Analysis and Design Document
for
OPAL

January 23, 2010

Chapter 1

Introduction

The primary goal is create a framework that helps the users to realize the tunning task following the schema

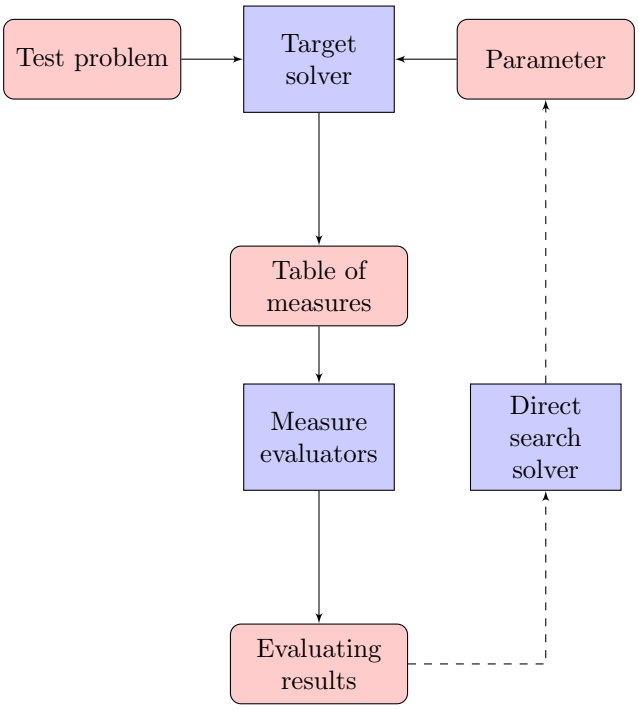

Figure 1.1: General schema of parameter tunning

Chapter 2

Backgrounds

The principles are built basing on the three observations

- The Optimization of Algorithmic parameters framework can be analyzed as either a proccessing data system or black-box optimization problem solving.
- We can decompose any data proccessing to the elementary things by Data-Operator principle
- Problem solving is can be decomposed by Data-Operator principle.

2.1 Decomposition a system by Data-Operator principle

- There are main entities Data and Operator
    1. Data is in fact set of elements with the methods set and get value. The set is organized in the different structure like a scalar, a vector or a matrix ...
    2. Operator represent for an operation, so it has the input and the output. It may has also parameters to generalize its functionality.
- A Data is characterized by Name, Type, Value and Storage (file or in memory, ...). Many data entity can be grouped to create a Data Set.
- An Operator is characterized by its Input and Output. Input and Output may be either the Data or an Operator with only constraint that their type are the same.
    1. Input and Ouput are Data, the Operator is called Evaluator.
    2. Input and Output are Operators, the Operator is called Manipulator.

- We can combine many Operators in different ways to get a Process that are actually an Operator.
    1. A process of two sequenial Operators is a such combination that: Output of the first Opearator is input of the second Operator
    2. Cooperation: Two Operators have the same Input.
- The relations between two Operators are:
    1. Dependence: A manipulator depends on the others if it used the others to proccess the Data
    2. Independence.
    3. Inclusion A manipulator can be decomposed as combinations of the others
    4. Cooperation

2.2 Analyse solving proccess by Data-Operator principle

A solving process for an optimization problem is defined by the following diagram:

