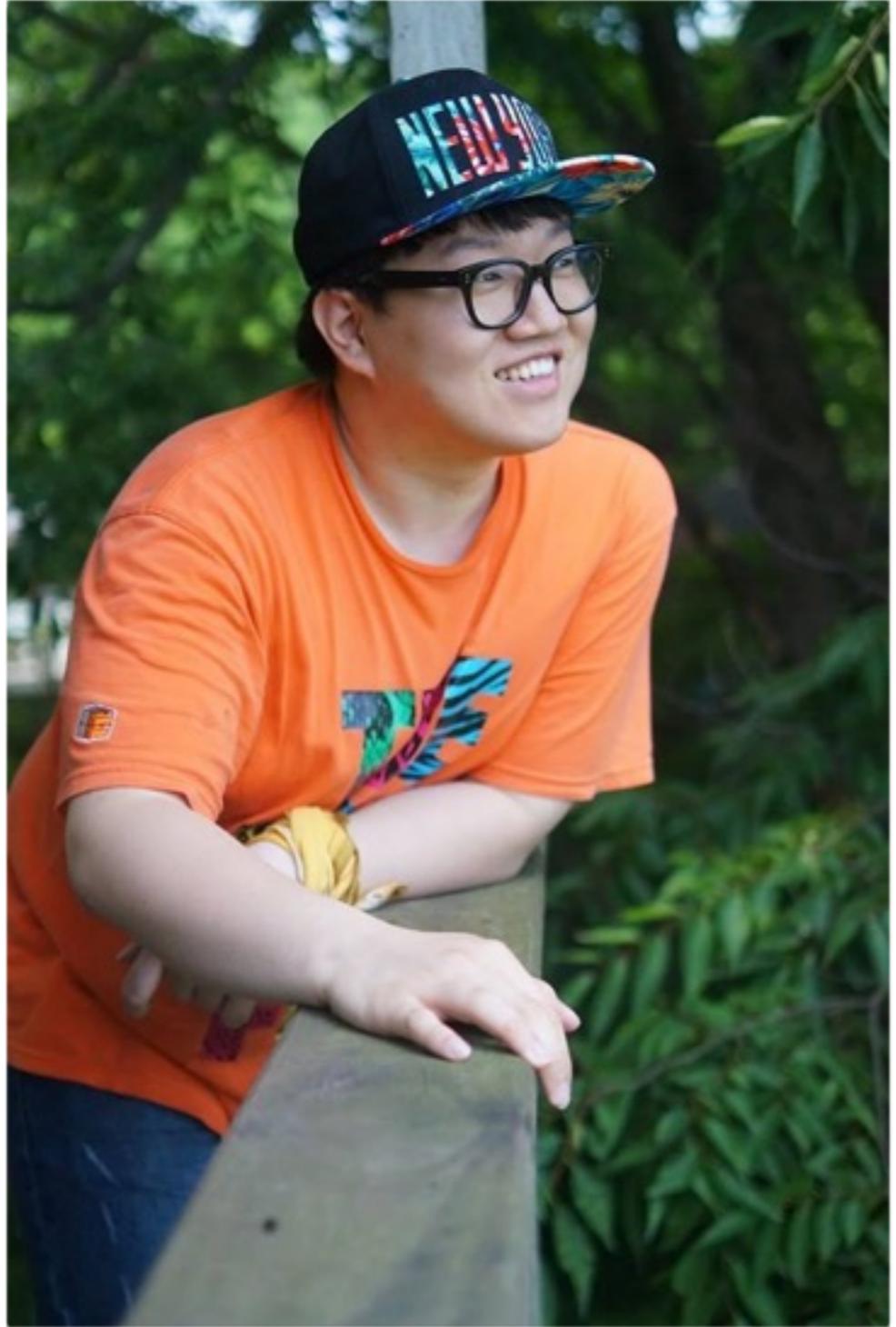


# Decision Making with Genetic Algorithms using DEAP

Chisung Song



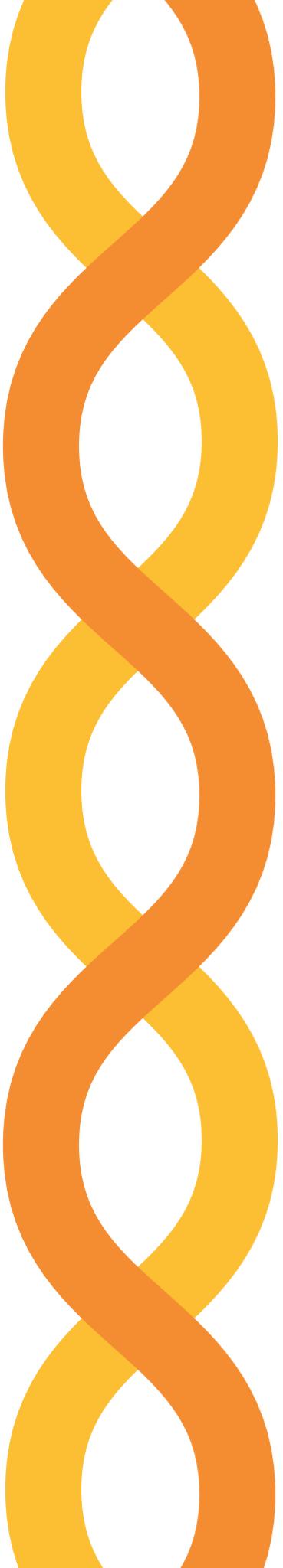
# Chisung Song



- ▶ working for Smartforecast.
- ▶ studying NLP in babelfish  
(<https://www.facebook.com/groups/babelPish/>)
- ▶ specially interested in  
HCI / NLP / Data visualization.
- ▶ Wanna be a GENERALIST.
- ▶ Contact:
  - [daydrilling@gmail.com](mailto:daydrilling@gmail.com)
  - [facebook.com/shuraba](https://facebook.com/shuraba)

