MarmoteMDP

Generated by Doxygen 1.8.13

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1.1 Class Hierarchy

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Chapter 4

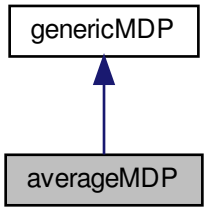
Class Documentation

4.1 averageMDP Class Reference

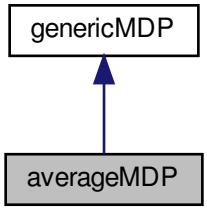
Class averageMDP header: definition of an infinite horizon average MDP class.

`#include <averageMDP.h>`

Inheritance diagram for averageMDP:



Collaboration diagram for averageMDP:



Public Member Functions

- void writeMDP ()

  function providing printing function to stdout.
- averageMDP (std::string r, marmoteSet ∗states, marmoteSet ∗actions, std::vector< sparseMatrix ∗> trans, sparseMatrix ∗rews)

  Constructor to create averageMDP object.
- averageMDP (std::string r, marmoteSet ∗states, marmoteSet ∗actions, std::vector< sparseMatrix ∗> trans, std::vector< sparseMatrix ∗> rews)

  Constructor to create averageMDP object.
- averageMDP (std::string r, marmoteSet ∗states, marmoteSet ∗actions, sparseMatrix ∗rews)

  Constructor to create averageMDP object with no vector of transition in parameters.
- ∼averageMDP ()

  destructor to delete averageMDP object.
- void changeIndex (int index)

  A function to change the index of the state used in value iteration.
- solutionMDP ∗ valueIteration (double epsilon, int maxIter)

  A function to solve (discrete time) MDP using value iteration algorithm.
- solutionMDP ∗ relativeValueIteration (double epsilon, int maxIter)

  A function to solve (discrete time) MDP using value relative iteration algorithm.
- solutionMDP ∗ policyIteration (int maxIter)

  A function to solve (discrete time) MDP using policy iteration algorithm.
- solutionMDP ∗ valueIterationGS (double epsilon, int maxIter)

  A function that should implements relative value iteration with Gauss Seidel decomposition.
- double ∗ policyCost (solutionMDP ∗policy, double epsilon, int maxIter)

  A function to evaluate the average cost of a policy with iteration of the power.
- solutionMDP ∗ policyIterationModified (double epsilon, int maxIter, double delta, int maxInIter)

  A function to solve (discrete time) MDP using modified policy iteration algorithm.
- solutionMDP ∗ policyIterationModifiedAA (double epsilon, int maxIter, double delta, int maxInIter)

  A function to solve (discrete time) MDP using modified policy iteration algorithm and an auto adaptation of error.
- solutionMDP ∗ valueIterationMC (double epsilon, int maxIter)

  A function to solve (discrete time) MDP using value iteration algorithm for multichain problem.
- sparseMatrix ∗ getChain (solutionMDP ∗policy)

  A function to build the transition matrix associated to a policy.

Protected Attributes

- double rho
- std::string type_c
- int indexEtatSpecifique

4.1.1 Detailed Description

Class averageMDP header: definition of an infinite horizon average MDP class.

Author

Emmanuel Hyon.

Version

1.1

Date

january 2019

This class is inherited from the abstract class genericMDP.

4.1.2 Constructor & Destructor Documentation

4.1.2.1 averageMDP() [1/3]

```
averageMDP::averageMDP (
            std::string r,
            marmoteSet * states,
            marmoteSet * actions,
            std::vector< sparseMatrix *> trans,
            sparseMatrix * rews )
```

Constructor to create averageMDP object.

Author

EH

Version

0.91

Date

jan 2019

Parameters

r	string : type_r rule value can be "min" , "max".
states	marmoteSet : State space
actions	marmoteSet : Action space
trans	vector<sparseMatrix*> : transition structures vector of sparseMatrix.
rews	sparseMatrix : reward structure : sparseMatrix object (state, action) an * entry of the matrix is the reward for state indexed by line and action indexed by * column.

Returns

none.

trans : transition structures vector of sparseMatrix objects an entry of the vector * is a transition structure matrix from state to state for the action at vector index.

reward structure : (state, action) an entry of the sparseMatrix is the reward for * state in line and action in column.

4.1.2.2 averageMDP() [2/3]

```
averageMDP::averageMDP (
            std::string r,
```

```
            marmoteSet * states,
            marmoteSet * actions,
            std::vector< sparseMatrix *> trans,
            std::vector< sparseMatrix *> rews )
```

Constructor to create averageMDP object.

Author

EH

Version

0.9.1

Date

jan 2019

Parameters

r	string : type_r rule value can be "min" , "max".
states	marmoteSet : State space
actions	marmoteSet : Action space
trans	vector<sparseMatrix*> : transition structures vector of sparseMatrix.
rews	vector<sparseMatrix*> vector of sparse matrix objects an entry of the vector is the reward structure from state to state for the action.

Returns

none.

This second constructor take an other form of reward description. It corresponds with the theoretical model where reward depends on transition and reached state r(i,a,j) Then cost_perStage method is used to be consistent with the reward attribute

trans : transition structures vector of sparseMatrix objects an entry of the vector is a transition structure matrix from state to state for the action at vector index.

rews vector of sparse matrix objects: an entry of the vector is the reward structure from state to state when trigger action (action is the index of the vector).

4.1.2.3 averageMDP() [3/3]

```
averageMDP::averageMDP (
            std::string r,
            marmoteSet * states,
            marmoteSet * actions,
            sparseMatrix * rews )
```

Constructor to create averageMDP object with no vector of transition in parameters.

Author

Hyon

Version

1

Date

july 2020

Parameters

r	: string, type_r rule can be "min" , "max".
states	: marmoteSet. State space
actions	: marmoteSet. Action space
rews	: reward : sparseMatrix object (state, action) an entry of the matrix is the reward for state line and action column.

Returns

none.

this third constructor does not take any vector of transition.

The transition should be added after

rews : reward structure : (state, action) an entry of the sparseMatrix is the reward for state line and action column.

4.1.2.4 ~averageMDP()

```
averageMDP::~averageMDP ( )  [inline]
```

destructor to delete averageMDP object.

Author

EH

4.1.3 Member Function Documentation

4.1.3.1 changeIndex()

```
void averageMDP::changeIndex (
            int index )  [inline]
```

A function to change the index of the state used in value iteration.

Author

Hyon

Version

3

Date

juil 2018

Parameters

index	int the index of the new

4.1.3.2 getChain()

```
sparseMatrix * averageMDP::getChain (
            solutionMDP * policy )  [virtual]
```

A function to build the transition matrix associated to a policy.

Author

Hyon

Version

0.1

Date

dec 2020

Parameters

policy	solutionMDP$*$: pointer to a solution that contains the policy.

Returns

a sparseMatrix

Implements genericMDP.

4.1.3.3 policyCost()

```
double * averageMDP::policyCost (
            solutionMDP * policy,
            double epsilon,
            int maxIter )  [virtual]
```

A function to evaluate the average cost of a policy with iteration of the power.

Author

Hyon

Version

0.1

Date

Feb 2019

Parameters

policy	solutionMDP : object to get of the action
maxIter	int : the maximum number of iterations.
epsilon	double.

Returns

a pointer on a double which is the average cost in each state (identical in unichain model).

Implements genericMDP.

4.1.3.4 policyIteration()

```
solutionMDP * averageMDP::policyIteration (
            int maxIter )  [virtual]
```

A function to solve (discrete time) MDP using policy iteration algorithm.

Author

Hyon

Version

3

Date

nov 2018

Parameters

maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

Warning

not implemented

Implements genericMDP.

4.1.3.5 policyIterationModified()

```
solutionMDP * averageMDP::policyIterationModified (
            double epsilon,
            int maxIter,
            double delta,
            int maxInIter )  [virtual]
```

A function to solve (discrete time) MDP using modified policy iteration algorithm.

Author

Hyon

Version

0.1

Date

Feb 2019

Parameters

epsilon	double the precision in the outer loop
maxIter	int : the maximum number of iterations.
delta	precision in the inner loop
maxInIter	nb iter max in the inner loop

Returns

solutionMDP object.

also called modified value iteration in Puterman's book

In the value part of the solution. The average gain is placed.

For an unichain problem the same value is given in the solution for any state.

Implements genericMDP.

4.1.3.6 policyIterationModifiedAA()

```
solutionMDP * averageMDP::policyIterationModifiedAA (
            double epsilon,
            int maxIter,
            double delta,
            int maxInIter )
```

A function to solve (discrete time) MDP using modified policy iteration algorithm and an auto adaptation of error.

Author

Hyon

Version

0.1

Date

Feb 2019

Parameters

epsilon	double the precision in the outer loop
maxIter	int : the maximum number of iterations.
delta	precision in the inner loop
maxInIter	nb iter max in the inner loop

Returns

solutionMDP object.

Also called modified value iteration in Puterman's book.

Here the error for the computation of the iterative solution of the value function is decreased as soon as it is larger than the span.

In the value part of the solution. The average gain is placed.

For an unichain problem : the same value is given in the solution for any state.

AA means AutoAdaptatable

4.1.3.7 relativeValueIteration()

```
solutionMDP * averageMDP::relativeValueIteration (
            double epsilon,
            int maxIter )
```

A function to solve (discrete time) MDP using value relative iteration algorithm.

Author

Hyon

Version

0.1

Date

jan 2019

Parameters

epsilon	double precision of the solution
maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

This is the relative value iteration algorithm which compute a Bellman Equation including bias an average gain.

For unichain problem The average gain is placed in the solution for any state.

4.1.3.8 valueIteration()

```
solutionMDP * averageMDP::valueIteration (
            double epsilon,
            int maxIter )  [virtual]
```

A function to solve (discrete time) MDP using value iteration algorithm.

Author

Hyon

Version

0.1

Date

jan 2019

Parameters

epsilon	double precision of the solution
maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

This is the value iteration algorithm which compute a Bellman Equation defined in part 8.5.1 of Puterman.

In the value part of the solution.

For an unichain problem The average gain is placed for any state in the solution returned.

Implements genericMDP.

4.1.3.9 valueIterationGS()

```
solutionMDP * averageMDP::valueIterationGS (
            double epsilon,
            int maxIter )  [virtual]
```

A function that should implements relative value iteration with Gauss Seidel decomposition.

Author

Hyon

Version

3

Date

apr 2020

Parameters

epsilon	double the precision of the computation
maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

Warning

not implemented

Implements genericMDP.

4.1.3.10 valueIterationMC()

```
solutionMDP * averageMDP::valueIterationMC (
            double epsilon,
            int maxIter )
```

A function to solve (discrete time) MDP using value iteration algorithm for multichain problem.

Author

Hyon

Version

0.1

Date

jul 2020

Parameters

epsilon	double precision of the solution
maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

This is the value iteration algorithm for multichain problem

It implements the algorithm described in Puterman chapter 8

The average gain is placed for any state of state of the recureent class in the solution returned.

4.1.4 Member Data Documentation

4.1.4.1 indexEtatSpecifique

```
int averageMDP::indexEtatSpecifique  [protected]
```

index de l'etat specifique pour calculer le cout moyen

4.1.4.2 rho

```
double averageMDP::rho  [protected]
```

avergae value

4.1.4.3 type_c

```
std::string averageMDP::type_c  [protected]
```

MDP criteria: here "average"

The documentation for this class was generated from the following files:

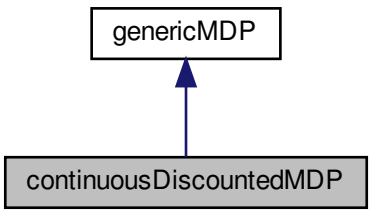
- averageMDP.h
- averageMDP.cpp

4.2 continuousDiscountedMDP Class Reference

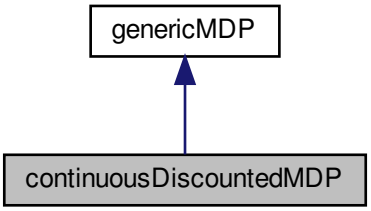
Class continuousDiscountedMDP header: definition of a continuous time infinite horizon discounted MDP.

```
#include <continuousDiscountedMDP.h>
```

Inheritance diagram for continuousDiscountedMDP:



Collaboration diagram for continuousDiscountedMDP:



Public Member Functions

- void writeMDP ()

  function providing printing function to stdout.
- discountedMDP (std::string r, marmoteSet ∗states, marmoteSet ∗actions, std::vector< sparseMatrix ∗> trans, std::vector< sparseMatrix ∗> rews, double b)

  Constructor to create discountedMDP object.

