Model Report

CAT_Lib

Version 1.0.1

Date: 4/29/2022

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Table of Contents

CAT_Lib

The Contract Automata Library supports the Contract Automata formalism and their operations, and can be easily extended to support similar automata-based formalisms.
Currently, synchronous Communicating Machines are also supported by the library.
This library is a by-product of scientific research on behavioural types/contracts, and implements results published in international conferences and journals.
Using the library it is possible to create new automata, import/export them, and to perform operations on them, as for example computing a composition of contracts, or computing a refinement of a composition satisfying some property (expressed as an automaton or an invariant).

Contract automata are a dialect of Finite State Automata, with special labels and tailored composition and synthesis operations.
Contract automata are composable: a composition of contracts is again a contract automaton.
Contract automata support as operation the synthesis of the most permissive controller from Supervisory Control Theory for Discrete Event Systems.
Contract automata are used to express behavioural contracts, which are used to specify (behavioural) services interfaces, for computing a composition of contracts and synthesise a composition enjoying well-behaving properties, specified as invariants or as automata.

Contract automata formalise behavioural service contracts in terms of service offer actions and service request actions that need to match to achieve agreement among a composition of contracts.
Modalities are used to indicate when an action must be matched (necessary) and when it can be withdrawn (permitted) in the synthesised coordination.
Contract automata can be configured using a product line, where each product (or configuration) predicate on which actions are required and which are forbidden.

For more info and references on publications about Contract Automata (conferences proceedings and journals) check https://contractautomataproject.github.io/ContractAutomataLib/

Package in package 'Package1'

CAT_Lib

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io

Package in package 'CAT_Lib'

io

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github

Package in package 'io'

github

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contractautomata

Package in package 'github'

contractautomata

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catlib

Package in package 'contractautomata'

catlib

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automaton

The automaton package contains the class implementing an automaton.
Each `Automaton` has a set of transitions, a set of states, an initial state and a set of final states.
To be composable, an Automaton implements the interface `Ranked`. The rank is the number of components contained in the automaton.
Contract Automata have special labels, implemented inside the package labels. Contract Automata have been introduced (and formalised) in :

- Basile, D., et al. 2016. Automata for specifying and orchestrating service contracts. Logical methods in computer science, 12. https://doi.org/10.2168/LMCS-12(4:6)2016

Package in package 'catlib'

automaton

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automaton diagram

Class diagram in package 'automaton'

automaton
Version 1.0
Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/23/2022

Figure 1: automaton

label

The label package groups classes related to labels of automata.
`Label` is the super class having a content that is a tuple of a generic type.
Labels have a rank (size of the tuple) and implements
the `Matchable` interface, to check if two actions match.
`CALabel` extends Label to implement labels of Contract Automata.
In this case labels are list of actions, with specific constraints.

Package in package 'automaton'

label

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label diagram

Class diagram in package 'label'

label
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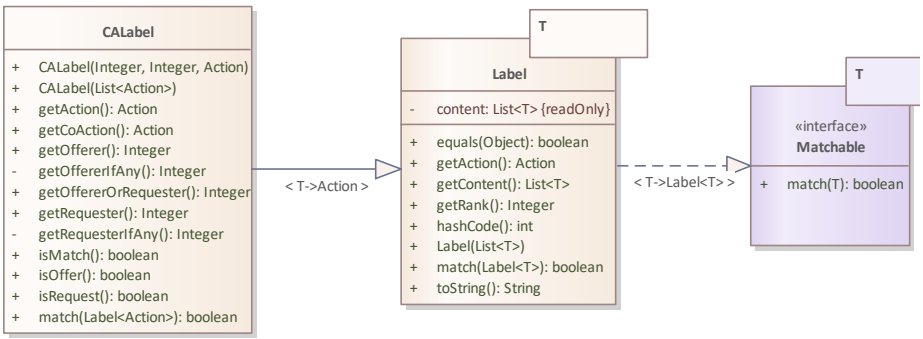

Figure 2: label

action

Package in package 'label'

action

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action diagram

The action package groups the classes implementing actions of labels.
`Action` is the super class from which the other actions are inheriting.
In Contract Automata, an action can be either an `OfferAction`, a `RequestAction` or an `IdleAction` (i.e., nil action).
Actions are matchable and a request action matches an offer action (and vice-versa) if both have the same label.
Actions can have an `Address`, in this case implementing the interface `AddressedAction`.
Actions with addresses are `AddressedOfferAction` and `AddressedRequestActions`.
These actions are equipped with an address storing senders and receivers of actions.
For two addressed actions to match also their sender and receiver must be equal.
Addressed actions are used to implement Communicating Machines, in which each participant in the composition is aware of the other participants. Communicating Machines are a model for choreographies.
Actions not having an address are used in Contract Automata: in this case the participants are oblivious of the other partners and the model assume the presence of an orchestrator in charge of pairing offers and requests.

Class diagram in package 'action'

action
Version 1.0
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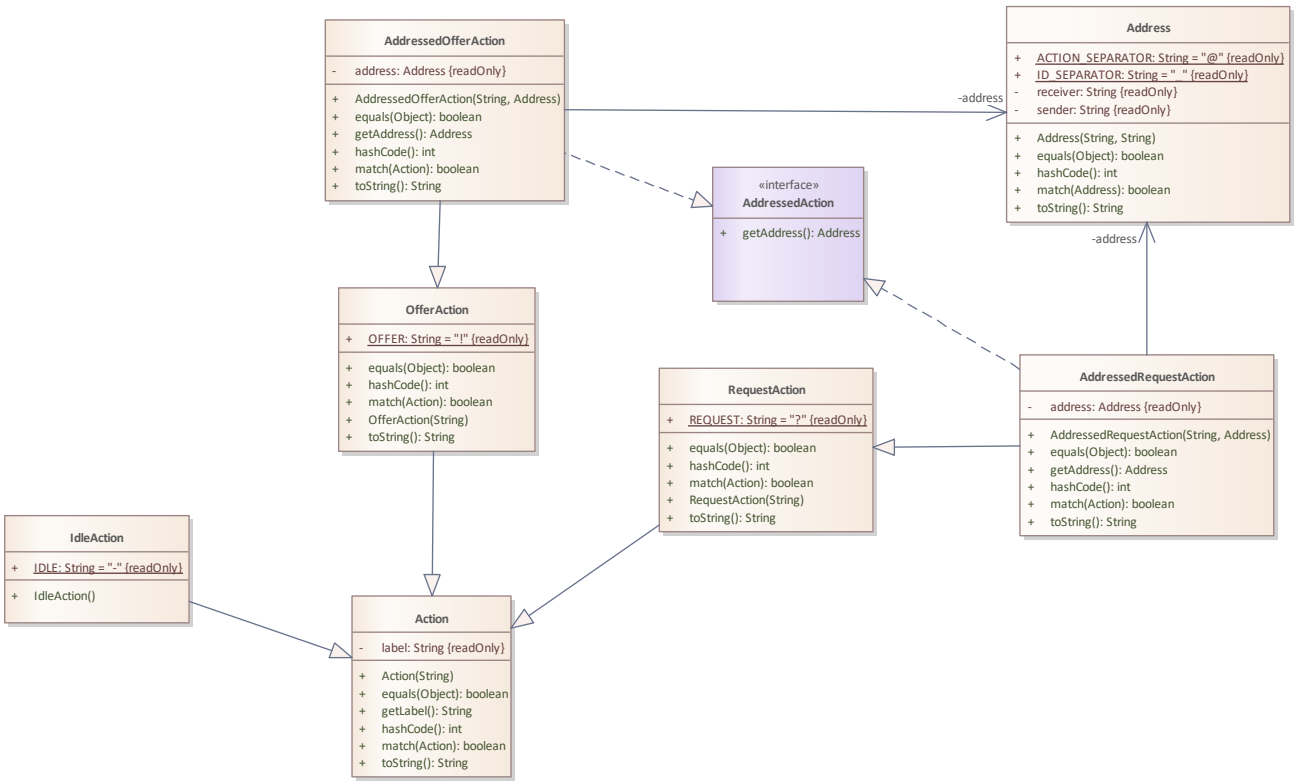

Figure 3: action

Action

Class in package 'action'

Class implementing an action of a label. Actions are matchable, i.e., they can match other actions.

Action

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OUTGOING STRUCTURAL RELATIONSHIPS

Realization from Action to Matchable

[Direction is 'Source -> Destination'.]

INCOMING STRUCTURAL RELATIONSHIPS

Generalization from IdleAction to Action

[Direction is 'Source -> Destination'.]

Generalization from RequestAction to Action

[Direction is 'Source -> Destination'.]

Generalization from OfferAction to Action

[Direction is 'Source -> Destination'.]

ATTRIBUTES

label : String Private Const

the content/label of this action

[Is static True. Containment is Not Specified.]

OPERATIONS

Action (label : String) : Public

Constructor for an action.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

equals (o : Object) : boolean Public

Overrides the method of the object class
@return true if the two objects are equal

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

OPERATIONS

getLabel () : String Public

Getter of the content of this action
@return the label of this action

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

hashCode () : int Public

Overrides the method of the object class
@return the hashcode of this object

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

match (arg : Action) : boolean Public

Implementation of the interface Matchable. True if this action is matching arg. Two actions match if they have the same content.
@return true if this action matches arg

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toString () : String Public

Print a String representing this object
@return a String representing this object

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

Address

Class in package 'action'

Class implementing the address of an action. An address is formed by a sender and a receiver. Two addresses are matching if they have the same sender and receiver. Addressed actions are using this class to represent the address of the action.

Address

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

OUTGOING STRUCTURAL RELATIONSHIPS

Realization from Address to Matchable

[Direction is 'Source -> Destination'.]

ATTRIBUTES

ACTION_SEPARATOR : String Public Const = "@"

constant symbol used for separating the address from the action

[Is static True. Containment is Not Specified.]

ID_SEPARATOR : String Public Const = "_"

constant symbol used for separating the sender from the receiver

[Is static True. Containment is Not Specified.]

receiver : String Private Const

the receiver

[Is static True. Containment is Not Specified.]

sender : String Private Const

the sender

[Is static True. Containment is Not Specified.]

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) AddressedRequestAction Target: Private address (Class) Address

Association (direction: Source -> Destination)

Source: Public (Class) AddressedOfferAction Target: Private address (Class) Address

OPERATIONS

Address (sender : String , receiver : String) : Public

Constructor for an address

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

equals (o : Object) : boolean Public

Overrides the method of the object class
@return true if the two objects are equal

OPERATIONS

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

hashCode () : int Public

Overrides the method of the object class
@return the hashcode of this object

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

match (arg : Address) : boolean Public

Two addresses are matching if they have the same sender and receiver.
@return true if the addresses are matching

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toString () : String Public

Print a String representing this object
@return a String representing this object

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

AddressedOfferAction

Class in package 'action'

Class implementing an addressed offer action. It extends offer action and implements addressed action.

AddressedOfferAction

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Realization from AddressedOfferAction to AddressedAction
[Direction is 'Source -> Destination'.]

Generalization from AddressedOfferAction to OfferAction
[Direction is 'Source -> Destination'.]

ATTRIBUTES

ATTRIBUTES

address : Address Private Const

the address of the action

[Is static True. Containment is Not Specified.]

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) AddressedOfferAction Target: Private address (Class) Address

OPERATIONS

AddressedOfferAction (label : String , address : Address) : Public

Constructor for an addressed offer action

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

equals (o : Object) : boolean Public

Overrides the method of the object class
@return true if the two objects are equal

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getAddress () : Address Public

Getter of the address of this action
@return the address of this action

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

hashCode () : int Public

Overrides the method of the object class
@return the hashcode of this object

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

match (arg : Action) : boolean Public

Redefinition of the match of an action. Returns true if arg is an addressed action, the corresponding addresses are matching as well as their super classes. For example, an addressed offer action matches an addressed request action if both addresses are matching and the offer is matching the request.

OPERATIONS

@return true if the two actions are matching.

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toString () : String Public

Print a String representing this object
@return a String representing this object

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

AddressedRequestAction

Class in package 'action'

Class implementing an addressed request action. It extends request action and implements addressed action.

AddressedRequestAction

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OUTGOING STRUCTURAL RELATIONSHIPS

Generalization from AddressedRequestAction to RequestAction
[Direction is 'Source -> Destination'.]

Realization from AddressedRequestAction to AddressedAction
[Direction is 'Source -> Destination'.]

ATTRIBUTES

address : Address Private Const

the address of this action
[Is static True. Containment is Not Specified.]

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) AddressedRequestAction Target: Private address (Class) Address

OPERATIONS

AddressedRequestAction (label : String , address : Address) : Public

OPERATIONS

Constructor for an addressed request action

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

equals (o : Object) : boolean Public

Overrides the method of the object class
@return true if the two objects are equal

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getAddress () : Address Public

Getter of the address of this action
@return the address of this action

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

hashCode () : int Public

Overrides the method of the object class
@return the hashcode of this object

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

match (arg : Action) : boolean Public

Redefinition of the match of an action. Returns true if arg is an addressed action, the corresponding addresses are matching as well as their super classes. For example, an addressed offer action matches an addressed request action if both addresses are matching and the offer is matching the request.
@return true if the two actions are matching.