# Contents

- 
- A large, stylized illustration of a giraffe's head and neck. The giraffe is yellow with orange spots. It has two small brown horns and a black eye. Its tongue is out and pink. The base of the giraffe is a light blue shape.
1. Decision Making
  2. Genetic Algorithms (GA)
  3. GA Practice 1
  4. Multi-Objective GA
  5. GA Practice 2
- 
- A smaller, stylized illustration of a giraffe's head and neck, positioned to the right of the first one. It has a similar yellow body with orange spots, two small brown horns, and a black eye. Its tongue is out and pink. The base of the giraffe is a light blue shape.



# Decision Making

# Need for Decision Making



# Need for Decision Making

## Factors to Consider buying Phones (Past)



- ▶ Call Connection
- ▶ Price

# Need for Decision Making

## Factors to Consider buying Phones (Now)

- ▶ Design
- ▶ New model
- ▶ Popular model
- ▶ Display
- ▶ battery
- ▶ Camera
- ▶ ...



# We Need Help!

⟨ Difficult & Easy Question ⟩

$$(13455 + 34346) * 3758 / \log(29847) = ?$$



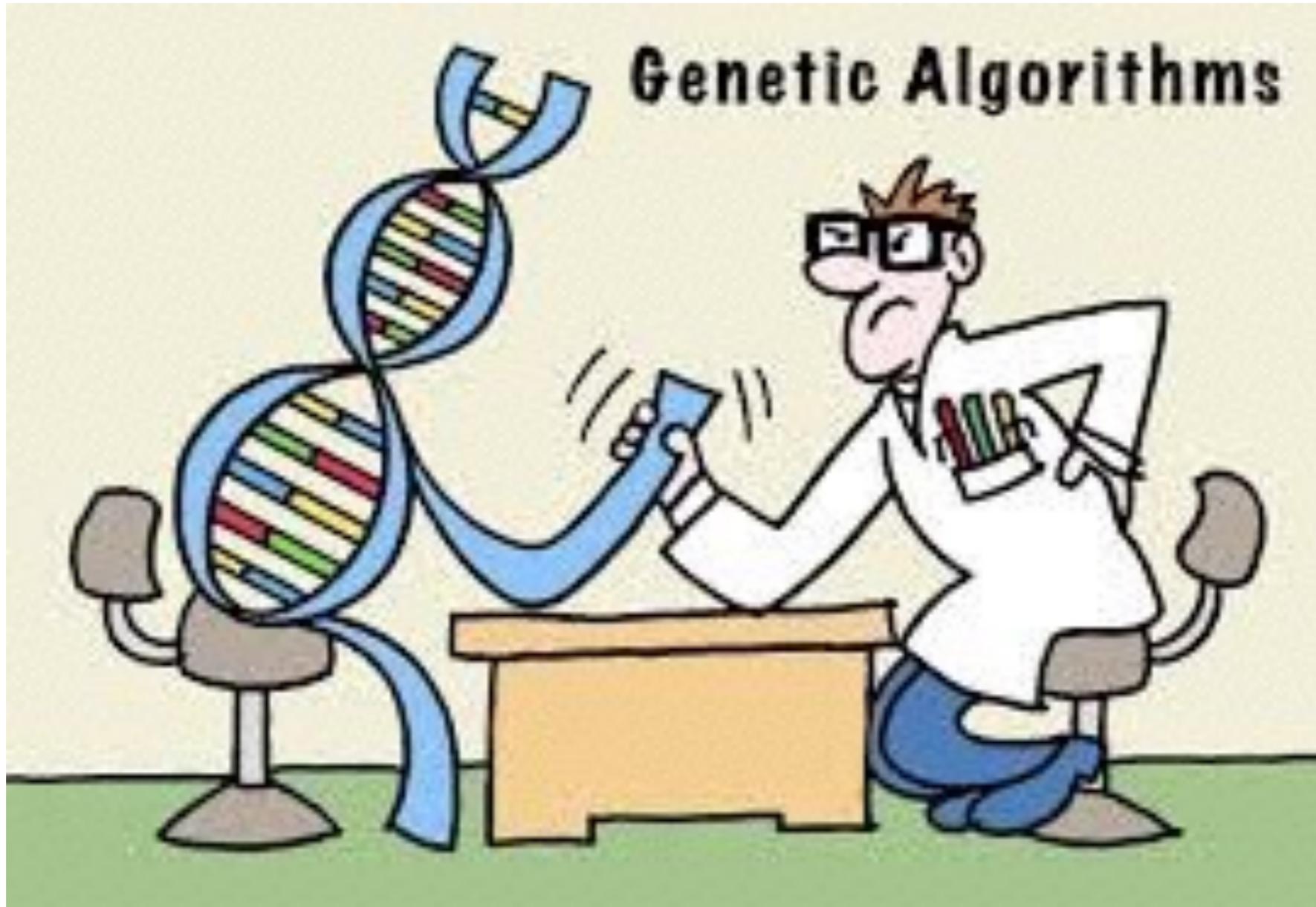
# We Need Help!

