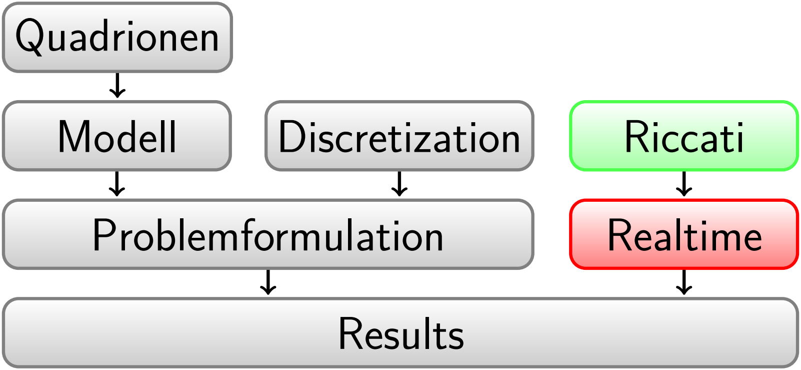
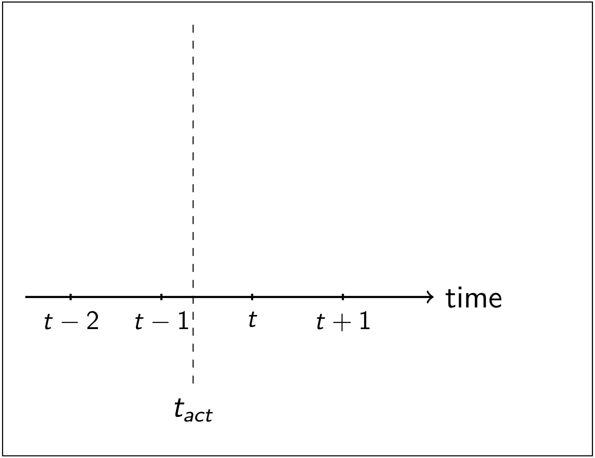

Quadrionen
Modell
Discretization
Riccati
Problemformulation
Realtime
Results

Setting



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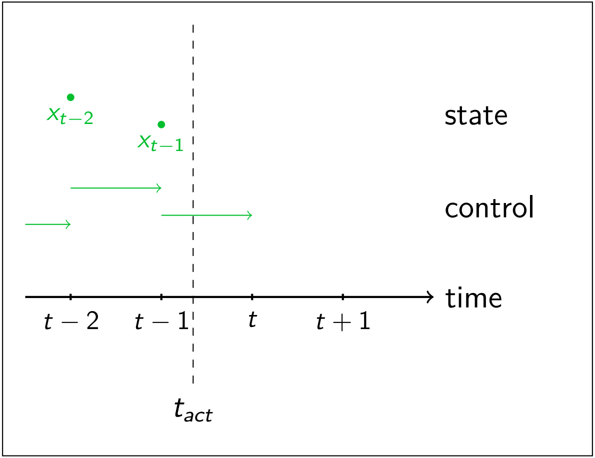

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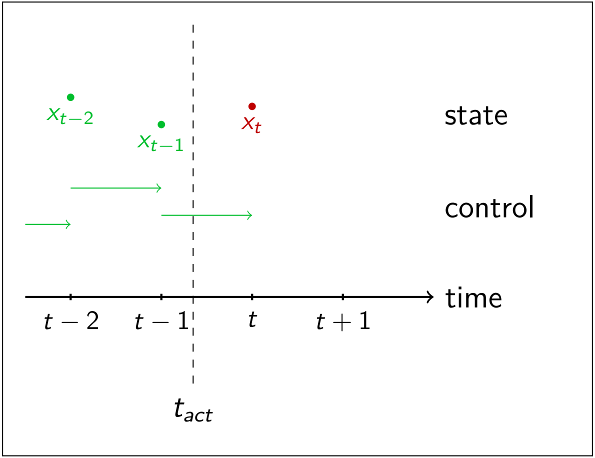

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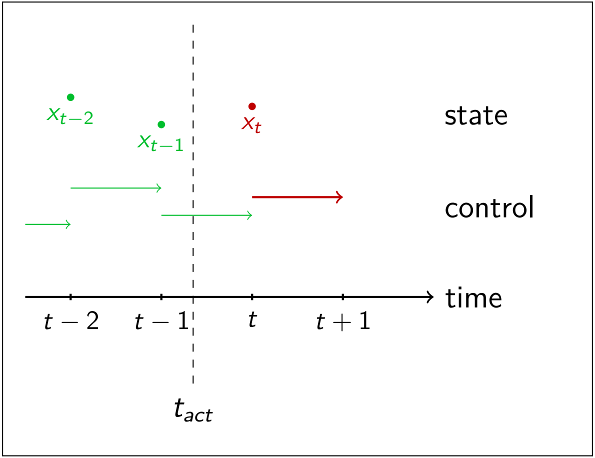