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toString () : String Public

Print a String representing this object
@return a String representing this object

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

IdleAction

Class in package 'action'

Class implementing an idle action.

IdleAction

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Generalization from IdleAction to Action

[Direction is 'Source -> Destination'.]

ATTRIBUTES

IDLE : String Public Const = "-"

Constant symbol denoting an idle action

[Is static True. Containment is Not Specified.]

OPERATIONS

IdleAction () : Public

Constructor for an idle action

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

OfferAction

Class in package 'action'

Class implementing an offer action.

OfferAction

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OUTGOING STRUCTURAL RELATIONSHIPS

Generalization from OfferAction to Action

[Direction is 'Source -> Destination'.]

INCOMING STRUCTURAL RELATIONSHIPS

Generalization from AddressedOfferAction to OfferAction

[Direction is 'Source -> Destination'.]

ATTRIBUTES

ATTRIBUTES

OFFER : String Public Const = "!"

Constant symbol denoting an offer

[Is static True. Containment is Not Specified.]

OPERATIONS

equals (o : Object) : boolean Public

Overrides the method of the object class
@return true if the two objects are equal

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

hashCode () : int Public

Overrides the method of the object class
@return the hashcode of this object

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

match (arg : Action) : boolean Public

An offer action matches a request action with the same label.
@return true if this actions matches arg

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

OfferAction (label : String) : Public

Constructor for an offer action

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toString () : String Public

Print a String representing this object
@return a String representing this object

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

RequestAction

Class in package 'action'

Class implementing a request action.

RequestAction

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Generalization from RequestAction to Action

[Direction is 'Source -> Destination'.]

INCOMING STRUCTURAL RELATIONSHIPS

Generalization from AddressedRequestAction to RequestAction

[Direction is 'Source -> Destination'.]

ATTRIBUTES

REQUEST : String Public Const = "?"

Constant symbol denoting a request

[Is static True. Containment is Not Specified.]

OPERATIONS

equals (o : Object) : boolean Public

Overrides the method of the object class
@return true if the two objects are equal

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

hashCode () : int Public

Overrides the method of the object class
@return the hashcode of this object

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

match (arg : Action) : boolean Public

A request action matches an offer action with the same label.
@return true if this actions matches arg

Properties:

OPERATIONS

annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

RequestAction (label : String) : Public

Constructor for a request action
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toString () : String Public

Print a String representing this object
@return a String representing this object

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

AddressedAction

Interface in package 'action'

Interface for an addressed action. An addressed action must provide a method to retrieve the corresponding address.

AddressedAction

Davide Basile created on 4/23/2022. Last modified 4/23/2022

INCOMING STRUCTURAL RELATIONSHIPS

Realization from AddressedOfferAction to AddressedAction
[Direction is 'Source -> Destination'.]

Realization from AddressedRequestAction to AddressedAction
[Direction is 'Source -> Destination'.]

OPERATIONS

getAddress () : Address Public

Returns the address of this object
@return the address of this object
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

CALabel

Class in package 'label'

Class implementing a label of a Contract Automaton, by extending the super class <code>Label</code>.
 The content of each label is a list of actions.
 Contract automata labels can be of three types:

- offer: one action is an offer action and all the others are idle actions,
- request: one action is a request action and all the others are idle actions,
- match: two actions are matching (i.e., one is a request, the other an offer, and h the content is the same) and all the others are idle.

CALabel

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OUTGOING STRUCTURAL RELATIONSHIPS

Generalization from CALabel to Label

[Direction is 'Source -> Destination'.]

OPERATIONS

CALabel (rank : Integer , principal : Integer , action : Action) : Public

Constructor only used for requests or offer actions, i.e., only one principal is moving. The action must be either a request action or an offer action. The index of the principal moving must be lower than the rank.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

CALabel (label : List<Action>) : Public

Constructor using a list of strings. Each element in the list is the action of the principal at that position. The label must be well-formed (see description of this class).

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getAction () : Action Public

If the label is a request it returns the requests action, if it is an offer or match returns the offer action.
@return if the label is a request it returns the requests action, if it is an offer or match returns the offer action

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getCoAction () : Action Public

Returns the complementary action of the one returned by getAction(). If, for example, getAction() returns an offer, getCoAction() returns a request with the same content.
@return the complementary action of the one returned by getAction().

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getOfferer () : Integer Public

Returns the index of the principal performing the offer action. There must be a principal performing an offer action.
@return the index of the principal performing the offer action. There must be a principal performing an offer action.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getOffererIfAny () : Integer Private

OPERATIONS

Returns the index of the principal performing the offer action, or -1 in case no principal is performing an offer.
@return the index of the principal performing the offer actions, or -1 in case no principal is performing an offer.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getOffererOrRequester () : Integer Public

Returns the index of the offerer or requester. The label must not be a match.
@return the index of the offerer or requester.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getRequester () : Integer Public

Returns the index of the principal performing the request action. There must be a principal performing a request action.
@return the index of the principal performing the request action. There must be a principal performing a request action.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getRequesterIfAny () : Integer Private

Returns the index of the principal performing the request action, or -1 in case no principal is performing a request
@return the index of the principal performing the request action, or -1 in case no principal is performing a request.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isMatch () : boolean Public

Returns true if the action is a match
@return true if the action is a match
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isOffer () : boolean Public

Returns true if the action is an offer
@return true if the action is an offer
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isRequest () : boolean Public

Returns true if the action is a request
@return true if the action is a request
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

match (label : Label<Action>) : boolean Public

Implementation of the match method of interface Matchable. Two contract automata labels are matching if their corresponding actions have the same content but with complementary type (i.e., one is a request and the other an offer). The argument must be an instance of CALabel.
@return true if this action matches the label passed as argument

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

OPERATIONS

Label

Class in package 'label'

Class representing a Label of a transition.
 Each label contains a tuple of elements of unconstrained generic type.
 The rank is the size of the tuple. Labels can be matched by other labels thanks
 to the Matchable interface.

Label

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Realization from Label to Ranked

[Direction is 'Source -> Destination'.]

Realization from Label to Matchable

[Direction is 'Source -> Destination'.]

INCOMING STRUCTURAL RELATIONSHIPS

Generalization from CALabel to Label

[Direction is 'Source -> Destination'.]

ATTRIBUTES

content : List<T> Private Const

the content of the label

[Is static True. Containment is Not Specified.]

OPERATIONS

equals (obj : Object) : boolean Public

Overrides the method of the object class
@return true if the two objects are equal

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getAction () : Action Public

This method requires a label to be a list of actions, and requires the actions in the label to be either idle or not, all actions that are not idle must be equals, and at least one action must not be idle. It returns the unique action.
@return the (unique) action of the label

OPERATIONS

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getContent () : List<T> Public

Getter of the content of this label
@return the content of this label

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getRank () : Integer Public

Method inherited from the interface Ranked. It returns the rank of the label.
@return the rank of the label.

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

hashCode () : int Public

Overrides the method of the object class
@return the hashcode of this object

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

Label (content : List<T>) : Public

Constructor for a label

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

match (arg : Label<T>) : boolean Public

Implementation of the match method of the Matchable interface. Two labels match if their content is equal.
@return true if this label matches with arg label.

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toString () : String Public

Print a String representing this object
@return a String representing this object

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

Matchable

Interface in package 'label'

Interface for a matchable element.
 This interface is implemented by all classes that
 provide a match method to match other objects of type T.
@param <T> the type of the object to match with

Matchable

Davide Basile created on 4/23/2022. Last modified 4/23/2022

INCOMING STRUCTURAL RELATIONSHIPS

Realization from Action to Matchable

[Direction is 'Source -> Destination'.]

Realization from Address to Matchable

[Direction is 'Source -> Destination'.]

Realization from Label to Matchable

[Direction is 'Source -> Destination'.]

OPERATIONS

match (arg : T) : boolean Public

Returns true if this object matches with arg
@return true if this object matches with arg

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

state

The state package groups the classes implementing states of automata.
`AbstractState` is the (abstract) super class, where a state can be initial or final and has a label.
A `BasicState` implements an `AbstractState` of a single participant, it has rank 1 and the label of the state cannot have further inner components.
A `State` implements an `AbstractState` with a rank: it is a list of basic states.

Package in package 'automaton'

state

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state diagram

Class diagram in package 'state'

state
Version 1.0
Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/23/2022

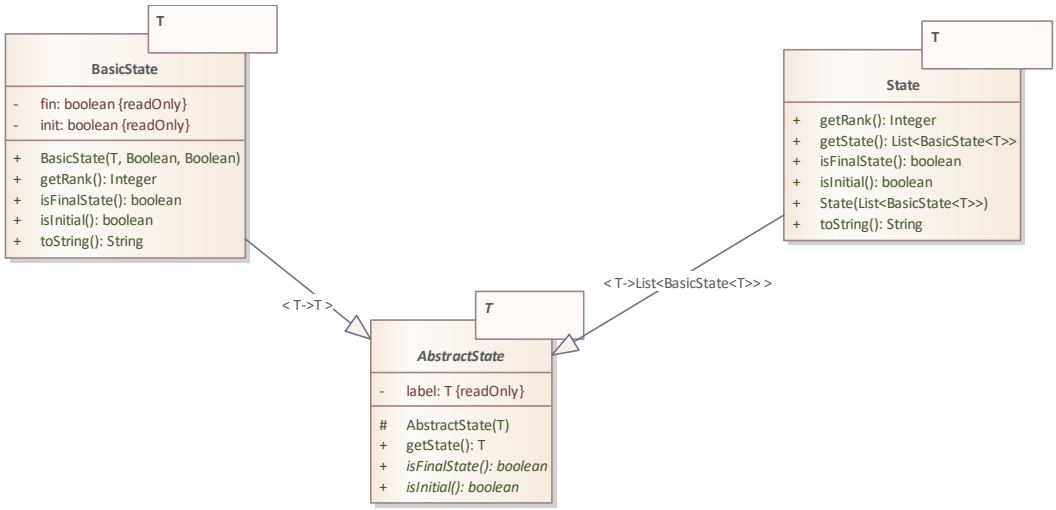


Figure 4: state

AbstractState

Class in package 'state'

Class implementing an abstract state of an automaton.
 An abstract state can be either initial or final, or none,
 and has a label (its content).
@param <T> generic type of the content of the state

AbstractState

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

OUTGOING STRUCTURAL RELATIONSHIPS

Realization from AbstractState to Ranked

[Direction is 'Source -> Destination'.]

INCOMING STRUCTURAL RELATIONSHIPS

Generalization from State to AbstractState

[Direction is 'Source -> Destination'.]

Generalization from BasicState to AbstractState

[Direction is 'Source -> Destination'.]

ATTRIBUTES

label : T Private Const

the content of the state

[Is static True. Containment is Not Specified.]

OPERATIONS

AbstractState (label : T) : Protected

Constructs an abstract state from its label (content). Label must be non-null

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getState () : T Public

Getter of the content (of type T) of the state
@return the content of the state

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isFinalState () : boolean Public

Returns true if the state is final
@return true if the state is final

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isInitial () : boolean Public

Returns true if the state is initial
@return true if the state is initial

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

BasicState

Class in package 'state'

Class implementing a BasicState of an Automaton.
 A BasicState implements an AbstractState of rank 1, i.e.,
 it is the internal state of a single principal.
@param <T> generic type of the content of the basic state

BasicState

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Generalization from BasicState to AbstractState

[Direction is 'Source -> Destination'.]

ATTRIBUTES

fin : boolean Private Const

the flag signalling if the state is final

[Is static True. Containment is Not Specified.]

init : boolean Private Const

the flag signalling if the state is initial

[Is static True. Containment is Not Specified.]

OPERATIONS

BasicState (label : T , init : Boolean , fin : Boolean) : Public

Constructor for a BasicState. Label must not be a list of elements, and elements cannot be instances of abstract state. In other words, a basic state cannot contain inner states.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getRank () : Integer Public

Method inherited from the interface Ranked. The rank of the basic state is always one.
@return the rank of the basic state, always one.

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isFinalState () : boolean Public

Returns true if the state is final
@return true if the state is final

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

OPERATIONS

isInitial () : boolean Public

Returns true if the state is initial
@return true if the state is initial

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toString () : String Public

Print a String representing this object
@return a String representing this object

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

State

Class in package 'state'

Class implementing a state of an Automaton.
 A state is a tuple (list) of basic states of principals.
 A state has a rank. Rank 1 is for an ensemble containing a single principal.
 A rank greater than one is for an ensemble of states of principals.
@param <T> generic type of the content the basic states

State

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Generalization from State to AbstractState
[Direction is 'Source -> Destination'.]

OPERATIONS

getRank () : Integer Public

Method inherited from the interface Ranked. It returns the rank of the state.
@return the rank of the state

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getState () : List<BasicState<T>> Public

Getter of the content of this state
@return the list of basic states

OPERATIONS

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isFinalState () : boolean Public

Returns true if the state is final
@return true if the state is final

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isInitial () : boolean Public

Returns true if the state is initial
@return true if the state is initial

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

State (listState : List<BasicState<T>>) : Public

Constructor for a State
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toString () : String Public

Print a String representing this object
@return a String representing this object

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

transition

The transition package groups the transitions of an automaton.
`Transition` is the super class, it has a source and target states and a label.
`ModalTransition` extends `Transition` to include modalities.
Modalities of Contract Automata are permitted and necessary.
A necessary transition has a label that must be match in a composition whilst a permitted transition can be withdrawn.
Necessary transitions can be further distinguished between urgent and lazy, where urgent is the classic notion of uncontrollability, whereas lazy is a novel notion introduced in contract automata.
Lazy transitions can be either controllable or uncontrollable, according to a given predicate evaluated on the whole automaton to which this transition belongs to.