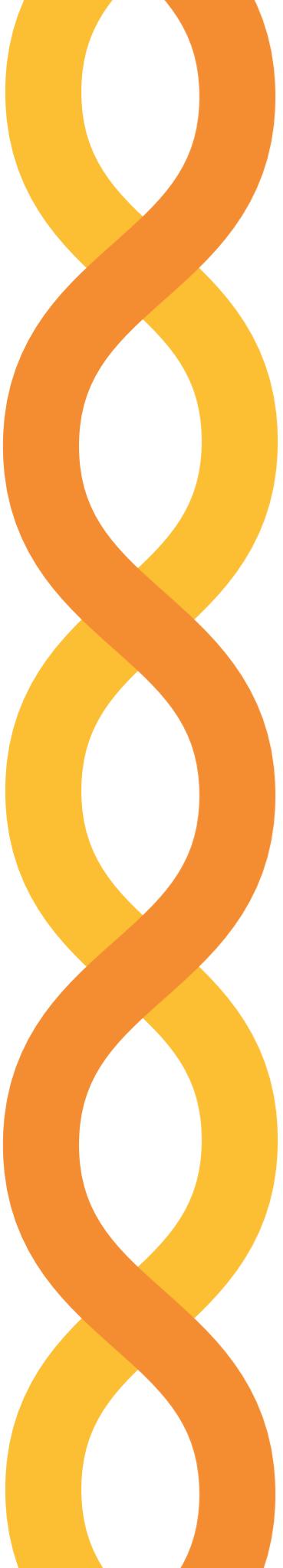
⟨ Difficult & Easy Question ⟩

$$(13455 + 34346) * 3758 / \log(29847) = ?$$

```
In [1]: from math import log  
       (13455 + 34346) * 3758 / log(29847)|  
  
Out[1]: 17433904.716814335
```