Protected Attributes

- double beta
- std::string type_c
- sparseMatrix ∗ accumulateRewards

4.2.1 Detailed Description

Class continuousDiscountedMDP header: definition of a continuous time infinite horizon discounted MDP.

Author

Emmanuel Hyon

Version

3

Date

dec 2018

This class is inherited from the abstract class genericMDP.

This class is dedicated to the modeling and the solving of discounted infinite horizon MDP

4.2.2 Member Function Documentation

4.2.2.1 discountedMDP()

```
continuousDiscountedMDP::discountedMDP (
            std::string r,
            marmoteSet * states,
            marmoteSet * actions,
            std::vector< sparseMatrix *> trans,
            std::vector< sparseMatrix *> rews,
            double b )
```

Constructor to create discountedMDP object.

Author

EH

Version

0.1

Date

Oct 2020

Parameters

r	string : type_r rule value can be "min" , "max".
states	marmoteSet : State space
actions	marmoteSet : Action space
trans	vector<sparseMatrix*> : transition structures vector of sparseMatrix.
rews	sparseMatrix : reward structure : sparseMatrix object (state, action) an entry of the matrix is the reward for state indexed by line and action indexed by * column. These costs are instanteneousCosts
accumRews	sparseMatrix : reward structure : sparseMatrix object (state, action) an entry of the matrix is the reward for state indexed by line and action indexed by * column. these costs are given in per unit of time
b	double : discount factor beta

Returns

none.

This second constructor take an other form of reward description. It corresponds with the theoretical model where reward depends on transition and reached state : r(i,a,j) Then cost_perStage method is used to be consistent with the reward attribute

trans : transition structures vector of sparseMatrix objects an entry of the vector ∗ is a transition structure matrix from state to state for the action at vector index.

rews vector of sparse matrix objects an entry of the vector is the reward structure from state to state when trigger action (action is the index of the vector).

4.2.3 Member Data Documentation

4.2.3.1 accumulateRewards

```
sparseMatrix* continuousDiscountedMDP::accumulateRewards  [protected]
```

a rewards (costs) structure (row : state, column : action)

4.2.3.2 beta

```
double continuousDiscountedMDP::beta  [protected]
```

discount factor

4.2.3.3 type_c

```
std::string continuousDiscountedMDP::type_c  [protected]
```

MDP criteria: here "infinite discounted"

The documentation for this class was generated from the following file:

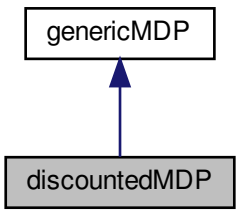
- continuousDiscountedMDP.h

4.3 discountedMDP Class Reference

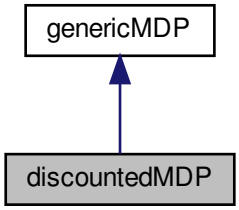
Class discountedMDP header: definition of an infinite horizon discounted MDP class.

```
#include <discountedMDP.h>
```

Inheritance diagram for discountedMDP:



Collaboration diagram for discountedMDP:



Public Member Functions

- void writeMDP ()

  function providing printing function to stdout.
- discountedMDP (std::string r, marmoteSet ∗states, marmoteSet ∗actions, std::vector< sparseMatrix ∗> trans, sparseMatrix ∗rews, double b)

  Constructor to create discountedMDP object.
- discountedMDP (std::string r, marmoteSet ∗states, marmoteSet ∗actions, std::vector< sparseMatrix ∗> trans, std::vector< sparseMatrix ∗> rews, double b)

  Constructor to create discountedMDP object.
- discountedMDP (std::string r, marmoteSet ∗states, marmoteSet ∗actions, sparseMatrix ∗rews, double b)

  Constructor to create discountedMDP object with no vector of transition in parameters.
- virtual ∼discountedMDP ()

  destructor to delete discountedMDP object.
- solutionMDP ∗ valueIteration (double epsilon, int maxIter)

  A function to solve (discrete time) MDP using value iteration algorithm.
- solutionMDP ∗ valueIterationGS (double epsilon, int maxIter)

  A function to solve (discrete time) MDP using value iteration algorithm with Gauss Seidel improvement.
- solutionMDP ∗ policyIterationModified (double epsilon, int maxIter, double delta, int maxInIter)

  A function to solve (discrete time) MDP using modified policy iteration algorithm.
- solutionMDP ∗ policyIterationModifiedGS (double epsilon, int maxIter, double delta, int maxInIter)

  A function to solve (discrete time) MDP using modified policy iteration algorithm and Gauss Seidel improvement.
- solutionMDP ∗ policyIteration (int maxIter)

  A function to solve (discrete time) MDP using policy iteration algorithm.
- double ∗ policyCost (solutionMDP ∗policy, double epsilon, int maxIter)

  A function to evaluate the cost of a policy with iteration of the power.
- double ∗ policyCostbyIndex (solutionMDP ∗policy, double epsilon, int maxIter)

  A function to evaluate the cost of a policy with iteration of the power and the scan of the set is done by index.
- sparseMatrix ∗ getChain (solutionMDP ∗policy)

  A function to build the transition matrix associated to a policy.

Protected Attributes

- double beta
- std::string type_c

4.3.1 Detailed Description

Class discountedMDP header: definition of an infinite horizon discounted MDP class.

Author

Emmanuel Hyon

Version

3

Date

dec 2018

This class is inherited from the abstract class genericMDP.

This class is dedicated to the modeling and the solving of discounted infinite horizon MDP

4.3.2 Constructor & Destructor Documentation

4.3.2.1 discountedMDP() [1/3]

```
discountedMDP::discountedMDP (
            std::string r,
            marmoteSet * states,
            marmoteSet * actions,
            std::vector< sparseMatrix *> trans,
            sparseMatrix * rews,
            double b )
```

Constructor to create discountedMDP object.

Author

EH

Version

1

Date

dec 2018

Parameters

r	string : type_r rule value can be "min" , "max".
states	marmoteSet : State space
actions	marmoteSet : Action space
trans	vector<sparseMatrix*> : transition structures vector of sparseMatrix.
rews	sparseMatrix : reward structure : sparseMatrix object (state, action) an entry of the matrix is the reward for state indexed by line and action indexed by * column.
b	double : discount factor beta

Returns

none.

trans : transition structures vector of sparseMatrix objects an entry of the vector is a transition structure matrix from state to state for the action at vector index.

reward structure : (state, action) an entry of the sparseMatrix is the reward for state in line and action in column.

4.3.2.2 discountedMDP() [2/3]

```
discountedMDP::discountedMDP (
            std::string r,
            marmoteSet * states,
            marmoteSet * actions,
            std::vector< sparseMatrix *> trans,
            std::vector< sparseMatrix *> rews,
            double b )
```

Constructor to create discountedMDP object.

Author

EH

Version

1

Date

dec 2018

Parameters

r	string : type_r rule value can be "min" , "max".
states	marmoteSet : State space
actions	marmoteSet : Action space
trans	vector<sparseMatrix*> : transition structures vector of sparseMatrix.
rews	vector<sparseMatrix*> vector of sparse matrix objects an entry of the vector is the reward structure from state to state for the action.
b	double : discount factor beta

Returns

none.

This second constructor take an other form of reward description. It corresponds with the theoretical model where reward depends on transition and reached state : r(i,a,j) Then cost_perStage method is used to be consistent with the reward attribute

trans : transition structures vector of sparseMatrix objects an entry of the vector ∗ is a transition structure matrix from state to state for the action at vector index.

rews vector of sparse matrix objects an entry of the vector is the reward structure from state to state when trigger action (action is the index of the vector).

4.3.2.3 discountedMDP() [3/3]

```
discountedMDP::discountedMDP (
            std::string r,
            marmoteSet * states,
            marmoteSet * actions,
            sparseMatrix * rews,
            double b )
```

Constructor to create discountedMDP object with no vector of transition in parameters.

Author

Hyon

Version

1

Date

july 2020

Parameters

r	string : type_r rule value can be "min" , "max".
states	: marmoteSet. State space
actions	: marmoteSet. Action space
rews	: reward : sparseMatrix object (state, action) an entry of the matrix is the reward for state line and action column.
b	double : discount factor beta

Returns

none.

this third constructor does not take any vector of transition.

The transition should be added after

rews : reward structure : (state, action) an entry of the sparseMatrix is the reward for state line and action column.

4.3.2.4 ~discountedMDP()

```
discountedMDP::~discountedMDP ( )  [virtual]
```

destructor to delete discountedMDP object.

Author

EH

4.3.3 Member Function Documentation

4.3.3.1 getChain()

```
sparseMatrix * discountedMDP::getChain (
            solutionMDP * policy )  [virtual]
```

A function to build the transition matrix associated to a policy.

Author

Hyon

Version

0.1

Date

dec 2020

Parameters

policy	solutionMDP* : pointer to a solution that contains the policy.

Returns

a sparseMatrix

Implements genericMDP.

4.3.3.2 policyCost()

```
double * discountedMDP::policyCost (
            solutionMDP * policy,
            double epsilon,
            int maxIter )  [virtual]
```

A function to evaluate the cost of a policy with iteration of the power.

Author

EH

Version

1.1

Date

april 2018

Parameters

policy	solutionMDP : object to get of the action
maxIter	int : the maximum number of iterations.
epsilon	double.

Returns

double.

Implements genericMDP.

4.3.3.3 policyCostbyIndex()

```
double * discountedMDP::policyCostbyIndex (
            solutionMDP * policy,
            double epsilon,
            int maxIter )
```

A function to evaluate the cost of a policy with iteration of the power and the scan of the set is done by index.

Author

EH

Version

3

Date

april 2018

Parameters

policy	solutionMDP : object to get of the action
maxIter	int : the maximum number of iterations.
epsilon	double.

Returns

double.

For purpose of debug

4.3.3.4 policyIteration()

```
solutionMDP * discountedMDP::policyIteration (
            int maxIter )  [virtual]
```

A function to solve (discrete time) MDP using policy iteration algorithm.

Author

EH

Version

3

Date

jan 2018

Parameters

maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

Warning

not fully implemented

Implements genericMDP.

4.3.3.5 policyIterationModified()

```
solutionMDP * discountedMDP::policyIterationModified (
            double epsilon,
            int maxIter,
            double delta,
            int maxInIter )  [virtual]
```

A function to solve (discrete time) MDP using modified policy iteration algorithm.

Author

EH

Version

1.4

Date

Feb 2019

Parameters

epsilon	double the precision in the outer loop
maxIter	int : the maximum number of iterations.
delta	precision in the inner loop
maxInIter	nb iter max in the inner loop

Returns

solutionMDP object.

also called hybrid value iteration in Powell

Implements genericMDP.

4.3.3.6 policyIterationModifiedGS()

```
solutionMDP * discountedMDP::policyIterationModifiedGS (
            double epsilon,
            int maxIter,
            double delta,
            int maxInIter )
```

A function to solve (discrete time) MDP using modified policy iteration algorithm and Gauss Seidel improvement.

Author

EH

Version

1.4

Date

Feb 2019

Parameters

epsilon	double the precision in the outer loop
maxIter	int : the maximum number of iterations.
delta	precision in the inner loop
maxInIter	nb iter max in the inner loop

Returns

solutionMDP object.

also called hybrid value iteration in Powell

4.3.3.7 valueIteration()

```
solutionMDP * discountedMDP::valueIteration (
            double epsilon,
            int maxIter )  [virtual]
```

A function to solve (discrete time) MDP using value iteration algorithm.

Author

EH

Version

3

Date

jan 2018

Parameters

epsilon	double precision of the solution
maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

Implements genericMDP.

4.3.3.8 valueIterationGS()

```
solutionMDP * discountedMDP::valueIterationGS (
            double epsilon,
            int maxIter )  [virtual]
```

A function to solve (discrete time) MDP using value iteration algorithm with Gauss Seidel improvement.

