# Multi-objective optimisation

Purpose: Find solution which optimises several objectives. Find compromise of multiple conflicting objectives such as find low risk and high profit for stocks.

MOO problems has a number of objective functions to be minimised/maximised

Objective space: Possible solutions of the different objectives/features

Non dominating front is the curve that connects non-dominating solutions

**Pareto-optimal set:** Non-dominated set of the entire feasible decision space.

Goals for MOO

* Find a set of solutions as close as possible to the pareto-optimal front
* Find a set of solutions as diverse as possible – specific to MMO

## Methods

### Weighted sum method

**Advantages**

* Simples way to solve MOO
* Intuitive and easy to use
* Guarantees finding solutions from the entire Pareto-optimal set for convex objective spaces

**Disadvantages**

* Hard to init weight vector
* Approach cannot find some Pareto-optimal solutions for a non-convex objective space

### Epsilon-constraint method

Keep one of the objectives and restrict the rest of the objectives

Keep f2 as an objective and take f1 as a constraint f1(x) < ε1. Constraint divides the original feasible objective space into two parts: f1 <= ε1 and f1 > ε1

**Advantages**

* Efficient for problems with convex or non-convex objective spaces

**Disadvantages**

* Solution depends on the chosen ε
* ε must be chosen so that it lies within the minimum or maximum values of an objective function

### Evolutionary Multi-Objective Optimisation (EMO)

### Vector Evaluated GA – VEGA

Chart, box and whisker chart

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**Advantage**

* Simple approach with minimum changes to a GA

**Disadvantage**

* Solutions are not evaluated for other (M - 1) objective functions
* Prefers solutions close to the optimum of an individual objective function

### Diversity preservation

Used for problems that require finding a number of local optimum solutions in addition to the global optimum solutions.

*Crowding:* offspring replace a solution similar to itself

*Sharing function:* Degrade the fitness of similar solutions instead of replacing*.* If in same group, they are all degraded proportionally such that other groups are more likely to be picked for crossover.

### Elitism

Elite-preservation favours the elites of a population by carrying them over to thee next population. F.ex. picking some top-scoring parents from previous generation.

### Elitist Non-Dominated Sorting GA (NSGA-II)

Uses elite-preservation strat and diversity preserving.

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