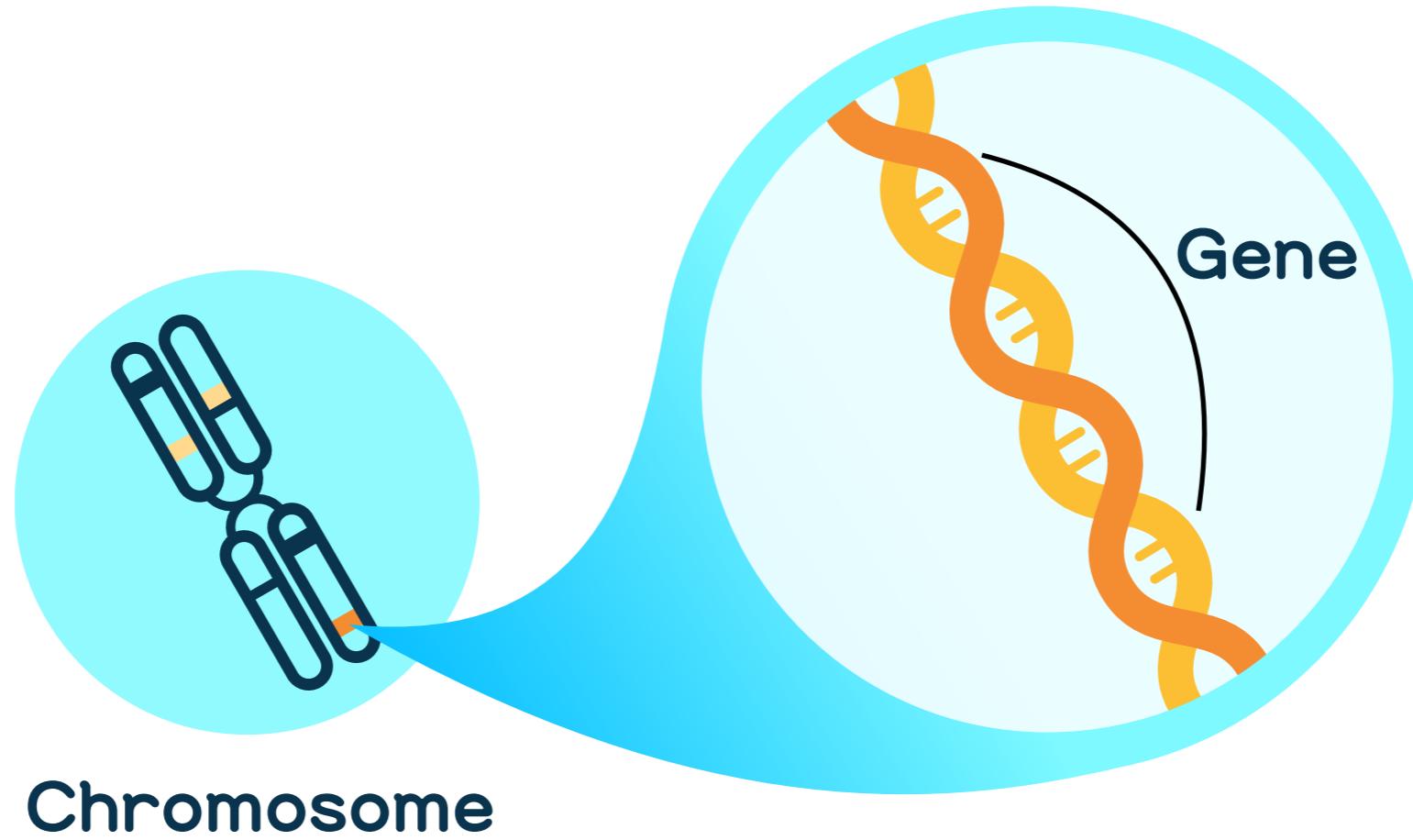
# Effective Tool for Decision Making





# Genetic Algorithms (GA)

# Genetics



- ▶ Genes are Basic instructions for building organism.
- ▶ Genes are located in chromosomes as sequential form.
- ▶ Each gene represents a specific trait of the organism.  
(eye color, blood type, ...)

