

[C] Conteneurs et listes chaînées

Introduction

Les conteneurs sont des **listes doublement chaînées** qui permettent de stocker et de gérer un tableau d'éléments de manière dynamique et optimisé.

Concepts

Conteneur

Une **conteneur** est une structure de donnée contenant 4 éléments :

- Un pointeur sur le premier noeud.
- Un pointeur sur le dernier noeud.
- Un entier représentant le nombre de noeud présent dans le conteneur.
- Un pointeur sur la fonction de destruction des items.

Noeud

Un **noeud** est une structure de donnée contenant 3 éléments :

- Un pointeur sur le noeud précédent.
- Un pointeur sur le noeud suivant.
- Un pointeur sur l'item à stocker.

Item

L'**item** est l'élément à stocker dans le noeud.

Lors de son implémentation dans le noeud, il est converti au format générique **void***.

Bibliothèque

container.c

```
/*
 * container.c
 *
 * Created on: 16 mars 2022
 * Author: Thierry Boyer
 */

#include <stdio.h>
#include <stdlib.h>
#include <assert.h>
#include "container.h"

/**
 * @brief type definition of node structure
 * [] Node component: Hidden structure
 */
typedef struct s_node{
    []struct s_node *m_pPrev;[]/* Pointer to the previous node in the current list */
    []struct s_node *m_pNext;[]/* Pointer to the next node in the current list[]*/
    [][] void *m_pltem;[]/* Pointer to the item stored at this node in the current list */
}t_node;

/* Node component: Hidden functions-----*/
/**
 * @brief Node "constructor".
 *
 * @param [in] pPrev pointer to the previous node in the linked list.
 * @param [in] pNext pointer to the next node in the linked list.
 * @param [in] pltem pointer to the item to be linked to the node.
 * @return t_node* pointer to the mewly created node.
 */
t_node*NodeNew(t_node*pPrev, t_node*pNext, void*pltem){
    []t_node*pNewNode=(t_node*)malloc(sizeof(t_node));
```

```

    assert(pNewNode);
    *pNewNode=(t_node){
        .m_pPrev = pPrev,
        .m_pNext = pNext,
        .m_pltem = pItem
    };
    if(pPrev) pPrev->m_pNext = pNewNode;
    if(pNext) pNext->m_pPrev = pNewNode;
    return pNewNode;
}

/**
 * @brief Node "destructor".
 * [] This version will return the next node to the deleted current node.
 *
 * @param [in] pNodeToDel pointer to the node to delete.
 * @param [in] pDeleteFunc pointer to the item destruction function.
 * @return t_node* pointer to the next node to this one.
 */
t_node*NodeDelReturnNext(t_node*pNodeToDel, t_ptfV pDeleteFunc){
    if(pDeleteFunc) pDeleteFunc(pNodeToDel->m_pltem);
    else free(pNodeToDel->m_pltem);
    t_node*pNextNode=pNodeToDel->m_pNext;
    if(pNodeToDel->m_pPrev) pNodeToDel->m_pPrev->m_pNext=pNodeToDel->m_pNext;
    if(pNodeToDel->m_pNext) pNodeToDel->m_pNext->m_pPrev=pNodeToDel->m_pPrev;
    return pNextNode;
}

/**
 * @brief Node "destructor".
 * [] This version will return the next node to the deleted current node.
 * [] The associated item will be not destroyed by this function!
 *
 * @param pNodeToDel pointer to the node to delete.
 * @return t_node* pointer to the next node to this one.
 */
t_node*NodeDelOnlyReturnNext(t_node*pNodeToDel){
    t_node*pNextNode=pNodeToDel->m_pNext;
    if(pNodeToDel->m_pPrev) pNodeToDel->m_pPrev->m_pNext=pNodeToDel->m_pNext;
    if(pNodeToDel->m_pNext) pNodeToDel->m_pNext->m_pPrev=pNodeToDel->m_pPrev;

```

```

return pNodeToDel->m_pNext;
}

```

```

/**
 * @brief Node "destructor".
 * [] This version will return the previous node to the deleted current node.
 * [] The associated item will be not destroyed by this function!
 *
 * @param pNodeToDel pointer to the node to delete.
 * @return t_node* pointer to the previous node to this one.
 */

