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MPC (model Predictive control) for energy - an overview

Basic MPC idea

- Have a model for the process
- Use that model to predict outputs based on (present and future) controls
- Use those prediction to
  - compute future errors
  - compute some cost function
- Solve the so posed problem wrt future controls
- Apply the 1st so computed control & iterate

Note:unreviewed material

Typical use: minimise some cost function in the form

$$J = \underbrace{\sum \text{weights} \cdot \text{errors}^2}_{e'Qe} + \underbrace{\sum \text{weights} \cdot \text{controls}^2}_{u'Ru}$$

Q: symm, ≥ 0, often diag; R: symm, > 0

subject to constraints

- on the controls (e.g., $u_{i\,min} \leq u_i \leq u_{i\,max}$)
- and sometimes on the outputs (avoid if possible as this may cause feasibility problems)

Tool of election to solve the problem: KKT

Alternatives exist, especially for computational simplicity (Active sets, ...)

Mainstream procedure

- Start from the process model and discretise with a suitably chosen time step
- Construct the prediction of future outputs

$$\hat{y}(k+1), \dots \hat{y}(k+N) \leftarrow \text{parameters } u(k), \dots u(k+N-1)$$

↑ horizon to be decided

4. Construct $J\left(u(k), \ldots u(k+N-1), \hat{y}(k+1), \ldots \hat{y}(k+N)\right)$

- Set up constraints (sometimes they may vary over time, For example think of a heater that reduces its capacity)
- Minimise J s.t. the constraints

$$\Rightarrow u_0(k), u_0(k+1), \ldots u_0(k+N-1)$$

↑ optimal

- Apply $u_0(k)$ and repeat the entire process at the following step.

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