

Flowchart of NSGAII





NSGAII — Elitism

 Elitism: Keep the best Parent Child individuals from the parent and child population





NSGAII — Elitism





NSGAII — Crowding Distance

Crowding distance

- c=a+b
- Ends have infinite crowding distance



SPEA2



- SPEA2: Improving the Strength Pareto Evolutionary Algorithm
- Compared to SPEA:
 - Fitness assignment scheme is used, which takes for each individual into account how many individuals it dominates and it is dominated by.
 - Fitness is NOT based on objective function values
 - Objective function values determine dominance relation
 - A nearest neighbour density estimation technique is incorporated which allows a more precise guidance of the search process.
 - A new archive truncation method guarantees the preservation of boundary solutions.

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Flowchart of SPEA2





Fitness Assignment

- Each individual both dominating and dominated solutions are taken into account
- Fitness F(i) = Raw fitness R(i) +Density D(i)
 - Nondominated: F(i) <1; dominated: F(i) >=1
- Raw fitness R(i)
 - Strength value S(*i*), representing the number of solutions (in both Population and Archive) *i* dominates: $S(i) = |j|j \in (Pop + Arch) \land i \succ j|$
 - Raw fitness R(i): is determined by the strengths of its dominators in both archive and population:

$$R(i) = \sum_{j \in (Pop + Arch), j \succ i} S(j)$$

- Density D(i):
 - Additional density information is incorporated to discriminate between individuals having identical raw fitness values.
 - k-th nearest neighbour method: the inverse of the distance σ_{ik} (in objective space) to the k-th nearest neighbour (in both archive and population) as the density estimate: $D(i) = \frac{1}{k - \sqrt{|Pop| + |Arch|}}$

$$D(\mathbf{i}) = \frac{1}{\sigma_{\mathbf{i}}^{k} + 2} \qquad \qquad k = \sqrt{|Pop| + |Arch|}$$

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Archive Truncation

- if |Archive|<S, add dominated ones based on the fitness values
- if |Archive|>S, delete crowded ones based on density measure



Figure 2: Illustration of the archive truncation method used in SPEA2. On the right, a nondominated set is shown. On the left, it is depicted which solutions are removed in which order by the truncate operator (assuming that $\overline{N} = 5$). Bing.Xue@ecs.vuw.ac.nz ECRG VUW