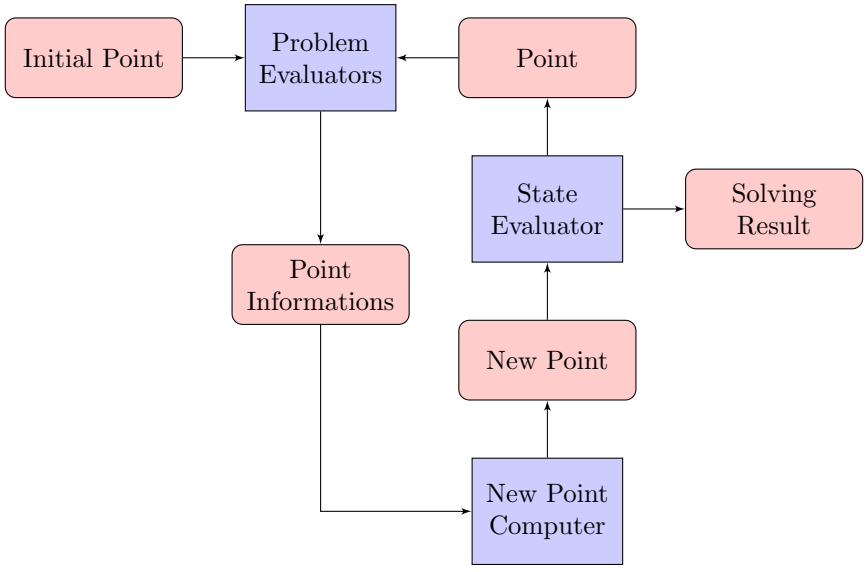

Figure 2.1: Solving problem process

Chapter 3

System analysis

We apply the principle above to describe the framework in a typical use-case. So, we try to analyse the framework in following steps:

1. Decompose the framework into the elementary thingss such that they are detail enough.
2. Identify and group the elements to describe the main components of our problem solving proccesses as well the other supporting components.

3.1 Parameter Optimization is Data proccessing

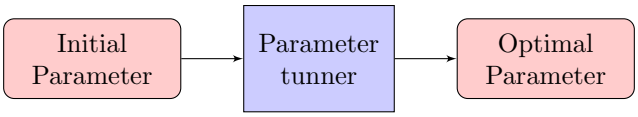

Figure 3.1: Top view of tunning parameter

3.2 Parameter Optimization is Black Box Optimization problem solving

There are two opimization problem solvings involed in parameter optimization.

- A Black box optimization problem is solved by a direct search solver
- One or many test problems are solved by target solver