Author

EH

Version

1

Date

feb 2019

Parameters

epsilon	double precision of the solution
maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

Warning

not fully implemented

Implements genericMDP.

4.3.4 Member Data Documentation

4.3.4.1 beta

```
double discountedMDP::beta  [protected]
```

discount factor

4.3.4.2 type_c

```
std::string discountedMDP::type_c  [protected]
```

MDP criteria: here "infinite discounted"

The documentation for this class was generated from the following files:

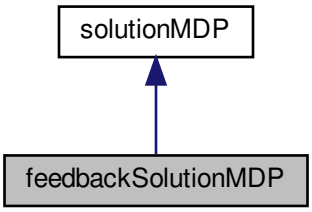
- discountedMDP.h
- discountedMDP.cpp

4.4 feedbackSolutionMDP Class Reference

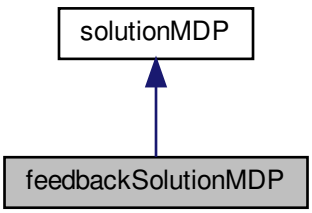
Class feedbackSolutionMDP: implementation of a feebackSolutionMDP class.

```
#include <feedbackSolutionMDP.h>
```

Inheritance diagram for feedbackSolutionMDP:



Collaboration diagram for feedbackSolutionMDP:



Public Member Functions

- feedbackSolutionMDP ()

  Constructor to create feedbackSolution object.
- ~feedbackSolutionMDP ()

  destructor to delete feedbackSolution object.
- void setAction (int *a)

  setter of the action vector
- int * getAction ()

  getter of the action vector
- void setValue (double *t)

  setter of the value function vector
- double * getValue ()

  getter of the value function vector
- void setActionIndex (int indice, int value)

  setter of only one action at index
- int getActionIndex (int indice)

  getter of only one action at index
- double getValueIndex (int indice)

  getter of only one value at index
- void writeSolution ()

  A function to print the solution object.
- void writeSolutionByDim (int d, marmoteSet *set)

  A function to print the solution object w.r.t. a dimension.

Protected Attributes

- int * action
- double * value

4.4.1 Detailed Description

Class feedbackSolutionMDP: implementation of a feebackSolutionMDP class.

This class is inherited from the abstract class solutionMDP.

Author

Hyon, lip6.

Version

3

Date

jan 2018

4.4.2 Constructor & Destructor Documentation

4.4.2.1 feedbackSolutionMDP()

```
feedbackSolutionMDP::feedbackSolutionMDP ( )
```

Constructor to create feedbackSolution object.

Author

EH

Constructeur qui initialise deux vecteurs null pour les deux attributs

4.4.2.2 ~feedbackSolutionMDP()

```
feedbackSolutionMDP::~feedbackSolutionMDP ( )
```

destructor to delete feedbackSolution object.

Author

AM EH

4.4.3 Member Function Documentation

4.4.3.1 getAction()

```
int * feedbackSolutionMDP::getAction ( )
```

getter of the action vector

Author

EH

Date

july 2019

Returns

a pointer to the array of int that code the indexes of the optimal action.

4.4.3.2 getActionIndex()

```
int feedbackSolutionMDP::getActionIndex (
            int indice )
```

getter of only one action at index

Author

AM EH

Date

feb 2018

Parameters

indice	: int index de la valeur de l'action à retourner

Returns

int the index of the action

4.4.3.3 getValue()

```
double * feedbackSolutionMDP::getValue ( )
```

getter of the value function vector

Author

EH

Date

july 2019

Returns

double ∗ Pointeur sur un vecteur (tableau) de double de dimension le cardinal de l'espace d etat.

4.4.3.4 getValueIndex()

```
double feedbackSolutionMDP::getValueIndex (
            int indice )
```

getter of only one value at index

Author

EH

Date

feb 2019

Parameters

indice	: int index de la valeur à retourner

Returns

double the value at indice

4.4.3.5 setAction()

```
void feedbackSolutionMDP::setAction (
            int * a )
```

setter of the action vector

Author

AM EH

Date

feb 2018

Parameters

a	: int $*$. Pointeur sur un vecteur d'entiers de dimension le cardinal de l'espace d etat. Chaque entree représente represente l'index de l'action à effectuer quand on est dans l'etat dont l'index est la coordonnée.

Returns

none.

4.4.3.6 setActionIndex()

```
void feedbackSolutionMDP::setActionIndex (
            int indice,
            int value )
```

setter of only one action at index

Author

AM EH

Date

feb 2018

Parameters

indice	: int index de la valeur de l'action à modifier
value	: int nouvelle valeur

Returns

none.

4.4.3.7 setValue()

```
void feedbackSolutionMDP::setValue (
            double * t )
```

setter of the value function vector

Author

AM EH

Date

feb 2018

Parameters

t	: double * Pointeur sur un vecteur de double de dimension le cardinal de l'espace d etat. Chaque entree représente la valeur est la valeur de la fonction de valeur dans l etat dont l'index est la coordonnée du vecteur

Returns

none.

4.4.3.8 writeSolution()

```
void feedbackSolutionMDP::writeSolution ( )  [virtual]
```

A function to print the solution object.

Author

Abood Mourad.

Returns

none.

Reimplemented from solutionMDP.

4.4.3.9 writeSolutionByDim()

```
void feedbackSolutionMDP::writeSolutionByDim (
            int d,
            marmoteSet * set )  [virtual]
```

A function to print the solution object w.r.t. a dimension.

Author

E.H.

Date

Jul 2020

Parameters

d	an integer giving the dimension
set	the stateSpace of the problem

Returns

none.

Reimplemented from solutionMDP.

4.4.4 Member Data Documentation

4.4.4.1 action

```
int* feedbackSolutionMDP::action  [protected]
```

A vector of actions representing the optimal policy.

4.4.4.2 value

```
double* feedbackSolutionMDP::value  [protected]
```

A vector of associated values.

The documentation for this class was generated from the following files:

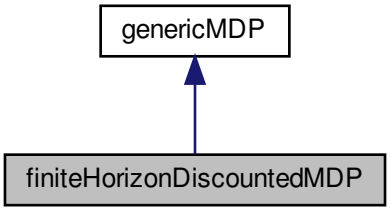
- feedbackSolutionMDP.h
- feedbackSolutionMDP.cpp

4.5 finiteHorizonDiscountedMDP Class Reference

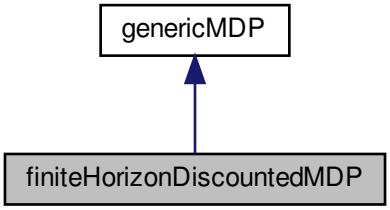
Class finiteHorizonDiscountedMDP: definition of a finite horizon MDP class with discounted cost.

`#include <finiteHorizonDiscountedMDP.h>`

Inheritance diagram for finiteHorizonDiscountedMDP:



Collaboration diagram for finiteHorizonDiscountedMDP:



Public Member Functions

- void writeMDP ()

  function providing printing function to stdout.
- finiteHorizonDiscountedMDP (std::string r, marmoteSet *states, marmoteSet *actions, std::vector< sparse↩ Matrix *> trans, sparseMatrix *rews, int horiz, double b)

  Constructor to create finiteHorizonDiscountedMDP object.
- finiteHorizonDiscountedMDP (std::string r, marmoteSet *states, marmoteSet *actions, std::vector< sparse↩ Matrix *> trans, std::vector< sparseMatrix *> rews, int horiz, double b)

  Constructor to create finiteHorizonDiscountedMDP object.
- ~finiteHorizonDiscountedMDP ()

  destructor to delete finiteMDP object.
- solutionMDP * valueIteration (double epsilon, int maxIter)

  A function to solve (discrete time finite horizon MDP with discounted cost using DP algorithm.

- solutionMDP * valueIteration ()

  A function to solve discrete time finite horizon MDP with discounted cost without parameters.
- solutionMDP * valueIterationGS (double epsilon, int maxIter)

  A function that has no significance for finite horizon problem.
- solutionMDP * policyIterationModified (double epsilon, int maxIter, double delta, int maxInIter)

  A function that has no significance for finite horizon.
- solutionMDP * policyIteration (int maxIter)

  A function that has no significance for finite horizon.
- double * policyCost (solutionMDP *policy, double epsilon, int maxIter)

  A function to evaluate the cost of a policy.
- sparseMatrix * getChain (solutionMDP *policy)

  A function to build the transition matrix associated to a policy.

Protected Attributes

- int horizon_
- std::string type_c
- double beta_

4.5.1 Detailed Description

Class finiteHorizonDiscountedMDP: definition of a finite horizon MDP class with discounted cost.

Author

Hyon, lip6.

Version

0.1

Date

12th May 2020

This class is inherited from the abstract class genericMDP.

It describes a finite horizon MDP model with horizon and stationary transitions and stationnary costs. A discount factor is also considered

The index of the times varies between 0 and horizon-1.

We assume that the cost at index horizon is null

4.5.2 Constructor & Destructor Documentation

4.5.2.1 finiteHorizonDiscountedMDP() [1/2]

```
finiteHorizonDiscountedMDP::finiteHorizonDiscountedMDP (
            std::string r,
            marmoteSet * states,
            marmoteSet * actions,
            std::vector< sparseMatrix *> trans,
            sparseMatrix * rews,
            int horiz,
            double b )
```

Constructor to create finiteHorizonDiscountedMDP object.

Author

EH

Version

0.9

Date

May 2020

Parameters

r	string : type_r rule value can be "min" , "max".
states	marmoteSet : State space
actions	marmoteSet : Action space
trans	vector<sparseMatrix∗> : transition structures vector of sparseMatrix.
rews	sparseMatrix : reward structure. The sparseMatrix object (state, action) an ∗ entry of the matrix is the reward for state indexed by line and action indexed by ∗ column.
horiz	: int. The horizon of the problem.
b	: double the discount factor

Returns

none.

trans : transition structures vector of sparseMatrix objects an entry of the vector ∗ is a transition structure matrix from state to state for the action at vector index.

reward structure : (state, action) an entry of the sparseMatrix is the reward for ∗ state in line and action in column.

4.5.2.2 finiteHorizonDiscountedMDP() [2/2]

```
finiteHorizonDiscountedMDP::finiteHorizonDiscountedMDP (
            std::string r,
            marmoteSet * states,
```

```
marmoteSet * actions,
std::vector< sparseMatrix *> trans,
std::vector< sparseMatrix *> rews,
int horiz,
double b )
```

Constructor to create finiteHorizonDiscountedMDP object.

Author

EH

Version

0.9

Date

May 2020

Parameters

r	string : type_r rule value can be "min" , "max".
states	marmoteSet : State space
actions	marmoteSet : Action space
trans	vector<sparseMatrix*> : transition structures vector of sparseMatrix.
rews	vector<sparseMatrix*> vector of sparse matrix objects an entry of the vector is the reward structure from state to state for the action.
horiz	: int. The horizon of the problem.
b	: double the discount factor

Returns

none.

This second constructor take an other form of reward description. It corresponds with the theoretical model where reward depends on transition and reached state r(i,a,j) Then cost_perStage method is used to be consistent with the reward attribute

trans : transition structures vector of sparseMatrix objects an entry of the vector is a transition structure matrix from state to state for the action at vector index.

rews vector of sparse matrix objects: an entry of the vector is the reward structure from state to state when trigger action (action is the index of the vector).

4.5.2.3 ~finiteHorizonDiscountedMDP()

```
finiteHorizonDiscountedMDP::~finiteHorizonDiscountedMDP ( )  [inline]
```

destructor to delete finiteMDP object.

Author

EH

Version

0.9

Date

jul 2019

4.5.3 Member Function Documentation

4.5.3.1 getChain()

```
sparseMatrix * finiteHorizonDiscountedMDP::getChain (
            solutionMDP * policy )  [virtual]
```

A function to build the transition matrix associated to a policy.

Author

Hyon

Version

0.1

Date

dec 2020

Parameters

policy	solutionMDP∗ : pointer to a solution that contains the policy.

Returns

a sparseMatrix

Implements genericMDP.

4.5.3.2 policyCost()

```
double * finiteHorizonDiscountedMDP::policyCost (
            solutionMDP * policy,
            double epsilon,
            int maxIter )  [virtual]
```

A function to evaluate the cost of a policy.