```

```

t_node*NodeDelOnlyReturnPrev(t_node*pNodeToDel){
    t_node*pPrevNode=pNodeToDel->m_pPrev;
    if(pNodeToDel->m_pPrev) pNodeToDel->m_pPrev->m_pNext=pNodeToDel->m_pNext;
    if(pNodeToDel->m_pNext) pNodeToDel->m_pNext->m_pPrev=pNodeToDel->m_pPrev;
    return pPrevNode;
}

```

```

/**
 * @brief type definition of container structure.
 * [] Container component: Hidden structure.
 */

```

```

struct s_container{
    t_node *m_pHead;[]/* Pointer to the first node of the container list: also known as HEAD of list.*/
    t_node *m_pTail;[]/* Pointer to the last node of the container list: also known as TAIL of list.*/
    size_t m_szCard;[]/* Number of total nodes in container: also known as CARDINAL of list.*/
    t_ptfV m_pDeleteItemFunc;[]/* Function pointer to the function responsible for item destruction.*/
};

```

```

/* Container component: Public functions implementation-----*/

```

```

/**
 * @brief Container "constructor".
 *
 * @param [in] pDeleteItemFunc []function pointer to the function responsible of
 * []properly deleting items in stored in container.
 * @return t_container* pointer on the newly created container.

```

```

*/
t_container* ContainerNew(t_ptfV pDeleteItemFunc){
    t_container* pContainer=(t_container*)malloc(sizeof(t_container));
    assert(pContainer);
    *pContainer=(t_container){
        .m_pDeleteItemFunc = pDeleteItemFunc,
    };
    return pContainer;
}

/**
 * @brief Container "destructor".
 *
 * @param [in] pContainer pointer to the container to destroy.
 * @return t_container* NULL.
 */
t_container* ContainerDel(t_container *pContainer){
    free(ContainerFlush(pContainer));
    return NULL;
}

/**
 * @brief Flushing the container by deleting all items and nodes.
 * The container structure is not destroyed !
 *
 * @param [in] pContainer pointer to the container to flush.
 * @return t_container* the flushed container.
 */
t_container* ContainerFlush(t_container *pContainer){
    assert(pContainer);
    while(pContainer->m_pHead){
        pContainer->m_pHead=NodeDelReturnNext(pContainer->m_pHead, pContainer->m_pDeleteItemFunc);
        pContainer->m_szCard--;
    }
    assert(pContainer->m_szCard==0);
    pContainer->m_pTail=NULL;
    return pContainer;
}

/**

```

```

* @brief Returns the number of elements in container.
*
* @param pContainer pointer to the container to get cardinal.
* @return size_t number of elements.
*/
size_t ContainerCard(const t_container*pContainer){
    assert(pContainer);
    return pContainer->m_szCard;
}

/**
* @brief Append a item at the end of the container.
*
* @param [in] pContainer pointer to the container to append to.
* @param [in] pItem pointer to the item to append.
* @return void* pointer to the item that was appended.
*/
void*ContainerPushback(t_container*pContainer, void*pItem){
    assert(pContainer);
    if(pContainer->m_szCard==0){
        assert(pContainer->m_pHead==NULL);
        assert(pContainer->m_pTail==NULL);
        pContainer->m_pHead=pContainer->m_pTail=NodeNew(NULL, NULL, pItem);
    }
    else{
        pContainer->m_pTail=NodeNew(pContainer->m_pTail, NULL, pItem);
    }
    pContainer->m_szCard++;
    assert(pContainer->m_pTail->m_pItem==pItem);
    return pContainer->m_pTail->m_pItem;
}

/**
* @brief Append a item at the beginning of the container.
*
* @param [in] pContainer pointer to the container to append to.
* @param [in] pItem pointer to the item to append.
* @return void* pointer to the item that was appended.
*/
void*ContainerPushfront(t_container*pContainer, void*pItem){