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# Story about Evolution



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# Story about Evolution



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# Story about Evolution

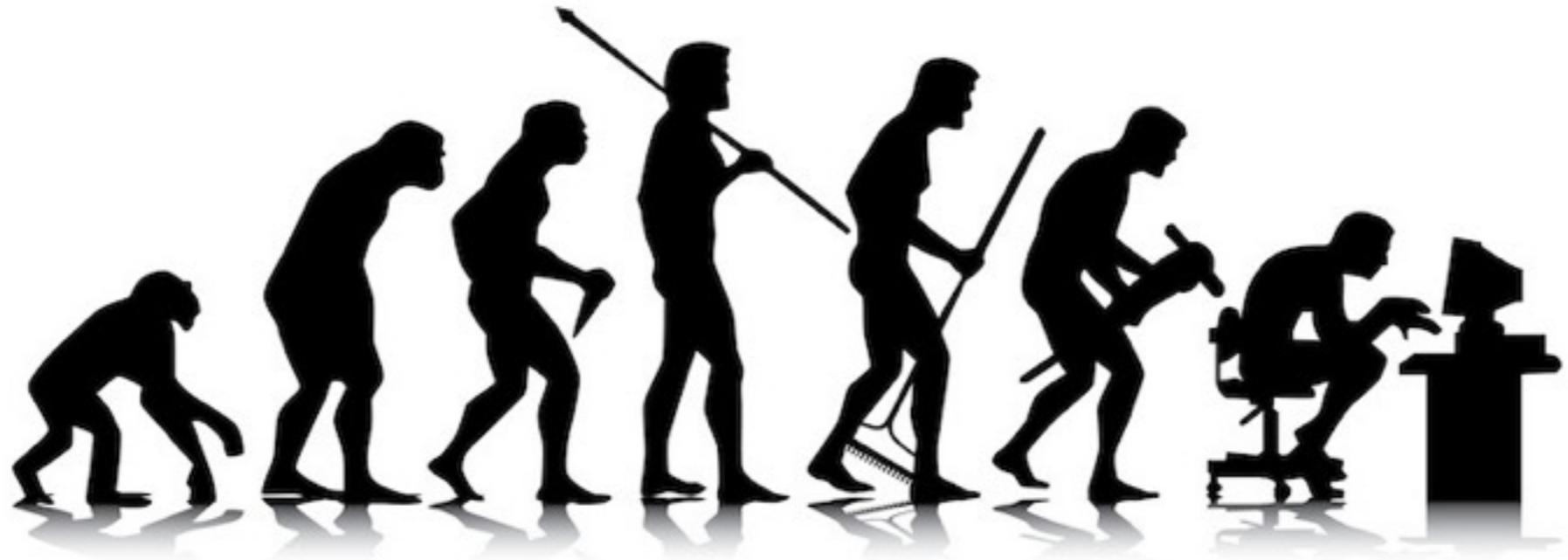


# Story about Evolution



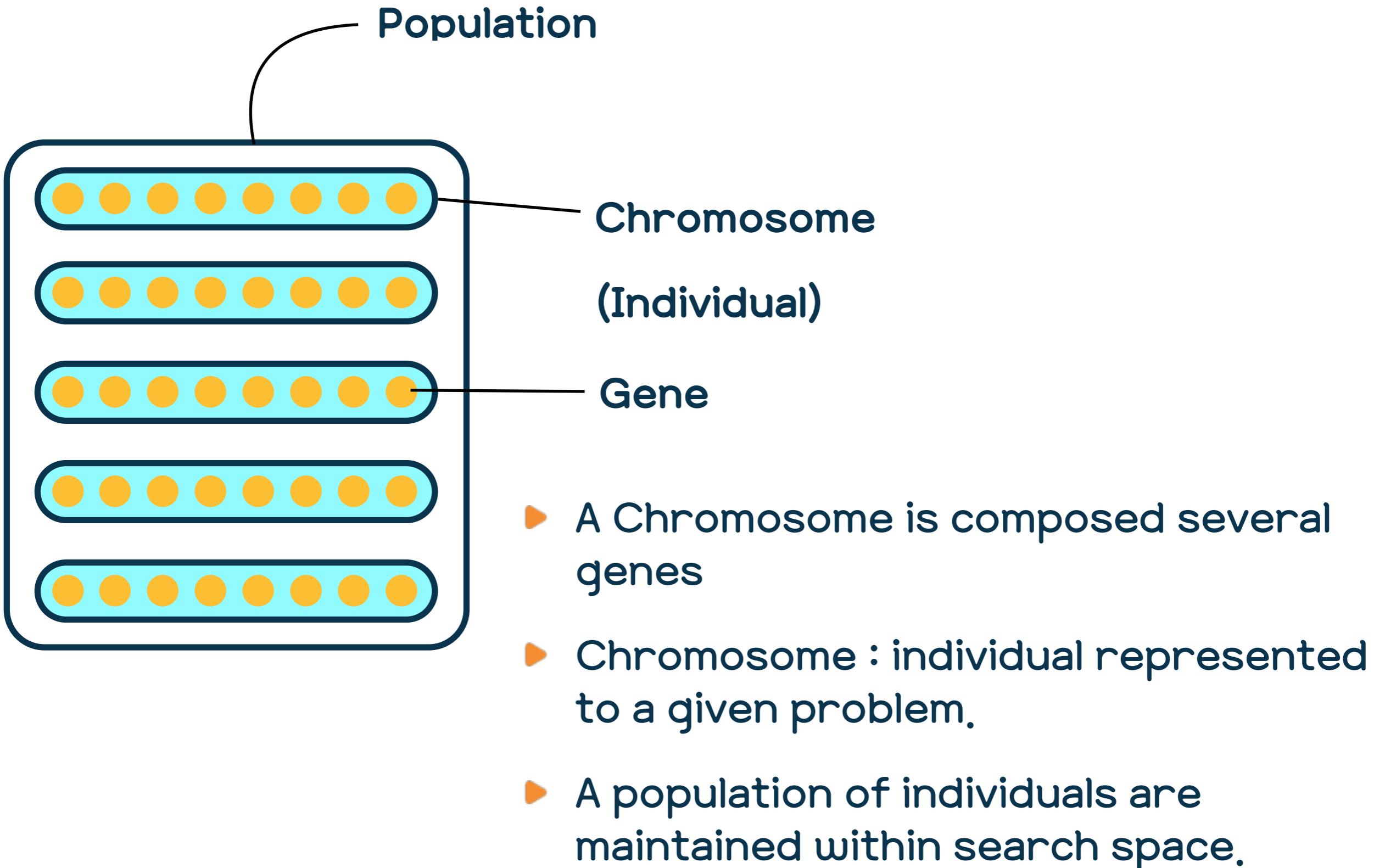
**Survival  
of the Fittest**

# Genetic Algorithms (GA)



- ▶ Machine learning which derives its behavior from a metaphor of the processes of evolution in nature.  
*(Natural selection and Genetic Inheritance by Darwin, 1859)*
- ▶ Originally developed by John Holland. (1975)
- ▶ Heuristic -> Generate useful solutions to optimization and search problems.

# Individuals & Populations



# Operators of GA

⟨ Basic Operators of GA ⟩

Selection

Crossover

Mutation

# Operators of GA

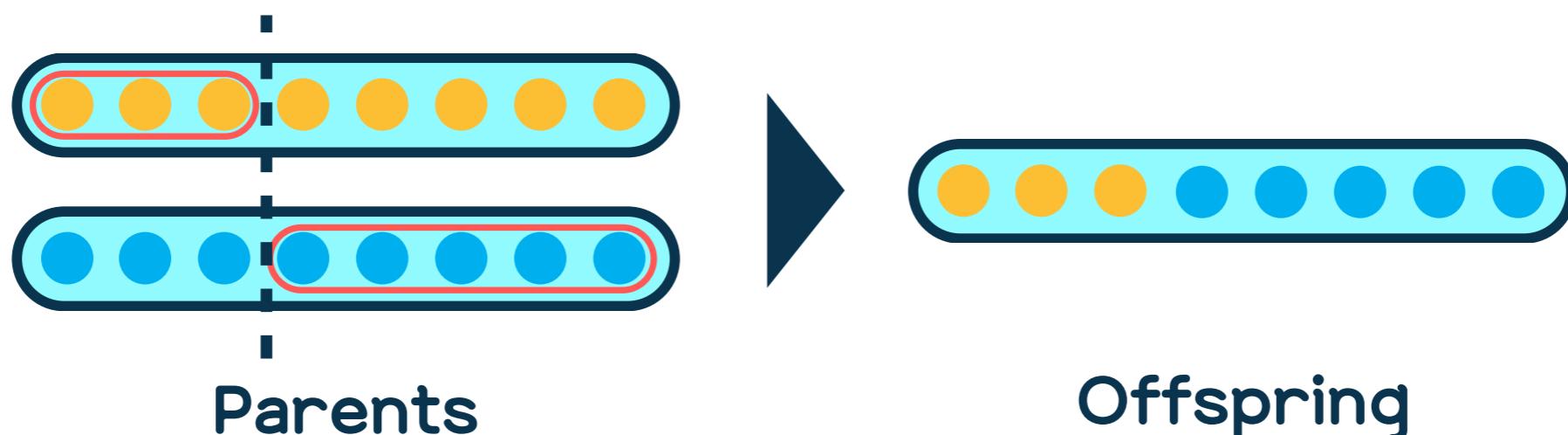
## Selection

- ▶ Give Preference to better individuals, allowing them to pass on their genes to the generation.
- ▶ The goodness of each individual depends on its fitness. (by evaluation)
- ▶ Fitness may be determined by an objective function or by subjective judgement.

