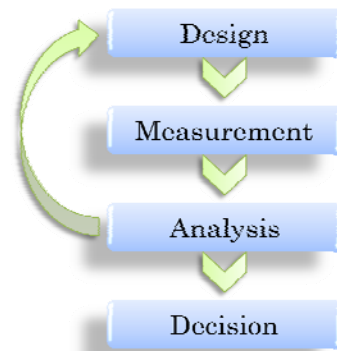# Mathematical Methods for Automatic Tuning

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Automatic Tuning has been researched from 1990's. Automatic tuning is a kind of optimization, but its mathematical aspects have not been clearly discussed in the past. In this research, we focus on mathematical aspects of automatic tuning.

The right figure shows our abstraction of automatic tuning. In *design* of experiments, the values of tuning parameters for experiments are determined. That affects efficiency of information collection through experiments. In *measurements*, the performance values and related data are collected. However, they may be contaminated by various perturbations. In *analysis*, the measured data are combined with performance models and other a priori knowledge. Problems here are how to find good models for tuning, and how to fit models to the data optimally. In *decision*, the tuning parameters are fixed based on the results of analysis. This is a kind of optimization problem, so objective function and constraints are basic.

In many of past research works, those factors were not discussed in a mathematically clear way. Mathematical aspects of automatic tuning have been rarely discussed separately from other factors. In this presentation, we will focus on mathematical aspects of automatic tuning, and what kind of mathematical methods are needed. We found the past works treated the problems in a heuristic way in most cases, and refinements on mathematical methods are needed for all the four phases shown above. Several concepts from statistics, operations research, control theory, machine learning etc. are helpful.

By definition, tuning is executed automatically in automatic tuning. Then the methods of automatic tuning should be robust and stable, because human supervision is minimal. Every method should be reconsidered from this viewpoint. Also we note that a library collection of good mathematical methods for automatic tuning will be beneficial in future developments.