

# ***Robust Facility Locations: Hedging Against Disruptions***

## **Documentation**

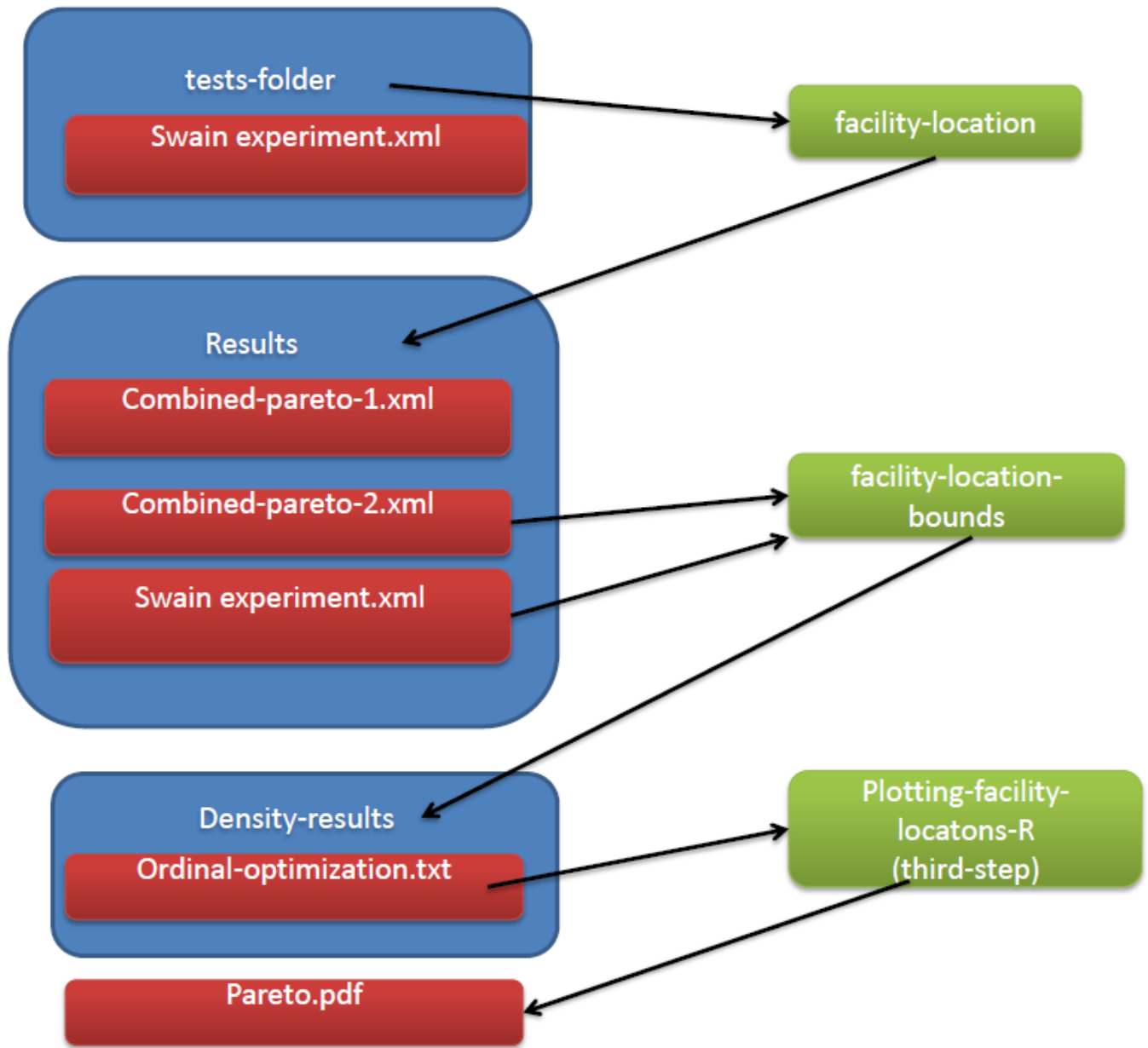
### **Objective**

In order to write the paper *Robust Facility Locations: Hedging Against Disruptions*, various programs were created in order to run various experiments. This document describes the inputs and outputs of those programs. The programs are available for free download on github.