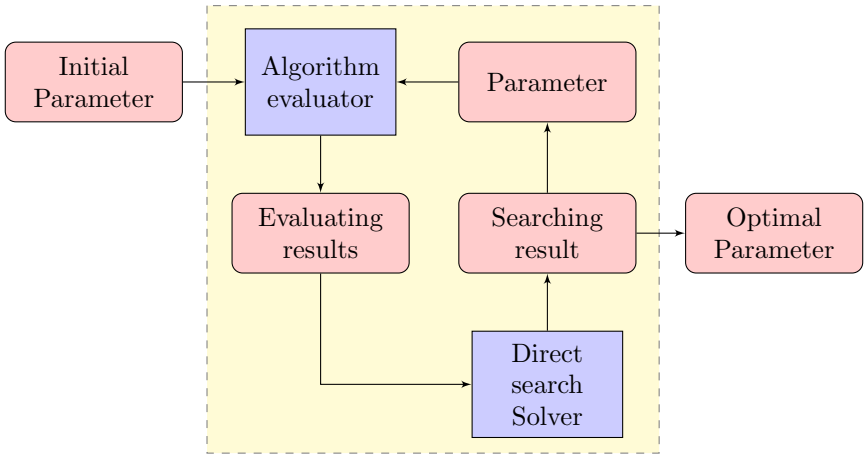

Figure 3.2: Black box optimization view of tunning parameter

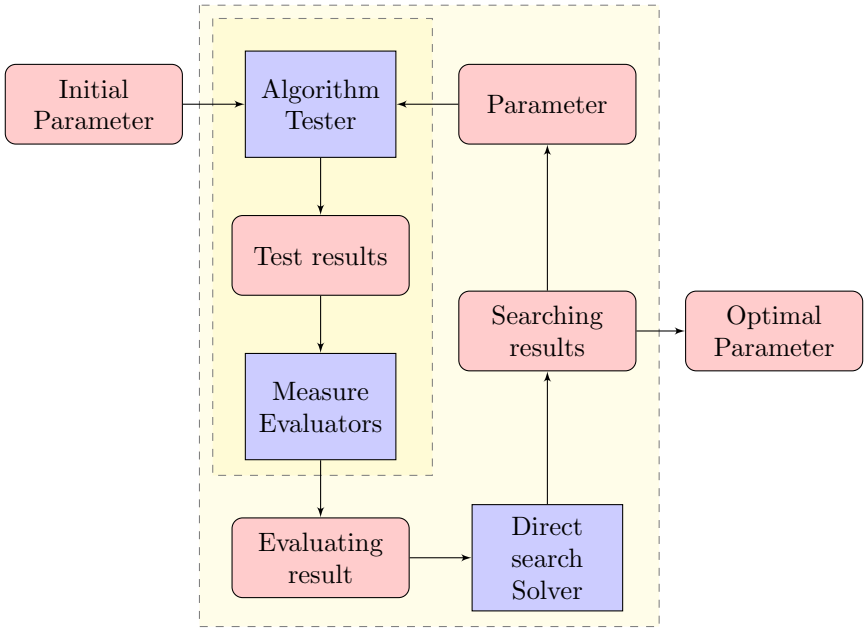

Figure 3.3: Empirical test view of tunning parameter

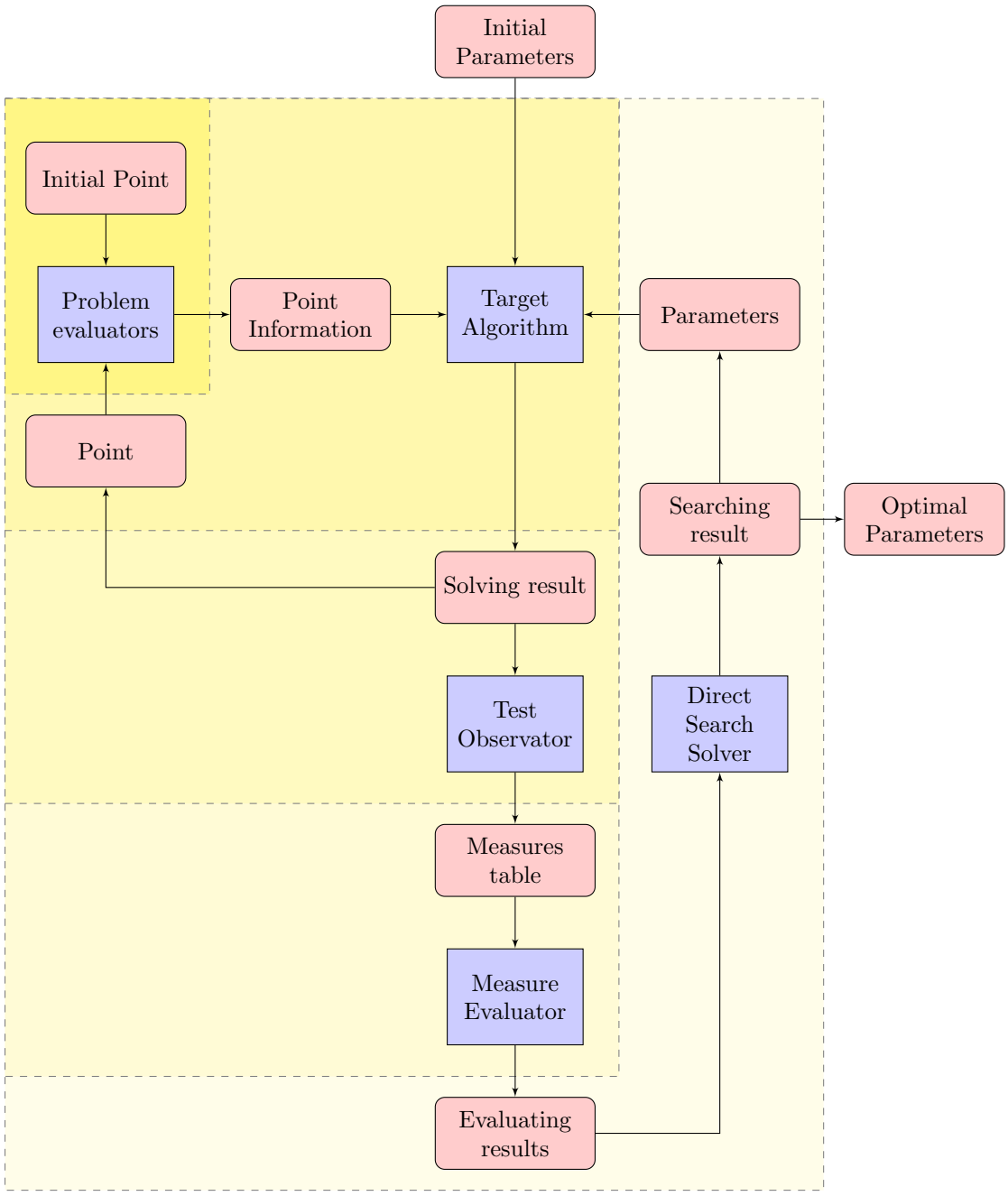

Figure 3.4: Algorithm view

Chapter 4

System design

We try indentify three main types of objects in the above diagram: data, process and data manipulator

- Data that is the input, output and parameter of a process or a manipulator. Data has name, data type, value and a propeties determine its physical storage that is either system standard output or a file.
- A manipulator represents for a data processing. It accepts a data object as input and return the other data object that are the outputs. A manipulator may have one or many parameters that are the data objects too to generalize the function. One thing important to define a manipulator is definition his function of data processing.
- A process is in general the cooperation of two or many manipulators. From the black box view, a process is a manipulator with input, output and parameters except that we don't need to specify its functionality.

4.1 Process hiearachy

