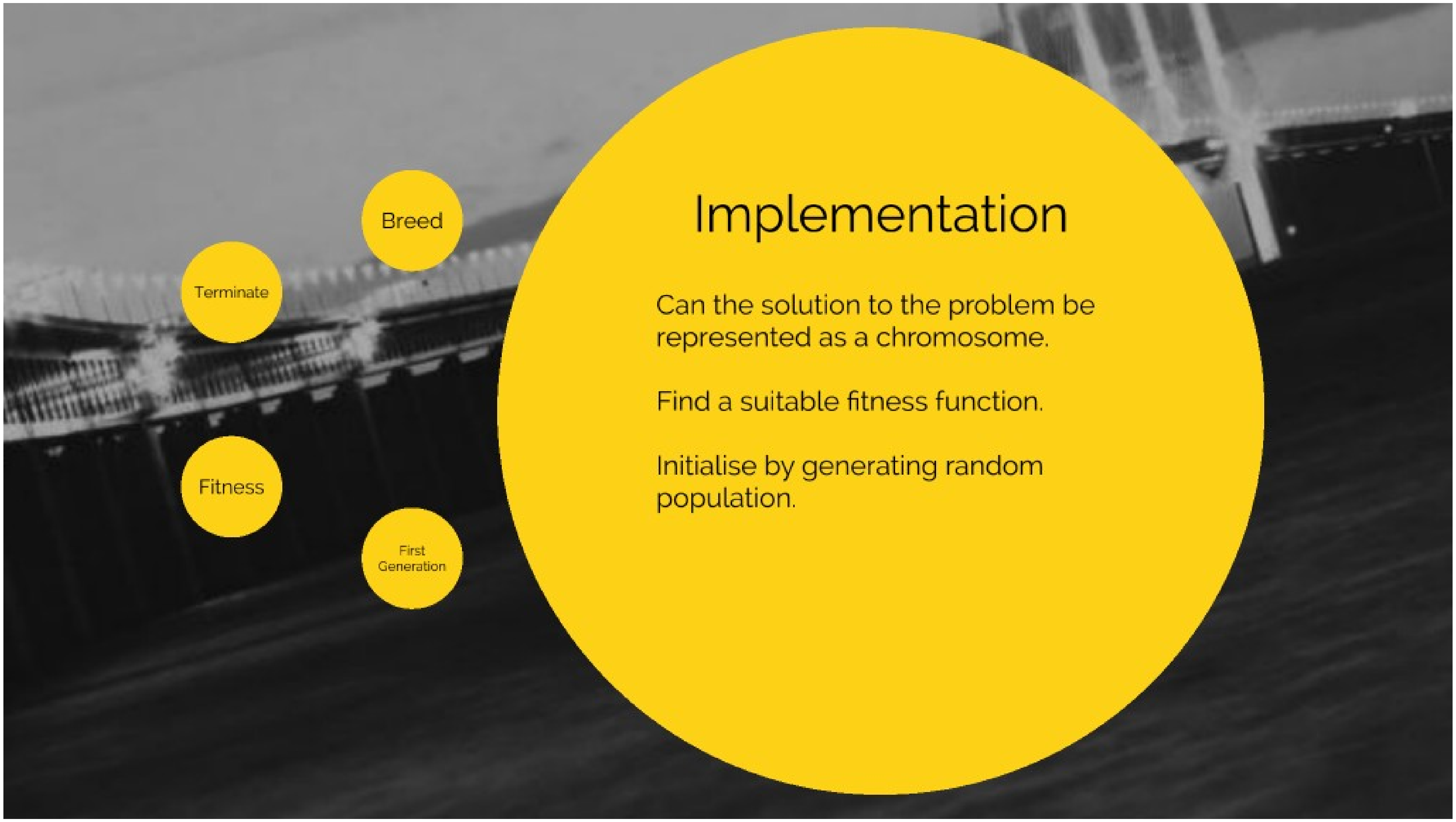


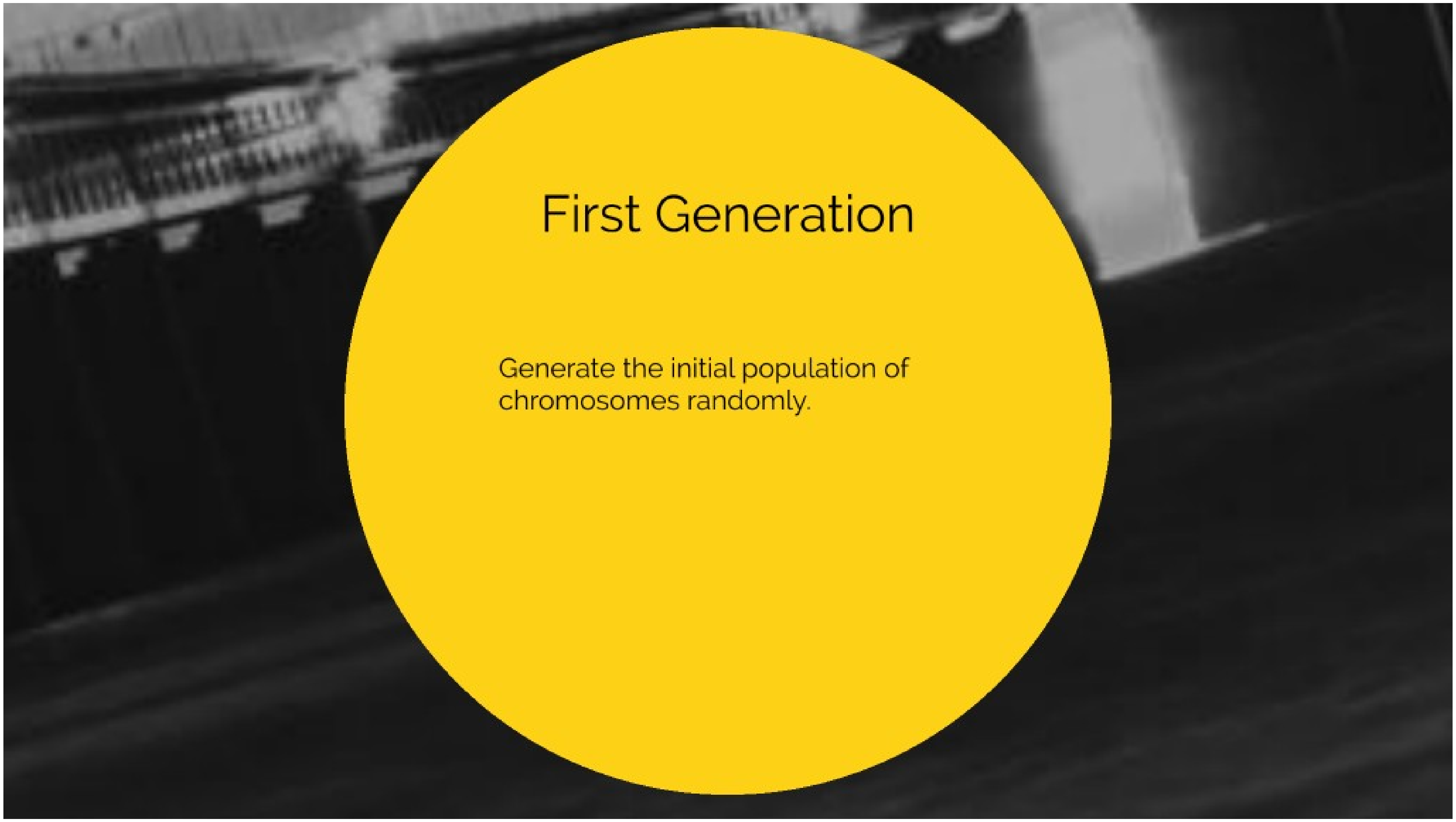
Implementation

Can the solution to the problem be represented as a chromosome.

Find a suitable fitness function.

