Deques

Estruturas de Dados e Algoritmos – Ciência da Computação

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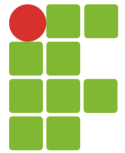
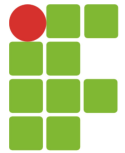
IFB – Instituto Federal de Brasília,
Campus Taguatinga



Sumário



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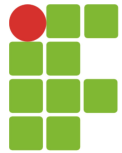
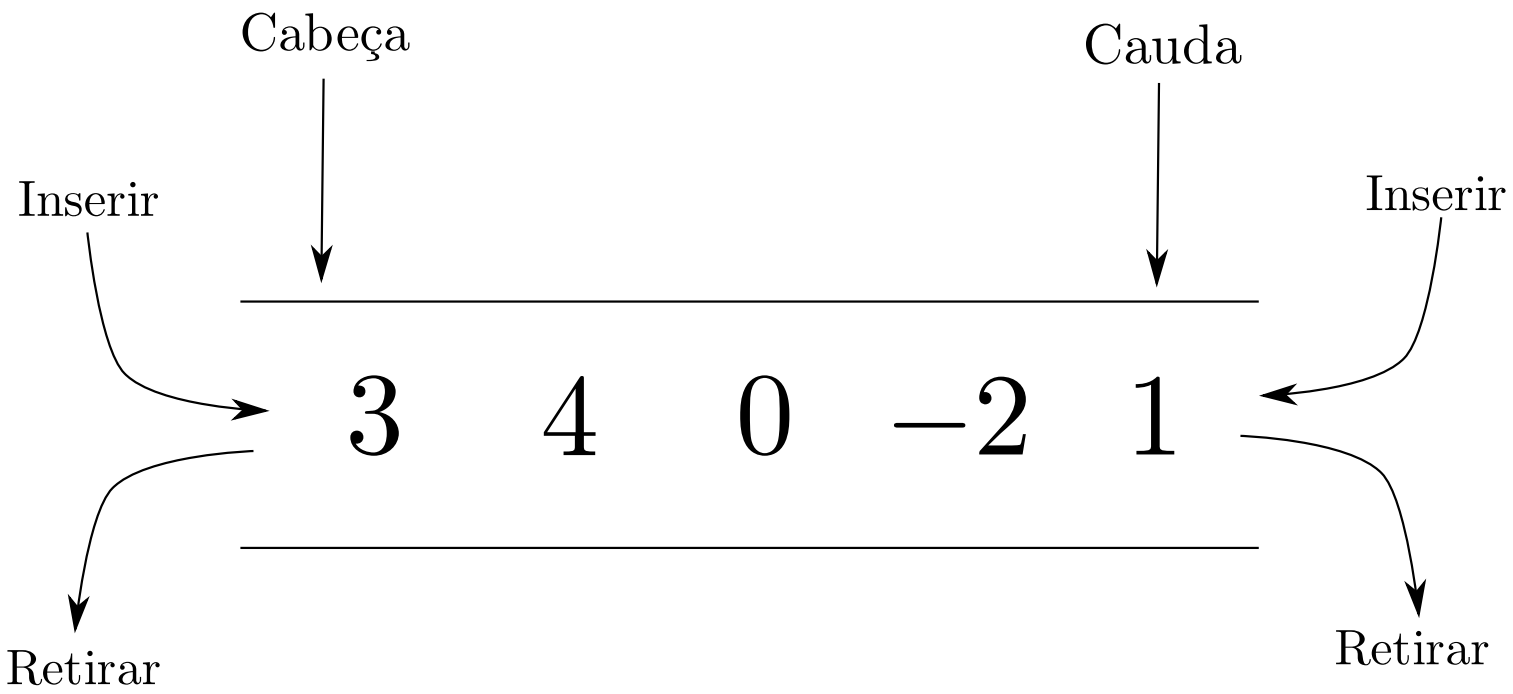
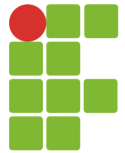


Deques

- Deque: Double-Ended-Queue.
- Deques são TADs que generalizam filas.
- Em deques, elementos podem ser adicionados tanto no início quando no fim da fila.
- Pode-se retirar elementos nas duas extremidades também.