```

```

    assert(pContainer);
    if(pContainer->m_szCard==0){
        assert(pContainer->m_pHead==NULL);
        assert(pContainer->m_pTail==NULL);
        pContainer->m_pHead=pContainer->m_pTail=NodeNew(NULL, NULL, pItem);
    }
    else{
        pContainer->m_pHead=NodeNew(NULL,pContainer->m_pHead,pItem);
    }
    pContainer->m_szCard++;
    assert(pContainer->m_pHead->m_pItem==pItem);
    return pContainer->m_pHead->m_pItem;
}

/**
 * @brief Insert a item in the container at index.
 *
 * @param [in] pContainer pointer to the container to insert into.
 * @param [in] pItem pointer to the item to insert.
 * @param [in] szAt index to insert at.
 * @return void* pointer to the item that was inserted.
 */
void*ContainerPushat(t_container*pContainer, void*pItem, size_t szAt){
    assert(pContainer);
    assert((int)szAt>=0);
    assert(szAt<=pContainer->m_szCard);

    if(szAt==0) return ContainerPushfront(pContainer, pItem);
    if(szAt==pContainer->m_szCard) return ContainerPushback(pContainer, pItem);

    t_node*pInsert;
    if(szAt<=pContainer->m_szCard/2){
        pInsert=pContainer->m_pHead;
        for (size_t k = 0; k < szAt; k++){
            pInsert=pInsert->m_pNext;
        }
    }
    else{
        pInsert=pContainer->m_pTail;
        for (size_t k = pContainer->m_szCard-1; k>szAt; k--) {

```

```

    pInsert=pInsert->m_pPrev;
}
}

pInsert=NodeNew(pInsert->m_pPrev, pInsert, pItem);
pContainer->m_szCard++;
assert(pInsert->m_pItem==pItem);
return pInsert->m_pItem;
}

//void*ContainerPushat(t_container*pContainer, void*pItem, size_t szAt){
//    assert(pContainer);
//    assert((int)szAt >=0);
//    assert(szAt <= pContainer->m_szCard);
//
//    if(szAt == 0) return ContainerPushfront(pContainer, pItem);
//    if(szAt == pContainer->m_szCard) return ContainerPushback(pContainer, pItem);
//
//    t_node * pInsert;
//
//    for(size_t k = 0; k<szAt;k++){
//        pInsert =pInsert->m_pNext;
//    }
//
//    pInsert = NodeNew(pInsert->m_pPrev, pInsert, pItem);
//    pContainer->m_szCard++;
//    assert(pInsert->m_pItem == pItem);
//    return pInsert->m_pItem;
//}

```

/**

* @brief Get the last item from the container. The item persists in


```

* [] the container!
*
* @param pContainer pointer to the container to get from.
* @return void* pointer to the got item.
*/
void*ContainerGetback(const t_container*pContainer){
    []assert(pContainer);
    []assert(pContainer->m_szCard);
    []return pContainer->m_pTail->m_pltem;
}

/**
* @brief Get the first item from the container. The item persists in
* [] the container!
*
* @param pContainer pointer to the container to get from.
* @return void* pointer to the got item.
*/
void*ContainerGetfront(const t_container*pContainer){
    []assert(pContainer);
    []assert(pContainer->m_szCard);
    []return pContainer->m_pHead->m_pltem;
}

/**
* @brief Get the item stored at index from the container. The
* [] item persists in the container!
*
* @param [in] pContainer pointer to the container to get from.
* @param [in] sAt index to get from.
* @return void* pointer to the got item.
*/
void*ContainerGetat(const t_container*pContainer, size_t szAt){
    []assert(pContainer);
    []assert((int)szAt>=0);
    []assert(szAt<pContainer->m_szCard);[]* WARNING!!! szAt MUST BE STRICTLY LESSER THAN m_szCard!!! */

    []if(szAt==0) return ContainerGetfront(pContainer);

    []* WARNING!!! m_szCard-1 BECAUSE szAt MUST BE STRICTLY LESSER THAN m_szCard!!! */

