DynamicNLPModels

David Cole, Sungho Shin, Francois Pacaud

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Part I

Introduction

Chapter 1

Introduction

Welcome to the documentation of DynamicNLPModels.jl

Warning

This documentation page is under construction.

Note

This documentation is also available in PDF format.

Chapter 2

What is DynamicNLPModels?

Chapter 3

Bug reports and support

Please report issues and feature requests via the Github issue tracker.

Part II

Quick Start

Part III

API Manual

Chapter 4

API Manual

DynamicNLPModels.DenseLQDynamicBlocks – Type.

Struct containing block A and B matrices used in creating the DenseLQDynamicModel. These matrices are given by Jerez, Kerrigan, and Constantinides in section 4 of "A sparse and condensed QP formulation for predictive control of LTI systems" (doi:10.1016/j.automatica.2012.03.010).

A is a ns(N+1) x ns matrix and B is a ns(N) x nu matrix containing the first column of the B block matrix in the above text. Note that the first block of zeros is omitted.

source

DynamicNLPModels.DenseLQDynamicModel – Method.

```
DenseLQDynamicModel(dnlp::LQDynamicData; implicit = false)     -> DenseLQDynamicModel
DenseLQDynamicModel(s0, A, B, Q, R, N; implicit = false ...) -> DenseLQDynamicModel
```

A constructor for building a DenseLQDynamicModel <: QuadraticModels.AbstractQuadraticModel

Input data is for the problem of the form

$$minimize \frac{1}{2}\sum_{i=0}^{N-1}(s_i^T Q s_i + 2u_i^T S^T x_i + u_i^T R u_i) + \frac{1}{2}s_N^T Q f s_N subject to s_{i+1} = As_i + Bu_i for i = 0, 1, ..., N-1 u_i = K$$

Data is converted to the form

$$minimize \frac{1}{2}u^T H u + h^T u + h0 subject to Jz \leq gul \leq u \leq uu$$

Resulting H, J, h, and h0 matrices are stored within QuadraticModels.QPData as H, A, c, and c0 attributes respectively

If K is defined, then u variables are replaced by v variables. The bounds on u are transformed into algebraic constraints, and u can be queried by get_u and get_s within DynamicNLPModels.jl

Keyword argument implicit = false determines how the Jacobian is stored within the QPData. If implicit = false, the full, dense Jacobian matrix is stored. If implicit = true, only the first nu columns of the Jacobian are stored with the Linear Operator LQJacobianOperator.

source

DynamicNLPModels.LQDynamicData – Type.

```
LQDynamicData{T,V,M,MK} <: AbstractLQDynData{T,V}
```

A struct to represent the features of the optimization problem

$$minimize \frac{1}{2}\sum_{i=0}^{N-1}(s_i^T Q s_i + 2u_i^T S^T x_i + u_i^T R u_i) + \frac{1}{2}s_N^T Q f s_N subject to s_{i+1} = As_i + Bu_i for i = 0, 1, ..., N-1 u_i = K$$

Attributes include:

- `s0`: initial state of system
- `A` : constraint matrix for system states
- `B` : constraint matrix for system inputs
- `Q` : objective function matrix for system states from 1:(N-1)
- `R` : objective function matrix for system inputs from 1:(N-1)
- `N` : number of time steps
- `Qf`: objective function matrix for system state at time N
- `S` : objective function matrix for system states and inputs
- `ns`: number of state variables
- `nu`: number of input varaibles
- `E` : constraint matrix for state variables
- `F` : constraint matrix for input variables
- `K` : feedback gain matrix
- `sl`: vector of lower bounds on state variables
- `su`: vector of upper bounds on state variables
- `ul`: vector of lower bounds on input variables
- `uu`: vector of upper bounds on input variables
- `gl`: vector of lower bounds on constraints
- `gu`: vector of upper bounds on constraints

see also `LQDynamicData(s0, A, B, Q, R, N; ...)`

source

DynamicNLPModels.LQDynamicData – Method.

```
LQDynamicData(s0, A, B, Q, R, N; ...) -> LQDynamicData{T, V, M, MK}
```

A constructor for building an object of type `LQDynamicData` for the optimization problem

$$minimize \frac{1}{2}\sum_{i=0}^{N-1}(s_i^T Q s_i + 2u_i^T S^T x_i + u_i^T R u_i) + \frac{1}{2}s_N^T Q f s_N subject to s_{i+1} = As_i + Bu_i \forall i = 0, 1, ..., N-1 u_i = Kx$$

- `s0`: initial state of system
- `A` : constraint matrix for system states
- `B` : constraint matrix for system inputs
- `Q` : objective function matrix for system states from 1:(N-1)
- `R` : objective function matrix for system inputs from 1:(N-1)
- `N` : number of time steps