Package in package 'automaton'

transition

Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/23/2022

transition diagram

Class diagram in package 'transition'

transition
Version 1.0
Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/23/2022

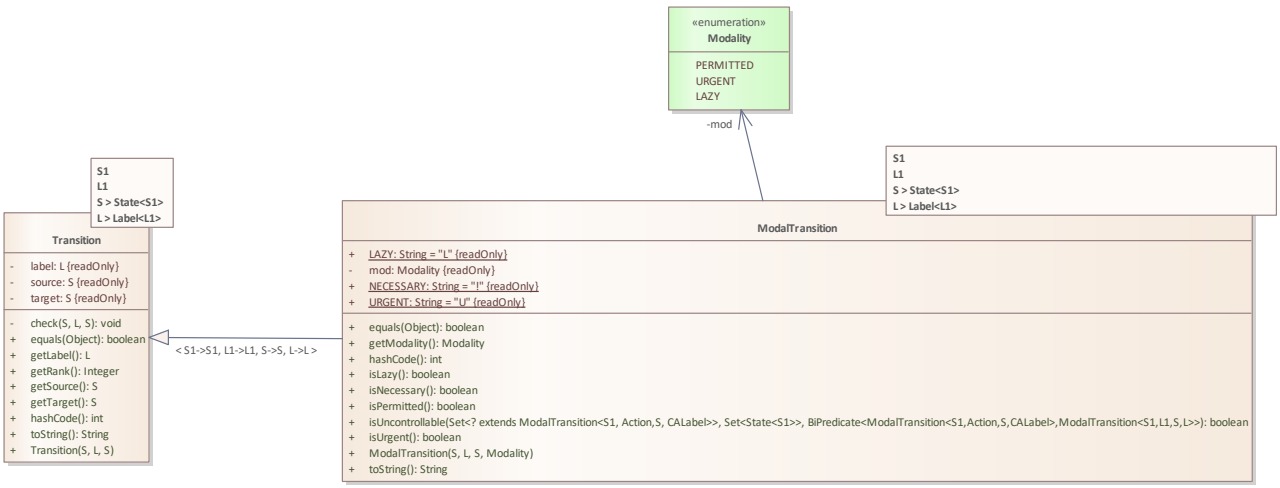


Figure 5: transition

ModalTransition

Class in package 'transition'

Class implementing a Modal Transition of an Automaton.
 A modal transition is a transition further equipped with a modality.
 Modalities are either permitted and necessary.
 A permitted transition is controllable.
Necessary transitions can be either urgent (i.e., uncontrollable) or lazy.
 A lazy transition can be either controllable or uncontrollable according
 to a controllability predicate that predicates over the set of transitions of an automaton.
@param <S1> generic type of the content of S
@param <L1> generic type of the content of L
@param <S> generic type of the state

@param <L> generic type of the label

ModalTransition

Davide Basile created on 4/23/2022. Last modified 4/29/2022

ELEMENTS OWNED BY ModalTransition

Modality : Enumeration

OUTGOING STRUCTURAL RELATIONSHIPS

Generalization from ModalTransition to Transition

[Direction is 'Source -> Destination'.]

ATTRIBUTES

LAZY : String Public Const = "L"

Constant symbol denoting a lazy modality

[Is static True. Containment is Not Specified.]

mod : Modality Private Const

the modality of this transition

[Is static True. Containment is Not Specified.]

NECESSARY : String Public Const = "!"

Constant symbol denoting a necessary modality

[Is static True. Containment is Not Specified.]

URGENT : String Public Const = "U"

Constant symbol denoting a urgent modality

[Is static True. Containment is Not Specified.]

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) ModalTransition Target: Private mod (Enumeration) Modality

OPERATIONS

equals (obj : Object) : boolean Public

Overrides the method of the object class
@return true if the two objects are equal

OPERATIONS

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getModality () : Modality Public

Getter of modality
@return the modality
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

hashCode () : int Public

Overrides the method of the object class
@return the hashcode of this object

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isLazy () : boolean Public

Returns true if the transition is lazy
@return true if the transition is lazy
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isNecessary () : boolean Public

Returns true if the transition is necessary
@return true if the transition is necessary
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isPermitted () : boolean Public

Returns true if the transition is permitted
@return true if the transition is permitted
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isUncontrollable (tr : Set<? extends ModalTransition<S1, Action,S, CALabel>> , badStates : Set<State<S1>> , controllabilityPred : BiPredicate<ModalTransition<S1,Action,S,CALabel>,ModalTransition<S1,L1,S,L>>) : boolean Public

Returns true if the transition is uncontrollable. An urgent transition is uncontrollable, a permitted transition is not uncontrollable. A lazy transition is uncontrollable if and only if none of the pairs formed by this transition and a transition t belonging to tr satisfies the controllability predicate, where t must be a match and the source state of t must not be contained in the set badStates.
@return true if the transition is uncontrollable
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isUrgent () : boolean Public

Returns true if the transition is urgent

OPERATIONS

@return true if the transition is urgent
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ModalTransition (source : S , label : L , target : S , type : Modality) : Public

Constructing a modal transition from the source, target states, the label and the modality. The modality must be non-null. Requirements of the constructor of the super-class must hold.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toString () : String Public

Print a String representing this object
@return a String representing this object

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

Modality

Enumeration owned by 'ModalTransition', in package 'transition'

The enum of possible modalities of a transition

Modality

Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/23/2022

ATTRIBUTES

PERMITTED : Public

the permitted modality
[Stereotype is «enum». Is static True. Containment is Not Specified.]

URGENT : Public

the urgent modality
[Stereotype is «enum». Is static True. Containment is Not Specified.]

LAZY : Public

the lazy modality
[Stereotype is «enum». Is static True. Containment is Not Specified.]

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) ModalTransition Target: Private mod (Enumeration) Modality

ASSOCIATIONS

Transition

Class in package 'transition'

Class implementing a Transition of an Automaton.
 States and Labels are generics, and must inherit from the corresponding
 super class.
@param <S1> generic type of the content of S
@param <L1> generic type of the content of L
@param <S> generic type of the state
@param <L> generic type of the label

Transition

Davide Basile created on 4/23/2022. Last modified 4/23/2022

INCOMING STRUCTURAL RELATIONSHIPS

Generalization from ModalTransition to Transition

[Direction is 'Source -> Destination'.]

ATTRIBUTES

label : L Private Const

the label

[Is static True. Containment is Not Specified.]

source : S Private Const

the source state

[Is static True. Containment is Not Specified.]

target : S Private Const

the target state

[Is static True. Containment is Not Specified.]

OPERATIONS

check (source : S , label : L , target : S) : void Private

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

equals (obj : Object) : boolean Public

Overrides the method of the object class
@return true if the two objects are equal

Properties:
annotations = @Override

OPERATIONS

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getLabel () : L Public

Getter of label
@return label

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getRank () : Integer Public

Method inherited from the interface Ranked. It returns the rank of the transition.
@return the rank of the transition

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getSource () : S Public

Getter of source state
@return source state

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getTarget () : S Public

Getter of target state
@return target state

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

hashCode () : int Public

Overrides the method of the object class
@return the hashcode of this object

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toString () : String Public

Print a String representing this object
@return a String representing this object

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

Transition (source : S , label : L , target : S) : Public

Constructing a transition from a source and target states and a label Parameters must be non-null, and must have the same rank.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

Automaton

Class in package 'automaton'

This class implements an automaton.
 An automaton has a set of transitions, a set of states, an initial state and a set of final states.
 The types of states, transitions, labels of transitions, are all generics and must extend the corresponding
 super-class.
 Each automaton object is ranked: it can represent either a single principal, or an ensemble of principals.
 States and labels are tuples whose size equals the rank of the automaton.
@param <S1> the generic type in State<S1>, the content of a state.
@param <L1> the generic type in Label<L1>, the content of a label.
@param <S> the generic type of states
@param <T> the generic type of transitions

Automaton

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Realization from Automaton to Ranked

[Direction is 'Source -> Destination'.]

ATTRIBUTES

tra : Set<T> Private Const

The set of transitions of the automaton

[Is static True. Containment is Not Specified.]

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) FMCA

Target: Private aut (Class) Automaton

OPERATIONS

Automaton (tr : Set<T>) : Public

This constructor builds an automaton from its set of transitions.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getBasicStates () : Map<Integer,Set<BasicState<S1>>> Public

Returns a map where for each entry the key is the index of principal, and the value is its set of basic states. It is required that states are lists of basic states.
@return a map where for each entry the key is the index of principal, and the value is its set of basic states

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getForwardStar (source : AbstractState<?>) : Set<T> Public

OPERATIONS

Returns the set of transitions outgoing from the state source
@return set of transitions outgoing state source
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getInitial () : S Public

Returns the unique initial state
@return the unique initial state
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getNumStates () : int Public

It returns the number of states of the automaton.
@return the number of states of the automaton.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getRank () : Integer Public

Method inherited from the interface Ranked. It returns the rank of the automaton.
@return the rank of the automaton

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getStates () : Set<S> Public

Returns the states of the automaton.
@return all states that appear in at least one transition.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getTransition () : Set<T> Public

Getter of the set of transitions
@return the set of transitions
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toString () : String Public

Print a String representing this object
@return a String representing this object

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

Ranked

Interface in package 'automaton'

This interface is implemented by ranked elements. An element is ranked if it has a rank. An element of rank 1 represents a principal. For ranks greater than one, the corresponding element represents an ensemble of principals.

Ranked

Davide Basile created on 4/23/2022. Last modified 4/23/2022

INCOMING STRUCTURAL RELATIONSHIPS

Realization from AbstractState to Ranked

[Direction is 'Source -> Destination'.]

Realization from Automaton to Ranked

[Direction is 'Source -> Destination'.]

Realization from Label to Ranked

[Direction is 'Source -> Destination'.]

OPERATIONS

getRank () : Integer Public

Returns the rank of this object
@return the rank of this object

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

converters

The converters package contains the classes for I/O operations (import/export).
The library contains the class `AutDataConverter`, implementing
the interface `AutConverter`, for converting
an automaton in a textual format, with extension `.data`.

Package in package 'catlib'

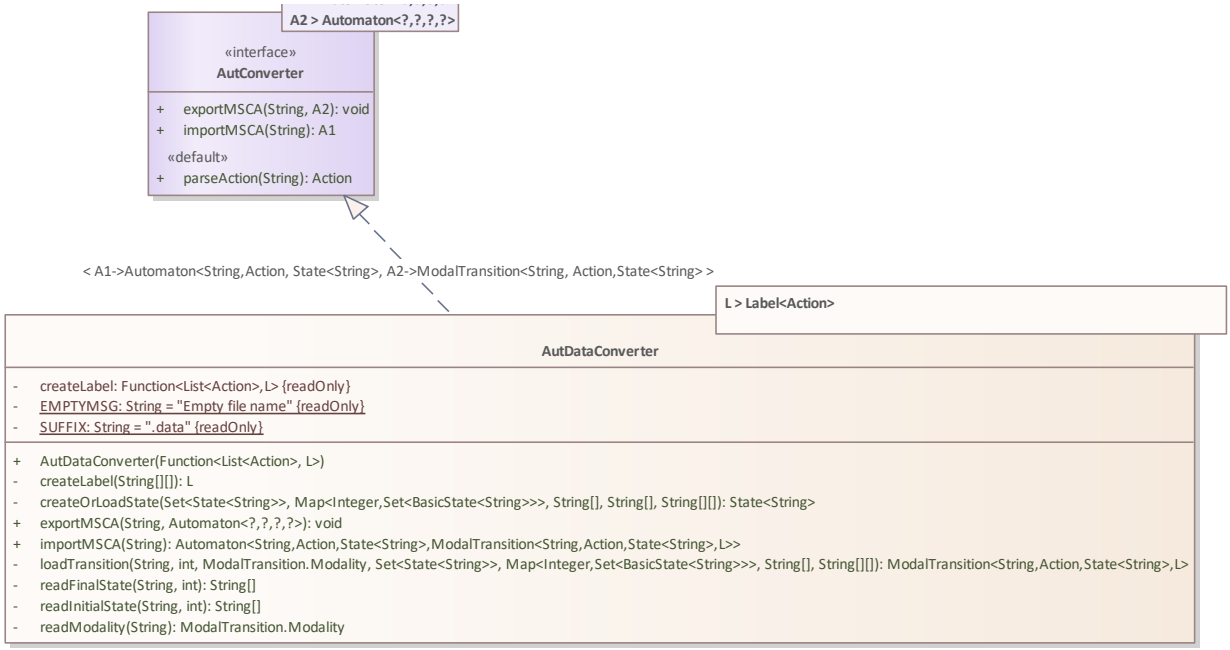
converters

Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/23/2022

converters diagram

Class diagram in package 'converters'

converters
Version 1.0
Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/23/2022



«interface»
AutConverter

+ exportMSCA(String, A2): void
+ importMSCA(String): A1

«default»
+ parseAction(String): Action

< A1->Automaton<String,Action, State<String>, A2->ModalTransition<String, Action,State<String> >

L > Label<Action>

AutDataConverter

- createLabel: Function<List<Action>,L> {readOnly}
- EMPTYMSG: String = "Empty file name" {readOnly}
- SUFFIX: String = ".data" {readOnly}

+ AutDataConverter(Function<List<Action>, L>)
- createLabel(String[][]): L
- createOrLoadState(Set<State<String>>, Map<Integer,Set<BasicState<String>>>, String[], String[], String[][]): State<String>
+ exportMSCA(String, Automaton<?,?,?,?>): void
+ importMSCA(String): Automaton<String,Action,State<String>,ModalTransition<String,Action,State<String>,L>>
- loadTransition(String, int, ModalTransition.Modality, Set<State<String>>, Map<Integer,Set<BasicState<String>>>, String[], String[][]): ModalTransition<String,Action,State<String>,L>
- readFinalState(String, int): String[]
- readInitialState(String, int): String[]
- readModality(String): ModalTransition.Modality

Figure 6: converters

AutDataConverter

Class in package 'converters'

This class supports the conversion of an automaton into a textual format, with extension <code>.data</code>.
@param <L> the type of the label of the automaton to import, must extend <code>Label<Action></code>

AutDataConverter

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Realization from AutDataConverter to AutConverter

[Direction is 'Source -> Destination'.]