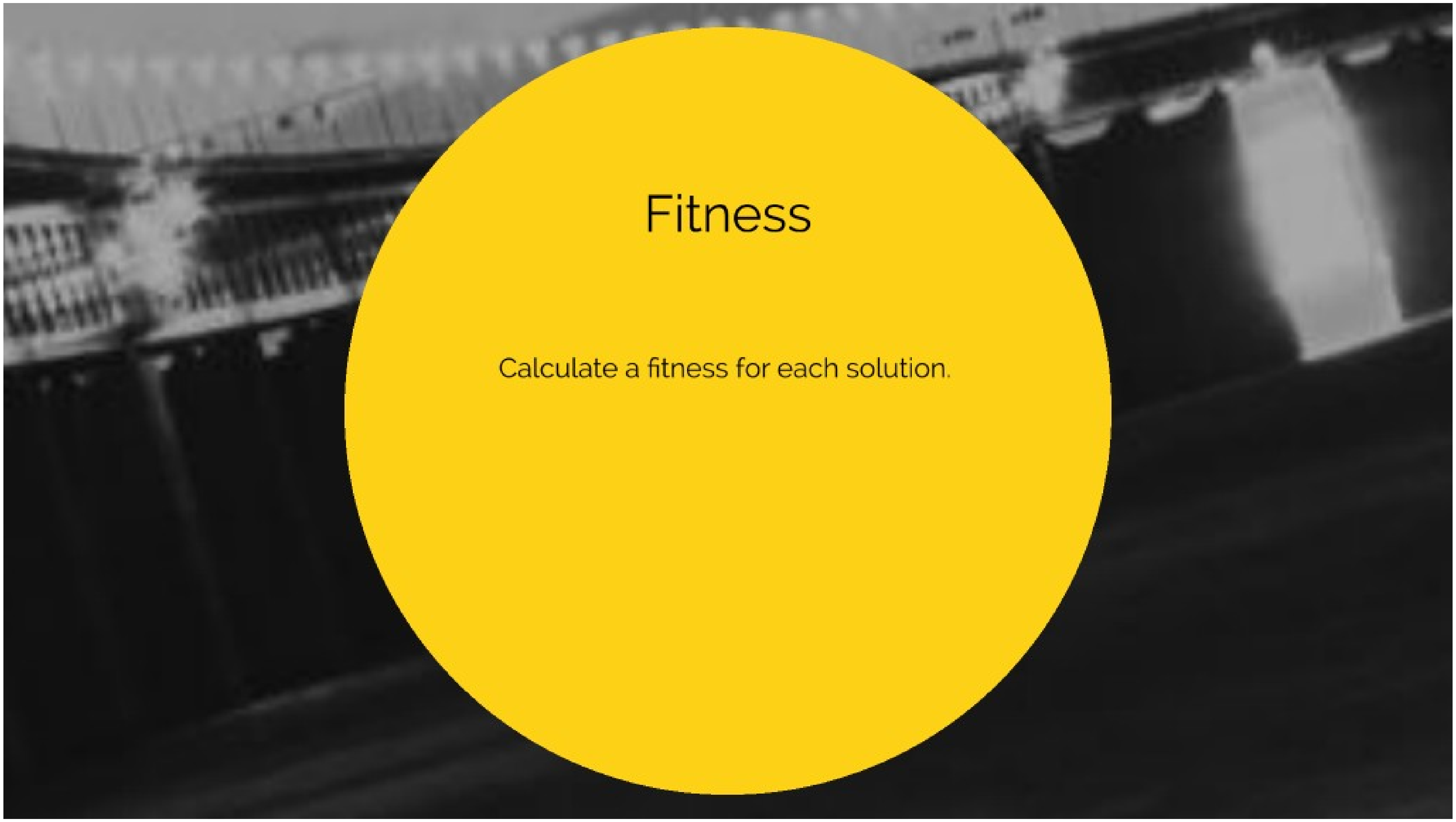
Initialise by generating random population.