Author

Hyon

Version

1

Date

May 2020

Parameters

policy	solutionMDP∗ : pointer to a solution that contains the optimal policy.
maxIter	int : the maximum number of iterations.
epsilon	double.

Returns

a pointer to the array of the value at the first step.

Note that all the values are filled in.

Implements genericMDP.

4.5.3.3 policyIteration()

```
solutionMDP * finiteHorizonDiscountedMDP::policyIteration (
            int maxIter )  [virtual]
```

A function that has no significance for finite horizon.

Author

Hyon

Version

1

Date

jul 2020

Parameters

maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

Warning

return a NULL

Not implemented Kept only for compatibility

Implements genericMDP.

4.5.3.4 policyIterationModified()

```
solutionMDP * finiteHorizonDiscountedMDP::policyIterationModified (
            double epsilon,
            int maxIter,
            double delta,
            int maxInIter )  [virtual]
```

A function that has no significance for finite horizon.

Author

EH

Version

1

Date

Jul 2020

Parameters

epsilon	double the precision in the outer loop
maxIter	int : the maximum number of iterations.
delta	precision in the inner loop
maxInIter	nb iter max in the inner loop

Returns

solutionMDP object.

Warning

return a NULL

Not implemented Kept only for compatibility

Implements genericMDP.

4.5.3.5 valueIteration() [1/2]

```
solutionMDP * finiteHorizonDiscountedMDP::valueIteration (
            double epsilon,
            int maxIter )  [virtual]
```

A function to solve (discrete time finite horizon MDP with discounted cost using DP algorithm.

Author

EH

Version

0.9

Date

May 2020

Parameters

epsilon	double : no utility only for be consistent with genericMDP
maxIter	int : no utility only for be consistent with genericMDP

Returns

solutionMDP object.

Implements genericMDP.

4.5.3.6 valueIteration() [2/2]

```
solutionMDP * finiteHorizonDiscountedMDP::valueIteration ( )
```

A function to solve discrete time finite horizon MDP with discounted cost without parameters.

Author

EH

Version

0.9

Date

May 2020

Returns

solutionMDP object. Do only a call to the generic value iteration function with dummy parameters

4.5.3.7 valueIterationGS()

```
solutionMDP * finiteHorizonDiscountedMDP::valueIterationGS (
            double epsilon,
            int maxIter )  [virtual]
```

A function that has no significance for finite horizon problem.

Author

EH

Version

1

Date

jul 2020

Parameters

epsilon	double precision of the solution
maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

Warning

return a NULL

Not implemented Kept only for compatibility

Implements genericMDP.

4.5.3.8 writeMDP()

```
void finiteHorizonDiscountedMDP::writeMDP ( )  [virtual]
```

function providing printing function to stdout.

Author

EH

Version

0.9

Date

May 2020

Reimplemented from genericMDP.

4.5.4 Member Data Documentation

4.5.4.1 beta_

```
double finiteHorizonDiscountedMDP::beta_  [protected]
```

discount factor

4.5.4.2 horizon_

```
int finiteHorizonDiscountedMDP::horizon_  [protected]
```

the time horizon>

4.5.4.3 type_c

```
std::string finiteHorizonDiscountedMDP::type_c  [protected]
```

MDP criteria: here "finiteHorizonDiscounted"

The documentation for this class was generated from the following files:

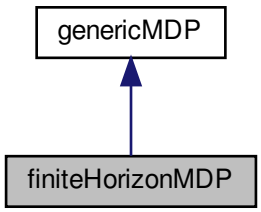
- finiteHorizonDiscountedMDP.h
- finiteHorizonDiscountedMDP.cpp

4.6 finiteHorizonMDP Class Reference

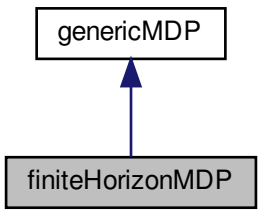
Class finiteHorizonMDP: definition of a finite horizon MDP class.

```
#include <finiteHorizonMDP.h>
```

Inheritance diagram for finiteHorizonMDP:



Collaboration diagram for finiteHorizonMDP:



Public Member Functions

- void writeMDP ()

  function providing printing function to stdout.
- finiteHorizonMDP (std::string r, marmoteSet ∗states, marmoteSet ∗actions, std::vector< sparseMatrix ∗> trans, sparseMatrix ∗rews, int horiz)

  Constructor to create finiteHorizonMDP object.
- finiteHorizonMDP (std::string r, marmoteSet ∗states, marmoteSet ∗actions, std::vector< sparseMatrix ∗> trans, std::vector< sparseMatrix ∗> rews, int horiz)

  Constructor to create finiteHorizonMDP object.
- ∼finiteHorizonMDP ()

  destructor to delete finiteMDP object.
- solutionMDP ∗ valueIteration (double epsilon, int maxIter)

  A function to solve (discrete time finite horizon MDP using DP algorithm.
- solutionMDP ∗ valueIteration ()

  A function to solve discrete time finite horizon MDP without parameters.
- solutionMDP ∗ valueIterationGS (double epsilon, int maxIter)

  A function that has no significance for finite horizon problem.
- solutionMDP ∗ policyIterationModified (double epsilon, int maxIter, double delta, int maxInIter)

  A function that has no significance for finite horizon.
- solutionMDP ∗ policyIteration (int maxIter)

  A function that has no significance for finite horizon.
- double ∗ policyCost (solutionMDP ∗policy, double epsilon, int maxIter)

  A function to evaluate the cost of a policy.
- sparseMatrix ∗ getChain (solutionMDP ∗policy)

  A function to build the transition matrix associated to a policy.

Protected Attributes

- int horizon_
- std::string type_c

4.6.1 Detailed Description

Class finiteHorizonMDP: definition of a finite horizon MDP class.

Author

Hyon, lip6.

Version

1.1

Date

12th jan 2020

This class is inherited from the abstract class genericMDP.

It describes a finite horizon MDP model with horizon and stationary transitions and costs.

The index of the times varies between 0 and horizon-1.

We assume that the cost at index horizon is null

4.6.2 Constructor & Destructor Documentation

4.6.2.1 finiteHorizonMDP() [1/2]

```
finiteHorizonMDP::finiteHorizonMDP (
            std::string r,
            marmoteSet * states,
            marmoteSet * actions,
            std::vector< sparseMatrix *> trans,
            sparseMatrix * rews,
            int horiz )
```

Constructor to create finiteHorizonMDP object.

Author

EH

Version

0.9

Date

jul 2019

Parameters

r	string : type_r rule value can be "min" , "max".
states	marmoteSet : State space
actions	marmoteSet : Action space
trans	vector<sparseMatrix*> : transition structures vector of sparseMatrix.
rews	sparseMatrix : reward structure. The sparseMatrix object (state, action) an * entry of the matrix is the reward for state indexed by line and action indexed by * column.
horiz	: int. The horizon of the problem.

Returns

none.

trans : transition structures vector of sparseMatrix objects an entry of the vector * is a transition structure matrix from state to state for the action at vector index.

reward structure : (state, action) an entry of the sparseMatrix is the reward for * state in line and action in column.

4.6.2.2 finiteHorizonMDP() [2/2]

```
finiteHorizonMDP::finiteHorizonMDP (
            std::string r,
            marmoteSet * states,
            marmoteSet * actions,
            std::vector< sparseMatrix *> trans,
            std::vector< sparseMatrix *> rews,
            int horiz )
```

Constructor to create finiteHorizonMDP object.

Author

EH

Version

0.9

Date

jul 2019

Parameters

r	string : type_r rule value can be "min" , "max".
states	marmoteSet : State space
actions	marmoteSet : Action space
trans	vector<sparseMatrix*> : transition structures vector of sparseMatrix.
rews	vector<sparseMatrix*> vector of sparse matrix objects an entry of the vector is the reward structure from state to state for the action.
horiz	: int. The horizon of the problem.

Returns

none.

This second constructor take an other form of reward description. It corresponds with the theoretical model where reward depends on transition and reached state r(i,a,j) Then cost_perStage method is used to be consistent with the reward attribute

trans : transition structures vector of sparseMatrix objects an entry of the vector is a transition structure matrix from state to state for the action at vector index.

rews vector of sparse matrix objects: an entry of the vector is the reward structure from state to state when trigger action (action is the index of the vector).

4.6.2.3 ~finiteHorizonMDP()

```
finiteHorizonMDP::~finiteHorizonMDP ( )  [inline]
```

destructor to delete finiteMDP object.

Author

EH

Version

0.9

Date

jul 2019

4.6.3 Member Function Documentation

4.6.3.1 getChain()

```
sparseMatrix * finiteHorizonMDP::getChain (
            solutionMDP * policy )  [virtual]
```

A function to build the transition matrix associated to a policy.

Author

Hyon

Version

0.1

Date

dec 2020

Parameters

policy	solutionMDP* : pointer to a solution that contains the policy.

Returns

a sparseMatrix

Implements genericMDP.

4.6.3.2 policyCost()

```
double * finiteHorizonMDP::policyCost (
            solutionMDP * policy,
            double epsilon,
            int maxIter )  [virtual]
```

A function to evaluate the cost of a policy.

Author

Hyon

Version

1

Date

oct 2019

Parameters

policy	solutionMDP∗ : pointer to a solution that contains the optimal policy. It should be a nonstationarySolutionMDP
maxIter	int : the maximum number of iterations.
epsilon	double.

Returns

a pointer to the array of the value at first Step.

Implements genericMDP.

4.6.3.3 policyIteration()

```
solutionMDP * finiteHorizonMDP::policyIteration (
            int maxIter )  [virtual]
```

A function that has no significance for finite horizon.

Author

Hyon

Version

1

Date

jul 2019

Parameters

maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

Warning

return a NULL

Not implemented Kept only for compatibility

Implements genericMDP.

4.6.3.4 policyIterationModified()

```
solutionMDP * finiteHorizonMDP::policyIterationModified (
            double epsilon,
            int maxIter,
            double delta,
            int maxInIter )  [virtual]
```

A function that has no significance for finite horizon.

Author

EH

Version

1

Date

Jul 2019

Parameters

epsilon	double the precision in the outer loop
maxIter	int : the maximum number of iterations.
delta	precision in the inner loop
maxInIter	nb iter max in the inner loop

Returns

solutionMDP object.

Warning

return a NULL

Not implemented Kept only for compatibility

Implements genericMDP.

4.6.3.5 valueIteration() [1/2]

```
solutionMDP * finiteHorizonMDP::valueIteration (
            double epsilon,
            int maxIter )  [virtual]
```

A function to solve (discrete time finite horizon MDP using DP algorithm.

Author

EH

Version

0.91

Date

jan 2020

Parameters

epsilon	double : no utility only for be consistent with genericMDP
maxIter	int : no utility only for be consistent with genericMDP

Returns

solutionMDP object.

Implements genericMDP.

4.6.3.6 valueIteration() [2/2]

```
solutionMDP * finiteHorizonMDP::valueIteration ( )
```

A function to solve discrete time finite horizon MDP without parameters.

Author

EH

Version

1

Date

jan 2020

Returns

solutionMDP object. Do only a call to the generic value iteration function with dummy parameters

4.6.3.7 valueIterationGS()

```
solutionMDP * finiteHorizonMDP::valueIterationGS (
            double epsilon,
            int maxIter )  [virtual]
```

A function that has no significance for finite horizon problem.

Author

EH

Version

1

Date

jul 2019

Parameters

epsilon	double precision of the solution
maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

Warning

return a NULL

Not implemented Kept only for compatibility

Implements genericMDP.

4.6.3.8 writeMDP()

```
void finiteHorizonMDP::writeMDP ( )  [virtual]
```

function providing printing function to stdout.

Author

EH

Version

0.9

Date

jul 2019

Reimplemented from genericMDP.