```

```
if(szAt==pContainer->m_szCard-1) return ContainerGetback(pContainer);
```

```
t_node*pGet;
```

```
if(szAt<=pContainer->m_szCard/2){
```

```
    pGet=pContainer->m_pHead;
```

```
    for (size_t k = 0; k < szAt; k++){
```

```
        pGet=pGet->m_pNext;
```

```
    }
```

```
}
```

```
else{
```

```
    pGet=pContainer->m_pTail;
```

```
    for (size_t k = pContainer->m_szCard-1; k>szAt; k--) {
```

```
        pGet=pGet->m_pPrev;
```

```
    }
```

```
}
```

```
return pGet->m_pItem;
```

```
}
```

```
/**
```

```
 * @brief Extract the last item from the container, and return it to caller.
```

```
 * [] The item is removed from the container and the corresponding node is deleted.
```

```
 *
```

```
 * @param pContainer pointer to the container to extract from.
```

```
 * @return void* pointer to the popped item.
```

```
 */
```

```
void*ContainerPopback(t_container*pContainer){
```

```
    assert(pContainer);
```

```
    assert(pContainer->m_szCard);
```

```
    void*pReturnItem=pContainer->m_pTail->m_pItem;
```

```
    if(pContainer->m_pHead==pContainer->m_pTail) pContainer->m_pHead=NULL;
```

```
    pContainer->m_pTail=NodeDelOnlyReturnPrev(pContainer->m_pTail);
```

```
    pContainer->m_szCard--;
```

```
    return pReturnItem;
```

```
}
```

```
/**
```

```
 * @brief Extract the first item from the container, and return it to caller.
```

```
 * [] The item is removed from the container and the corresponding node is deleted.
```

```
 *
```

```

* @param [in] pContainer pointer to the container to extract from.
* @return void* pointer to the popped item.
*/
void*ContainerPopfront(t_container*pContainer){
    assert(pContainer);
    assert(pContainer->m_szCard);

    void*pReturnItem=pContainer->m_pHead->m_pItem;
    if(pContainer->m_pTail==pContainer->m_pHead) pContainer->m_pTail=NULL;
    pContainer->m_pHead=NodeDelOnlyReturnNext(pContainer->m_pHead);
    pContainer->m_szCard--;
    return pReturnItem;
}

/**
* @brief Extract the item located at index from the container, and return it to caller.
* [] The item is removed from the container and the corresponding node is deleted.
*
* @param [in] pContainer pointer to the container to extract from.
* @param [in] szAt index to extract from.
* @return void* pointer to the popped item.
*/
void*ContainerPopat(t_container*pContainer, size_t szAt){
    assert(pContainer);
    assert((int)szAt>=0);
    assert(szAt<pContainer->m_szCard);/* WARNING!!! szAt MUST BE STRICTLY LESSER THAN m_szCard!!! */

    if(szAt==0) return ContainerPopfront(pContainer);

    /* WARNING!!! m_szCard-1 BECAUSE szAt MUST BE STRICTLY LESSER THAN m_szCard!!! */
    if(szAt==pContainer->m_szCard-1) return ContainerPopback(pContainer);

    t_node*pPop;
    if(szAt<=pContainer->m_szCard/2){
        pPop=pContainer->m_pHead;
        for (size_t k = 0; k < szAt; k++){
            pPop=pPop->m_pNext;
        }
    }
    else{

```

```

    pPop=pContainer->m_pTail;
    for (size_t k = pContainer->m_szCard-1; k>szAt; k--) {
        pPop=pPop->m_pPrev;
    }
}

void*pReturnItem=pPop->m_pltem;
NodeDelOnlyReturnNext(pPop);
pContainer->m_szCard--;
return pReturnItem;
}

/**
 * @brief Parsing the container from front to back, and for each item, calling
 * the parsing function with parameters the pointer to the corresponding
 * item and the pParam parameter.
 * The parsing is stopped if the parsing function returns a non null value,
 * and in this case, the function returns the corresponding item to the caller.
 *
 * @param [in] pContainer pointer to the container to parse.
 * @param [in] pParseFunc pointer to the called function for each parsed item.
 * @param [in] pParam parameter directly passed to the called function during parsing.
 * @return void* NULL in case of a complete parsing,
 * pointer to the item in case of interrupted parsing.
 */
void*ContainerParse(const t_container*pContainer, t_ptfVV pParseFunc, void*pParam){
    assert(pContainer);
    assert(pParseFunc);

    t_node*pParse=pContainer->m_pHead;
    while(pParse){
        if(pParseFunc(pParse->m_pltem, pParam)) return pParse->m_pltem;
        pParse=pParse->m_pNext;
    }
    return NULL;
}

/**
 * @brief Parsing the container from front to back, and for each item, calling
 * the parsing function with parameters the pointer to the corresponding
 * item and the pParam parameter.