ATTRIBUTES

createLabel : Function<List<Action>,L> Private Const

a builder of a label of type L from a list of actions

[Is static True. Containment is Not Specified.]

EMPTYMSG : String Private Const = "Empty file name"

message to show in case of an empty file name

[Is static True. Containment is Not Specified.]

SUFFIX : String Private Const = ".data"

suffix, the used file extension

[Is static True. Containment is Not Specified.]

OPERATIONS

AutDataConverter (createLabel : Function<List<Action>, L>) : Public

Constructor.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

createLabel (tr : String[][]) : L Private

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

createOrLoadState (states : Set<State<String>> , mapBasicStates : Map<Integer,Set<BasicState<String>>> , state : String[] , initial : String[] , fin : String[][]) : State<String> Private

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

exportMSCA (filename : String , aut : Automaton<?,?,?,?>) : void Public

Store the automaton passed as argument in a <code>.data</code> format.

Properties:
annotations = @Override
throws = IOException

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

importMSCA (filename : String) : Automaton<String,Action,State<String>,ModalTransition<String,Action,State<String>,L>> Public

Impor an automaton from a textual representation

OPERATIONS

@return the imported automaton, where the content of each state and action is a String, labels are of type L, and transitions can have modalities

Properties:
throws = IOException
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

loadTransition (str : String , rank : int , type : ModalTransition.Modality , states : Set<State<String>> , mapBasicStates : Map<Integer,Set<BasicState<String>>> , initial : String[] , fin : String[][]) : ModalTransition<String,Action,State<String>,L> Private

Properties:
throws = IOException
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

readFinalState (strLine : String , rank : int) : String Private
[Is static False. Is abstract False. Is return array True. Is query False. Is synchronized False.]

readInitialState (strLine : String , rank : int) : String Private
[Is static False. Is abstract False. Is return array True. Is query False. Is synchronized False.]

readModality (strLine : String) : ModalTransition.Modality Private
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

AutConverter

Interface in package 'converters'

The interface used to import/export automata. Each converter must implement this interface.
@param <A1> the type of the automaton to import
@param <A2> the type of the automaton to export

AutConverter

Davide Basile created on 4/23/2022. Last modified 4/23/2022

INCOMING STRUCTURAL RELATIONSHIPS

Realization from AutDataConverter to AutConverter
[Direction is 'Source -> Destination'.]

OPERATIONS

exportMSCA (filename : String , aut : A2) : void Public

This method is used to store an automaton into a file

Properties:
throws = ParserConfigurationException,IOException,TransformerException
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

OPERATIONS

importMSCA (filename : String) : A1 Public

This method is used to import an automaton of type A1 stored in a file
@return an automaton of type A1 loaded from the file

Properties:
throws = IOException,ParserConfigurationException,SAXException
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

parseAction (action : String) : Action Public

This method provides facilities for parsing a string encoding a textual representation of an action into an object Action. If the string is not parsable a run-time exception is thrown.
@return the object Action encoded in the parameter
[Stereotype is «default». Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

family

The family package groups together the functionalities that extend
contract automata to product lines.
Featured Modal Contract Automata (FMCA) is the name of this extension.
The class `FMCA` implements this type of automata.
The family of products is implemented by the class `Family`.
Each product is implemented by the class `Product`.
Each feature of a product is implemented by the class `Feature`.
FMCA exploits the possibility of having partial products, i.e., products where the assignment of features is not completely known.
The class `PartialProductGenerator` is used for generating all partial products
starting from the set of total products, i.e., products where all features are either
assigned or not.
The extension of Contract Automata to product lines is fully specified in:

- Basile, D. et al., 2020. Controller synthesis of service contracts with variability. Science of Computer Programming, vol. 187, pp. 102344. (https://doi.org/10.1016/j.scico.2019.102344)

Package in package 'catlib'

family

Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/23/2022

family diagram

Class diagram in package 'family'

family
Version 1.0
Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/23/2022

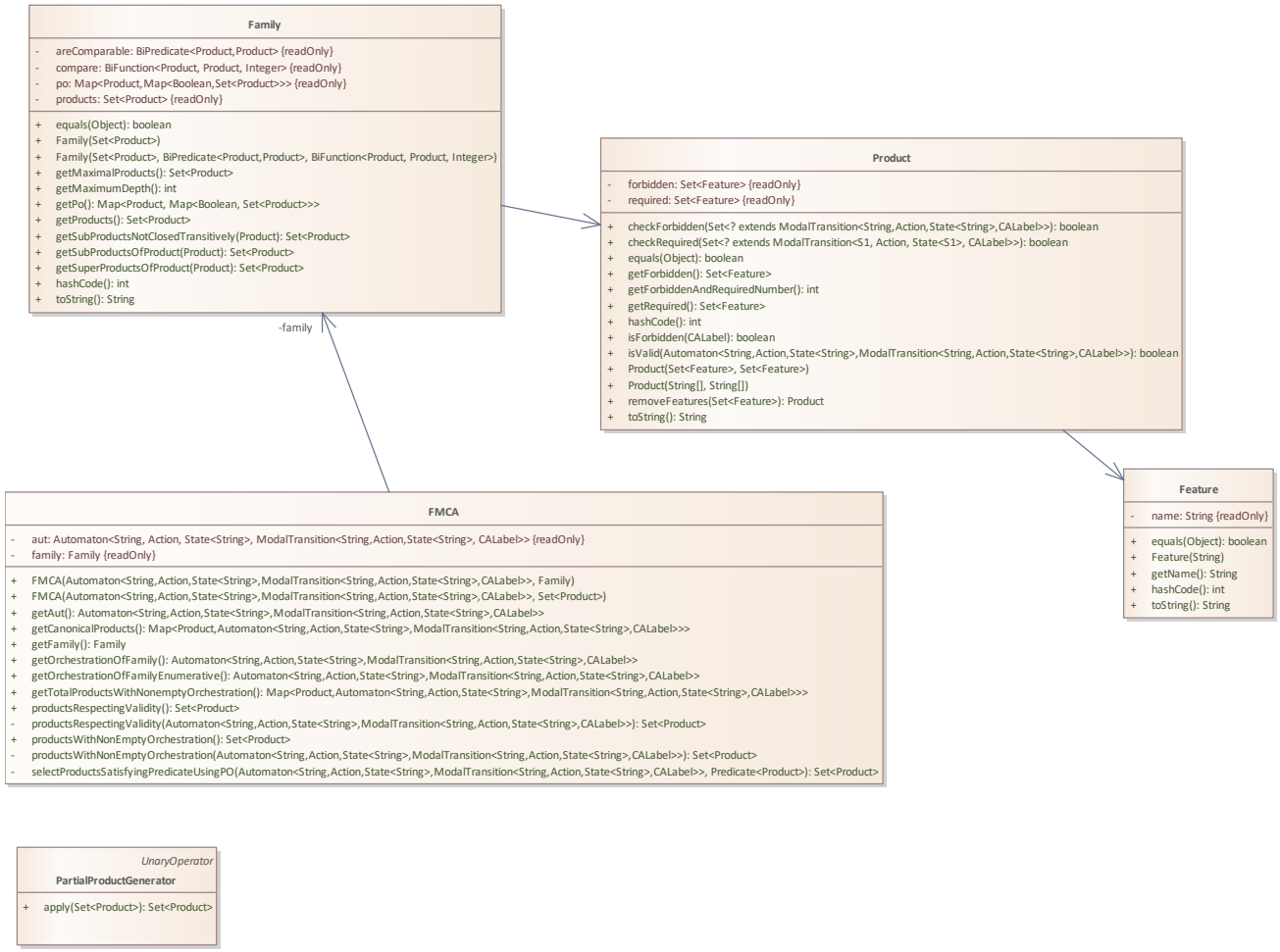


Figure 7: family

converters

The family.converters package groups the I/O operations of import/export
of a product line.
Each of these converters must implement the interface `FamilyConverter`,
with methods for importing/exporting.
`ProdFamilyConverter` converts a family to a textual representation, with extension `.prod`.
`FeatureIDEfamilyConverter` imports the products generated using the tool FeatureIDE.
`DimacFamilyConverter` imports all products that are models of a formula expressed in DIMAC format,
in a file with extension `.dimac`

Package in package 'family'

converters

Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/23/2022

converters diagram

Class diagram in package 'converters'

converters

Version 1.0
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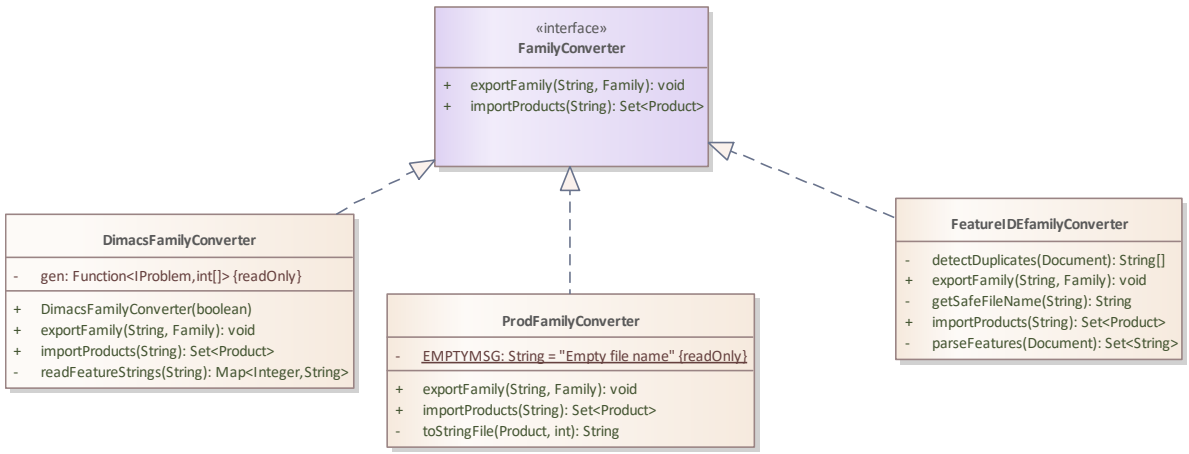

Figure 8: converters

DimacsFamilyConverter

Class in package 'converters'

Class for importing and exporting DIMACS CNF models as families of products.
 The DIMACS CNF format is a textual representation of a formula in conjunctive normal form.
 It is the standard format for SAT solvers.

DimacsFamilyConverter

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Realization from DimacsFamilyConverter to FamilyConverter

[Direction is 'Source -> Destination'.]

ATTRIBUTES

gen : Function<IProblem,int[]> Private Const

[Is static True. Containment is Not Specified.]

OPERATIONS

DimacsFamilyConverter (allModels : boolean) : Public

Constructor for this converter.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

exportFamily (filename : String , fam : Family) : void Public

Operation not supported.

Properties:
annotations = @Override

OPERATIONS

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

importProducts (filename : String) : Set<Product> Public

Overrides the FamilyConverter method.
@return a set of products generated from the DIMACS filename.

Properties:
annotations = @Override
throws = IOException,ParseFormatException,ContradictionException,TimeoutException

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

readFeatureStrings (filename : String) : Map<Integer,String> Private

Properties:
throws = IOException

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

FeatureIDEfamilyConverter

Class in package 'converters'

Class implementing import/export of products generated by FeatureIDE.

FeatureIDEfamilyConverter

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Realization from FeatureIDEfamilyConverter to FamilyConverter

[Direction is 'Source -> Destination'.]

OPERATIONS

detectDuplicates (doc : Document) : String Private

reads all iff constraints (eq node) and returns a table such that forall i table[i][0] equals table[i][1]

[Is static False. Is abstract False. Is return array True. Is query False. Is synchronized False.]

exportFamily (filename : String , fam : Family) : void Public

Overrides the method of FamilyConverter. This operation is not supported.