The following attributes of the `LQDynamicData` type are detected automatically from the length of s0 and size of R

- `ns`: number of state variables
- `nu`: number of input varaibles

The following keyward arguments are also accepted

- `Qf = Q`: objective function matrix for system state at time N; dimensions must be ns x ns
- `S = nothing`: objective function matrix for system state and inputs
- `E = zeros(eltype(Q), 0, ns)` : constraint matrix for state variables
- `F = zeros(eltype(Q), 0, nu)` : constraint matrix for input variables
- `K = nothing` : feedback gain matrix
- `sl = fill(-Inf, ns)`: vector of lower bounds on state variables
- `su = fill(Inf, ns)` : vector of upper bounds on state variables
- `ul = fill(-Inf, nu)`: vector of lower bounds on input variables
- `uu = fill(Inf, nu)` : vector of upper bounds on input variables
- `gl = fill(-Inf, size(E, 1))` : vector of lower bounds on constraints
- `gu = fill(Inf, size(E, 1))` : vector of upper bounds on constraints

source

`DynamicNLPModels.LQJacobianOperator` – Type.

```
LQJacobianOperator{T, V, M}
```

Struct for storing the implicit Jacobian matrix. All data for the Jacobian can be stored in the first nu columns of J. This struct contains the needed data and storage arrays for calculating `Jx`, `J^T x`, and `J^T Sigma J`. `Jx` and `J^T x` are performed through extensions to `LinearAlgebra.mul!()`.

Attributes

- `Jac`: Matrix of first `nu` columns of the Jacobian
- `N` : number of time steps
- `nu` : number of inputs
- `nc` : number of algebraic constraints of the form gl <= Es + Fu <= gu
- `nsc`: number of bounded state variables
- `nuc`: number of bounded input variables (if K is defined)

- scaled_Jac: placeholder to avoid allocaiton when calculating Sigma J
- J1Bx : vector for storing multiplications when doing Jx
- J2Bx : vector for storing multiplications when doing Jx
- J3Bx : vector for storing multiplications when doing Jx
- J1BTx: vector for storing multiplications when doing J^T x
- J2BTx: vector for storing multiplications when doing J^T x
- J3BTx: vector for storing multiplications when doing J^T x
- J1B : matrix for storing multiplicaitons when doing J^T Sigma J
- J2B : matrix for storing multiplicaitons when doing J^T Sigma J
- J3B : matrix for storing multiplicaitons when doing J^T Sigma J

source

DynamicNLPModels.SparseLQDynamicModel – Method.

```
SparseLQDynamicModel(dnlp::LQDynamicData)     -> SparseLQDynamicModel
SparseLQDynamicModel(s0, A, B, Q, R, N; ...) -> SparseLQDynamicModel
```

A constructor for building a SparseLQDynamicModel <: QuadraticModels.AbstractQuadraticModel Input data is for the problem of the form

$$minimize \frac{1}{2} \sum_{i=0}^{N-1} (s_i^T Q s_i + 2u_i^T S^T x_i + u_i^T R u_i) + \frac{1}{2} s_N^T Q f s_N subject to s_{i+1} = As_i + Bu_i for i = 0, 1, ..., N-1 u_i = K$$

Data is converted to the form

$$minimize \frac{1}{2} z^T H z subject to lcon \leq Jz \leq ucon lvar \leq z \leq uvar$$

Resulting H and J matrices are stored as QuadraticModels.QPData within the SparseLQDynamicModel struct and variable and constraint limits are stored within NLPModels.NLPModelMeta

If K is defined, then u variables are replaced by v variables, and u can be queried by get_u and get_s within DynamicNLPModels.jl

source

DynamicNLPModels._set_sparse_H! – Method.

```
_set_sparse_H!(H_colptr, H_rowval, H_nzval, Q, R, N; Qf = Q, S = zeros(T, size(Q, 1), size(R,
↪  1))
```

set the data needed to build a SparseArrays.SparseMatrixCSC matrix. Hcolptr, Hrowval, and Hnzval are set so that they can be passed to SparseMatrixCSC() to obtain the H matrix such that z^T H z = sum{i=1}^{N-1} si^T Q s + sum{i=1}^{N-1} u^T R u + sN^T Qf sn .

source

DynamicNLPModels._set_sparse_J! – Method.

```
_set_sparse_J!(J_colptr, J_rowval, J_nzval, A, B, E, F, K, bool_vec, N, nb)
_set_sparse_J!(J_colptr, J_rowval, J_nzval, A, B, E, F, K, N)
```

set the data needed to build a SparseArrays.SparseMatrixCSC matrix. Jcolptr, Jrowval, and J_nzval are set so that they can be passed to SparseMatrixCSC() to obtain the Jacobian, J. The Jacobian contains the data for the following constraints:

Asi + Bui = s{i + 1} gl <= Esi + Fui <= getu

If K is defined, then this matrix also contains the constraints ul <= Kxi + vi <= uu

source

DynamicNLPModels.get_A – Method.

```
get_A(LQDynamicData)
get_A(SparseLQDynamicModel)
get_A(DenseLQDynamicModel)
```

Return the value A from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamic-Model.dynamicdata

source

DynamicNLPModels.get_B – Method.

```
get_B(LQDynamicData)
get_B(SparseLQDynamicModel)
get_B(DenseLQDynamicModel)
```

Return the value B from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamic-Model.dynamicdata

source

DynamicNLPModels.get_E – Method.

```
get_E(LQDynamicData)
get_E(SparseLQDynamicModel)
get_E(DenseLQDynamicModel)
```

Return the value E from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamic-Model.dynamicdata

source

DynamicNLPModels.get_F – Method.

```
get_F(LQDynamicData)
get_F(SparseLQDynamicModel)
get_F(DenseLQDynamicModel)
```

Return the value F from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamic-Model.dynamicdata

source

DynamicNLPModels.get_K – Method.

```
get_K(LQDynamicData)
get_K(SparseLQDynamicModel)
get_K(DenseLQDynamicModel)
```

Return the value K from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.get_N – Method.

```
get_N(LQDynamicData)
get_N(SparseLQDynamicModel)
get_N(DenseLQDynamicModel)
```

Return the value N from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.get_Q – Method.

```
get_Q(LQDynamicData)
get_Q(SparseLQDynamicModel)
get_Q(DenseLQDynamicModel)
```

Return the value Q from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.get_Qf – Method.

```
get_Qf(LQDynamicData)
get_Qf(SparseLQDynamicModel)
get_Qf(DenseLQDynamicModel)
```

Return the value Qf from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.get_R – Method.

```
get_R(LQDynamicData)
get_R(SparseLQDynamicModel)
get_R(DenseLQDynamicModel)
```

Return the value R from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.get_S – Method.

```
get_S(LQDynamicData)
get_S(SparseLQDynamicModel)
get_S(DenseLQDynamicModel)
```

Return the value S from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.get_gl – Method.

```
get_gl(LQDynamicData)
get_gl(SparseLQDynamicModel)
get_gl(DenseLQDynamicModel)
```

Return the value gl from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.get_gu – Method.

```
get_gu(LQDynamicData)
get_gu(SparseLQDynamicModel)
get_gu(DenseLQDynamicModel)
```

Return the value gu from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.get_jacobian – Method.

```
get_jacobian(lqdm::DenseLQDynamicModel) -> LQJacobianOperator
get_jacobian(Jac::AdjointLinearOpeartor{T, LQJacobianOperator}) -> LQJacobianOperator
```

Gets the `LQJacobianOperator` from `DenseLQDynamicModel` (if the `QPdata` contains a `LQJacobian Operator`) or returns the `LQJacobian Operator` from the adjoint of the `LQJacobianOperator`

source

DynamicNLPModels.get_ns – Method.

```
get_ns(LQDynamicData)
get_ns(SparseLQDynamicModel)
get_ns(DenseLQDynamicModel)
```

Return the value ns from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.get_nu – Method.

```
get_nu(LQDynamicData)
get_nu(SparseLQDynamicModel)
get_nu(DenseLQDynamicModel)
```

Return the value nu from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.get_s – Method.

```
get_s(solution_ref, lqdm::SparseLQDynamicModel) -> s <: vector
get_s(solution_ref, lqdm::DenseLQDynamicModel) -> s <: vector
```

Query the solution s from the solver. If `lqdm <: SparseLQDynamicModel`, the solution is queried directly from `solution_ref.solution` If `lqdm <: DenseLQDynamicModel`, then `solution_ref.solution` returns u (if `K = nothing`) or v (if `K <: AbstactMatrix`), and s is found form transforming u or v into s using A, B, and K matrices.

source

DynamicNLPModels.get_s0 – Method.

```
get_s0(LQDynamicData)
get_s0(SparseLQDynamicModel)
get_s0(DenseLQDynamicModel)
```

Return the value s0 from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.get_sl – Method.

```
get_sl(LQDynamicData)
get_sl(SparseLQDynamicModel)
get_sl(DenseLQDynamicModel)
```

Return the value sl from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.get_su – Method.

```
get_su(LQDynamicData)
get_su(SparseLQDynamicModel)
get_su(DenseLQDynamicModel)
```

Return the value su from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.get_u – Method.

```
get_u(solution_ref, lqdm::SparseLQDynamicModel) -> u <: vector
get_u(solution_ref, lqdm::DenseLQDynamicModel) -> u <: vector
```

Query the solution u from the solver. If `K = nothing`, the solution for u is queried from `solution_ref.solution`