4.6.4 Member Data Documentation

4.6.4.1 horizon_

```
int finiteHorizonMDP::horizon_  [protected]
```

the time horizon>

4.6.4.2 type_c

```
std::string finiteHorizonMDP::type_c  [protected]
```

MDP criteria: here "finiteHorizon"

The documentation for this class was generated from the following files:

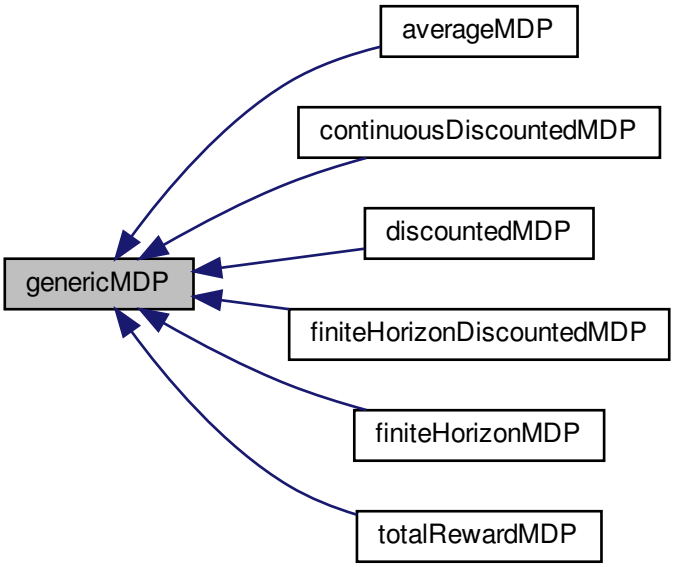
- finiteHorizonMDP.h
- finiteHorizonMDP.cpp

4.7 genericMDP Class Reference

Class genericMDP header : implementation of an abstract MDP class that represents an MDP object and can be inherited by other classes.

```
#include <genericMDP.h>
```

Inheritance diagram for genericMDP:



Public Member Functions

- virtual void writeMDP ()

  virtual function providing interface framework (printing function to stdout.
- genericMDP (std::string t, std::string r, marmoteSet ∗states, marmoteSet ∗actions, std::vector< sparseMatrix ∗> trans, sparseMatrix ∗rews)

  Constructor to create genericMDP object.
- genericMDP (std::string t, std::string r, marmoteSet ∗states, marmoteSet ∗actions, std::vector< sparseMatrix ∗> trans, std::vector< sparseMatrix ∗> rews)

  Constructor to create genericMDP object with a vector of transition structure for rewards.
- genericMDP (std::string t, std::string r, marmoteSet ∗states, marmoteSet ∗actions, sparseMatrix ∗rews)

  Constructor to create genericMDP object with no vector of transition in parameters.
- sparseMatrix ∗ cost_perStage (std::vector< sparseMatrix ∗> rews)

  A function to calculate costs (rewards) per stage.
- void clearRew ()

  a function to delete reward when it has been created during the building of the object
- void addMatrix (int i, sparseMatrix ∗spM)

  a function to add a reference to a transition matrix in a dedicated position in the vector
- void deleMatrix (int i)

  a function to delete a reference in a specified position in the vector
- virtual solutionMDP ∗ valueIteration (double epsilon, int maxIter)=0

  A function to solve (discrete time) MDP using value iteration algorithm.
- virtual solutionMDP ∗ valueIterationGS (double epsilon, int maxIter)=0

  A function to solve (discrete time) MDP using value iteration algorithm with Gauss Seidel improvement.
- virtual solutionMDP ∗ policyIterationModified (double epsilon, int maxIter, double delta, int moyIter)=0

  A function to solve (discrete time) MDP using modified policy iteration algorithm.
- virtual solutionMDP ∗ policyIteration (int maxIter)=0

  A function to solve (discrete time) MDP using policy iteration algorithm.
- virtual double ∗ policyCost (solutionMDP ∗policy, double epsilon, int maxIter)=0

  A function to evaluate the cost of a policy with iteration of the power.
- virtual sparseMatrix ∗ getChain (solutionMDP ∗policy)=0

  A function to build the transition matrix associated to a policy.

Protected Attributes

- std::string type_t
- std::string type_r
- marmoteSet ∗ stateSpace
- marmoteSet ∗ actionSpace
- std::vector< sparseMatrix ∗ > transitions
- sparseMatrix ∗ rewards
- bool opMin

4.7.1 Detailed Description

Class genericMDP header : implementation of an abstract MDP class that represents an MDP object and can be inherited by other classes.

Author

Hyon, lip6

Date

18 feb 2019

Version

1.4

This class is generic, it contains the general elements of MDP: MDP type : time type, optimization rule, state space, action space, action space, list of transition probabilities, list of transition rewards.

4.7.2 Constructor & Destructor Documentation

4.7.2.1 genericMDP() [1/3]

```
genericMDP::genericMDP (
            std::string t,
            std::string r,
            marmoteSet * states,
            marmoteSet * actions,
            std::vector< sparseMatrix *> trans,
            sparseMatrix * rews )
```

Constructor to create genericMDP object.

Author

Hyon

Version

3

Date

jan 2018

Parameters

t	string : type_t value : "discrete" , "continuous".
r	string : type_r rule value can be "min" , "max".
states	marmoteSet : State space
actions	marmoteSet : Action space
trans	vector<sparseMatrix*> : transition structures vector of sparseMatrix.
rews	sparseMatrix : reward structure : sparseMatrix object (state, action) an entry of the matrix is the reward for state line and action column.

Returns

none.

trans : transition structures vector of sparseMatrix objects an entry of the vector is a transition structure matrix from state to state for the action at vector index.

reward structure : (state, action) an entry of the sparseMatrix is the reward for state line and action column.

4.7.2.2 genericMDP() [2/3]

```
genericMDP::genericMDP (
            std::string t,
            std::string r,
            marmoteSet * states,
            marmoteSet * actions,
            std::vector< sparseMatrix *> trans,
            std::vector< sparseMatrix *> rews )
```

Constructor to create genericMDP object with a vector of transition structure for rewards.

Author

Hyon

Version

3

Date

jan 2018

Parameters

t	: string, type_t values : "discrete" , "continuous".
r	: string, type_r rule can be "min" , "max".
states	: marmoteSet. State space
actions	: marmoteSet. Action space
trans	: vector<sparseMatrix*> transition structures vector of sparseMatrix.
rews	: vector<sparseMatrix*> : vector of sparse matrix objects an entry of the vector is the reward structure from state to state for the action.

Returns

none.

this second constructor take an other form reward description. It corresponds with the theoretical model where reward depends on transition r(i,a,j). Then cost_perStage method is used to be consistent with the reward attribute

trans : transition structures vector of sparseMatrix objects an entry of the vector is a transition structure matrix from state to state for the action at vector index.

rews : vector of sparse matrix objects an entry of the vector is the reward structure from state to state when trigger action (action is the index of the vector).

4.7.2.3 genericMDP() [3/3]

```
genericMDP::genericMDP (
            std::string t,
            std::string r,
            marmoteSet * states,
            marmoteSet * actions,
            sparseMatrix * rews )
```

Constructor to create genericMDP object with no vector of transition in parameters.

Author

Hyon

Version

1

Date

june 2020

Parameters

t	: string, type_t values : "discrete" , "continuous".
r	: string, type_r rule can be "min" , "max".
states	: marmoteSet. State space
actions	: marmoteSet. Action space
rews	: reward : sparseMatrix object (state, action) an entry of the matrix is the reward for state line and action column.

Returns

none.

this third constructor does not take any vector of transition. The vector is created during this constructor

rews : reward structure : (state, action) an entry of the sparseMatrix is the reward for state line and action column.

4.7.3 Member Function Documentation

4.7.3.1 addMatrix()

```
void genericMDP::addMatrix (
            int i,
            sparseMatrix * spM )
```

a function to add a reference to a transition matrix in a dedicated position in the vector

Author

EH

Date

apr 2020

Version

0.1

Parameters

i	an integer which is the index of the position of the sparse matrix
spM	a sparseMatrix

4.7.3.2 clearRew()

```
void genericMDP::clearRew ( )
```

a function to delete reward when it has been created during the building of the object

Author

EH

Date

mar 2018

4.7.3.3 cost_perStage()

```
sparseMatrix * genericMDP::cost_perStage (
            std::vector< sparseMatrix *> rews )
```

A function to calculate costs (rewards) per stage.

Author

Abood Mourad.

Version

2

Date

jan 2016

Parameters

rews	vector<sparseMatrix*> : for reward vector of transitionStructure objects (state, action, state), one reward matrix for each action.

Returns

sparseMatrix pointer.

this method transforms this vector in a transition matrix where first entry is the initial state and second entry is the action.

4.7.3.4 deleMatrix()

```
void genericMDP::deleMatrix (
            int i )
```

a function to delete a reference in a specified position in the vector

Author

EH

Date

oct 2020

Version

0.1

Parameters

i	an integer which is the index of the position of the sparse matrix to delete

4.7.3.5 getChain()

```
virtual sparseMatrix* genericMDP::getChain (
            solutionMDP * policy )  [pure virtual]
```

A function to build the transition matrix associated to a policy.

Author

Hyon

Version

0.1

Date

dec 2020

Parameters

policy	solutionMDP∗ : pointer to a solution that contains the policy.

Returns

a sparseMatrix

Implemented in averageMDP, discountedMDP, finiteHorizonDiscountedMDP, finiteHorizonMDP, and totalReward↩MDP.

4.7.3.6 policyCost()

```
virtual double* genericMDP::policyCost (
            solutionMDP * policy,
            double epsilon,
            int maxIter )  [pure virtual]
```

A function to evaluate the cost of a policy with iteration of the power.

Author

Hyon

Version

3

Date

jan 2018

Parameters

policy	solutionMDP∗ : pointer to a solution that contains the optimal policy.
maxIter	int : the maximum number of iterations.
epsilon	double.

Returns

double.

Implemented in discountedMDP, averageMDP, finiteHorizonDiscountedMDP, finiteHorizonMDP, and totalReward↩MDP.

4.7.3.7 policyIteration()

```
virtual solutionMDP* genericMDP::policyIteration (
            int maxIter )  [pure virtual]
```

A function to solve (discrete time) MDP using policy iteration algorithm.

Author

Hyon

Version

3

Date

jan 2018

Parameters

maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

Implemented in discountedMDP, finiteHorizonDiscountedMDP, averageMDP, finiteHorizonMDP, and totalReward↩MDP.

4.7.3.8 policyIterationModified()

```
virtual solutionMDP* genericMDP::policyIterationModified (
            double epsilon,
            int maxIter,
            double delta,
            int moyIter )  [pure virtual]
```

A function to solve (discrete time) MDP using modified policy iteration algorithm.

Author

Hyon

Version

3

Date

jan 2018

Parameters

epsilon	double.
maxIter	int : the maximum number of iterations.
delta	precision in the inner loop
moyIter	nb iter max in the inner loop

Returns

solutionMDP object.

Implemented in averageMDP, finiteHorizonDiscountedMDP, totalRewardMDP, finiteHorizonMDP, and discounted↩MDP.

4.7.3.9 valueIteration()

```
virtual solutionMDP* genericMDP::valueIteration (
            double epsilon,
            int maxIter )  [pure virtual]
```

A function to solve (discrete time) MDP using value iteration algorithm.

Author

Hyon

Version

3

Date

jan 2018

Parameters

epsilon	double precision of the solution
maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

Implemented in averageMDP, discountedMDP, totalRewardMDP, finiteHorizonDiscountedMDP, and finiteHorizon↩ MDP.

4.7.3.10 valueIterationGS()

```
virtual solutionMDP* genericMDP::valueIterationGS (
            double epsilon,
            int maxIter )  [pure virtual]
```

A function to solve (discrete time) MDP using value iteration algorithm with Gauss Seidel improvement.

Author

Hyon

Version

1

Date

feb 2019

Parameters

epsilon	double precision of the solution
maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

Implemented in averageMDP, finiteHorizonDiscountedMDP, finiteHorizonMDP, discountedMDP, and totalReward↩MDP.

4.7.4 Member Data Documentation

4.7.4.1 actionSpace

```
marmoteSet* genericMDP::actionSpace  [protected]
```

Action space represented by marmoteSet object.

4.7.4.2 opMin

```
bool genericMDP::opMin  [protected]
```

the translation of the type for minimizing or maximizing. Equals true if the aim is to minimizing.

4.7.4.3 rewards

```
sparseMatrix* genericMDP::rewards  [protected]
```

a rewards (costs) structure (row : state, column : action)

4.7.4.4 stateSpace

```
marmoteSet* genericMDP::stateSpace  [protected]
```

State space represented by marmoteSet object.