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getSafeFileName (filename : String) : String Private

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

OPERATIONS

importProducts (filename : String) : Set<Product> Public

Import the list of products generated through FeatureIDE.
@return the imported set of products

Properties:
annotations = @Override
throws = ParserConfigurationException,SAXException,IOException
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

parseFeatures (doc : Document) : Set<String> Private
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ProdFamilyConverter

Class in package 'converters'

Class implementing import/export from the <code>.prod</code> textual format.

ProdFamilyConverter

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Realization from ProdFamilyConverter to FamilyConverter
[Direction is 'Source -> Destination'.]

ATTRIBUTES

EMPTYMSG : String Private Const = "Empty file name"
[Is static True. Containment is Not Specified.]

OPERATIONS

exportFamily (filename : String , fam : Family) : void Public

Overrides the method of FamilyConverter

Properties:
annotations = @Override
throws = IOException
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

importProducts (filename : String) : Set<Product> Public

Overrides the method of FamilyConverter
@return a set of products loaded from filename, representing a family of products

OPERATIONS

Properties:
annotations = @Override
throws = IOException
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toStringFile (p : Product , id : int) : String Private

Returns a String representation of the product (to be stored in a file .prod).
@return a String representation of the product (to be stored in a file .prod).
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

FamilyConverter

Interface in package 'converters'

This is the interface to be implemented for importing/exporting a family.

FamilyConverter

Davide Basile created on 4/23/2022. Last modified 4/23/2022

INCOMING STRUCTURAL RELATIONSHIPS

Realization from FeatureIDEfamilyConverter to FamilyConverter
[Direction is 'Source -> Destination'.]

Realization from DimacsFamilyConverter to FamilyConverter
[Direction is 'Source -> Destination'.]

Realization from ProdFamilyConverter to FamilyConverter
[Direction is 'Source -> Destination'.]

OPERATIONS

exportFamily (filename : String , fam : Family) : void Public

Stores the content of the family fam in the file filename.

Properties:
throws = IOException
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

importProducts (filename : String) : Set<Product> Public

Returns a set of products loaded from filename, representing a family of products, imported from filename.
@return a set of products loaded from filename, representing a family of products

Properties:
throws =

OPERATIONS

IOException,ParserConfigurationException,SAXException,ParseFormatException,ContradictionException,TimeoutException

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

Family

Class in package 'family'

Class implementing a family of products (i.e., a product line).
 A family is represented by its products (or configurations).
 In featured modal contract automata, partial products are also considered, also known as sub-families.
 In a partial product not all features are rendered as required or forbidden.
 The sub-products are partially ordered.
  The formal definitions can be found in:

- Basile, D. et al., 2020. Controller synthesis of service contracts with variability. Science of Computer Programming, vol. 187, pp. 102344. (https://doi.org/10.1016/j.scico.2019.102344)

Family

Davide Basile created on 4/23/2022. Last modified 4/23/2022

ATTRIBUTES

areComparable : BiPredicate<Product,Product> Private Const

a predicate for checking if two products are comparable.

[Is static True. Containment is Not Specified.]

compare : BiFunction<Product, Product, Integer> Private Const

a predicate for comparing two comparable products.

[Is static True. Containment is Not Specified.]

po : Map<Product,Map<Boolean,Set<Product>>> Private Const

the partial order of products. A map such that for each product (key) a map is returned (value). The value is amp partitioning in false/true the sub/super products of the key, where a sub product contains all the features (required/forbidden) of its super product.

[Is static True. Containment is Not Specified.]

products : Set<Product> Private Const

the set of products.

[Is static True. Containment is Not Specified.]

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) Family Target: Public (Class) Product

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) FMCA Target: Private family (Class) Family

OPERATIONS

equals (obj : Object) : boolean Public

Overrides the method of the object class
@return true if the two objects are equal

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

Family (products : Set<Product>) : Public

Constructor of a family from a set of products. In this constructor, two products are comparable if one (p1) contains all required and forbidden features of the other (p2), and in this case p1 is less than p2.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

Family (products : Set<Product> , areComparable : BiPredicate<Product,Product> , compare : BiFunction<Product, Product, Integer>) : Public

Constructor of a family from a set of products, and the predicates for the partial order.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getMaximalProducts () : Set<Product> Public

Returns all maximal products p s.t. there is no p' greater than p.
@return all maximal products p s.t. there is no p' greater than p.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getMaximumDepth () : int Public

Returns the maximum number of features available for a product in this product-line, i.e., the maximum depth of the partial order.
@return the maximum number of features available for a product in this product-line, i.e., the maximum depth of the partial order.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getPo () : Map<Product, Map<Boolean, Set<Product>>> Public

Getter of the partial order of products.
@return the partial order of products.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getProducts () : Set<Product> Public

Getter of the set of products.

OPERATIONS

@return the set of products.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getSubProductsNotClosedTransitively (p : Product) : Set<Product> Public

Returns the sub-products of prod not closed transitively. These are all sub-products of p such that, given two of them, it is never the case that one is a sub-product of the other.
@return the sub-products not closed transitively of prod.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getSubProductsOfProduct (prod : Product) : Set<Product> Public

Returns the sub-products of prod.
@return the sub-products of prod.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getSuperProductsOfProduct (prod : Product) : Set<Product> Public

Returns the super-products of prod.
@return the super-products of prod.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

hashCode () : int Public

Overrides the method of the object class
@return the hashcode of this object

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toString () : String Public

Print a representation of this object as String
@return a representation of this object as String

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

Feature

Class in package 'family'

Class implementing a feature of product.

Feature

Davide Basile created on 4/23/2022. Last modified 4/23/2022

ATTRIBUTES

name : String Private Const

the name of the feature

[Is static True. Containment is Not Specified.]

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) Product

Target: Public (Class) Feature

OPERATIONS

equals (obj : Object) : boolean Public

Overrides the method of the object class
@return true if the two objects are equal

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

Feature (name : String) : Public

Constructor for a feature

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getName () : String Public

Getter of the name of the feature
@return the name of the feature

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

hashCode () : int Public

Overrides the method of the object class
@return the hashcode of this object

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toString () : String Public

Print a representation of this object as String
@return a representation of this object as String

Properties:
annotations = @Override

OPERATIONS

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

FMCA

Class in package 'family'

Class implementing a Featured Modal Contract Automaton (FMCA).
 An FMCA pairs a modal contract automaton with a family, and provides operations on this pair.
  FMCA and their operations have been introduced in:

- Basile, D. et al., 2020. Controller synthesis of service contracts with variability. Science of Computer Programming, vol. 187, pp. 102344. (https://doi.org/10.1016/j.scico.2019.102344)

FMCA

Davide Basile created on 4/23/2022. Last modified 4/23/2022

ATTRIBUTES

aut : Automaton<String, Action, State<String>, ModalTransition<String,Action,State<String>, CALabel>> Private Const

the modal contract automaton.

[Is static True. Containment is Not Specified.]

family : Family Private Const

the family.

[Is static True. Containment is Not Specified.]

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) FMCA — Target: Private family (Class) Family

Association (direction: Source -> Destination)

Source: Public (Class) FMCA — Target: Private aut (Class) Automaton

OPERATIONS

FMCA (aut : Automaton<String,Action,State<String>,ModalTransition<String,Action,State<String>,CALabel>> , family : Family) : Public

Constructor for an FMCA from an automaton and a family.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

FMCA (aut : Automaton<String,Action,State<String>,ModalTransition<String,Action,State<String>,CALabel>> , products : Set<Product>) : Public

This constructor instantiates the family of products by performing a pre-processing, to polish the set of products prod given as

OPERATIONS

argument.
 Firstly, all features that are not labels of the given automaton are removed from the products.
 After that, redundant products are removed (those requiring features present in aut but not in its orchestration in agreement).

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getAut () : Automaton<String,Action,State<String>,ModalTransition<String,Action,State<String>,CALabel>> Public

Getter of the automaton.
@return the automaton.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getCanonicalProducts () : Map<Product,Automaton<String,Action,State<String>,ModalTransition<String,Action,State<String>,CALabel>>> Public

Returns the canonical products of this FMCA.
 A canonical product represents all the maximal elements in the FMCA that have the same set of forbidden actions.
 It is required that the automaton does not contain transitions labelled with "dummy" (these labels are generated when computing the union of a set of automata).
@return the canonical products of this FMCA.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getFamily () : Family Public

Getter of the family.
@return the family.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getOrchestrationOfFamily () : Automaton<String,Action,State<String>,ModalTransition<String,Action,State<String>,CALabel>> Public

Returns the orchestration of the family as the union of orchestrations of canonical products.
@return the orchestration of the family as the union of orchestrations of canonical products.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getOrchestrationOfFamilyEnumerative () : Automaton<String,Action,State<String>,ModalTransition<String,Action,State<String>,CALabel>> Public

Returns the orchestration of the family as the union of orchestrations of total products.
@return the orchestration of the family as the union of orchestrations of total products

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getTotalProductsWithNonemptyOrchestration () : Map<Product,Automaton<String,Action,State<String>,ModalTransition<String,Action,State<String>,CALabel>>> Public

Returns a map pairing a product with its non-empty orchestration in agreement.
@return a map pairing a product with its non-empty orchestration in agreement.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

productsRespectingValidity () : Set<Product> Public

Returns the set of products respecting validity.
 A product p is respecting validity iff all the mandatory actions in p correspond to executable transitions in the automaton and no action forbidden in p have executable counterparts in the automaton.
 This method exploits the partial order so it starts from maximal products.

OPERATIONS

@return the set of products respecting validity
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

productsRespectingValidity (a : Automaton<String,Action,State<String>,ModalTransition<String,Action,State<String>,CALabel>>) : Set<Product> Private
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

productsWithNonEmptyOrchestration () : Set<Product> Public

The set of products with non-empty orchestration in agreement.
@return the set of products with non-empty orchestration in agreement.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

productsWithNonEmptyOrchestration (aut : Automaton<String,Action,State<String>,ModalTransition<String,Action,State<String>,CALabel>>) : Set<Product> Private
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

selectProductsSatisfyingPredicateUsingPO (a : Automaton<String,Action,State<String>,ModalTransition<String,Action,State<String>,CALabel>> , pred : Predicate<Product>) : Set<Product> Private
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

PartialProductGenerator

Class in package 'family'

Class implementing the partial product generation operator.
 This operator takes in input a set of total products (with all features assigned),
 and returns a set of products comprehending total products and partial products (not all features assigned).
 This operator is similar to the Quine-McCluskey algorithm.

PartialProductGenerator

Davide Basile created on 4/23/2022. Last modified 4/23/2022

OPERATIONS

apply (setprod : Set<Product>) : Set<Product> Public

This operator takes in input a set of total products (with all features assigned), and returns a set of products comprehending total products and partial products (not all features assigned).
 This operator is similar to the Quine-McCluskey algorithm.
 Given two products p1 p2 identical but for a feature f activated in one and deactivated in the other, a super product (a.k.a. sub-family) is generated such that f is left unresolved.
 This method generates all possible super products.
 All generated super products are such that the corresponding feature model formula is satisfied.
@return the set of all total and partial products.

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

Product

Class in package 'family'

A configuration/product of a product line/family, identified as set of required and forbidden features.

Product

Davide Basile created on 4/23/2022. Last modified 4/23/2022

ATTRIBUTES

forbidden : Set<Feature> Private Const

the set of forbidden features

[Is static True. Containment is Not Specified.]

required : Set<Feature> Private Const

the set of required features

[Is static True. Containment is Not Specified.]

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) Product — Target: Public (Class) Feature

Association (direction: Source -> Destination)

Source: Public (Class) Family — Target: Public (Class) Product

Association (direction: Source -> Destination)

Source: Public (Class) ProductOrchestrationSynthesisOperator — Target: Private p (Class) Product

OPERATIONS

checkForbidden (tr : Set<? extends ModalTransition<String,Action,State<String>,CALabel>>) : boolean Public

Returns true if all forbidden actions of this product are not available in the transitions tr, i.e, all features name are not equal to any of the content of the actions of the transitions in tr.
@return true if all forbidden actions are not available in the transitions tr.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

checkRequired (tr : Set<? extends ModalTransition<S1, Action, State<S1>, CALabel>>) : boolean Public

Returns true if all required actions are available in the transitions tr, i.e, all features name of this product are equal to the content of some action of some transition in tr.
@param <S1> the type of the content of the state.
@return true if all required actions are available in the transitions tr.