# Operators of GA

## Crossover

- ▶ Process of taking more than one parents and producing a offspring from them.
- ▶ By recombining portions of good individuals, the GA is more likely to create a better individual.
- ▶ Various methods for combining the parents.  
(One-point Crossover, Edge Recombination...)



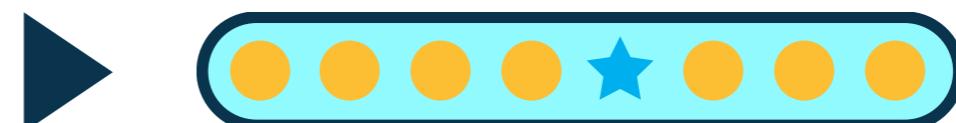
# Operators of GA

## Mutation

- ▶ With crossover, offsprings can get good traits of its parents, but they can't get traits that parents don't possess.
- ▶ Offspring can have traits which their parents don't have by mutation.
- ▶ Encourages genetic diversity among individuals and attempts to prevent local minimum.



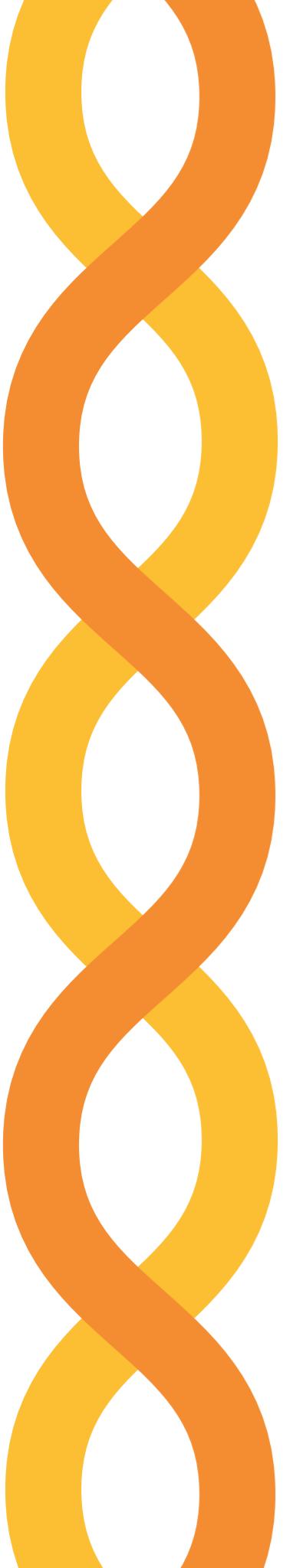
Before Mutation



After Mutation

# Outline of GA

1. Randomly initialize population( $t$ )
2. Evaluate fitness of population( $t$ )
3. Repeat
  1. Select parents from population( $t$ )
  2. Perform crossover on parents creating population( $t+1$ )
  3. Perform Mutation of population( $t+1$ )
  4. Evaluate fitness of population( $t+1$ )
4. Until best individual is good enough



# GA Practice 1

# DEAP



DISTRIBUTED  
EVOLUTIONARY  
ALGORITHMS IN  
PYTHON

- ▶ Distributed evolutionary Algorithms in Python.
- ▶ Novel framework for rapid prototyping and testing of ideas.
- ▶ Easy to customizing based on special purpose.

# Core Architecture of DEAP

## Creator

- ▶ Meta-factory allowing the run-time creation of classes via both inheritance and composition.
- ▶ Attributes, both data and functions, can be dynamically added to existing classes in order to create user-specific new types.
- ▶ By using this, the creation of individuals and populations from any data structure ( list, set, dictionary, tree, etc... )

# Core Architecture of DEAP

## Toolbox

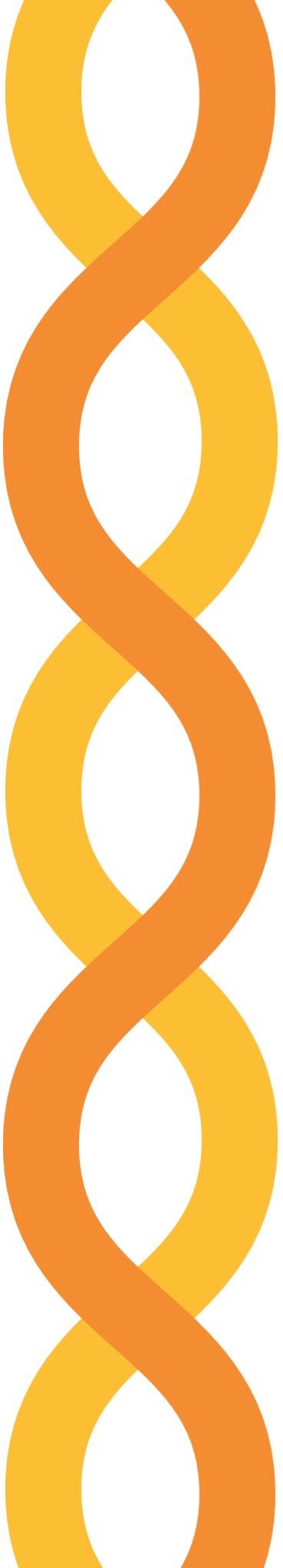
- ▶ Container for the tools (operators) that the user wants to use.
- ▶ Manually populated by the user with selected tools.

