then sequentially added to the first species with which $\delta < \delta_t$, if there are no compatible species, a new species is created.

$$\delta = \frac{C_1 E}{N} + \frac{C_2 D}{N} + C_3 \bar{w} \tag{1}$$

The number of offspring allocated to a species is based on the shared fitness of the species with respect to the entire population. Equation 2 describes the adjusted fitness, the sum of which is fitness for a species. This restricts one species from dominating the entire population. Within a sub-population, elitist selection is then performed before repopulating the species.

$$f_i' = \frac{f_i}{\sum_{j=1}^{n} sh(\delta(i,j))} \tag{2}$$

$$sh(\delta(i,j)) \begin{cases} 1, & \text{if } \delta(i,j) < \delta_t \\ 0, & \text{else} \end{cases} \tag{3}$$

2.3 Multi-Objective Selection

In multi-objective optimisation rather than maximising the solution according to a single criterion, there are a set of criterion $f = \{f_i\}_{i=1}^{N}$, with respect to which the solution must be optimised. Often there is not a single solution which maximises all objective functions f_i, this particularly true is cases where the f contains functions which are in conflict rather than complimentary. In this scenario, there are often a range of Pareto optimal solutions with different characteristics.[2]

Give an accessible example

2.3.1 Pareto Efficiency

efficient or optimal?

A system is said to be Pareto efficient when no improvement can be made to any of the criterion f_i without causing a deterioration in at least one other criterion. This leads to a collection of solutions across the objective function space which are Pareto optimal, these are known as a Pareto set or Pareto front and are said to be non-dominated. Figure 4 shows an example of a Pareto front in two dimensional space. A solution is non-dominated when there is no solution which is better by one criterion and at least equal in all others. More formally this is given by equation 4 for a two dimensional problem. These non-dominated solutions collectively form the Pareto set for a collection of solutions.

$$(f_1(x) \geq f_1(\{x\}_{i=1}^{N}) \land f_2(x) > f_2(\{x\}_{i=1}^{N})) \lor (f_1(x) > f_1(\{x\}_{i=1}^{N}) \land f_2(x) \geq f_2(\{x\}_{i=1}^{N})) \tag{4}$$

re-format

↳ Talk us through this eqn