Properties:

OPERATIONS

generic = <S1>
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

equals (obj : Object) : boolean Public

Overrides the method of the object class
@return true if the two objects are equal

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getForbidden () : Set<Feature> Public

Getter of the set of forbidden features.
@return the set of forbidden features.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getForbiddenAndRequiredNumber () : int Public

Returns the number of forbidden and required features of this product.
@return the number of forbidden and required features of this product.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getRequired () : Set<Feature> Public

Getter of the set of required features.
@return the set of required features.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

hashCode () : int Public

Overrides the method of the object class
@return the hashcode of this object

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isForbidden (l : CALabel) : boolean Public

Returns true if the action of l is equal to some name of a forbidden feature.
@return true if the action of l is equal to some name of a forbidden feature.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isValid (aut : Automaton<String,Action,State<String>,ModalTransition<String,Action,State<String>,CALabel>>) : boolean Public

Returns true if the set of transitions of aut satisfies this.checkForbidden and this.checkRequired
@return true if the set of transitions of aut satisfies this.checkForbidden and this.checkRequired

OPERATIONS

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

Product (required : Set<Feature> , forbidden : Set<Feature>) : Public

Constructor for a product from sets of features

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

Product (r : String[] , f : String[]) : Public

Constructor for a product from arrays of Strings

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

removeFeatures (sf : Set<Feature>) : Product Public

Returns a new product where the features in sf have been removed (from both required and forbidden features).
@return a new product where the features in sf have been removed (from both required and forbidden features).

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

toString () : String Public

Print a representation of this object as String
@return a representation of this object as String

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

operations

This package groups the various operations that can be performed on automata.
`Projection` is used to extract a principal automaton from a composed automaton.
`Relabeling` is used to relabel the states of an automaton.
`Union` is used to compute the union of different contract automata.
The main operations are `Composition`, to compose automata, and `Synthesis` to refine an automaton to satisfy given predicates.
These two classes are generics.
`MSCACompositionFunction` instantiates the generic types to those used by a modal contract automaton.
`ModelCheckingFunction` extends `CompositionFunction` to compose an automaton with a property.
`ModelCheckingSynthesisOperator` is used to synthesise an automaton enforcing a given property, using both model checking and synthesis.
From this last class the `MpcSynthesisOperator`, `OrchestrationSynthesisOperator`, and `ChoreographySynthesisOperator` are derived.
`ProductOrchestrationSynthesisOperator` further specialises the orchestration synthesis for a given configuration.
These operations are formally specified in:

- Basile, D. et al., 2020. Controller synthesis of service contracts with variability. Science of Computer Programming, vol. 187, pp. 102344. (https://doi.org/10.1016/j.scico.2019.102344)
- Basile, D., et al., 2020. Synthesis of Orchestrations and Choreographies: Bridging the Gap between Supervisory Control and Coordination of Services. Logical Methods in Computer Science, vol. 16(2), pp. 9:1 - 9:29. (https://doi.org/10.23638/LMCS-16(2:9)2020)

Package in package 'catlib'

operations

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operations diagram

Class diagram in package 'operations'

operations
Version 1.0
Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/23/2022

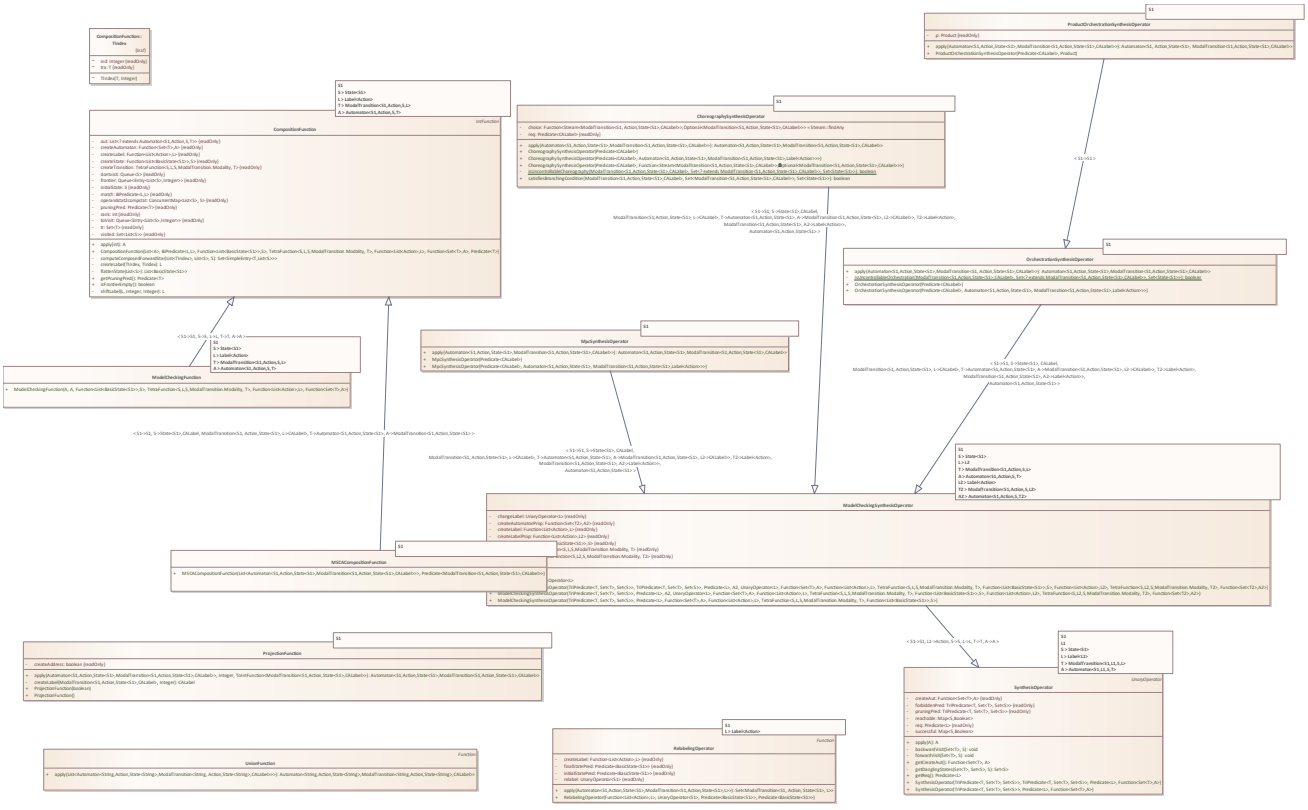

Figure 9: operations

interfaces

Package in package 'operations'

interfaces

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interfaces diagram

Class diagram in package 'interfaces'

interfaces
Version 1.0
Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/23/2022

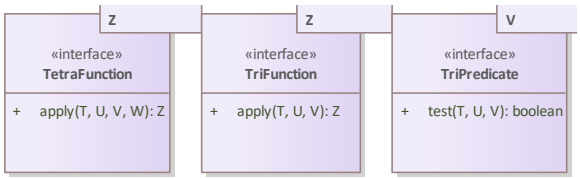

Figure 10: interfaces

TetraFunction

Interface in package 'interfaces'

A function over four arguments.
@param <T>
@param <U>
@param <V>
@param <W>
@param <Z>

TetraFunction

Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/23/2022

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) ModelCheckingSynthesisOperator

Target: Private createTransition (Interface) TetraFunction

Association (direction: Source -> Destination)

Source: Public (Class) ModelCheckingSynthesisOperator

Target: Private createTransitionProp (Interface) TetraFunction

Association (direction: Source -> Destination)

Source: Public (Class) CompositionFunction

Target: Private createTransition (Interface) TetraFunction

OPERATIONS

apply (arg1 : T , arg2 : U , arg3 : V , arg4 : W) : Z Public
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

TriFunction

Interface in package 'interfaces'

A function over three arguments.
@param <T> first argument
@param <U> second argument
@param <V> third argument
@param <Z> returned class

TriFunction

Davide Basile created on 4/23/2022. Last modified 4/23/2022

INCOMING STRUCTURAL RELATIONSHIPS

Realization from ProjectionFunction to TriFunction
[Direction is 'Source -> Destination'.]

OPERATIONS

apply (arg1 : T , arg2 : U , arg3 : V) : Z Public
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

TriPredicate

Interface in package 'interfaces'

A predicate over three arguments. * Used in the synthesis method of MSCA for readability.
@param <T> generic type of the first argument
@param <U> generic type of the second argument
@param <V> generic type of the third argument

TriPredicate

Davide Basile created on 4/23/2022. Last modified 4/23/2022

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) SynthesisOperator — Target: Private pruningPred (Interface) TriPredicate

Association (direction: Source -> Destination)

Source: Public (Class) SynthesisOperator — Target: Private forbiddenPred (Interface) TriPredicate

OPERATIONS

test (arg1 : T , arg2 : U , arg3 : V) : boolean Public
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ChoreographySynthesisOperator

Class in package 'operations'

Class implementing the Choreography Synthesis. The implemented algorithm is formally specified in Definition 4.4 and Theorem 5.5 of

- Basile, D., et al., 2020. Synthesis of Orchestrations and Choreographies: Bridging the Gap between Supervisory Control and Coordination of Services. Logical Methods in Computer Science, vol. 16(2), pp. 9:1 - 9:29. (https://doi.org/10.23638/LMCS-16(2:9)2020)

@param <S1> the type of the content of states

ChoreographySynthesisOperator

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

OUTGOING STRUCTURAL RELATIONSHIPS

Generalization from ChoreographySynthesisOperator to ModelCheckingSynthesisOperator
[Direction is 'Source -> Destination'.]

ATTRIBUTES

choice : Function<Stream<ModalTransition<S1, Action,State<S1>,CALabel>>,Optional<ModalTransition<S1,Action,State<S1>,CALabel>>> Private = Stream::findAny
[Is static True. Containment is Not Specified.]

req : Predicate<CALabel> Private Const
[Is static True. Containment is Not Specified.]

OPERATIONS

apply (arg : Automaton<S1,Action,State<S1>,ModalTransition<S1,Action,State<S1>,CALabel>>) : Automaton<S1,Action,State<S1>,ModalTransition<S1,Action,State<S1>,CALabel>> Public

Applies the choreography synthesis operator to aut
@return the synthesised choreography, removing only one transition violating the branching condition each time no further updates are possible. The transition to remove is chosen non-deterministically in case a specific strategy was not provided in the constructor.

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ChoreographySynthesisOperator (req : Predicate<CALabel>) : Public

Constructor for the choreography synthesis operator enforcing the requirement req.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ChoreographySynthesisOperator (req : Predicate<CALabel> , prop : Automaton<S1,Action,State<S1>,ModalTransition<S1,Action,State<S1>,Label<Action>>>) : Public

Constructor for the choreography synthesis operator enforcing the requirement req and property prop.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ChoreographySynthesisOperator (req : Predicate<CALabel> , choice : Function<Stream<ModalTransition<S1,Action,State<S1>,CALabel>>, Optional<ModalTransition<S1,Action,State<S1>,CALabel>>>) : Public

Constructor for the choreography synthesis operator enforcing the requirement req.
 This constructor also takes in input a strategy for resolving the choice when pruning a transition not satisfying the branching condition.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isUncontrollableChoreography (tra : ModalTransition<S1,Action,State<S1>,CALabel> , str : Set<? extends ModalTransition<S1,Action,State<S1>,CALabel>> , badStates : Set<State<S1>>) : boolean Private

Properties:

OPERATIONS

generic = <S1>
[Is static True. Is abstract False. Is return array False. Is query False. Is synchronized False.]

satisfiesBranchingCondition (tra : ModalTransition<S1,Action,State<S1>,CALabel> , trans : Set<ModalTransition<S1,Action,State<S1>,CALabel>> , bad : Set<State<S1>>) : boolean Public

Return true if the set of transitions and bad states violate the branching condition. The requirements for ensuring that the synthesised automaton is a (form of) choreography roughly amount to the so-called branching condition requiring that principals perform their offers/outputs independently of the other principals in the composition. See Definition 4.1 in

- Basile, D., et al., 2020. Synthesis of Orchestrations and Choreographies: Bridging the Gap between Supervisory Control and Coordination of Services. Logical Methods in Computer Science, vol. 16(2), pp. 9:1 - 9:29. (https://doi.org/10.23638/LMCS-16(2:9)2020)

@return true if the set of transitions and bad states violate the branching condition
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

CompositionFunction

Class in package 'operations'

Class implementing the Composition Function.
 The composition function supports an on-the-fly, bounded composition.
 It is possible to invoke a composition stopping at a given depth, and invoking again at a greater depth.
 In this case when reapplying the function, the previous states are stored and will not be generated again.
 This composition is a special type of synchronous product where synchronizations (called matches) are not broadcast, i.e., they only involve two principals.
 The arguments of the composition may be automata having rank greater than 1, i.e., representing an ensemble of composed automata.
 In this case, pre-existing matches inside the operands automata are preserved and are not rearranged.
 By changing the order in which principal automata are composed, different results can be obtained, in other words, this composition is non-associative.
 The associative composition is a special case where all operands are of rank 1.
 The formal definition of this composition is specified in Definition 5 of

- Basile, D. et al., 2020. Controller synthesis of service contracts with variability. Science of Computer Programming, vol. 187, pp. 102344. (https://doi.org/10.1016/j.scico.2019.102344)

@param <S1> the generic type of the content of states
@param <S> the generic type of states, must be a subtype of <code>State<S1></code>
@param <L> the generic type of the labels, must be a subtype of <code>Label<Action></code>
@param <T> the generic type of a transitions, must be a subtype of <code>ModalTransition<S1,Action,S,L></code>
@param <A> the generic type of the automata, must be a subtype of <code>Automaton<S1,Action,S,T ></code>

CompositionFunction

Davide Basile created on 4/23/2022. Last modified 4/29/2022

ELEMENTS OWNED BY CompositionFunction

TIndex : Class

INCOMING STRUCTURAL RELATIONSHIPS

Generalization from MSCACompositionFunction to CompositionFunction
[Direction is 'Source -> Destination'.]

