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650 Route des Lucioles

F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C

Association à but non lucratif enregistrée à la

Sous-Préfecture de Grasse (06) N° 7803/88

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# Annex B (normative): Standard Collections

## B.1 The TTCN3\_standard\_collections module

The classes and external functions defined in this module provide users with commonly used data structures.

**module** TTCN3\_standard\_collections {

**function** instanceEqual(object element1, object element2) **return boolean** {   
 **return** element1 == element2   
}

**public** **external function** createLinkedList(**in** equalsFunctionType equalsFunction := instanceEqual) **return** LinkedList;

**public** **external function** createQueue(in equalsFunctionType equalsFunction := instanceEqual)   
**return** Queue;

**public external function** createPriorityQueue(**in** comparatorFunctionType comparatorFunction)   
**return** PriorityQueue;

**public external function** createStack(**in** equalsFunctionType equalsFunction := instanceEqual)   
**return** Stack;

**public external function** createRingBuffer(**in integer** maxSize) **return** RingBuffer;

**public external function** createHashMap(**in** hashFunctionType hashFunction,   
 **in** equalsFunctionType equalsFunction) **return** HashMap;

**public external function** createSet(**in** equalsFunctionType equalsFunction := instanceEqual)   
**return** Set;

**public type class @abstract** Exception {

}

**type class @abstract** Iterator {

**function @abstract** hasNext() **return boolean**;

**function @abstract** next() **return object**;

}

**type class @abstract** Collection {

**function** size() **return** **integer**;

**function** contains(**object** element) **exception** Exception **return** **boolean**;

**function** @abstract iterator() **return** Iterator;

}

**type class @abstract** List **extends** Collection {

public function @abstract add(**object** element) **exception** Exception;

public function @abstract remove(object element) **exception** Exception **return** **boolean**;

public function @abstract get(integer index) **exception** Exception **return** **object**;

}

**public type class @abstract** LinkedList **extends** List {

**public function @abstract** getFirst() **exception** Exception **return object**;

**public function @abstract** getLast() **exception** Exception **return object**;

**public function @abstract** removeFirst() **exception** Exception **return object**;

**public function @abstract** removeLast() **exception** Exception **return object**;

**public function @abstract** addFirst(**object** element) **exception** Exception;

**public function @abstract** addLast(**object** element) **exception** Exception;

}

**public type class @abstract** Queue extends Collection {

**public function @abstract** add(**object** element) **exception** Exception;

**public function @abstract** remove() **exception** Exception **return object**;

}

**public type function** comparatorFunctionType(**in object** element1, **in object** element2) **exception** Exception **return integer**;

**public type class @abstract** PriorityQueue **extends** Queue {

}

**public type class @abstract** Stack extends Collection {

**public function @abstract** push(**object** element) **exception** Exception;

**public function @abstract** pop() **exception** Exception **return object**;

}

**public type class @abstract** RingBuffer extends Collection {

**public function @abstract** put(**object** element) **exception** Exception;

**public function @abstract** get() **exception** Exception **return object**;

**public function @abstract** capacity() **return integer**;

}

**public type function** hashFunctionType(**in object** element) **exception** Exception **return integer**;

public type function equalsFunctionType(in object element1, in object element2) exception Exception return boolean;

**public type class** **@abstract** HashMap {

**public function @abstract** put(**object** keyElement, **object** valueElement) **exception** Exception;

**public function @abstract** get(**object** keyElement) **exception** Exception **return object**;

**public function @abstract** containsKey(**object** keyElement) **exception** Exception **return boolean**;

**public function @abstract** remove(**object** keyElement) **exception** Exception **return object**;

**public function @abstract** keySet() **return Set**;

public function @abstract values() return List;

**public function @abstract** size() **return integer**;

}

**public type class @abstract** Set extends Collection {

**public function @abstract** add(**object** element) **exception** Exception **return** boolean;

**public function @abstract** remove(**object** element) **exception** Exception;

}

}

## B.1.1 The Collection class

The abstract [Collection](#Collection) class represents a data structure that is a collection of elements. It is used as a base class of more specific collection data structures like lists and sets.

External function and class methods :

* size  
  Returns the number of elements stored in the LinkedList.
* contains

Returns the value true if the given element is contained at least once in the collection.

* iterator

Returns an Iterator object for iterating over the elements of the collection.

## B.1.2 The List class

The abstract [List](#List) class represents a list of elements where each contained element has an index (starting from 0).

External function and class methods :

* add  
  Adds the given element to the list.
* remove  
  Tries to remove one instance of the provided element from the List.  
  Returns **true** if an element was removed, **false** if no elements were removed.  
  Please note, that a List might contain the same element several times, in which case only one instance will be removed.
* get  
  Gets the element at the given index from the list, if the index in in the range (0 .. size()-1).

