Introduction: System Identification.

* Def: System identification is the study of Modeling dynamic System from experimental data.

1. Modelling

* Mathematical Description of System Linear / nonlinear, Time invariant /varying.
* Parametric / non parametric

1. Parametric identification/estimation

3) Non-parametric Identification

Given, find

* Relation between Machine Learning / AI

Given data, find some features inside the data

* Machine Learning: Supervised Learning / unsupervised learning: classification,

Usually static system.

* System Identification: In/Out relations, Usually dynamic system

Ch.1 Introduction

1. Introduction
   1. System Theory
      1. Terminology

Input

Disturbance:

State:

Disturbance:, output disturbance (sometimes noise)

Output:

* + 1. Basic Problems
* Modeling / Analysis / Estimation / Control

1. Modeling

Relation between variables on the basis of prior knowledge, assumption about the uncertainties

Unknown / incomplete known coefficients :

1. Analysis

In system identification, **identifiability analysis:** “can the unknown parameter be uniquely, albeit locally, identified?”

1. Estimation

-State estimation / parameter estimation

-State estimation: based on the assumption that model is perfect, parameters are exactly known

-Parameter identification: estimate the model parameter from

1. Control
   1. Mathematical Models
      1. Model Properties

-Discrete-time

-Continuous-time

* Linearity

Assumption: Input: corresponding output:

The system is linear if

Input: then Output:

* Time- Invariance

Assumption: input output .

Then if input ,then

* Causality: The output does not depend on the future value of the input
* Estimation/ Prediction
* Dynamics

If the system depends on its history, and not just on the present input, it is called a dynamic system. See (1.1), (1.2)

* + 1. Structural model Representations
* Ex.1.4 / 1.5 A liquid storage tank:

The volume of the liquid in the storage tank: =

Inflows / outflows:

A proportional level controller:

* Let
* Differential Equation

1. The homogeneous solution: with
2. The total solution with initial condition
3. The system is linear
4. The system is time – invariant, because

1. The system is causal
2. The impulse response
3. Convolution model: the output is modelled as (1.5)
4. Differential equation model / state-space model

* The choice of model

-white box / black box (linear) / grey box

* Problem 1.2