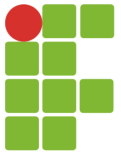
Deques



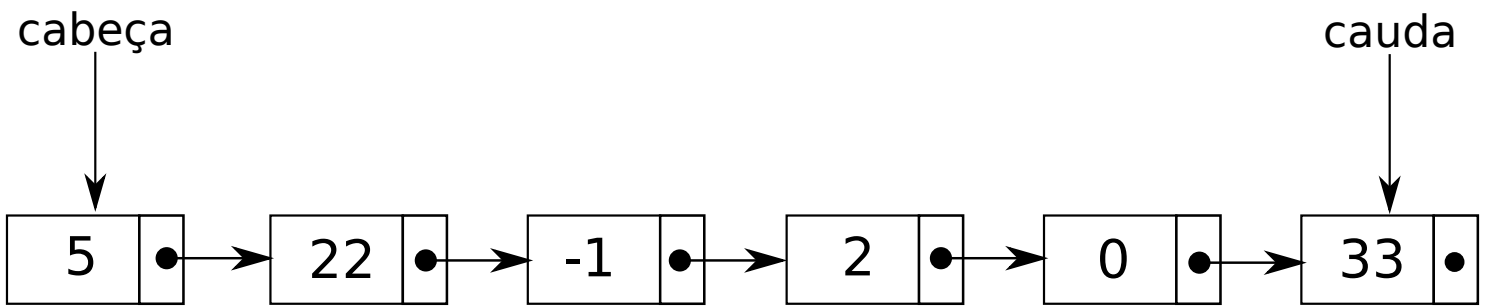


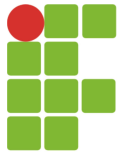
Implementação de Deques

- Que estruturas de dados podemos usar para implementar um deque?
- Esta estrutura deve suportar inserção/remoção na cabeça e na cauda em $\Theta(1)$.
- Será que uma lista encadeada simples funciona?



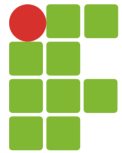
Implementação de Deques





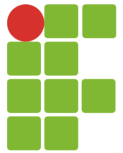
Listas Encadeadas: Análise

Operação	Complexidade
Inserção na cabeça	$\Theta(1)$
Inserção na cauda	$\Theta(1)$
Remoção da cabeça	$\Theta(1)$
Remoção da cauda	$\Theta(n)$
Acesso à cabeça	$\Theta(1)$
Acesso à cauda	$\Theta(1)$



Implementação de Deques

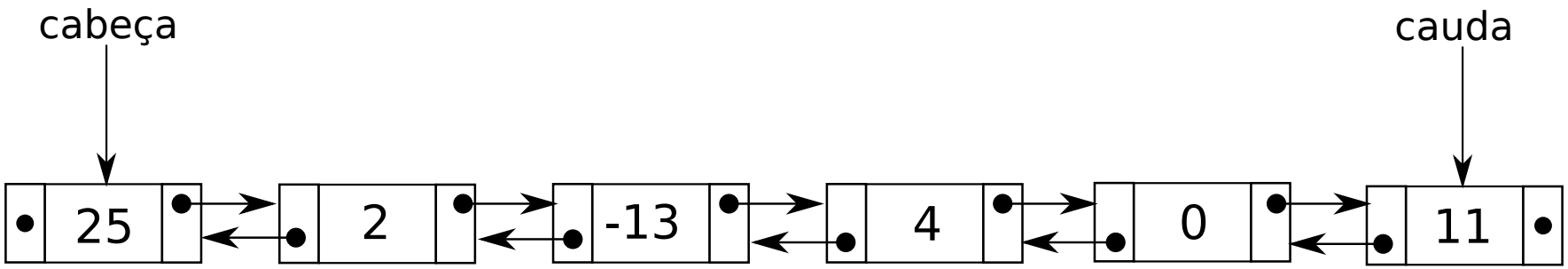
- Listas encadeadas simples não permitem remoção da cauda em tempo constante.
- Temos que recorrer às listas duplamente encadeadas!

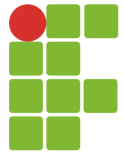


Listas Duplamente Encadeadas: Análise

Operação	Complexidade
Inserção na cabeça	$\Theta(1)$
Inserção na cauda	$\Theta(1)$
Remoção da cabeça	$\Theta(1)$
Remoção da cauda	$\Theta(1)$
Acesso à cabeça	$\Theta(1)$
Acesso à cauda	$\Theta(1)$

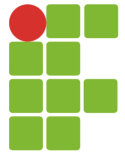
Implementação de Deques





Implementação de Deques

- Listas duplamente encadeadas se mostram uma escolha certa para implementação de Deques!