## B.1.3 The LinkedList class

The abstract [LinkedList](#LinkedList) class represents a double linked data structure for storing objects.  
A new Instance can be created via the external function **createLinkedList**. It is derived from the abstract List class.

External function and class methods :

* createLinkedList  
  Factory function for creating a new LinkedList instance.
* getFirst  
  Returns the first element of the LinkedList if it is not empty.  
  Raises an exception if the LinkedList is empty.
* getLast  
  Returns the last element of the LinkedList if it is not empty.  
  Raises an exception if the LinkedList is empty.
* removeFirst  
  Removes and returns the first element of the LinkedList if it is not empty.  
  Raises an exception if the LinkedList is empty.
* removeLast  
  Removes and returns the last element of the LinkedList if it is not empty.  
  Raises an exception if the LinkedList is empty.
* addFirst  
  Adds a new element as the first element of the LinkedList if this is possible.  
  Raises an exception in case of error, for example: running out of memory.
* addLast  
  Adds a new element as the last element of the LinkedList if this is possible.  
  Raises an exception in case of error, for example: running out of memory.
* iterator  
  Returns an iterator over the elements of this LinkedList.  
  The elements are iterated from first to last.
* size  
  Returns the number of elements stored in the LinkedList.

## B.1.4 The Queue class

The abstract [Queue](#Queue) class represents a queue data structure for storing objects. This data structure uses a First In First Out semantics, meaning that the element added first will also be the element removed first. It is derived from the abstract class Collection.  
A new Instance can be created via the external function **createQueue**.

External function and class methods :

* createQueue  
  Factory function for creating a new Queue instance.
* add  
  Adds an element to the end Queue if this is possible.  
  Raises an exception in case of error, for example: running out of memory.
* remove  
  Removes and returns the first element of the Queue if it is not empty.  
  Raises an exception if the Queue is empty.
* size  
  Returns the number of elements stored in the Queue.

## B.1.5 The PriorityQueue class

The abstract [PriorityQueue](#PriorityQueue) class represents a priority queue data structure for storing objects. This data structure stores its elements ordered according to the comparator function. This data structure does not allow null elements.  
A new Instance can be created via the external function **createPriorityQueue**. It is derived from the class Queue.

External function and class methods :

* createPriorityQueue  
  Factory function for creating a new PriorityQueue instance.
* comparatorFunctionType  
  Used to compare the 2 provided elements for their ordering.  
  Returns a negative integer if the element1 is less than element2.  
  Returns 0 if the element1 is equivalent to element2.  
  Return a positive integer if element1 is greater than element2.  
  Functions of this type can also raise an exception, for example if the object received as one of their actual parameters is not of the expected class.
* add  
  Adds an element to the PriorityQueue if this is possible. The element will be added before all elements that are greater than the element and after all elements that are smaller than or equal to the element. Thereby it is ensured that always the smallest element first added to the queue is at the head of the queue.   
  Raises an exception in case of error, for example: running out of memory, or adding a null object.
* remove  
  Removes and returns the head element of the PriorityQueue if it is not empty. The head element has the lowest priority among the elements of the PriorityQueue.  
  Raises an exception if the PriorityQueue is empty.
* size  
  Returns the number of elements stored in the PriorityQueue.

## B.1.6 The Stack class

The abstract [Stack](#Stack) class represents a stack data structure for storing objects. This data structure uses a Last In First Out semantics, meaning that the element added last will also be the element removed first.  
A new Instance can be created via the external function **createStack**.

External function and class methods :

* createStack  
  Factory function for creating a new Stack instance.
* push  
  Pushes an element onto the Stack if this is possible.  
  Raises an exception in case of error, for example: running out of memory.
* pop  
  Removes and returns the element inserted last from the Stack if it is not empty.  
  Raises an exception if the Stack is empty.
* size  
  Returns the number of elements stored in the Stack.

## B.1.7 The RingBuffer class

The abstract [RingBuffer](#RingBuffer) class represents a ringbuffer data structure for storing objects. This data structure uses a First In First Out semantics, with a fixed size limit. This means that the element added first will also be the element removed first. An instance of this collection can only accept elements to the maximum amount it is created for.  
A new Instance can be created via the external function **createRingBuffer**.