INCOMING STRUCTURAL RELATIONSHIPS

Generalization from ModelCheckingFunction to CompositionFunction
[Direction is 'Source -> Destination'.]

ATTRIBUTES

aut : List<? extends Automaton<S1,Action,S,T>> Private Const
[Is static True. Containment is Not Specified.]

createAutomaton : Function<Set<T>,A> Private Const
[Is static True. Containment is Not Specified.]

createLabel : Function<List<Action>,L> Private Const
[Is static True. Containment is Not Specified.]

createState : Function<List<BasicState<S1>>,S> Private Const
[Is static True. Containment is Not Specified.]

createTransition : TetraFunction<S,L,S,ModalTransition.Modality, T> Private Const
[Is static True. Containment is Not Specified.]

dontvisit : Queue<S> Private Const
[Is static True. Containment is Not Specified.]

frontier : Queue<Entry<List<S>,Integer>> Private Const
[Is static True. Containment is Not Specified.]

initialState : S Private Const
[Is static True. Containment is Not Specified.]

match : BiPredicate<L,L> Private Const
[Is static True. Containment is Not Specified.]

operandstat2compstat : ConcurrentMap<List<S>, S> Private Const
[Is static True. Containment is Not Specified.]

pruningPred : Predicate<T> Private Const
[Is static True. Containment is Not Specified.]

rank : int Private Const
[Is static True. Containment is Not Specified.]

toVisit : Queue<Entry<List<S>,Integer>> Private Const

ATTRIBUTES

[Is static True. Containment is Not Specified.]

tr : Set<T> Private Const

[Is static True. Containment is Not Specified.]

visited : Set<List<S>> Private Const

[Is static True. Containment is Not Specified.]

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) CompositionFunction

Target: Private createTransition (Interface) TetraFunction

OPERATIONS

apply (bound : int) : A Public

This is one of the main functionalities of the library. It applies the composition function to compute the non-associative composition.
@return the composed automaton

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

CompositionFunction (aut : List<A> , match : BiPredicate<L,L> , createState : Function<List<BasicState<S1>>,S> , createTransition : TetraFunction<S,L,S,ModalTransition.Modality, T> , createLabel : Function<List<Action>,L> , createAutomaton : Function<Set<T>,A> , pruningPred : Predicate<T>) : Public

Constructor for a composition function.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

computeComposedForwardStar (trans2index : List<TIndex> , source : List<S> , sourcestate : S) : Set<SimpleEntry<T,List<S>>> Private

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

createLabel (e1 : TIndex , e2 : TIndex) : L Private

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

flattenState (lstate : List<S>) : List<BasicState<S1>> Private

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getPruningPred () : Predicate<T> Public

Getter of the pruning predicate.
@return the pruning predicate.

OPERATIONS

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

isFrontierEmpty () : boolean Public

Returns true if no states are left to be generated, i.e., the whole depth of the composition has been generated.
 If it returns false, this composition can be reapplied with a major depth to produce a composition with the frontier further pushed onwards.
 When invoking again the composition, the previous information is stored to avoid recomputing the previously generated states.
@return true if no states are left to be generated, i.e., the whole depth of the composition has been generated.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

shiftLabel (lab : L , rank : Integer , shift : Integer) : L Private

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

TIndex

Class owned by 'CompositionFunction', in package 'operations'

each transition of each MSCA in aut is associated with the corresponding index in aut

TIndex

Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/23/2022

ATTRIBUTES

ind : Integer Package Const

[Is static True. Containment is Not Specified.]

tra : T Package Const

more readable than Entry

[Is static True. Containment is Not Specified.]

OPERATIONS

TIndex (tr : T , i : Integer) : Package

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ModelCheckingFunction

Class in package 'operations'

Class implementing the Model Checking Function.
 This is implemented by instantiating the <code>CompositionFunction</code> to the case where two automata are composed: the first is a contract automaton, whilst the second is a generic automaton describing a property.
 The output is a synchronous product between the contract automaton and the property.
@param <S1> the generic type of the content of states
@param <S> the generic type of states, must be a subtype of <code>State<S1></code>

@param <L> the generic type of the labels, must be a subtype of <code>Label<Action></code>
@param <T> the generic type of a transitions, must be a subtype of <code>ModalTransition<S1,Action,S,L></code>
@param <A> the generic type of the automata, must be a subtype of <code>Automaton<S1,Action,S,T ></code>

ModelCheckingFunction

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Generalization from ModelCheckingFunction to CompositionFunction

[Direction is 'Source -> Destination'.]

OPERATIONS

ModelCheckingFunction (aut : A , prop : A , createState : Function<List<BasicState<S1>>,S> , createTransition : TetraFunction<S,L,S,ModalTransition.Modality, T> , createLabel : Function<List<Action>,L> , createAutomaton : Function<Set<T>,A>) : Public

The constructor of a model checking function.
 The match function of <code>CompositionFunction</code> is instantiated to match two labels with the same action content (in the style of a synchronous product).
 The pruning predicate of <code>CompositionFunction</code> is instantiated to prune labels of transitions where the automaton is not synchronizing with the property (and vice-versa).
 The rank of the property must be 1.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ModelCheckingSynthesisOperator

Class in package 'operations'

This class implements a model checking operation followed by a synthesis operation.
 In case the property to model-check is not given, the synthesis operation is applied straightforward.
 Otherwise, the synthesis operation is applied on the result of the application of the model checking function.
@param <S1> the generic type of the content of states
@param <S> the generic type of states, must be a subtype of <code>State<S1></code>
@param <L> the generic type of the labels of the automaton to check, must be a subtype of <code>L2</code>
@param <T> the generic type of the transitions of the automaton to check, must be a subtype of <code>ModalTransition<S1,Action,S,L></code>
@param <A> the generic type of the automaton to check, must be a subtype of <code>Automaton<S1,Action,S,T ></code>
@param <L2> the generic type of the labels of the property, must be a subtype of <code>Label<Action></code>
@param <T2> the generic type of the transitions of the property, must be a subtype of <code>ModalTransition<S1,Action,S,L2></code>
@param <A2> the generic type of the automaton property, must be a subtype of <code>Automaton<S1,Action,S,T2 ></code>

ModelCheckingSynthesisOperator

Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Generalization from ModelCheckingSynthesisOperator to SynthesisOperator

[Direction is 'Source -> Destination'.]

INCOMING STRUCTURAL RELATIONSHIPS

INCOMING STRUCTURAL RELATIONSHIPS

Generalization from MpcSynthesisOperator to ModelCheckingSynthesisOperator
[Direction is 'Source -> Destination'.]

Generalization from OrchestrationSynthesisOperator to ModelCheckingSynthesisOperator
[Direction is 'Source -> Destination'.]

Generalization from ChoreographySynthesisOperator to ModelCheckingSynthesisOperator
[Direction is 'Source -> Destination'.]

ATTRIBUTES

changeLabel : UnaryOperator<L> Private Const
[Is static True. Containment is Not Specified.]

createAutomatonProp : Function<Set<T2>,A2> Private Const
[Is static True. Containment is Not Specified.]

createLabel : Function<List<Action>,L> Private Const
[Is static True. Containment is Not Specified.]

createLabelProp : Function<List<Action>,L2> Private Const
[Is static True. Containment is Not Specified.]

createState : Function<List<BasicState<S1>>,S> Private Const
[Is static True. Containment is Not Specified.]

createTransition : TetraFunction<S,L,S,ModalTransition.Modality, T> Private Const
[Is static True. Containment is Not Specified.]

createTransitionProp : TetraFunction<S,L2,S,ModalTransition.Modality, T2> Private Const
[Is static True. Containment is Not Specified.]

prop : A2 Private Const
[Is static True. Containment is Not Specified.]

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) ModelCheckingSynthesisOperator

Target: Private createTransition (Interface) TetraFunction

Association (direction: Source -> Destination)

ASSOCIATIONS

Source: Public (Class) ModelCheckingSynthesisOperator	Target: Private createTransitionProp (Interface) TetraFunction

OPERATIONS

apply (arg1 : A) : A Public

Applies the model checking and synthesis operator.
@return the automaton resulting from applying model checking and synthesis to arg

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getChangeLabel () : UnaryOperator<L> Public

Getter of the function changeLabel.
@return the function changeLabel
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ModelCheckingSynthesisOperator (pruningPredicate : TriPredicate<T, Set<T>, Set<S>> , forbiddenPredicate : TriPredicate<T, Set<T>, Set<S>> , req : Predicate<L> , prop : A2 , changeLabel : UnaryOperator<L> , createAutomaton : Function<Set<T>,A> , createLabel : Function<List<Action>,L> , createTransition : TetraFunction<S,L,S,ModalTransition.Modality, T> , createState : Function<List<BasicState<S1>>,S> , createLabelProp : Function<List<Action>,L2> , createTransitionProp : TetraFunction<S,L2,S,ModalTransition.Modality, T2> , createAutomatonProp : Function<Set<T2>,A2>) : Public

Constructor for a model checking synthesis operator, it requires also the constructors for the used generic types.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ModelCheckingSynthesisOperator (forbiddenPredicate : TriPredicate<T, Set<T>, Set<S>> , req : Predicate<L> , prop : A2 , changeLabel : UnaryOperator<L> , createAutomaton : Function<Set<T>,A> , createLabel : Function<List<Action>,L> , createTransition : TetraFunction<S,L,S,ModalTransition.Modality, T> , createState : Function<List<BasicState<S1>>,S> , createLabelProp : Function<List<Action>,L2> , createTransitionProp : TetraFunction<S,L2,S,ModalTransition.Modality, T2> , createAutomatonProp : Function<Set<T2>,A2>) : Public

Constructor for a model checking synthesis operator, it requires also the constructors for the used generic types.
 In this constructor the pruning predicate is set to always return false.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ModelCheckingSynthesisOperator (forbiddenPredicate : TriPredicate<T, Set<T>, Set<S>> , req : Predicate<L> , createAutomaton : Function<Set<T>,A> , createLabel : Function<List<Action>,L> , createTransition : TetraFunction<S,L,S,ModalTransition.Modality, T> , createState : Function<List<BasicState<S1>>,S>) : Public

Constructor for a model checking synthesis operator.
 This constructor sets to null the property and the related constructors.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

MpcSynthesisOperator

Class in package 'operations'

Class implementing the most permissive controller synthesis operator.
 The implemented algorithm is formally specified in Definition 2.3 and Theorem 5.3 of

- Basile, D., et al., 2020. Synthesis of Orchestrations and Choreographies: Bridging the Gap between Supervisory Control and Coordination of Services. Logical Methods in Computer Science, vol. 16(2), pp. 9:1 - 9:29. (https://doi.org/10.23638/LMCS-16(2:9)2020)

@param <S1> the type of the content of states

MpcSynthesisOperator

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Generalization from MpcSynthesisOperator to ModelCheckingSynthesisOperator

[Direction is 'Source -> Destination'.]

OPERATIONS

apply (aut : Automaton<S1,Action,State<S1>,ModalTransition<S1,Action,State<S1>,CALabel>>) : Automaton<S1,Action,State<S1>,ModalTransition<S1,Action,State<S1>,CALabel>> Public

Applies the mpc synthesis to aut. The argument must not contain lazy transitions.
@return the synthesised most permissive controller

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

MpcSynthesisOperator (req : Predicate<CALabel>) : Public

Constructor for the mpc synthesis enforcing the requirement req.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

MpcSynthesisOperator (req : Predicate<CALabel> , prop : Automaton<S1,Action,State<S1>, ModalTransition<S1,Action,State<S1>,Label<Action>>>) : Public

Constructor for the mpc synthesis enforcing the requirement req and property prop.

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

MSCACompositionFunction

Class in package 'operations'

Class implementing the composition of Contract Automata.
 This class is auxiliary and is used to instantiate the generic types of <code>CompositionFunction</code>, where labels are objects of type <code>CALabel</code> and transitions are objects of type <code>ModalTransition</code>.
@param <S1> the generic type of the content of states.

MSCACompositionFunction

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Generalization from MSCACompositionFunction to CompositionFunction

[Direction is 'Source -> Destination'.]

OPERATIONS

MSCACompositionFunction (aut : List<Automaton<S1,Action,State<S1>,ModalTransition<S1,Action,State<S1>,CALabel>>> , pruningPred : Predicate<ModalTransition<S1,Action,State<S1>,CALabel>>) : Public

Invokes the constructor of the superclass instantiating the generic types

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

OrchestrationSynthesisOperator

Class in package 'operations'

Class implementing the orchestration synthesis operator.
 The implemented algorithm is formally specified in Definition 3.2 and Theorem 5.4 of

- Basile, D., et al., 2020. Synthesis of Orchestrations and Choreographies: Bridging the Gap between Supervisory Control and Coordination of Services. Logical Methods in Computer Science, vol. 16(2), pp. 9:1 - 9:29. (https://doi.org/10.23638/LMCS-16(2:9)2020)

@param <S1> the type of the content of states

OrchestrationSynthesisOperator

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Generalization from OrchestrationSynthesisOperator to ModelCheckingSynthesisOperator

[Direction is 'Source -> Destination'.]