Breed
Terminate
Fitness
First Generation



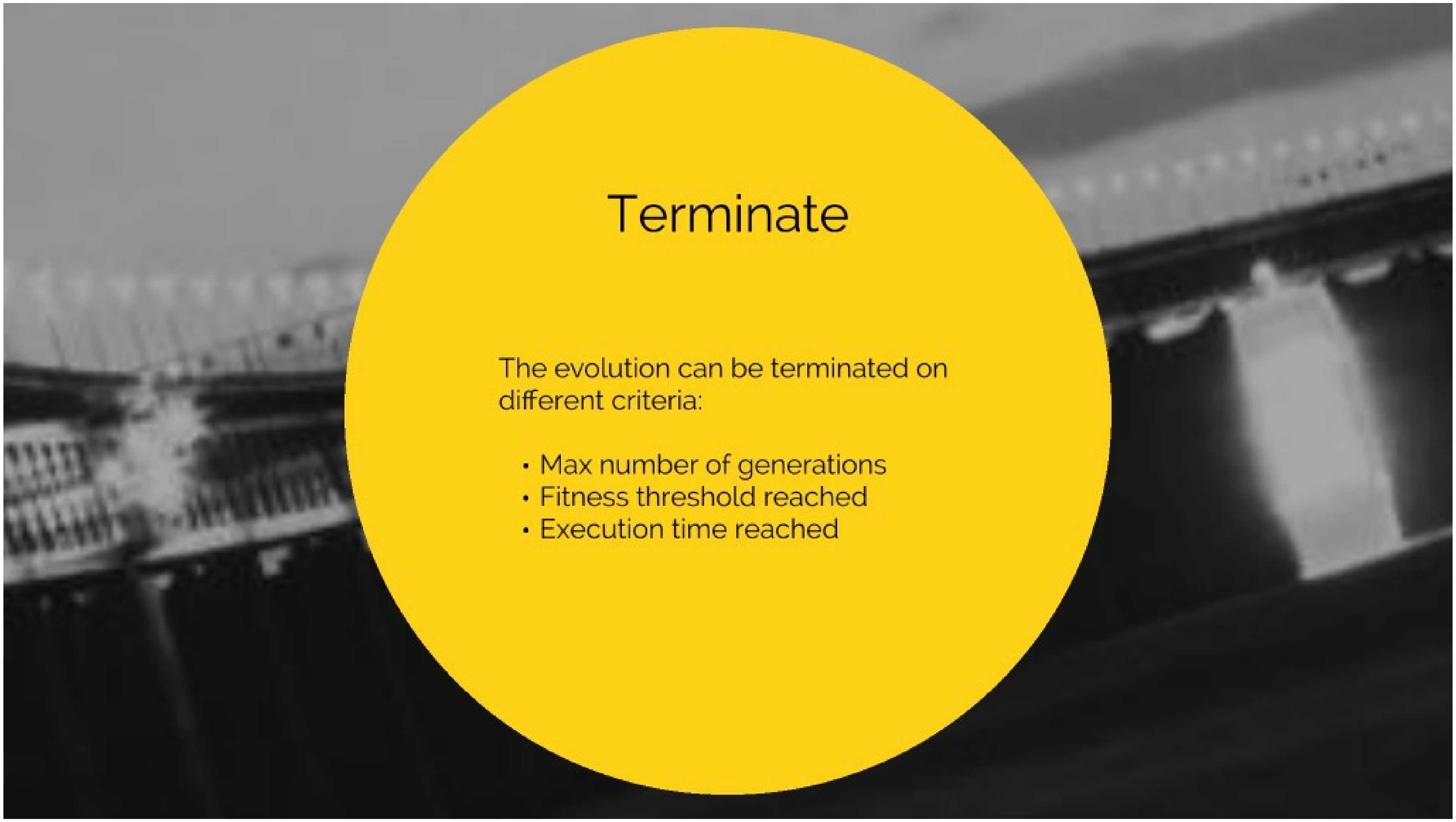
First Generation

Generate the initial population of chromosomes randomly.