### **Introduction**

Three main programs were created in order to run the experiments for the paper and visualize the results. The first program is called **facility-location**, which obtains the lower and upper bounds for the transportation cost. The second program is called **facility-location-bounds** and it obtains trade-off solutions that lie between the upper and lower bounds found with the facility-location program. The third program is composed of a series of routines written in R called **plotting-facility-locations-R** that take the output from the facility-location bounds and generate plots for visualizing results. Additionally some of the scripts in R can generate plots for the input datasets for the facility-location.

### **Architecture**



### ***facility-location***

This program was written in Python and uses functions from `inspyred` and `networkx`. The program receives as input the description of the experiments to run and generates a Pareto front with the trade-off solutions between transportation cost and number of facilities. Each solution has its associated worst-case transportation cost after a certain number of failures.

#### Inputs

Specified in the `main.py` file.

1. Path to a directory containing one or more **Experiment Files**. By default the name is test-folder.

#### Outputs

1. Folder named with the date in which the experiment was run. The folder contains detailed outputs in XML file and summary outputs in TXT. The outputs of interest for the user are:
  - combined-pareto-1: Pareto set of the trade-off between number of facilities and distance before failures (the distance after failure is set to zero). The file was created by combining the Pareto sets of MO-PSDA and NSGA-II.
  - combined-pareto-2: Pareto set of the second subproblem (obtaining the upper and lower bounds for all solutions found on combined-pareto-1). The file was created by combining the Pareto sets of MO-PSDA and NSGA-II.

#### ***facility-location-bounds***

This program was written in Python and uses functions from inspyred and networkx. This program can only be used after using the facility-location program.

#### Inputs

Specified in the file main.py

1. Path to the **experiment file** used in the facility-location program (e.g. a-experiment-swain-total-distance-interdiction.xml).
2. Path to the final Pareto set obtained by the facility-location program in (e.g. combined-pareto-2.xml)
3. Number of failures for which the exploration wants to be done (there must be at least one solution in the combined-pareto-2.xml file with the given number of failures)
4. Number of simulations for which the Monte Carlo simulation will be runned.
5. Facilities Range: range of the number of facilities for which the trade-off solutions will be search.

The facility-location-bounds will attempt to find more solutions for a given number of facilities and failures.

#### Outputs

1. A folder named with the time at which the experiment was run. The folder contains two files called ordinal-optimization. The XML version is detailed and the TXT version is more useful for plotting the results.

#### ***plotting-facility-locations-R***

This folder contains R scripts that use plyr and ggplot2 for generating all the plots that appear in

the paper. There are four main projects:

1. coordinates: used to plot the coordinates of the facilities.
2. first-step: used to plot the Pareto sets of the first subproblem (combined-pareto-1)
3. second-step: used to plot the Pareto sets of the second subproblem (combined-pareto-2).
4. third-step: used to plot the Pareto sets of the third subproblem (ordinal-optimization)

### **File Formats**

- Experiment File: this file describes in XML format how an experiment should be run. It contains multiple attributes, the ones that the user should modify to set up the experiments are:
  - Population Size: this parameter is used by both algorithms NSGA-II and MO-PSDA. The parameter specifies the size of the population used by the evolutionary algorithms.
  - Generations: this parameter is used by both algorithms NSGA-II and MO-PSDA. It specifies for how many generations the evolutionary algorithms will run.
  - Runs: this parameter is used by both algorithms NSGA-II and MO-PSDA. The parameter specifies how many times each evolutionary algorithm will be run in order to obtain better solutions. In the final step of the entire optimization process the solutions obtained by both algorithms are merged in a final Pareto set.
- Combined-pareto: this file describes the Pareto set obtained. The TXT version contains the objective function values of each solution (useful for plotting). The XML version contains the objective function value and the decision variables (which demand center is assigned to which facility).
- Ordinal-optimization: similar to combined-pareto but with results for the third subproblem of the paper.