4.7.4.5 transitions

```
std::vector<sparseMatrix*> genericMDP::transitions  [protected]
```

List (vector) of transitionStructure (one transition matrix for each action).

4.7.4.6 type_r

```
std::string genericMDP::type_r  [protected]
```

MDP rule: "min" , "max".

4.7.4.7 type_t

```
std::string genericMDP::type_t  [protected]
```

MDP type: "discrete" , "continuous".

The documentation for this class was generated from the following files:

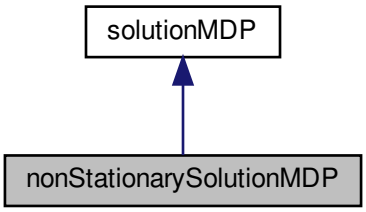
- genericMDP.h
- genericMDP.cpp

4.8 nonStationarySolutionMDP Class Reference

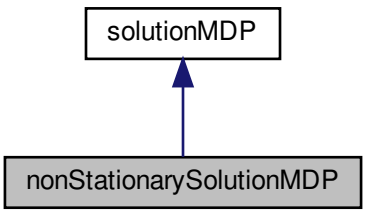
Class nonStationarySolutionMDP: implementation of a nonStationarySolutionMDP class.

```
#include <nonStationarySolutionMDP.h>
```

Inheritance diagram for nonStationarySolutionMDP:



Collaboration diagram for nonStationarySolutionMDP:



Public Member Functions

- nonStationarySolutionMDP (int h, int size)

  Constructor to create feedbackSolution object.
- ∼nonStationarySolutionMDP ()

  destructor to delete feedbackSolution object.
- void writeSolution ()

  A function to print the solution object.
- void setAction (int ∗∗a)

  setter of the action vector
- void setActionAtStep (int step, int ∗t)

  setter of the optimal action vector at step t
- void setActionAtStepIndex (int step, int indice, int action_op)

  setter of only one action at index at step t
- int ∗∗ getAction ()

  getter of the action vector
- int ∗ getActionAtStep (int step)

  getter of only one action vector at step t
- int getActionAtStepIndex (int step, int index)

  getter of only one action at index k at step t
- void setValue (double ∗∗t)

  setter of the value function vector
- void setValueAtStep (int step, double ∗t)

  setter of the value function vector at step t
- void setValueAtStepIndex (int step, int indice, double value_op)

  setter of only one value at index at step t
- double ∗∗ getValue ()

  getter of the value functions vector
- double ∗ getValueAtStep (int step)

  getter of a vector at a given step
- double getValueAtStepIndex (int step, int index)

  getter of only one value at index at step t
- int getHorizon ()

  getter of the horizon
- void writeSolutionByDim (int d, marmoteSet ∗set)

  A function to print the solution object w.r.t. a dimension.

Protected Attributes

- int horizon_
- int ∗∗ action
- double ∗∗ value

4.8.1 Detailed Description

Class nonStationarySolutionMDP: implementation of a nonStationarySolutionMDP class.

Author

Hyon lip6 2019.

Version

0.3

Date

july 2019

This class is inherited from the class solutionMDP.

It contains a data structure (here an array) with two entries one for the horizon and the other for the state.

The horizon is the size of one dimension of the array. The index of the time varies between 0 and horizon-1.

4.8.2 Constructor & Destructor Documentation

4.8.2.1 nonStationarySolutionMDP()

```
nonStationarySolutionMDP::nonStationarySolutionMDP (
            int h,
            int size )
```

Constructor to create feedbackSolution object.

Author

EH

Version

0.2

Date

jan 2019

Parameters

h	: int l'horizon du probleme fini
size	: int la taille de l'espace d'etat

Constructor which initialize two empty arrays pour les deux attributs. One double dimension array for the action and one double dimension array for the values

4.8.2.2 ∼nonStationarySolutionMDP()

```
nonStationarySolutionMDP::∼nonStationarySolutionMDP ( )
```

destructor to delete feedbackSolution object.

Author

AM EH

Version

0.2

Date

jan 2019

4.8.3 Member Function Documentation

4.8.3.1 getAction()

```
int ** nonStationarySolutionMDP::getAction ( )
```

getter of the action vector

Author

EH

Date

july 2019

Version

0.1

Returns

the pointer to the array

This method returns the double entries array

4.8.3.2 getActionAtStep()

```
int * nonStationarySolutionMDP::getActionAtStep (
            int step )
```

getter of only one action vector at step t

Author

EH

Date

jan 2019

Version

0.1

Parameters

step	: int the step for getting the vector

Returns

int * the value vector of the index of the actions

4.8.3.3 getActionAtStepIndex()

```
int nonStationarySolutionMDP::getActionAtStepIndex (
            int step,
            int index )
```

getter of only one action at index k at step t

Author

EH

Date

May 2020

Version

0.1

Parameters

step	: int the step for getting the action
index	: int the index for

Returns

int the action of the index at step

4.8.3.4 getHorizon()

```
int nonStationarySolutionMDP::getHorizon ( )
```

getter of the horizon

Author

EH

Date

oct 2020

Version

0.1

Returns

int the horizon

4.8.3.5 getValue()

```
double ** nonStationarySolutionMDP::getValue ( )
```

getter of the value functions vector

Author

EH

Date

july 2019

Version

0.1

Returns

the array of value functions

4.8.3.6 getValueAtStep()

```
double * nonStationarySolutionMDP::getValueAtStep (
            int step )
```

getter of a vector at a given step

Author

EH

Date

sept 2019

Version

0.2

Parameters

step	: int the step for getting the vector of value at step

Returns

double * the vector of the value at step

4.8.3.7 getValueAtStepIndex()

```
double nonStationarySolutionMDP::getValueAtStepIndex (
            int step,
            int index )
```

getter of only one value at index at step t

Author

EH

Date

jan 2020

Version

0.1

Parameters

step	: int the step for getting the vector
index	: int the index for which we want the value

Returns

double the value at step and index

4.8.3.8 setAction()

```
void nonStationarySolutionMDP::setAction (
            int ** a )
```

setter of the action vector

Author

EH

Date

jul 2019

Version

0.2

Parameters

a	: int $**$. Pointeur sur un tableau de vecteur d'entiers de dimension l'horizon, chaque vecteur etant de dimension le cardinal de l'espace d etat.

This method is a setter for the double entries array

4.8.3.9 setActionAtStep()

```
void nonStationarySolutionMDP::setActionAtStep (
            int step,
            int * t )
```

setter of the optimal action vector at step t

Author

EH

Date

sep 2019

Version

0.2

Parameters

step	: int the step for including the vector
t	: int ∗ Pointer on an integer vector of double (whose dimension should be the state space cardinal)

Chaque entree représente l'action optimale à l'entree dont l'index est la coordonnée du vecteur

4.8.3.10 setActionAtStepIndex()

```
void nonStationarySolutionMDP::setActionAtStepIndex (
            int step,
            int indice,
            int action_op )
```

setter of only one action at index at step t

Author

EH

Date

sept 2019

Version

0.2

Parameters

step	: int the step for including the vector
indice	: int index de la valeur de l'action à modifier
action_op	: int nouvelle valeur de la solution optimale à l'index

4.8.3.11 setValue()

```
void nonStationarySolutionMDP::setValue (
            double ** t )
```

setter of the value function vector

Author

EH

Date

july 2019

Version

0.2

Parameters

t	: double ∗∗ pointer. Pointer on an double dimension array with size l times h. Where the first dimension is the horizon and the second dimension is the state space cardinal.

4.8.3.12 setValueAtStep()

```
void nonStationarySolutionMDP::setValueAtStep (
            int step,
            double * t )
```

setter of the value function vector at step t

Author

EH

Date

jan 2019

Version

0.1

Parameters

step	: int the step for including the vector
t	: double ∗ Pointeur sur un vecteur de double de dimension le cardinal de l'espace d etat.

Chaque entree représente la valeur de la fonction de valeur dans l etat dont l'index est la coordonnée du vecteur

4.8.3.13 setValueAtStepIndex()

```
void nonStationarySolutionMDP::setValueAtStepIndex (
```

```
            int step,
            int indice,
            double value_op )
```

setter of only one value at index at step t

Author

EH

Date

sept 2019

Version

0.2

Parameters

step	: int the step for including the vector
indice	: int index de la valeur de l'action à modifier
value_op	: double nouvelle valeur de l 'index de la valeur optimale

4.8.3.14 writeSolution()

```
void nonStationarySolutionMDP::writeSolution ( )  [virtual]
```

A function to print the solution object.

Author

AM EH

Version

0.2

Date

jan 2019

Reimplemented from solutionMDP.

4.8.3.15 writeSolutionByDim()

```
void nonStationarySolutionMDP::writeSolutionByDim (
            int d,
            marmoteSet * set )  [virtual]
```

A function to print the solution object w.r.t. a dimension.

Author

E.H.

Date

Jul 2020

Parameters

d	an integer giving the dimension wrt to the variation
set	is the stateSpace

Returns

none.

Reimplemented from solutionMDP.

4.8.4 Member Data Documentation

4.8.4.1 action

```
int** nonStationarySolutionMDP::action  [protected]
```

An array whose columns are the index of actions representing the optimal policy.

4.8.4.2 horizon_

```
int nonStationarySolutionMDP::horizon_  [protected]
```

the time horizon>

4.8.4.3 value

```
double** nonStationarySolutionMDP::value  [protected]
```

An array whose columns are the value at each step.

The documentation for this class was generated from the following files:

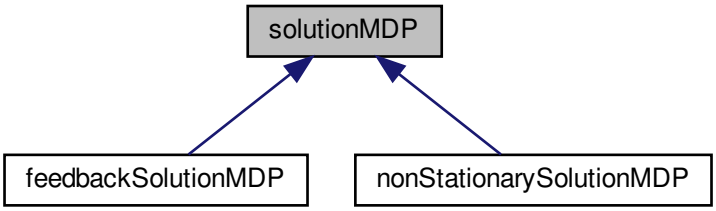
- nonStationarySolutionMDP.h
- nonStationarySolutionMDP.cpp

4.9 solutionMDP Class Reference

Class solutionMDP: implementation of an abstract solutionMDP class.

```
#include <solutionMDP.h>
```

Inheritance diagram for solutionMDP:



Public Member Functions

- solutionMDP ()

  Constructor to create solutionMDP object.
- virtual ~solutionMDP ()

  the destructor of the object solutionMDP
- virtual void writeSolution ()

  A function to print the solution object.
- virtual void writeSolutionByDim (int d, marmoteSet *set)

  A function to print the solution object w.r.t. a dimension.
- void setSize (int s)

  setter of the size.

Protected Attributes

- int size_

4.9.1 Detailed Description

Class solutionMDP: implementation of an abstract solutionMDP class.

This class is to be inherited by other classes.

Author

Abood Mourad, and E. Hyon, lip6

Date

18 jan 2018

Version

2

4.9.2 Constructor & Destructor Documentation

4.9.2.1 solutionMDP()

```
solutionMDP::solutionMDP ( )
```

Constructor to create solutionMDP object.

Author

Hyon

Version

1

Date

feb 2018

4.9.2.2 ~solutionMDP()

```
solutionMDP::~solutionMDP ( )  [virtual]
```

the destructor of the object solutionMDP

Author

EH

Version

1

Date

feb 2018

4.9.3 Member Function Documentation

4.9.3.1 setSize()

```
void solutionMDP::setSize (
            int s )
```

setter of the size.

Author

EH

Date

mar 2018

Returns

none.

4.9.3.2 writeSolution()

```
void solutionMDP::writeSolution ( )  [virtual]
```

A function to print the solution object.

Author

Abood Mourad.

Date

feb 2018

Returns

none.

Reimplemented in feedbackSolutionMDP, and nonStationarySolutionMDP.

4.9.3.3 writeSolutionByDim()

```
void solutionMDP::writeSolutionByDim (
            int d,
            marmoteSet * set )  [virtual]
```

A function to print the solution object w.r.t. a dimension.

Author

E.H.

Date

Jul 2020

Parameters

d	an integer giving the dimension
set	a pointer to an object describing the stateSpace w.r.t we enumerate the states

Returns

none.

Reimplemented in nonStationarySolutionMDP, and feedbackSolutionMDP.

