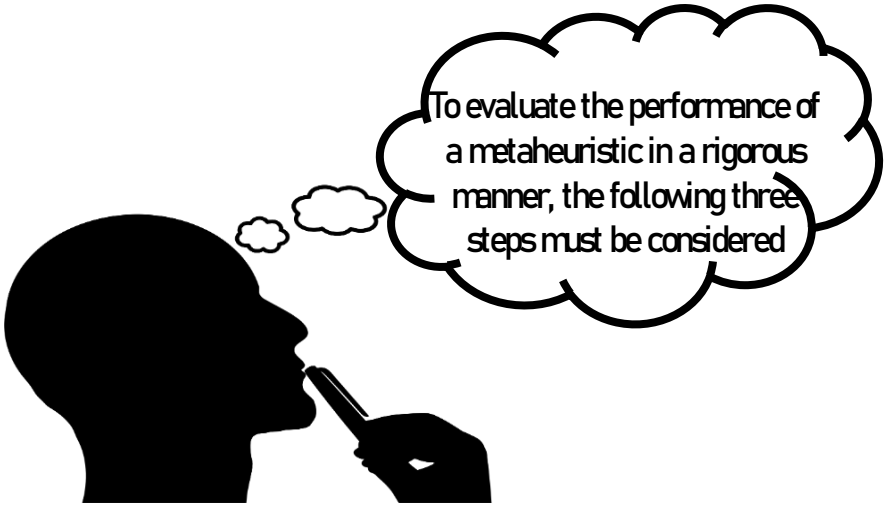
Performance analysis of metaheuristics

Performance analysis of metaheuristics is a necessary task to perform and must be done on a fair basis.



Experimental design: the goals of the experiments, the selected instances, and factors have to be defined.

Measurement: the measures to compute are selected. After executing the different experiments, statistical analysis is applied to the obtained results. The performance analysis must be done with state-of-the-art optimization algorithms dedicated to the problem.

Reporting: Finally, the results are presented in a comprehensive way, and an analysis is carried out following the defined goals.

For more details, please refer to chapter one, Talbi, E.-G. Metaheuristics: from design to implementation, 2009

Statistical Analysis

To conduct a reliable statistical analysis for the obtained results, all proposed algorithms are executed 31 times on each of the tested instances

Statistical significance: It is a widely-used concept in statistical hypothesis testing. It indicates the probability that the difference or observed relationship between a variation and a control **isn't due to chance**.

Different statistical tests may be carried out to analyze and compare the metaheuristics.The statistical tests are performed **to estimate the confidence of the results to be scientifically valid.**

Before choosing the statistical test, the following steps should be adopted:

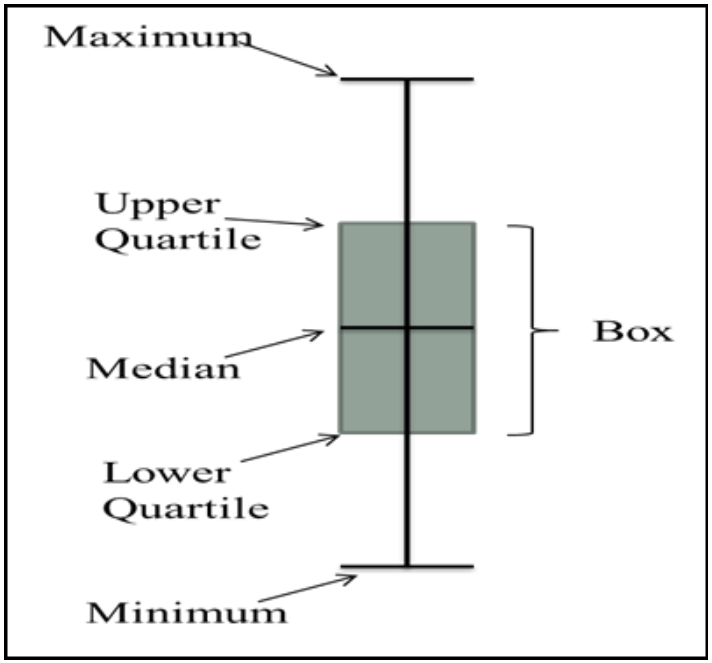
1. Conduct a **Normality Test** on your data to show the data distribution (normally distributed or not).
2. **If Normality distributed** then **the parametric tests** are used.
   Otherwise, (not normally distributed) the non-parametric tests are used.
3. Under the parametric tests, the most widely used tests are: **the paired t-test (2 groups)** and **ANOVA (*n* groups), where n>2.**
4. Under the non-parametric tests, the most widely used tests are: **the Wilcoxon test (2 groups)** and **Friedman (*n* groups) where *n*>2.**

Box-whisker Plot

In general, it is not sufficient to present the large amount of data results using tables. Some visualization tools to analyze the data are welcome to complement the numerical results. The box-whisker plot offers a good overview of solution's distribution, as it gives five summary statistics:

1. **Median**: the middle value of the list when it arranged in ascending order based on their values.
2. **Lower Quartile:** the median of the lower part of the data.
3. **Upper Quartile:** the median of the upper part of the data.
4. **Minimum value:** the smallest value of the list.
5. **Maximum value:** the largest value of the list.

- A box represents the middle 50% of the data (the values between the lower and upper quartiles).
- A short box indicates that the solutions tend to be very close to the median, while a long box indicates that the solutions are spread out over a wider space.
- A certain algorithm will be more consistent compared to others if its box is **shorter and more skewed to the minimum value** than the others.



THANK YOU