# GA Practice

## Basic Genetic Algorithm

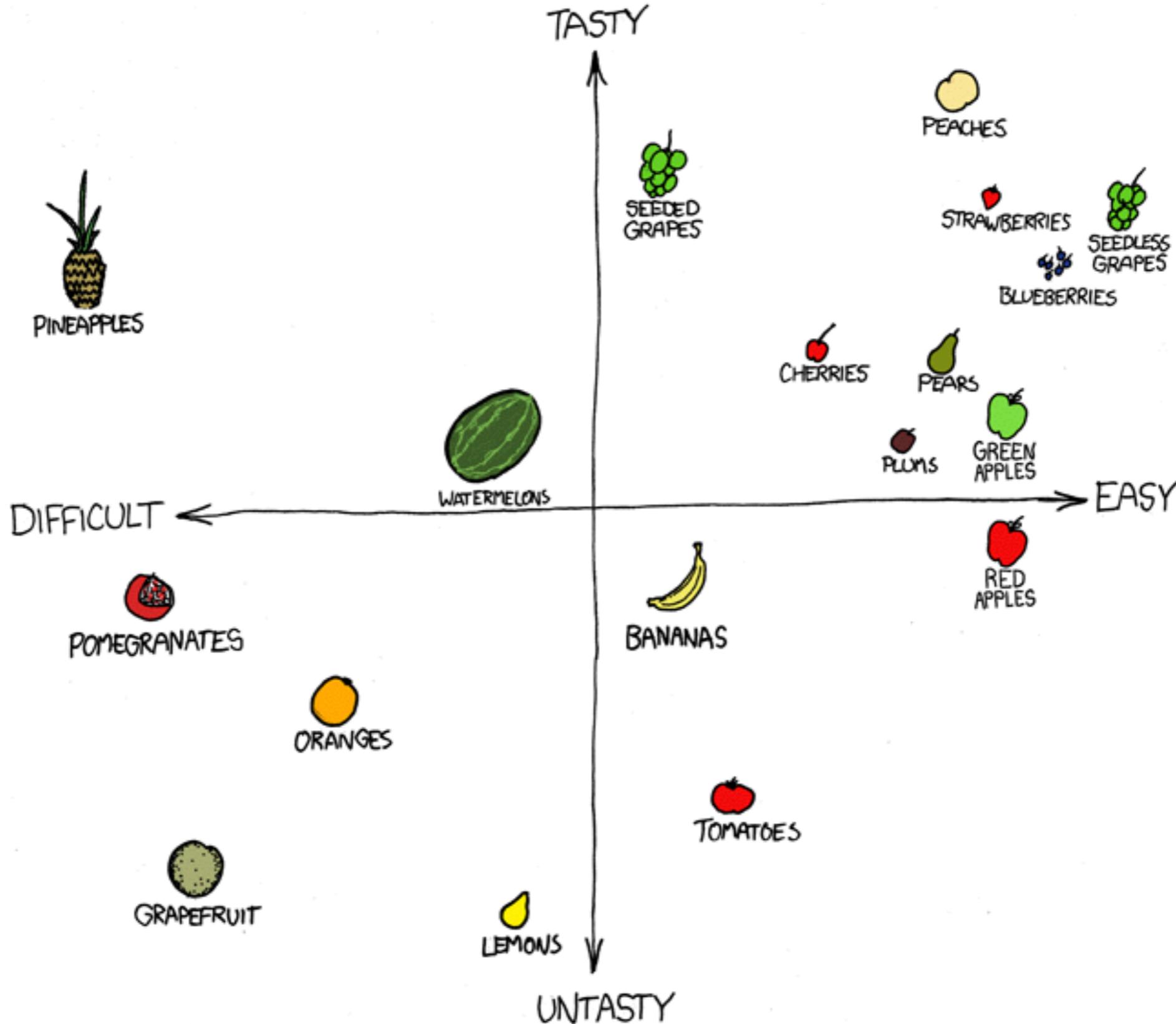


[https://github.com/daydrill/qa\\_pycon\\_2016\\_apac/blob/master/  
Decision\\_Making\\_with\\_GA\\_using\\_DEAP.ipynb](https://github.com/daydrill/qa_pycon_2016_apac/blob/master/Decision_Making_with_GA_using_DEAP.ipynb)