4.9.4 Member Data Documentation

4.9.4.1 size_

```
int solutionMDP::size_  [protected]
```

_size of the solution

The documentation for this class was generated from the following files:

- solutionMDP.h
- solutionMDP.cpp

4.10 structuralPropertiesPol Class Reference

Class structuralPropertiesVF: implementation of a class to test structural Properties of Value Function.

```
#include <structuralPropertiesPol.h>
```

Public Member Functions

- structuralPropertiesPol (marmoteSet *st)

  Constructor to create class to check properties of policy.
- ~structuralPropertiesPol ()

  destructor to delete feedbackSolution object.
- int monotonicityPol (feedbackSolutionMDP *solution)

  A generic function to evaluate monotonicity of the policy.
- int monotonicityPol (nonStationarySolutionMDP *solution)

  A generic function to evaluate monotonicity of the policy.
- int monotonicityPolByDim (feedbackSolutionMDP *solution, int dim)

  A generic function to evaluate monotonicity of the policy by dimension.
- int monotonicityPolByDim (nonStationarySolutionMDP *solution, int dim)

  A generic function to evaluate monotonicity of the policy by dimension.
- int thresholdPol (feedbackSolutionMDP *solution)

  A generic function to evaluate if the policy has threshold type.
- int thresholdPol (nonStationarySolutionMDP *solution)

  A generic function to evaluate if the policy has threshold type.
- bool sSPol (feedbackSolutionMDP *solution)

  A generic function to test if the policy is sS.
- bool sSPol (nonStationarySolutionMDP *solution)

  A generic function to test if the policy is sS.
- bool sSPolbyDim (feedbackSolutionMDP *solution)

  A generic function to test if the policy is sS following a dimension.
- bool sSPolbyDim (nonStationarySolutionMDP *solution)

  A generic function to test if the policy is sS following a dimension.

Protected Attributes

- marmoteSet * space_

4.10.1 Detailed Description

Class structuralPropertiesVF: implementation of a class to test structural Properties of Value Function.

Author

Hyon 2020.

Version

0.1

Date

oct 2020

4.10.2 Constructor & Destructor Documentation

4.10.2.1 structuralPropertiesPol()

```
structuralPropertiesPol::structuralPropertiesPol (
            marmoteSet * st )
```

Constructor to create class to check properties of policy.

Author

Hyon

Version

1

Date

jul 2020

Parameters

st	: state space set

Returns

none.

4.10.2.2 ~structuralPropertiesPol()

```
structuralPropertiesPol::~structuralPropertiesPol ( )  [inline]
```

destructor to delete feedbackSolution object.

Author

EH

Version

0.3

Date

oct 2020

4.10.3 Member Function Documentation

4.10.3.1 monotonicityPol() [1/2]

```
int structuralPropertiesPol::monotonicityPol (
            feedbackSolutionMDP * solution )
```

A generic function to evaluate monotonicity of the policy.

Author

Hyon

Version

0.1

Date

oct 2020

Returns

int value is 1 if the policy is increasing -1 decreasing and 0 otherwise

version for testing feedback solution

4.10.3.2 monotonicityPol() [2/2]

```
int structuralPropertiesPol::monotonicityPol (
            nonStationarySolutionMDP * solution )
```

A generic function to evaluate monotonicity of the policy.

Author

Hyon

Version

0.1

Date

oct 2020

Returns

int value is 1 if the policy is increasing -1 decreasing and 0 otherwise

version for testing non stationary solution

4.10.3.3 monotonicityPolByDim() [1/2]

```
int structuralPropertiesPol::monotonicityPolByDim (
            feedbackSolutionMDP * solution,
            int dim )
```

A generic function to evaluate monotonicity of the policy by dimension.

Author

Hyon

Version

0.1

Date

oct 2020

Returns

int value is 1 if the policy is increasing.

For feedback solution

4.10.3.4 monotonicityPolByDim() [2/2]

```
int structuralPropertiesPol::monotonicityPolByDim (
            nonStationarySolutionMDP * solution,
            int dim )
```

A generic function to evaluate monotonicity of the policy by dimension.

Author

Hyon

Version

0.1

Date

oct 2020

Returns

int value is 1 if the policy is increasing.

For feedback solution

4.10.3.5 sSPol() [1/2]

```
bool structuralPropertiesPol::sSPol (
            feedbackSolutionMDP * solution )
```

A generic function to test if the policy is sS.

Author

Hyon

Version

0.1

Date

dec 2020

Returns

bool

version for testing feedback solution

4.10.3.6 sSPol() [2/2]

```
bool structuralPropertiesPol::sSPol (
            nonStationarySolutionMDP * solution )
```

A generic function to test if the policy is sS.

Author

Hyon

Version

0.1

Date

dec 2020

Returns

bool

version for testing non stationary solution

4.10.3.7 sSPolbyDim() [1/2]

```
bool structuralPropertiesPol::sSPolbyDim (
            feedbackSolutionMDP * solution )
```

A generic function to test if the policy is sS following a dimension.

Author

Hyon

Version

0.1

Date

dec 2020

Returns

bool

version for testing feedback solution

4.10.3.8 sSPolbyDim() [2/2]

```
bool structuralPropertiesPol::sSPolbyDim (
            nonStationarySolutionMDP * solution )
```

A generic function to test if the policy is sS following a dimension.

Author

Hyon

Version

0.1

Date

dec 2020

Returns

bool

version for testing non stationary solution

4.10.3.9 thresholdPol() [1/2]

```
int structuralPropertiesPol::thresholdPol (
            feedbackSolutionMDP * solution )
```

A generic function to evaluate if the policy has threshold type.

Author

Hyon

Version

0.0

Date

nov 2020

Returns

int value

version for testing feedback solution

4.10.3.10 thresholdPol() [2/2]

```
int structuralPropertiesPol::thresholdPol (
            nonStationarySolutionMDP * solution )
```

A generic function to evaluate if the policy has threshold type.

Author

Hyon

Version

0.0

Date

nov 2020

Returns

int value is 1 if the policy is increasing -1 decreasing and 0 otherwise

version for testing non stationary solution

4.10.4 Member Data Documentation

4.10.4.1 space_

```
marmoteSet* structuralPropertiesPol::space_  [protected]
```

State space represented by marmoteSet object.

The documentation for this class was generated from the following files:

- structuralPropertiesPol.h
- structuralPropertiesPol.cpp

4.11 structuralPropertiesVF Class Reference

Class structuralPropertiesVF: implementation of a class to test structural Properties of Value Function.

```
#include <structuralPropertiesVF.h>
```

Public Member Functions

- structuralPropertiesVF (marmoteSet *st)

  Constructor to create class to check properties.
- ~structuralPropertiesVF ()

  destructor to delete feedbackSolution object.
- int monotonicityVF (feedbackSolutionMDP *solution)

  A generic function to evaluate monotonicity of value function.
- int monotonicityVF (nonStationarySolutionMDP *solution)

  A generic function to evaluate monotonicity of value function.
- int monotonicityVFByDim (feedbackSolutionMDP *solution, int dim)

  A generic function to evaluate monotonicity of value function by dimension.
- int monotonicityVFByDim (nonStationarySolutionMDP *solution, int dim)

  A generic function to evaluate monotonicity of value function by dimension.
- int monotonicityCX (feedbackSolutionMDP *solution)

  A generic function to evaluate convexity of value function.
- int monotonicityCX (feedbackSolutionMDP *solution, int dim)

  A generic function to evaluate convexity of value function.

Protected Attributes

- marmoteSet * space_

4.11.1 Detailed Description

Class structuralPropertiesVF: implementation of a class to test structural Properties of Value Function.

Author

Hyon 2020.

Version

0.1

Date

oct 2020

4.11.2 Constructor & Destructor Documentation

4.11.2.1 structuralPropertiesVF()

```
structuralPropertiesVF::structuralPropertiesVF (
            marmoteSet * st )
```

Constructor to create class to check properties.

Author

Hyon

Version

1

Date

jul 2020

Parameters

st	: state space set

Returns

none.

4.11.2.2 ~structuralPropertiesVF()

```
structuralPropertiesVF::~structuralPropertiesVF ( )  [inline]
```

destructor to delete feedbackSolution object.

Author

EH

Version

0.3

Date

oct 2020

4.11.3 Member Function Documentation

4.11.3.1 monotonicityCX() [1/2]

```
int structuralPropertiesVF::monotonicityCX (
            feedbackSolutionMDP * solution )
```

A generic function to evaluate convexity of value function.

Author

Hyon

Version

0.1

Date

nov 2020

Returns

int value is 1 if value function is convex -1 concave and 0 otherwise

version for testing feedback solution

4.11.3.2 monotonicityCX() [2/2]

```
int structuralPropertiesVF::monotonicityCX (
            feedbackSolutionMDP * solution,
            int dim )
```

A generic function to evaluate convexity of value function.

Author

Hyon

Version

0.1

Date

oct 2020

Returns

int value is 1 if value function is convex -1 concave and 0 otherwise

version for testing feedback solution

4.11.3.3 monotonicityVF() [1/2]

```
int structuralPropertiesVF::monotonicityVF (
            feedbackSolutionMDP * solution )
```

A generic function to evaluate monotonicity of value function.

Author

Hyon

Version

0.1

Date

oct 2020

Returns

int value is 1 if value function is increasing -1 decreasing and 0 otherwise

version for testing feedback solution

4.11.3.4 monotonicityVF() [2/2]

```
int structuralPropertiesVF::monotonicityVF (
            nonStationarySolutionMDP * solution )
```

A generic function to evaluate monotonicity of value function.

Author

Hyon

Version

0.1

Date

oct 2020

Returns

int value is 1 if value function is increasing -1 decreasing and 0 otherwise

version for testing non stationary solution

4.11.3.5 monotonicityVFByDim() [1/2]

```
int structuralPropertiesVF::monotonicityVFByDim (
            feedbackSolutionMDP * solution,
            int dim )
```

A generic function to evaluate monotonicity of value function by dimension.

Author

Hyon

Version

0.1

Date

oct 2020

Returns

int value is 1 if value function is increasing.

For feedback solution

4.11.3.6 monotonicityVFByDim() [2/2]

```
int structuralPropertiesVF::monotonicityVFByDim (
            nonStationarySolutionMDP * solution,
            int dim )
```

A generic function to evaluate monotonicity of value function by dimension.

Author

Hyon

Version

0.1

Date

oct 2020

Returns

int value is 1 if value function is increasing.

For feedback solution

4.11.4 Member Data Documentation

4.11.4.1 space_

```
marmoteSet* structuralPropertiesVF::space_  [protected]
```

State space represented by marmoteSet object.

The documentation for this class was generated from the following files:

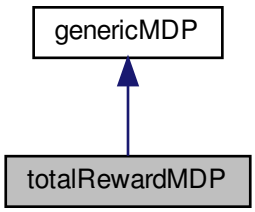
- structuralPropertiesVF.h
- structuralPropertiesVF.cpp

4.12 totalRewardMDP Class Reference

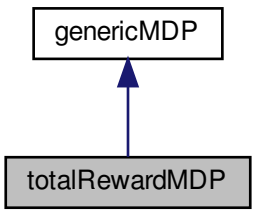
Class totalRewardMDP header: definition of an infinite horizon total reward MDP class.

```
#include <totalRewardMDP.h>
```

Inheritance diagram for totalRewardMDP:



Collaboration diagram for totalRewardMDP:



Public Member Functions

- totalRewardMDP (std::string r, marmoteSet ∗states, marmoteSet ∗actions, std::vector< sparseMatrix ∗> trans, sparseMatrix ∗rews)

  Constructor to create a totalRewardMDP object.
- totalRewardMDP (std::string r, marmoteSet ∗states, marmoteSet ∗actions, std::vector< sparseMatrix ∗> trans, std::vector< sparseMatrix ∗> rews)

  Constructor to create totalRewardMDP object.
- totalRewardMDP (std::string r, marmoteSet ∗states, marmoteSet ∗actions, sparseMatrix ∗rews)

  Constructor to create totalRewardMDP object with no vector of transition in parameters.
- virtual ∼totalRewardMDP ()

  destructor to delete discountedMDP object.
- void writeMDP ()

  function providing printing function to stdout.
- solutionMDP ∗ valueIteration (double epsilon, int maxIter)

  A function to solve (discrete time) MDP using value iteration algorithm.
- solutionMDP ∗ valueIterationGS (double epsilon, int maxIter)

  A function to solve (discrete time) MDP using value iteration algorithm with Gauss Seidel improvement.
- solutionMDP ∗ policyIteration (int maxIter)

  A function to solve (discrete time) MDP using policy iteration algorithm.
- solutionMDP ∗ policyIterationModified (double epsilon, int maxIter, double delta, int maxInIter)

  A function to solve (discrete time) MDP using modified policy iteration algorithm.
- double ∗ policyCost (solutionMDP ∗policy, double epsilon, int maxIter)

  A function to evaluate the cost of a policy with iteration of the power.
- sparseMatrix ∗ getChain (solutionMDP ∗policy)

  A function to build the transition matrix associated to a policy.