Fitness

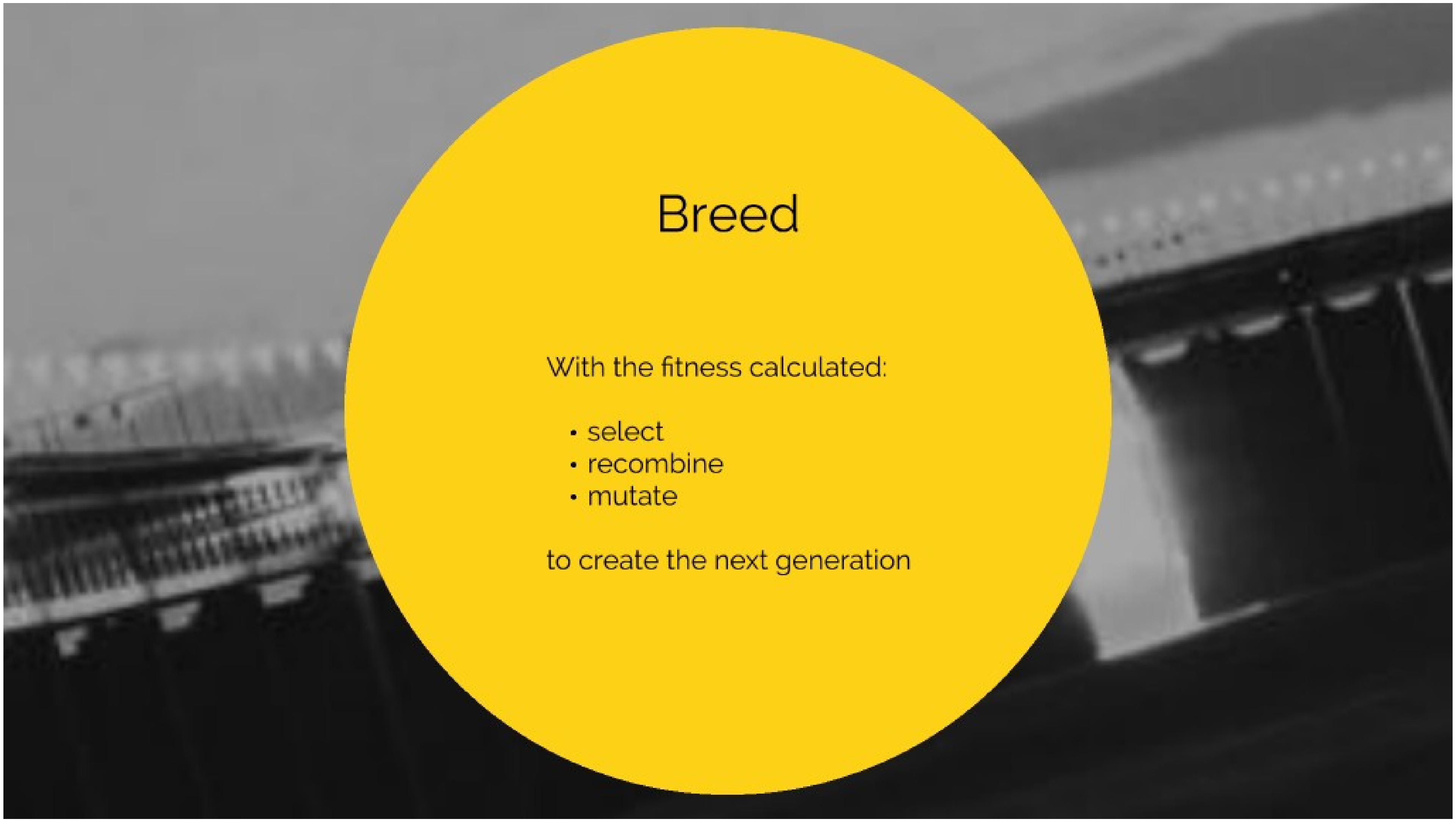
Calculate a fitness for each solution.