By showing the process hiearachy, we would like emphasize that, in our system, a process can be specified in two ways:

- Treat as a black box by specifying input, output and how to run.
- Specify the sub-processes and the evaluators of the process and the their combinations. For our framework, the combinations are pre-defined, it is so enough to figure out the sub-process. In most of case, the users build up a process from a sub-process and an evaluator

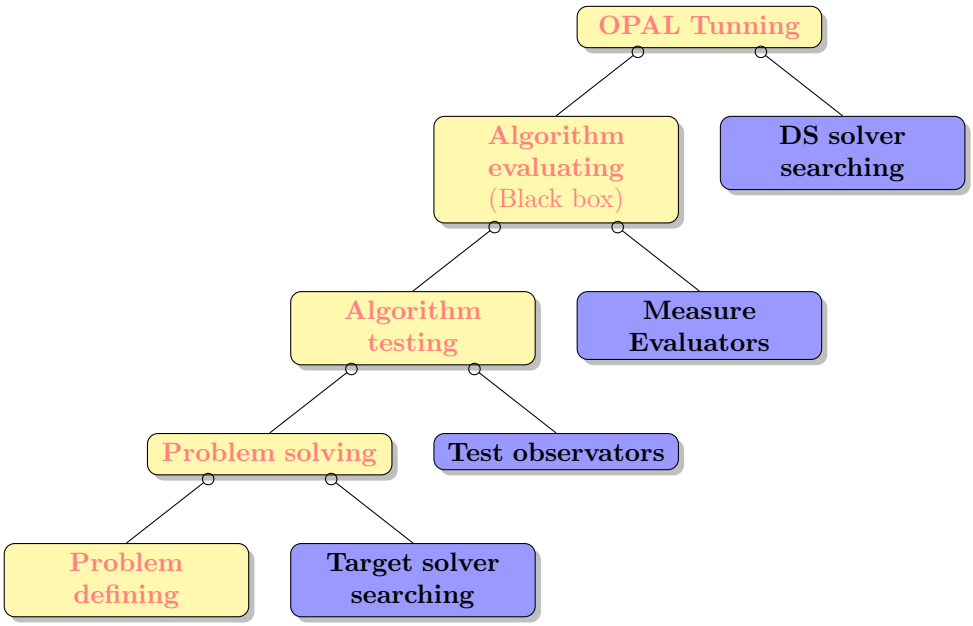

Figure 4.1: Manipulator hierachy

4.2 Problem and solver

The two elementary objects in a problem solving are built up from the Data, Evaluator and Operator.

- Problem includes a data set and one or many evaluator. For example, an optimization problem we need an initial point and one or many evaluators representing for its model like objective function computing, constraints computing, objective function gradient. Note the structure such as linearity, is embeded as the structure
- Solver is specified with a searching process that created by combining the model computing process in problem definition with an evaluator that compute new point from the information of current point (or model value).