Protected Attributes

- std::string type_c

4.12.1 Detailed Description

Class totalRewardMDP header: definition of an infinite horizon total reward MDP class.

Author

Emmanuel Hyon

Version

0.1

Date

jan 2019

This class is inherited from the abstract class genericMDP.

4.12.2 Constructor & Destructor Documentation

4.12.2.1 totalRewardMDP() [1/3]

```
totalRewardMDP::totalRewardMDP (
            std::string r,
            marmoteSet * states,
            marmoteSet * actions,
            std::vector< sparseMatrix *> trans,
            sparseMatrix * rews )
```

Constructor to create a totalRewardMDP object.

Author

EH

Version

0.1

Date

dec 2018

Parameters

r	string : type_r rule value can be "min" , "max".
states	marmoteSet : State space
actions	marmoteSet : Action space
trans	vector<sparseMatrix∗> : transition structures vector of sparseMatrix.
rews	sparseMatrix : reward structure : sparseMatrix object (state, action) an entry of the matrix is the reward for state indexed by line and action indexed by ∗ column.

Returns

none.

trans : transition structures vector of sparseMatrix objects an entry of the vector is a transition structure matrix from state to state for the action at vector index.

reward structure : (state, action) an entry of the sparseMatrix is the reward for state in line and action in column.

4.12.2.2 totalRewardMDP() [2/3]

```
totalRewardMDP::totalRewardMDP (
            std::string r,
```

```
            marmoteSet * states,
            marmoteSet * actions,
            std::vector< sparseMatrix *> trans,
            std::vector< sparseMatrix *> rews )
```

Constructor to create totalRewardMDP object.

Author

EH

Version

1

Date

dec 2018

Parameters

r	string : type_r rule value can be "min" , "max".
states	marmoteSet : State space
actions	marmoteSet : Action space
trans	vector<sparseMatrix*> : transition structures vector of sparseMatrix.
rews	vector<sparseMatrix*> : vector of sparse matrix objects an entry of the vector is the reward structure from state to state for the action.

Returns

none.

This second constructor take an other form of reward description. It corresponds with the theoretical model where reward depends on transition and reached state : r(i,a,j) Then cost_perStage method is used to be consistent with the reward attribute

trans : transition structures vector of sparseMatrix objects an entry of the vector is a transition structure matrix from state to state for the action at vector index.

rews vector of sparse matrix objects an entry of the vector is the reward structure from state to state when trigger action (action is the index of the vector).

4.12.2.3 totalRewardMDP() [3/3]

```
totalRewardMDP::totalRewardMDP (
            std::string r,
            marmoteSet * states,
            marmoteSet * actions,
            sparseMatrix * rews )
```

Constructor to create totalRewardMDP object with no vector of transition in parameters.

Author

Hyon

Version

1

Date

june 2020

Parameters

r	: string, type_r rule can be "min" , "max".
states	: marmoteSet. State space
actions	: marmoteSet. Action space
rews	: reward : sparseMatrix object (state, action) an entry of the matrix is the reward for state line and action column.

Returns

none.

this third constructor does not take any vector of transition.

rews : reward structure : (state, action) an entry of the sparseMatrix is the reward for state line and action column.

4.12.2.4 ~totalRewardMDP()

```
totalRewardMDP::~totalRewardMDP ( )  [virtual]
```

destructor to delete discountedMDP object.

Author

EH

4.12.3 Member Function Documentation

4.12.3.1 getChain()

```
sparseMatrix * totalRewardMDP::getChain (
            solutionMDP * policy )  [virtual]
```

A function to build the transition matrix associated to a policy.

Author

Hyon

Version

0.1

Date

dec 2020

Parameters

policy	solutionMDP∗ : pointer to a solution that contains the policy.

Returns

a sparseMatrix

Implements genericMDP.

4.12.3.2 policyCost()

```
double * totalRewardMDP::policyCost (
            solutionMDP * policy,
            double epsilon,
            int maxIter )  [virtual]
```

A function to evaluate the cost of a policy with iteration of the power.

Author

Hyon

Version

0.1

Date

april 2019

Parameters

policy	solutionMDP : object to get of the action
maxIter	int : the maximum number of iterations.
epsilon	double.

Returns

double.

Implements genericMDP.

4.12.3.3 policyIteration()

```
solutionMDP * totalRewardMDP::policyIteration (
            int maxIter ) [virtual]
```

A function to solve (discrete time) MDP using policy iteration algorithm.

Author

Hyon

Version

0.1

Date

feb 2019

Parameters

maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

Warning

not fully implemented

Implements genericMDP.

4.12.3.4 policyIterationModified()

```
solutionMDP * totalRewardMDP::policyIterationModified (
            double epsilon,
            int maxIter,
            double delta,
            int maxInIter )  [virtual]
```

A function to solve (discrete time) MDP using modified policy iteration algorithm.

Author

Hyon

Version

0.1

Date

Feb 2019

Parameters

epsilon	double the precision in the outer loop
maxIter	int : the maximum number of iterations.
delta	precision in the inner loop
maxInIter	nb iter max in the inner loop

Returns

solutionMDP object.

also called hybrid value iteration in Powell

Implements genericMDP.

4.12.3.5 valueIteration()

```
solutionMDP * totalRewardMDP::valueIteration (
            double epsilon,
            int maxIter )  [virtual]
```

A function to solve (discrete time) MDP using value iteration algorithm.

Author

Hyon

Version

0.1

Date

feb 2019

Parameters

epsilon	double precision of the solution
maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

Implements genericMDP.

4.12.3.6 valueIterationGS()

```
solutionMDP * totalRewardMDP::valueIterationGS (
            double epsilon,
            int maxIter )  [virtual]
```

A function to solve (discrete time) MDP using value iteration algorithm with Gauss Seidel improvement.

Author

Hyon

Version

0.1

Date

feb 2019

Parameters

epsilon	double precision of the solution
maxIter	int : the maximum number of iterations.

Returns

solutionMDP object.

Implements genericMDP.

4.12.4 Member Data Documentation

4.12.4.1 type_c

```
std::string totalRewardMDP::type_c  [protected]
```

MDP criteria: here "total reward"

The documentation for this class was generated from the following files:

- totalRewardMDP.h
- totalRewardMDP.cpp

Chapter 5

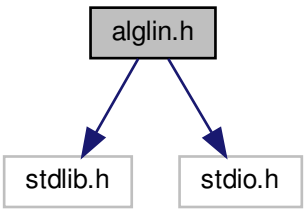
File Documentation

5.1 alglin.h File Reference

library of linear algebra functions (root programming)

```
#include <stdlib.h>
#include <stdio.h>
```

Include dependency graph for alglin.h:



Functions

- void verifVd (double *Vecteur, int dim)

  function to print a vector of double
- void verifVi (int *Vecteur, int dim)

  function to print a vector of integer
- void verifMat (double **M, int dim)

  function to print a matrix of double
- void verifMat2D (double **M, int dim1, int dim2)

  function to print a no square matrix
- void verifMatP (double **M, int dim)

  function to print a matrix of double (each double is printed with a large number of digits)
- double * produitMatVect (double **A, double **B, int dim1)

function to compute the product of a matrix and a vector

- double ** produitMatMat (double **A, double **B, int dim1)
  function to compute the product of two square matrices
- double prodScalV (double *U, int Size)
  function to sum all the term of a vector.
- double Norm (double *U, double *V, int Size)
  function to calculate the norm 1 of the difference of two vectors of doubles.
- double Span (double *U, double *V, int Size)
  function to calculate the span of the difference of two vectors of doubles.
- double SpanRecup (double *U, double *V, int Size, double *max, double *min)
  function to calculate the span of the difference of two vectors of doubles and to get the .
- void Transpose (double **Matrice, int dimension)
  function to transpose a matrix
- double * ResolutionSysLin (double **, double *, int)
- void Inversion (double **, double **, int)

5.1.1 Detailed Description

library of linear algebra functions (root programming)

header of linear algebra functions

Author

Hyon

Version

1

Date

jan 2018

5.1.2 Function Documentation

5.1.2.1 Inversion()

```
void Inversion (
            double ** ,
            double ** ,
            int  )
```

Nettoyage des malloc

5.1.2.2 Norm()

```
double Norm (
            double * U,
            double * V,
            int Size )
```

function to calculate the norm 1 of the difference of two vectors of doubles.

Author

Hyon

Parameters

U	double* vector1
V	double* vector2
Size	int size of the vectors

Returns

the difference

5.1.2.3 prodScalV()

```
double prodScalV (
            double * U,
            int Size )
```

function to sum all the term of a vector.

Author

Hyon

Parameters

U	double* vector
Size	int size of vector

Returns

the difference

5.1.2.4 produitMatMat()

```
double** produitMatMat (
            double ** A,
            double ** B,
            int dim1 )
```

function to compute the product of two square matrices

Author

Hyon

Parameters

A	double ∗∗ the first matrix
B	double ∗∗ the second matrix
dim1	the dimension of the matrices

Returns

a pointer to the created matrice that stores the product

5.1.2.5 produitMatVect()

```
double* produitMatVect (
             double ** A,
             double ** B,
             int dim1 )
```

function to compute the product of a matrix and a vector

Author

Hyon

Parameters

A	double ∗∗ the matrix
B	double ∗∗ the vector
dim1	the dimension of the matrix

Returns

a pointer to the created matrice that stores the product

5.1.2.6 ResolutionSysLin()

```
double* ResolutionSysLin (
             double ** ,
             double * ,
             int  )
```

Nettoyage des malloc

5.1.2.7 Span()

```
double Span (
             double * U,
             double * V,
             int Size )
```

function to calculate the span of the difference of two vectors of doubles.

Author

Hyon

Parameters

U	double* vector1
V	double* vector2
Size	of the vectors

Returns

the difference of the maximum gap minus the minimum gap

5.1.2.8 SpanRecup()

```
double SpanRecup (
             double * U,
             double * V,
             int Size,
             double * max,
             double * min )
```

function to calculate the span of the difference of two vectors of doubles and to get the .

Author

Hyon

Parameters

U	double* vector 1
V	double* vector 2
Size	of the vectors
max	pointer on the calue of the max
min	pointer on the value of the min

Returns

the difference of the maximum gap minus the minimum gap

5.1.2.9 Transpose()

```
void Transpose (
            double ** Matrice,
            int dimension )
```

function to transpose a matrix

Author

Hyon

Parameters

Matrice	Matrix to be transposed
dimension	int

Returns

none

5.1.2.10 verifMat()

```
void verifMat (
            double ** M,
            int dim )
```

function to print a matrix of double

Author

Hyon

Parameters

M	double ** the matrix
dim	the dimension of the matrix

5.1.2.11 verifMat2D()

```
void verifMat2D (
             double ** M,
             int dim1,
             int dim2 )
```

function to print a no square matrix

Author

Hyon

Parameters

M	double ** the matrix
dim1	number of rows
dim2	number of columns

5.1.2.12 verifMatP()

```
void verifMatP (
             double ** M,
             int dim )
```

function to print a matrix of double (each double is printed with a large number of digits)

Author

Hyon

Parameters

M	double ** the matrix
dim	the dimension of the matrix

5.1.2.13 verifVd()

```
void verifVd (
             double * Vecteur,
             int dim )
```

function to print a vector of double

Author

Hyon

Parameters

Vecteur	double * the vector
dim	the dimension of the vector

5.1.2.14 verifVi()

```
void verifVi (
             int * Vecteur,
             int dim )
```

function to print a vector of integer

Author

Hyon

Parameters

Vecteur	int * the vector
dim	the dimension of the vector

Index