Terminate

The evolution can be terminated on different criteria:

- Max number of generations
- Fitness threshold reached
- Execution time reached

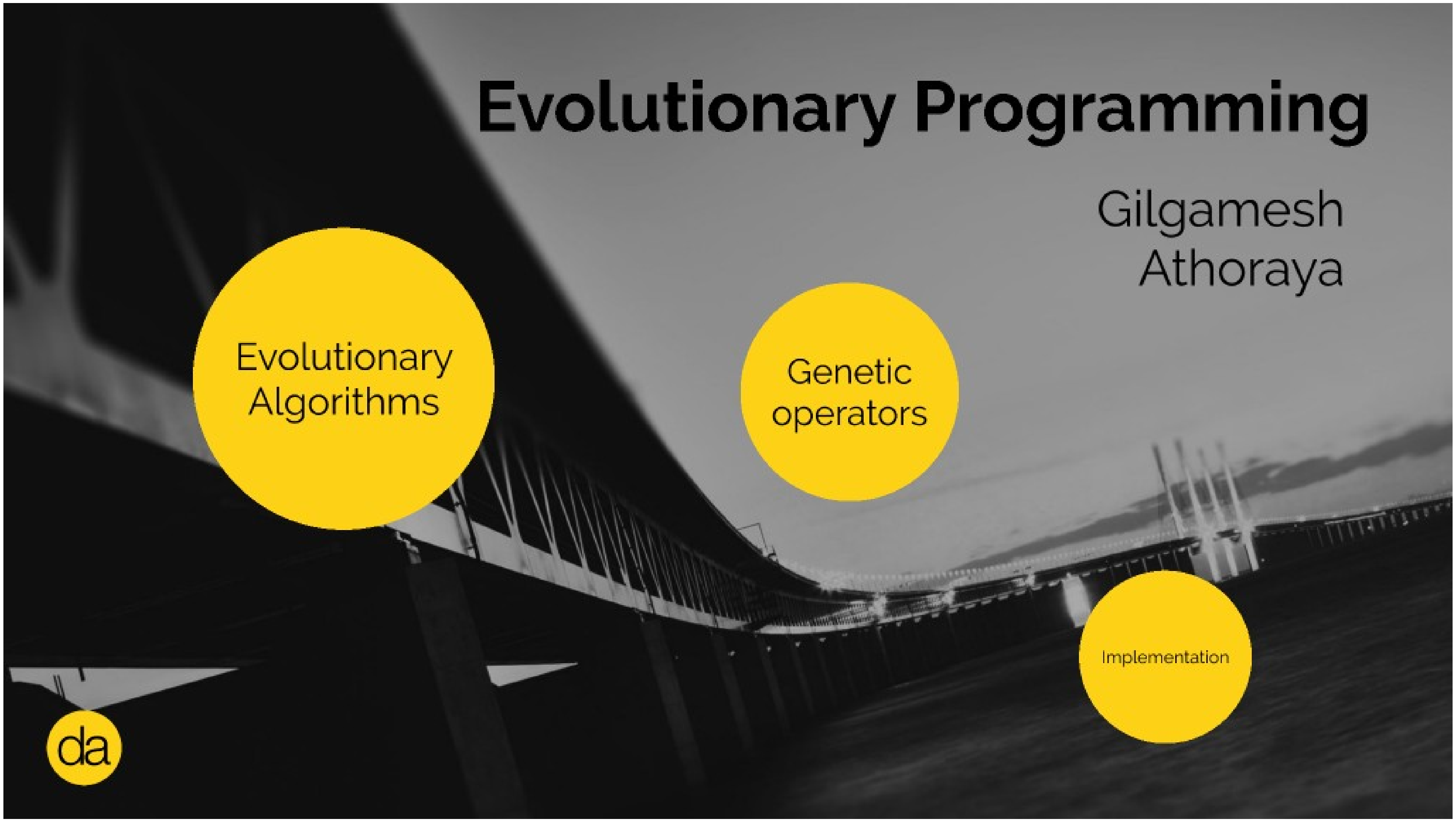


Breed

With the fitness calculated:

- select
- recombine
- mutate

to create the next generation



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