External function and class methods :

* createRingBuffer  
  Factory function for creating a new RingBuffer instance, with the provided maximum size.
* put  
  Adds an element to the end of the RingBuffer if this is possible.  
  Raises an exception in case of error, for example: reching the maximum allowed size of the buffer.
* get  
  Removes and returns the first element of the RingBuffer if it is not empty.  
  Raises an exception if the RingBuffer is empty.
* size  
  Returns the number of elements stored in the RingBuffer.
* capacity  
  Returns the maximum capacity of the RingBuffer.

## B.1.8 The HashMap class

The abstract [HashMap](#HashMap) class represents a hashmap data structure for storing key-value pairs of objects. This collection can be indexed with the keyElement part of the pair, to receive the valueElement of the pair.  
Pleae note that each key has to be unique according to the given **equalsFunction**.

A new Instance can be created via the external function **createHashMap**.  
The hash value of the keyElement object can be calculated using the provided **hashFunctionType** function and the equality of two given keyElements can be determined using the provided **equalsFunctionType** function.

External function and class methods :

* createHashMap  
  Factory function for creating a new HashMap instance, that will use the provided hashFunction for calculating the hash values of the key element objects and an equalsFunction for determinining the equality of keys The two functions need to fulfil the property that for all pairs of objects o1, o2, if equalsFunction(o1,o2) is true then also hashFunction(o1)==hashFunction(o2) is true.
* hashFunctionType  
  A behaviour type allowing the user of the collection to provide their implementation for calculating the hash value of their key element objects.  
  Functions of this type will be called with a key element object as their only parameter and must return an integer value that represents the hash value of the object.  
  Functions of this type can also raise an exception, for example if the object received as their actual parameter is not of the expected class.
* equalsFunctionType  
  A behaviour type allowing the user of the collection to provide their implementation with an equality relation between key objects insofar that different object instances of the same content can be seen as equal which allows to ensure the uniqueness property for the keys as there can be no two different key instances k1, k2 where equalsFunction(k1.k2) is true.
* put  
  Adds a new keyElement – valueElement pair to the HashMap.  
  If the HashMap already contains a pair with the same keyELement, the old pair is removed before inserting the new pair.  
  Raises an exception in case of error, for example: running out of memory.
* get  
  Returns the valueElement part of a keyElement – valueElement pair in the HashMap, if such a pair with the provided keyElement object exists in the HashMap..  
  Raises an exception if the HashMap has no keyElement – valueElement pair with the provided keyElement.
* containsKey  
  Returns **true** if the HashMap contains a keyElement – valueElement pair with the provided keyElement, **false** otherwise.  
  Raises an exception in case of error, for example the hashFunction raised an exception.
* remove  
  Removes a keyElement – valueElement and returns the valueElement part of a keyElement – valueElement pair in the HashMap, if such a pair with the provided keyElement object exists in the HashMap.  
  Raises an exception in case of error, for example the hashFunction raised an exception.
* keyset  
  Returns a Set object containg a set of the keyElements of all the keyElement – valueElement pairs in the HashMap.
* values  
  Returns a List object containing the valueElement objects of all the keyElement-valueElement pairs in the HashMap
* size  
  Returns the number of pairs stored in the HashMap.

## B.1.9 The Set class

The abstract [Set](#Set) class represents a set data structure for storing objects. This data structure is unordered and contains unique elements.  
A new Instance can be created via the external function **createSet**.

External function and class methods :

* createSet  
  Factory function for creating a new Set instance. It may be passed an equalsFunction to determine equality and ensure uniqueness of the contained set elements. Per default, instance equality is used.
* add  
  Adds an element to the Set if this is possible.  
  Returns true if the element could be added, returns false if the element was already present in the set and so was not added (to ensure uniqueness).  
  Raises an exception in case of error, for example: running out of memory.
* remove  
  Removes the provided element from the Set if it is present in the set.  
  Returns true if the element was located in the Set, false otherwise.  
  Subclasses might raise an exception.
* contains  
  Returns **true** if the Set contains the element, **false** otherwise.  
  Subclasses might raise an exception.
* iterator  
  Returns an iterator over the elements of this Set.  
  The elements are not iterated in any particular order.
* size  
  Returns the number of elements stored in the Queue.

## B.1.10 The Exception class

The abstract [Exception](#Exception) class represents a generic exception that can be raised by standard collections.

Please note, that later the list of raised exception can be updated with more specific exceptions.

## B.1.11 The Iterator class

The abstract [Iterator](#Iterator) class represents an iterator over a collection. An instance of the Iterator class allows to iterate over the elements of a collection.

Class methods :

* hasNext  
  Returns true if the iterated collection still has elements not yet visited by the iterator.
* next  
  Returns the next element in the collection and steps the iterator for the upcoming collection.  
  Raises an exception if the collection has no more elements not yet visited.