```

```

* [] In case of a non null return value from called function, the item and the
* [] corresponding node are destroyed. The parsing is then resumed to the next
* [] item and the same scenario takes place, until container back is reached.
*
* @param [in] pContainer pointer to the container to parse.
* @param [in] pParseFunc pointer to the called function for each parsed item.
* @param [in] pParam parameter directly passed to the called function during parsing.
* @return void* NULL (complete parsing).
*/
void*ContainerParseDellf(t_container*pContainer, t_ptfVV pParseFunc, void*pParam){
[]assert(pContainer);
[]assert(pParseFunc);

[]t_node*pParse=pContainer->m_pHead;
[]while(pParse){
[]if(pParseFunc(pParse->m_pltem, pParam)){
[]if(pContainer->m_pHead==pParse) pContainer->m_pHead=pParse->m_pNext;
[]if(pContainer->m_pTail==pParse) pContainer->m_pTail=pParse->m_pPrev;
[]pParse=NodeDelOnlyReturnNext(pParse);
[]pContainer->m_szCard--;
[]}
[]else{
[]pParse=pParse->m_pNext;
[]}
[]}
[]return NULL;
}

/**
* @brief Parsing the container A, and for each of its items, calls the intersection
* [] function with each item of the container B. In case of matched intersection,
* [] both item and node in container A are destroyed, and both item and node
* [] in container B are also destroyed. In this case, the parsing is resumed
* [] to the next item of container A, and the same scenario takes place by parsing
* [] container B from his front to back. Parsing ending when all items in each
* [] container has been intersected with each other.
*
* @param [in] pContainerA pointer the the first container to intersect .
* @param [in] pContainerB pointer the the second container to intersect .
* @param [in] plIntersectFunc pointer to the called intersect function for each parsed items.

```

* @param [in] pCallbackFunc pointer to the callback function in case of intersection.

* @param [in] pParam parameter directly passed to the callback function.

* @return void* NULL (complete parsing).

*/

```
void*ContainerIntersectDellf(t_container*pContainerA, t_container*pContainerB, t_ptfVV pIntersectFunc,t_ptfVV
pCallbackFunc, void*pParam){
```

```
    assert(pContainerA);
```

```
    assert(pContainerB);
```

```
    assert(pIntersectFunc);
```

```
    t_node *pParseA=pContainerA->m_pHead,
```

```
    **pParseB=pContainerB->m_pHead;
```

```
    int hasIntersected;
```

```
    while(pParseA && pParseB){
```

```
        hasIntersected=0; /* No intersection has occurred at this time */
```

```
        while(pParseA && pParseB){
```

```
            if(pIntersectFunc(pParseA->m_pltem, pParseB->m_pltem)){
```

```
                /* Notifying the intersection between the two items */
```

```
                hasIntersected=1;
```

```
            /* Processing callback if exist */
```

```
            if(pCallbackFunc) pCallbackFunc(pParam, NULL);
```

```
            /* Destroying current item of container A */
```

```
            if(pContainerA->m_pHead==pParseA) pContainerA->m_pHead=pParseA->m_pNext;
```

```
            if(pContainerA->m_pTail==pParseA) pContainerA->m_pTail=pParseA->m_pPrev;
```

```
            pParseA=NodeDelReturnNext(pParseA, pContainerA->m_pDeleteItemFunc);
```

```
            pContainerA->m_szCard--;
```

```
            /* Destroying current item of container B */
```

```
            if(pContainerB->m_pHead==pParseB) pContainerB->m_pHead=pParseB->m_pNext;
```

```
            if(pContainerB->m_pTail==pParseB) pContainerB->m_pTail=pParseB->m_pPrev;
```

```
            pParseB=NodeDelReturnNext(pParseB, pContainerB->m_pDeleteItemFunc);
```

```
            pContainerB->m_szCard--;
```

```
        }
```

```
    }else{
```

```
        pParseB=pParseB->m_pNext; /* Processing the next node of container B */
```

```

    }
}

/* Processing the next node of container A */
if(!hasIntersected) pParseA=pParseA->m_pNext;
/* Reseting the parsing pointer of container B to his header for a new scan */
pParseB=pContainerB->m_pHead;
}

return NULL;
}