INCOMING STRUCTURAL RELATIONSHIPS

Generalization from ProductOrchestrationSynthesisOperator to OrchestrationSynthesisOperator

[Direction is 'Source -> Destination'.]

OPERATIONS

apply (aut : Automaton<S1,Action,State<S1>,ModalTransition<S1, Action,State<S1>,CALabel>>) : Automaton<S1,Action,State<S1>,ModalTransition<S1,Action,State<S1>,CALabel>> Public

Applies the orchestration synthesis to aut. The argument must not contain necessary offers.
@return the synthesised orchestration.

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

OPERATIONS

isUncontrollableOrchestration (tra : ModalTransition<S1,Action,State<S1>,CALabel> , str : Set<? extends ModalTransition<S1,Action,State<S1>,CALabel>> , badStates : Set<State<S1>>) : boolean Private

Properties:
generic = <S1>
[Is static True. Is abstract False. Is return array False. Is query False. Is synchronized False.]

OrchestrationSynthesisOperator (req : Predicate<CALabel>) : Public

Constructor for the orchestration synthesis operator enforcing the requirement req.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

OrchestrationSynthesisOperator (req : Predicate<CALabel> , prop : Automaton<S1,Action,State<S1>, ModalTransition<S1,Action,State<S1>,Label<Action>>>) : Public

Constructor for the orchestration synthesis operator enforcing the requirement req and property prop.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ProductOrchestrationSynthesisOperator

Class in package 'operations'

Class implementing the orchestration synthesis for a specific product of a product line.
 This is a further specialization of the orchestration synthesis where the requirement also checks
 that an action must not be forbidden by the product, and in the resulting synthesised automaton
 all required actions must be reachable (otherwise an empty orchestration is returned).
 This operation is formally specified in Definition 14 of

- Basile, D. et al., 2020. Controller synthesis of service contracts with variability. Science of Computer Programming, vol. 187, pp. 102344. (https://doi.org/10.1016/j.scico.2019.102344)

@param <S1> the type of the content of states

ProductOrchestrationSynthesisOperator

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Generalization from ProductOrchestrationSynthesisOperator to OrchestrationSynthesisOperator
[Direction is 'Source -> Destination'.]

ATTRIBUTES

p : Product Private Const
[Is static True. Containment is Not Specified.]

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) ProductOrchestrationSynthesisOperator Target: Private p (Class) Product

OPERATIONS

apply (aut : Automaton<S1,Action,State<S1>,ModalTransition<S1,Action,State<S1>,CALabel>>) : Automaton<S1, Action,State<S1>, ModalTransition<S1,Action,State<S1>,CALabel>> Public

Apply the product orchestration synthesis operator to aut.
@return the synthesised orchestration of product p

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ProductOrchestrationSynthesisOperator (req : Predicate<CALabel> , p : Product) : Public

The constructor for the product orchestration synthesis operator.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ProjectionFunction

Class in package 'operations'

Class implementing the projection function.
 This function takes as arguments an automaton (of rank greater than 1) and an index, and returns the principal automaton (of rank 1) at position index.
 The projected automaton can store information, if needed, on the principals it was interacting with in the composition.
 In this case, the projected actions are addressed actions.
 The projection function is formally defined in Definition 5 of

- Basile, D. et al., 2020. Controller synthesis of service contracts with variability. Science of Computer Programming, vol. 187, pp. 102344. (https://doi.org/10.1016/j.scico.2019.102344)

@param <S1> the generic type of the content of states.

ProjectionFunction

Davide Basile created on 4/23/2022. Last modified 4/29/2022

OUTGOING STRUCTURAL RELATIONSHIPS

Realization from ProjectionFunction to TriFunction
[Direction is 'Source -> Destination'.]

ATTRIBUTES

createAddress : boolean Private Const
[Is static True. Containment is Not Specified.]

OPERATIONS

apply (aut : Automaton<S1,Action,State<S1>,ModalTransition<S1,Action,State<S1>,CALabel>> , indexprincipal : Integer , getNecessaryPrincipal : ToIntFunction<ModalTransition<S1,Action,State<S1>,CALabel>>) : Automaton<S1,Action,State<S1>,ModalTransition<S1,Action,State<S1>,CALabel>> Public

Apply the projection function.
@return the projected i-th principal automaton.

OPERATIONS

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

createLabel (t : ModalTransition<S1,Action,State<S1>,CALabel> , indexprincipal : Integer) : CALabel Private
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ProjectionFunction (createAddress : boolean) : Public

Constructor for a projection function.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

ProjectionFunction () : Public

Constructor of a projection function. As default, no addressed actions are generated.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

RelabelingOperator

Class in package 'operations'

Class implementing the relabeling operator.
 This operator can update the labels of states of an automaton, as well as initial and final states.
 As a side effect, in case the relabeling is the identity function, a clone of an automaton is created.
@param <S1> the generic type content of the states
@param <L> the generic type of the label, constrained to be a sub-type of Label<Action>

RelabelingOperator

Davide Basile created on 4/23/2022. Last modified 4/23/2022

ATTRIBUTES

createLabel : Function<List<Action>,L> Private Const
[Is static True. Containment is Not Specified.]

finalStatePred : Predicate<BasicState<S1>> Private Const
[Is static True. Containment is Not Specified.]

initialStatePred : Predicate<BasicState<S1>> Private Const
[Is static True. Containment is Not Specified.]

relabel : UnaryOperator<S1> Private Const
[Is static True. Containment is Not Specified.]

OPERATIONS

OPERATIONS

apply (aut : Automaton<S1,Action,State<S1>,ModalTransition<S1,Action,State<S1>,L>>) : Set<ModalTransition<S1, Action, State<S1>, L>> Public

This method applies the relabeling operator.
@return the relabeled automaton

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

RelabelingOperator (createLabel : Function<List<Action>,L> , relabel : UnaryOperator<S1> , initialStatePred : Predicate<BasicState<S1>> , finalStatePred : Predicate<BasicState<S1>>) : Public

Constructor for the relabeling operator.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

SynthesisOperator

Class in package 'operations'

Class implementing the abstract synthesis operator.
 The synthesis operation is an automatic refinement of an automaton to a refined one where
 given conditions hold.
 Contract automata are equipped with two specific conditions: agreement and strong agreement,
 detailed in the package requirements.
 The synthesis must also take into account when an action is controllable or uncontrollable.
The synthesis is an iterative procedure that at each step i
 updates incrementally a set of states Ri containing the bad states, i.e. those states that
 cannot prevent a forbidden state to be eventually reached, and refines an automaton Ki.
 The algorithm starts with an automaton K0 equal to A and a set R0 containing all
 dangling states in A, where a state is dangling if it cannot be reached from the initial state
 or cannot reach a final state. At each step i, the algorithm prunes from Kiâˆ’1 in a backwards
 fashion transitions with target state in Riâˆ’1 or forbidden source state. The set Ri is obtained
 by adding to Riâˆ’1 dangling states in Ki and source states of uncontrollable transitions of A
 with target state in Riâˆ’1. When no more updates are possible, the algorithm terminates.
 Termination is ensured since A is finite-state and has a finite set of transitions, and at each
 step the subsets of its states Ri cannot decrease while the set of its transitions TKi cannot
 increase. At its termination the algorithm returns the pair (Ks, Rs).
 We have that the result is empty, if the initial state of A is in Rs; otherwise, the result is
 obtained from Ks by removing the states Rs.

The abstract synthesis operations generalises the
 other synthesis operations by abstracting away the conditions under which a transition is
 pruned or a state is deemed bad, thus encapsulating and extrapolating the notion of controllability and
 safety. These two conditions, called pruning predicate (Ï†p) and forbidden predicate (Ï†f)
 are parameters to be instantiated by the corresponding instance of the synthesis algorithm
 (e.g. orchestration or choreography). Predicate Ï†p is used for selecting the transitions to be
 pruned. Depending on the specific instance, non-local information about the automaton or
 the set of bad states is needed by Ï†p. Therefore, Ï†p takes as input the current transition
 to be checked, the automaton, and the set of bad states. If Ï†p evaluates to true, then the
 corresponding transition will be pruned. Predicate Ï†f is used for deciding whether a state
 becomes bad. The input parameters are the same as Ï†p. However, Ï†f only inspects necessary
 transitions. If Ï†f evaluates to true, then the source state is deemed bad and added to
 the set of bad states.
The formal definition is given in Definition 5.1 of:

- Basile, D., et al., 2020. Synthesis of Orchestrations and Choreographies: Bridging the Gap between Supervisory Control and Coordination of Services. Logical Methods in Computer Science, vol. 16(2), pp. 9:1 - 9:29. (https://doi.org/10.23638/LMCS-16(2:9)2020)

SynthesisOperator

Davide Basile created on 4/23/2022. Last modified 4/23/2022

INCOMING STRUCTURAL RELATIONSHIPS

Generalization from ModelCheckingSynthesisOperator to SynthesisOperator

[Direction is 'Source -> Destination'.]

ATTRIBUTES

createAut : Function<Set<T>,A> Private Const

[Is static True. Containment is Not Specified.]

forbiddenPred : TriPredicate<T, Set<T>, Set<S>> Private Const

[Is static True. Containment is Not Specified.]

pruningPred : TriPredicate<T, Set<T>, Set<S>> Private Const

[Is static True. Containment is Not Specified.]

reachable : Map<S,Boolean> Private

[Is static True. Containment is Not Specified.]

req : Predicate<L> Private Const

[Is static True. Containment is Not Specified.]

successful : Map<S,Boolean> Private

[Is static True. Containment is Not Specified.]

ASSOCIATIONS

Association (direction: Source -> Destination)

Source: Public (Class) SynthesisOperator

Target: Private pruningPred (Interface) TriPredicate

Association (direction: Source -> Destination)

Source: Public (Class) SynthesisOperator

Target: Private forbiddenPred (Interface) TriPredicate

OPERATIONS

apply (aut : A) : A Public

This method applies the synthesis operator to aut.
@return the synthesised automaton.

Properties:
annotations = @Override

[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

OPERATIONS

backwardVisit (tr : Set<T> , currentstate : S) : void Private
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

forwardVisit (tr : Set<T> , currentstate : S) : void Private
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getCreateAut () : Function<Set<T>, A> Public

Getter of the function for creating an automaton.
@return the function for creating an automaton.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getDanglingStates (tr : Set<T> , states : Set<S> , initial : S) : Set<S> Private

@return states who do not reach a final state or are unreachable
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

getReq () : Predicate<L> Public

Getter of the requirement.
@return the requirement.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

SynthesisOperator (pruningPredicate : TriPredicate<T, Set<T>, Set<S>> , forbiddenPredicate : TriPredicate<T, Set<T>, Set<S>> , req : Predicate<L> , createAut : Function<Set<T>,A>) : Public

Constructor for the synthesis operator.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

SynthesisOperator (forbiddenPredicate : TriPredicate<T, Set<T>, Set<S>> , req : Predicate<L> , createAut : Function<Set<T>,A>) : Public

Constructor for the synthesis operator. The pruning predicate is instantiated to always return false.
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

UnionFunction

Class in package 'operations'

Class implementing the union function.
 This is the standard union operation of Finite State Automata, obtained by adding a new initial state with outgoing transitions to the initial states of the operands.
 These new transitions have a dummy label.
 Before being unified, the automata are relabeled to avoid having duplicate states.

UnionFunction

Davide Basile created on 4/23/2022. Last modified 4/23/2022

OPERATIONS

OPERATIONS

apply (aut : List<Automaton<String,Action,State<String>,ModalTransition<String, Action,State<String>,CALabel>>>) : Automaton<String,Action,State<String>,ModalTransition<String,Action,State<String>,CALabel>> Public

Compute the union function.
@return the automaton union of the automata in aut

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

requirements

This package groups the invariant requirements that can be enforced in a contract automaton.
The `Agreement` requirement is an invariant requiring that each transition
must not be a request: only offers and matches are allowed. This means that all
requests actions are matched, and an agreement is reached.
The `StrongAgreement` requirement is an invariant allowing only matches.
This means that all requests and offers actions of principals are matched.

Package in package 'catlib'

requirements

Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/23/2022

requirements diagram

Class diagram in package 'requirements'

requirements
Version 1.0
Davide Basile (ISTI CNR Italy) created on 4/23/2022. Last modified 4/29/2022

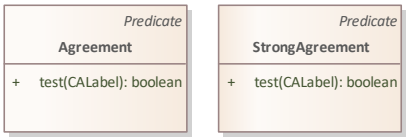

Figure 11: requirements

Agreement

Class in package 'requirements'

The predicate of Agreement over CALabels. It holds if a CALabel is not a request.

Agreement

Davide Basile created on 4/23/2022. Last modified 4/23/2022

OPERATIONS

test (l : CALabel) : boolean Public

Returns true if l is not a request.
@return true if l is not a request

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]

StrongAgreement

Class in package 'requirements'

The predicate of Strong Agreement over CALabels. Strong agreement holds if the label is a match.

StrongAgreement

Davide Basile created on 4/23/2022. Last modified 4/23/2022

OPERATIONS

test (l : CALabel) : boolean Public

Returns true if l is a match.
@return true if l is a match.

Properties:
annotations = @Override
[Is static False. Is abstract False. Is return array False. Is query False. Is synchronized False.]