

## Checkpoint 1 -- Framework

## What you will be doing

- Code up an evolutionary algorithm for solving a simple problem.
- Goals:
  - Learn the ins and out of coding an EA
  - Formulate a (conceptual and technical) framework for EAs
  - Create a code base for your quarter long problem.

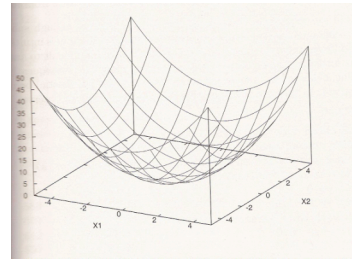
## The problem:

- Find  $x_1$  and  $x_2$  that maximize the 2 dimensional function:

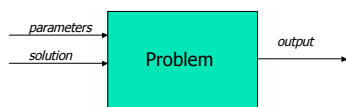
$$f(x_1, x_2) = x_1^2 + x_2^2$$

- $x_1$  and  $x_2$  in the range  $[-5, 5]$
- Example in chapter 1 of the text.

## The problem

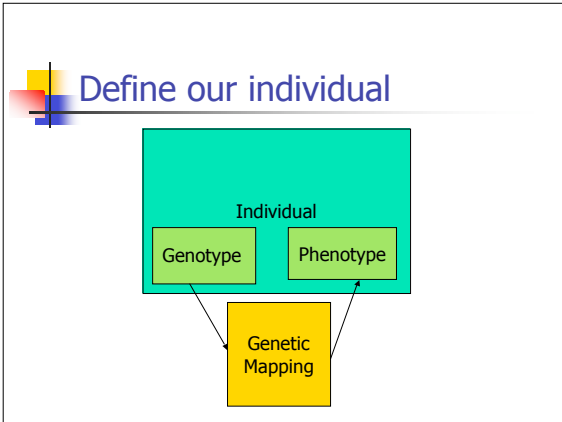


## Formally define the problem



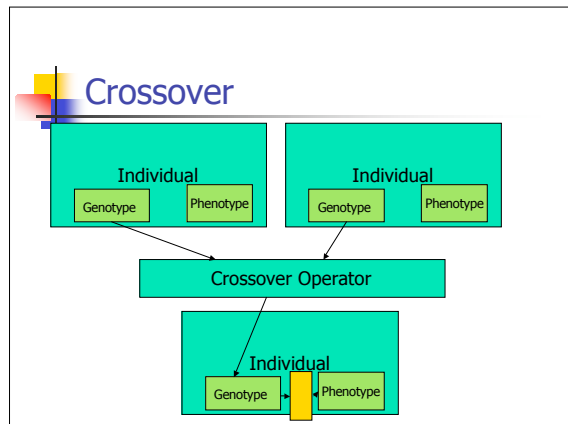
## Formally define the problem

- Parameters
  - None
- Solution:
  - Real valued feature vector:  $\langle x_1, x_2 \rangle$  in the range  $[-5, 5]$
- Output:
$$f(x_1, x_2) = x_1^2 + x_2^2$$

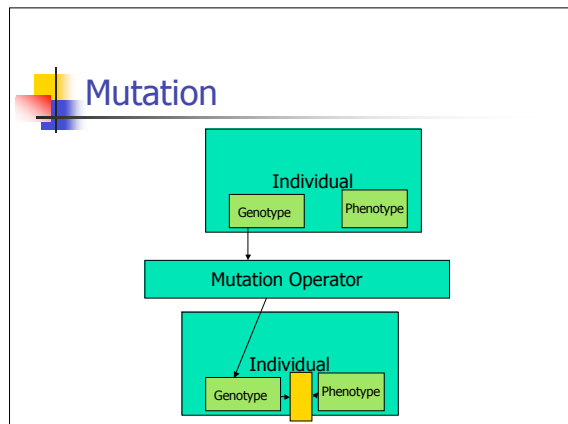


- ### Define our individual
- Phenotype
    - Real valued feature vector:  $\langle x_1, x_2 \rangle$  in the range  $[-5, 5]$
  - Genotype
    - 2 element real array, X
  - Genetic mapping
    - $x_1 = X[0]$
    - $x_2 = X[1]$
  - Best to give each individual a unique id.

- ### Fitness
- Since we want to maximize the function, the higher the value of the function, the higher the fitness.
  - Fitness =  $f(x_1, x_2)$



- ### Crossover
- Define crossover operation as:
    - For parents with genotype X and Y
    - Child will have genotype Z where
      - $Z[0] = X[0]$
      - $Z[1] = Y[1]$



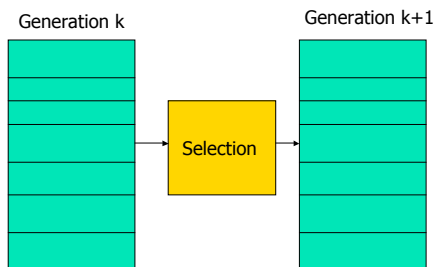
## Mutation

- Define mutation operator:
  - For a single genotype  $X$
  - Randomly choose either  $X[0]$ ,  $X[1]$ , or both
  - Add a random value to chosen "gene" between  $[-1$  and  $1]$ .
  - Clamp at  $-5$  and  $5$ .

## Generation 0

- Must randomly initialize 0th generation with random individuals.
  - Random genotypes:
    - For each individual, set  $X[0]$  and  $X[1]$  to some random value between  $-5$  and  $5$ .

## Talkin' bout my generation



## Selection mechanism

- Population size will be constant at 10.
- Create 10 new individuals by performing the following 5 times
  - Randomly choose 2 parents and create 1 offspring
  - Randomly choose 1 individual for mutation and create mutation.
- Out of the 10 original individuals and 10 new individuals, the 10 with the best fitness move to next generation.

## When to stop

- Run for 10 generations.
- At each generation, output the following:
  - The generation #
  - The min and max fitness
  - For each individual:
    - The ID
    - The feature vector
    - The fitness.

## Questions?



## Ground rules

- Free to use whatever language you please
- Can write from scratch or use a GA toolkit.
- To be done in your teams.
  
- Electronic submission via mycourses.



## Submission

- Single zip or tar file.
- Include:
  - Code
  - README
    - Team members
    - Platform
    - Toolkit (if any)
    - Language
    - Essentially how I can build and run the app.



## Submission

- Due Friday, December 22nd.
  
- Any trouble, see me sooner rather than later.