```

```

/*****/

```

```

void*ContainerInsert(t_container*pContainer, t_ptfVV pPredicaFunc, void*pltem){
    assert(pContainer);
    assert(pPredicaFunc);

    t_node*plInsert=pContainer->m_pHead;
    size_t szAt=0;

    while(plInsert!=NULL){
        if(pPredicaFunc(pltem, plInsert->m_pltem)){
            return ContainerPushat(pContainer, pltem, szAt);
        }
        plInsert=plInsert->m_pNext;
        szAt++;
    }
    return ContainerPushback(pContainer, pltem);
}

```

```

void*ContainerInsertUnic(t_container*pContainer, t_ptfVV pPredicaFunc, void*pltem){
    assert(pContainer);
    assert(pPredicaFunc);

    t_node*plInsert=pContainer->m_pHead;
    size_t szAt=0;

    while(plInsert!=NULL){

```

```

switch((long)pPredicaFunc(pltem, pInsert->m_pltem)){
case 0: /* Continue parsing */
    pInsert=pInsert->m_pNext;
    szAt++;
    break;
case 1: /* Inserting here */
    return ContainerPushat(pContainer, pltem, szAt);
    // no break;
case -1: /* Deleting item */
    if(pContainer->m_pDeleteltemFunc) pContainer->m_pDeleteltemFunc(pltem);
    else free(pltem);
    return NULL;
    // no break;
default:
    assert(NULL); /* Never enter in default case ! */
    break;
}
return ContainerPushback(pContainer, pltem);
}

void*ContainerSerialize(t_container*pContainer, t_ptfVV pSerializeFunc){

return NULL;
}

void*ContainerDeserialize(t_container*pContainer, t_ptfVV pDeserializeFunc){
return NULL;
}

```

container.h

```

/*
 * container.h
 *
 * Created on: 16 mars 2022
 * Author: Thierry Boyer
 */

```



```

/**
 * @brief Function pointers definition.
 */
typedef void*(*t_ptfV)(void*);/// For functions like: void*()(void*)
typedef void*(*t_ptfVV)(void*, void*);/// For functions like: void*()(void*, void*)


/**
 * @brief Container type definition: "hidden structure" or "incomplete structure" definition.
 */
typedef struct s_container t_container;


/**
 * @brief Container public functions declaration.
 */


/**
 * @brief Container "constructor".
 *
 * @param [in] pDeleteItemFunc function pointer to the function responsible of
 * properly deleting items in stored in container.
 * @return t_container* pointer on the newly created container.
 */
t_container*ContainerNew(t_ptfV pDeleteItemFunc);


/**
 * @brief Container "destructor".
 *
 * @param [in] pContainer pointer to the container to destroy.
 * @return t_container* NULL.
 */
t_container*ContainerDel(t_container *pContainer);


/**
 * @brief Flushing the container by deleting all items and nodes.
 * The container structure is not destroyed !
 *
 * @param [in] pContainer pointer to the container to flush.
 * @return t_container* the flushed container.

```

```

*/
t_container*ContainerFlush(t_container *pContainer);

/**
 * @brief Returns the number of elements in container.
 *
 *
 * @param pContainer pointer to the container to get cardinal.
 * @return size_t number of elements.
 */
size_t ContainerCard(const t_container*pContainer);

/**
 * @brief Append a item at the end of the container.
 *
 *
 * @param [in] pContainer pointer to the container to append to.
 * @param [in] pItem pointer to the item to append.
 * @return void* pointer to the item that was appended.
 */
void*ContainerPushback(t_container*pContainer, void*pItem);

/**
 * @brief Append a item at the beginning of the container.
 *
 *
 * @param [in] pContainer pointer to the container to append to.
 * @param [in] pItem pointer to the item to append.
 * @return void* pointer to the item that was appended.
 */
void*ContainerPushfront(t_container*pContainer, void*pItem);

/**
 * @brief Insert a item in the container at index.
 *
 *
 * @param [in] pContainer pointer to the container to insert into.
 * @param [in] pItem pointer to the item to insert.
 * @param [in] szAt index to insert at.
 * @return void* pointer to the item that was inserted.
 */
void*ContainerPushat(t_container*pContainer, void*pItem, size_t szAt);

/**