# Multi-Objective GA

# Multi-Objective Problem

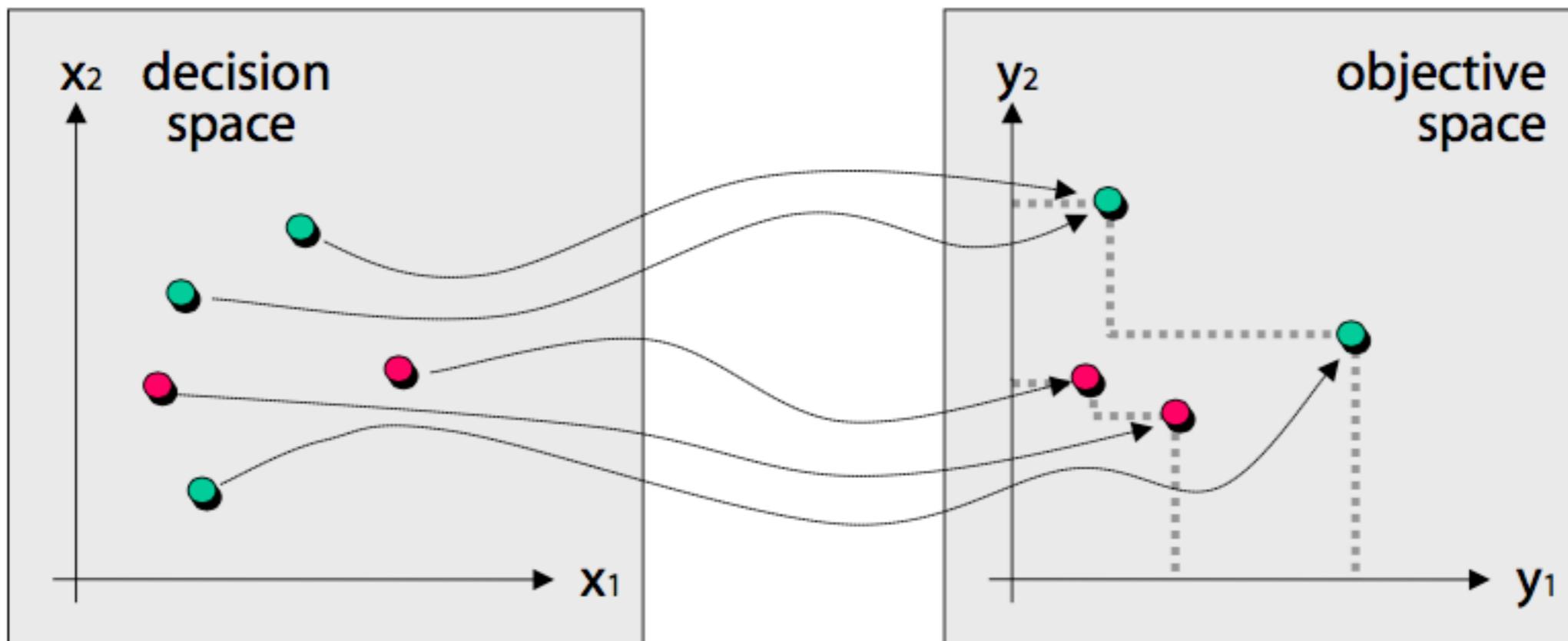


# NSGA-II

- Second version of Non-dominated Sorting Algorithm
- One of the most popular multi-objective optimization algorithms
- Special characteristics :
  - fast non-dominated sorting approach.
  - fast crowded distance estimation procedure.
  - Simple crowded comparison operator.

# NSGA-II

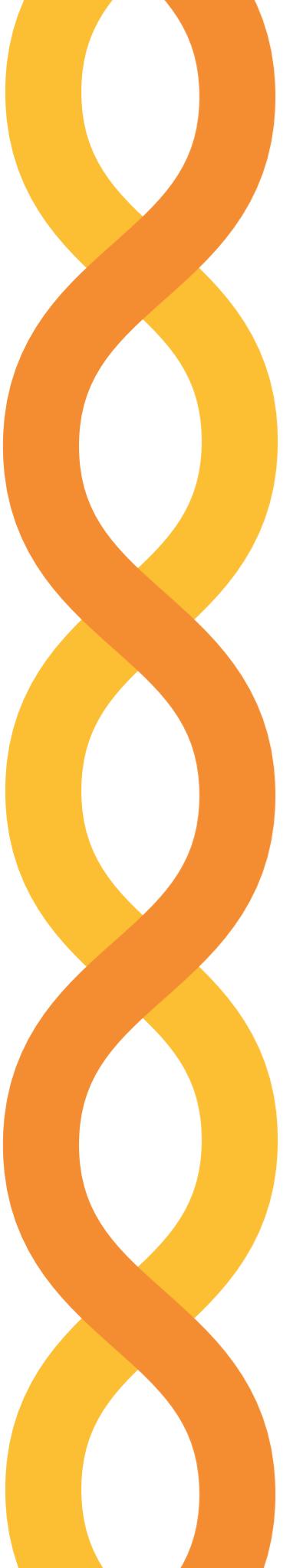
- Pareto set
- Pareto set approximation
- Pareto front
- Pareto front approximation



$$(x_1, x_2, \dots, x_n) \longrightarrow f \longrightarrow (y_1, y_2, \dots, y_k)$$

**search**

**evaluation**



# GA Practice 2

# Multi-Objective GA



Tomorrow, Simpson is going on a business trip to Korea.

It is his first time to visit Korea.

His Korean colleague recommended attractions.

Surprisingly, it was 75 spots with recommended scores!

But he is so busy and has only one day for free time.

He wants to go to only 5 spots based on

Short journey and high recommended scores.

How he can make an optimal decision?

# GA Practice 2

Find the Best Tour Route using NSGA-II



[https://github.com/daydrill/ga\\_pycon\\_2016\\_apac/blob/master/  
Decision\\_Making\\_with\\_GA\\_using\\_DEAP.ipynb](https://github.com/daydrill/ga_pycon_2016_apac/blob/master/Decision_Making_with_GA_using_DEAP.ipynb)

# References

- ▶ Deap Official docs:

<http://deap.readthedocs.io/en/master/>

- ▶ Luis Martí's evolutionary computation course :

<http://lmarti.github.io/evolutionary-computation-course/>

# Thank You -!



**PYCON**  
APAC 2016