If `K <: AbstractMatrix`, `solution_ref.solution` returns v, and `get_u` solves for u using the K matrix (and the A and B matrices if `lqdm <: DenseLQDynamicModel`)

source

DynamicNLPModels.get_ul – Method.

```
get_ul(LQDynamicData)
get_ul(SparseLQDynamicModel)
get_ul(DenseLQDynamicModel)
```

Return the value ul from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.get_uu – Method.

```
get_uu(LQDynamicData)
get_uu(SparseLQDynamicModel)
get_uu(DenseLQDynamicModel)
```

Return the value uu from LQDynamicData or SparseLQDynamicModel.dynamicdata or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_A! – Method.

```
set_A!(LQDynamicData, row, col, val)
set_A!(SparseLQDynamicModel, row, col, val)
set_A!(DenseLQDynamicModel, row, col, val)
```

Set the value of entry A[row, col] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_B! – Method.

```
set_B!(LQDynamicData, row, col, val)
set_B!(SparseLQDynamicModel, row, col, val)
set_B!(DenseLQDynamicModel, row, col, val)
```

Set the value of entry B[row, col] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_E! – Method.

```
set_E!(LQDynamicData, row, col, val)
set_E!(SparseLQDynamicModel, row, col, val)
set_E!(DenseLQDynamicModel, row, col, val)
```

Set the value of entry E[row, col] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_F! – Method.

```
set_F!(LQDynamicData, row, col, val)
set_F!(SparseLQDynamicModel, row, col, val)
set_F!(DenseLQDynamicModel, row, col, val)
```

Set the value of entry F[row, col] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_K! – Method.

```
set_K!(LQDynamicData, row, col, val)
set_K!(SparseLQDynamicModel, row, col, val)
set_K!(DenseLQDynamicModel, row, col, val)
```

Set the value of entry K[row, col] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_Q! – Method.

```
set_Q!(LQDynamicData, row, col, val)
set_Q!(SparseLQDynamicModel, row, col, val)
set_Q!(DenseLQDynamicModel, row, col, val)
```

Set the value of entry Q[row, col] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_Qf! – Method.

```
set_Qf!(LQDynamicData, row, col, val)
set_Qf!(SparseLQDynamicModel, row, col, val)
set_Qf!(DenseLQDynamicModel, row, col, val)
```

Set the value of entry Qf[row, col] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_R! – Method.

```
set_R!(LQDynamicData, row, col, val)
set_R!(SparseLQDynamicModel, row, col, val)
set_R!(DenseLQDynamicModel, row, col, val)
```

Set the value of entry R[row, col] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_S! – Method.

```
set_S!(LQDynamicData, row, col, val)
set_S!(SparseLQDynamicModel, row, col, val)
set_S!(DenseLQDynamicModel, row, col, val)
```

Set the value of entry S[row, col] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_gl! – Method.

```
set_gl!(LQDynamicData, index, val)
set_gl!(SparseLQDynamicModel, index, val)
set_gl!(DenseLQDynamicModel, index, val)
```

Set the value of entry gl[index] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_gu! – Method.

```
set_gu!(LQDynamicData, index, val)
set_gu!(SparseLQDynamicModel, index, val)
set_gu!(DenseLQDynamicModel, index, val)
```

Set the value of entry gu[index] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_s0! – Method.

```
set_s0!(LQDynamicData, index, val)
set_s0!(SparseLQDynamicModel, index, val)
set_s0!(DenseLQDynamicModel, index, val)
```

Set the value of entry s0[index] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_sl! – Method.

```
set_sl!(LQDynamicData, index, val)
set_sl!(SparseLQDynamicModel, index, val)
set_sl!(DenseLQDynamicModel, index, val)
```

Set the value of entry sl[index] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_su! – Method.

```
set_su!(LQDynamicData, index, val)
set_su!(SparseLQDynamicModel, index, val)
set_su!(DenseLQDynamicModel, index, val)
```

Set the value of entry su[index] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_ul! – Method.

```
set_ul!(LQDynamicData, index, val)
set_ul!(SparseLQDynamicModel, index, val)
set_ul!(DenseLQDynamicModel, index, val)
```

Set the value of entry ul[index] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

DynamicNLPModels.set_uu! – Method.

```
set_uu!(LQDynamicData, index, val)
set_uu!(SparseLQDynamicModel, index, val)
set_uu!(DenseLQDynamicModel, index, val)
```

Set the value of entry uu[index] to val for LQDynamicData, SparseLQDynamicModel.dynamicdata, or DenseLQDynamicModel.dynamicdata

source

LinearOperators.reset! – Method.

```
LinearOperators.reset!(Jac::LQJacobianOperator{T, V, M})
```

Resets the values of attributes JB1, JB2, and JB3 to zero

source