Discrete Problem

$$\min_{x,u} \sum_{i=t}^{N} J_i(x_i, u_i) \quad \text{s.t.} \quad h_i(x_i, u_i) = 0 \quad i = t, \dots, N$$

$J_i(x_i, u_i)$ discretized goal function

$h_i(x_i, u_i)$ equality condition at time i

The Lagrangian

$$L^t(y) = \sum_{i=t}^{N} J_i(x_i, u_i) + \sum_{i=t}^{N} \lambda_i^T h_i(x_i, u_i)$$

$$y := (\lambda, x, u)$$

$$y^* \text{ optimal} \Leftrightarrow \nabla_y L^t(y^*) = 0$$

The SQP Method

Find y^*:

$$y_{k+1} = y_k + s_k$$

$$\min_{s_k} \frac{1}{2} s_k^T \nabla^2 L(y_k) s_k + \nabla L(y_k)^T s_k$$

Quasi Newton-Method

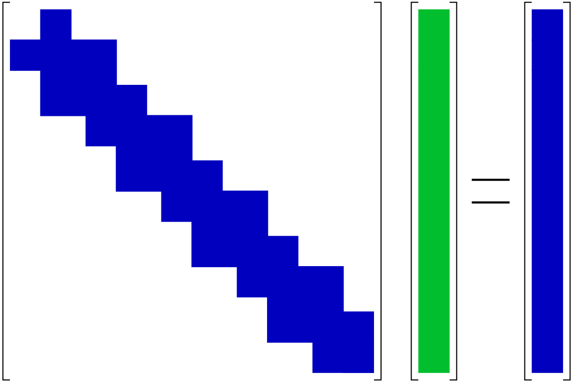
Find s_k with:

$$\nabla L(y_k) + \nabla^2 L(y_k) s_k = 0$$

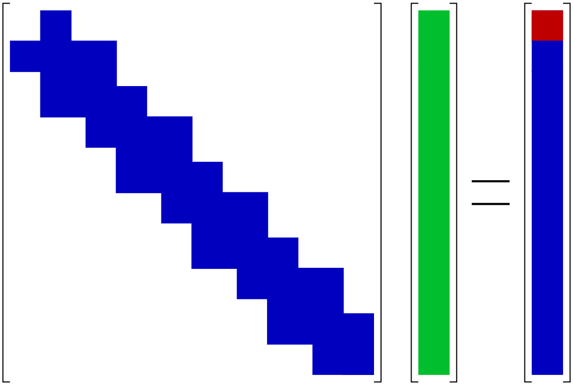
Approximate $\nabla^2 L(y_k)$ and solve:

$$H(y_k) s_k = -\nabla L(y_k)$$

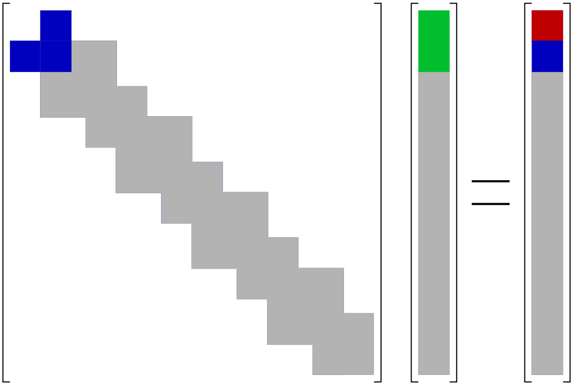
Riccati Recursion



Riccati Recursion



Riccati Recursion



Summary

What happens in interval $[t-1, t]$?

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1. calculate control u_{t-1} (Riccati Part II)

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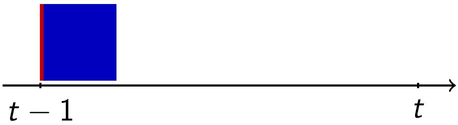

1. calculate control u_{t-1} (Riccati Part II)
2. calculate y (Riccati Part II)

Summary

What happens in interval $[t-1, t]$?

1. calculate control u_{t-1} (Riccati Part II)
2. calculate y (Riccati Part II)
3. prepare u_t (Newton & Riccati Part I)

Finite Horizon

$$\min_{s,q} \sum_{i=t}^{N-1} J_i(s_i, q_i) \quad s.t. \begin{cases} x_t - s_t = 0 \\ h_i(s_i, q_i) - s_{i+1} = 0 & \forall i = t, ..., N-1 \\ p_{A_i}(s_i, q_i) = 0 \end{cases}$$

How to choose N?

$N = t_{end} \qquad \rightarrow$ problem size decreasing

Finite Horizon

$$\min_{s,q} \sum_{i=t}^{N-1} J_i(s_i, q_i) \quad s.t. \quad \left\{ \begin{array}{r} x_t - s_t = 0 \\ h_i(s_i, q_i) - s_{i+1} = 0 \\ p_{A_i}(s_i, q_i) = 0 \end{array} \right. \quad \forall i = t, ..., N-1$$

How to choose N?

$N = t_{end} \quad \rightarrow$ problem size decreasing

$N = t + n \quad \rightarrow$ problem size constant

Results

Questions?