Systems and control theory
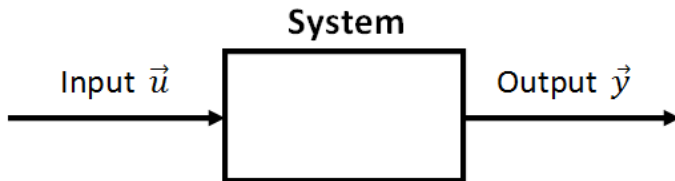
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Dynamical system

A dynamical system is a constantly changing system that connects outputs (denoted by $\vec{y}$) and inputs (denoted by $\vec{u}$).
The word dynamical refers to the fact that the system relates time-changing signals.

System

Input $\vec{u}$ → [ ] → Output $\vec{y}$

Everything is a dynamical system.

System theory

System theory occupies itself with the mathematical description and study of systems. Models describe the connections between input, output and states.

Examples are:

1. State space model
2. Transferfunction
3. ...
4. ...

1. afbeelding1
2. afbeelding2
3. afbeelding3
4. afbeelding4

State and order

Next to inputs and outputs, states (denoted by $\vec{x}$) are a third type of variable used to describe a system. They represent the internal state of the system at a given time. The next state is a function of the previous states. The order of a system is the number of state-variables (i.e. the size of the vector $\vec{x}$).

Control theory

Control theory deals with the behavior of dynamical systems and how their behavior is modified by feedback.
The output is compared to the desired output and the error is used to adjust the system.

Open loop

In an open loop system, the output is not fed back into the controller.
Therefore, the controller cannot *'see'* the effect of its actions.
This way it is hard to get the desired output.

For example: try pouring water in a glass without looking.

Feedback

In a feedback system, the output is fed back to the controller. This way, the new input becomes the error on the output.

Positive vs. Negative Feedback

Negative Feedback

1. Continuous behavior
2. Analog technology
3. Output primarily reflects the input
4. Loops enhance of amplify the changes between input and output

Positive Feedback

1. On-Off behavior
2. Digital Technology
3. Output primarily reflects memory of the past
4. Loops tend to dampen or buffer the changes between input and output

Millenium Bridge London

Resonance on the Millenium Bridge in London due to the rithm of walking people.

https://www.youtube.com/watch?v=eAXVa__XWZ8