```

```

* @brief Get the last item from the container. The item persists in
* [] the container!
*
* @param pContainer pointer to the container to get from.
* @return void* pointer to the got item.
*/
void*ContainerGetback(const t_container*pContainer);

/**
* @brief Get the first item from the container. The item persists in
* [] the container!
*
* @param pContainer pointer to the container to get from.
* @return void* pointer to the got item.
*/
void*ContainerGetfront(const t_container*pContainer);

/**
* @brief Get the item stored at index from the container. The
* [] item persists in the container!
*
* @param [in] pContainer pointer to the container to get from.
* @param [in] sAt index to get from.
* @return void* pointer to the got item.
*/
void*ContainerGetat(const t_container*pContainer, size_t szAt);

/**
* @brief Extract the last item from the container, and return it to caller.
* [] The item is removed from the container and the corresponding node is deleted.
* @param pContainer pointer to the container to extract from.
* @return void* pointer to the popped item.
*/
void*ContainerPopback(t_container*pContainer);

/**
* @brief Extract the first item from the container, and return it to caller.
* [] The item is removed from the container and the corresponding node is deleted.
* @param [in] pContainer pointer to the container to extract from.
* @return void* pointer to the popped item.

```

```

*/
void*ContainerPopfront(t_container*pContainer);

/**
 * @brief Extract the item located at index from the container, and return it to caller.
 * [] The item is removed from the container and the corresponding node is deleted.
 * @param [in] pContainer pointer to the container to extract from.
 * @param [in] sAt index to extract from.
 * @return void* pointer to the popped item.
 */
void*ContainerPopat(t_container*pContainer, size_t szAt);

/**
 * @brief Parsing the container from front to back, and for each item, calling
 * [] the parsing function with parameters the pointer to the corresponding
 * [] item and the pParam parameter.
 * [] The parsing is stopped if the parsing function returns a non null value,
 * [] and in this case, the function returns the corresponding item to the caller.
 *
 * @param [in] pContainer pointer to the container to parse.
 * @param [in] pParseFunc pointer to the called function for each parsed item.
 * @param [in] pParam parameter directly passed to the called function during parsing.
 * @return void* NULL in case of a complete parsing,
 * [] pointer to the item in case of interrupted parsing.
 */
void*ContainerParse(const t_container*pContainer, t_ptfVV pParseFunc, void*pParam);

/**
 * @brief Parsing the container from front to back, and for each item, calling
 * [] the parsing function with parameters the pointer to the corresponding
 * [] item and the pParam parameter.
 * [] In case of a non null return value from called function, the item and the
 * [] corresponding node are destroyed. The parsing is then resumed to the next
 * [] item and the same scenario takes place, until container back is reached.
 *
 * @param [in] pContainer pointer to the container to parse.
 * @param [in] pParseFunc pointer to the called function for each parsed item.
 * @param [in] pParam parameter directly passed to the called function during parsing.
 * @return void* NULL (complete parsing).
 */

```

```

void*ContainerParseDellf(t_container*pContainer, t_ptfVV pParseFunc, void*pParam);

/**
 * @brief Parsing the container A, and for each of its items, calls the intersection
 * [] function with each item of the container B. In case of matched intersection,
 * [] both item and node in container A are destroyed, and both item and node
 * [] in container B are also destroyed. In this case, the parsing is resumed
 * [] to the next item of container A, and the same scenario takes place by parsing
 * [] container B from his front to back. Parsing ending when all items in each
 * [] container has been intersected with each other.
 *
 * @param [in] pContainerA pointer the the first container to intersect.
 * @param [in] pContainerB pointer the the second container to intersect.
 * @param [in] pIntersectFunc pointer to the called intersect function for each parsed items.
 * @param [in] pCallbackFunc pointer to the callback function in case of intersection.
 * @param [in] pParam parameter directly passed to the callback function.
 * @return void* NULL (complete parsing).
 */
void*ContainerIntersectDellf(t_container*pContainerA, t_container*pContainerB, t_ptfVV pIntersectFunc,t_ptfVV
pCallbackFunc, void*pParam);

void*ContainerInsert(t_container*pContainer, t_ptfVV pPredicaFunc, void*pltem);

void*ContainerInsertUnic(t_container*pContainer, t_ptfVV pPredicaFunc, void*pltem);

void*ContainerSerialize(t_container*pContainer, t_ptfVV pSerializeFunc);

void*ContainerDeserialize(t_container*pContainer, t_ptfVV pDeserializeFunc);

```

Revision #2

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