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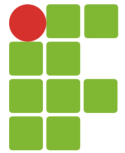

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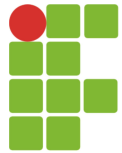
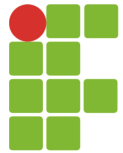


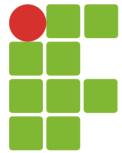
Deques: Definição

```
10 typedef void* (*deque_node_constructor_fn) (void*);
11 typedef void (*deque_node_destructor_fn)(void *);
```



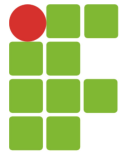
Deques: Definição

```
22 typedef struct deque_node_t{
23     struct deque_node_t* next;
24     struct deque_node_t* prev;
25     void* data;
26 }deque_node_t;
```



Deques: Definição

```
40 typedef struct deque_t{
41     struct deque_node_t* front;
42     struct deque_node_t* back;
43     deque_node_constructor_fn constructor;
44     deque_node_destructor_fn destructor;
45     size_t size;
46 }deque_t;
```



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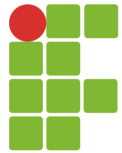
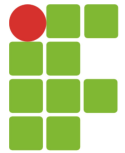


Deques: Inicialização

```
6  void deque_initialize(deque_t** d,deque_node_constructor_fn constructor,
7                        deque_node_destructor_fn destructor){
8      (*d) = mallocx(sizeof(deque_t));
9      (*d)->front = NULL;
10     (*d)->back = NULL;
11     (*d)->constructor = constructor;
12     (*d)->destructor = destructor;
13     (*d)->size = 0;
14 }
```



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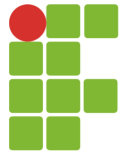
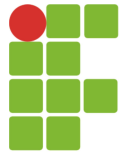


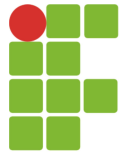
Deques: Funções Auxiliares

```
97  size_t deque_size(deque_t* d){
98      return d->size;
99  }
```



Deques: Funções Auxiliares

```
102 size_t deque_empty(deque_t* d){
103     return deque_size(d) == 0  ? 1 : 0;
104 }
```



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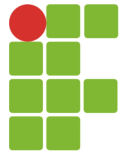
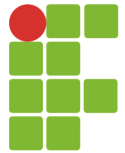


Deques: Inserção na Frente

```
26  void deque_push_front(deque_t* d,void* data){
27      deque_node_t* new_node = mallocx(sizeof(deque_node_t));
28      new_node->data = d->constructor(data);
29      new_node->next = d->front;
30      new_node->prev = NULL;
31      if(deque_empty(d)){
32          d->back = new_node;
33      }
34      else{
35          d->front->prev = new_node;
36      }
37      d->front = new_node;
38      d->size++;
39  }
```



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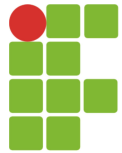
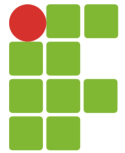


Deques: Inserção Atrás

```
43  void deque_push_back(deque_t* d,void* data){
44      deque_node_t* new_node = mallocx(sizeof(deque_node_t));
45      new_node->data = d->constructor(data);
46      new_node->next = NULL;
47      new_node->prev = d->back;
48      if(deque_empty(d)){
49          d->front = new_node;
50      }
51      else{
52          d->back->next = new_node;
53      }
54      d->back = new_node;
55      d->size++;
56  }
```



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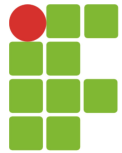
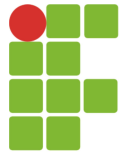


Deques: Acesso na Frente

```
85  void* deque_front(deque_t* d){
86      assert(!deque_empty(d));
87      return(d->front->data);
88  }
```



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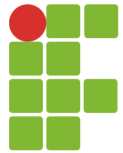
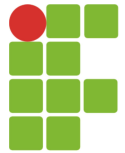


Deques: Acesso Atrás

```
91  void* deque_back(deque_t* d){
92      assert(!deque_empty(d));
93      return(d->back->data);
94  }
```



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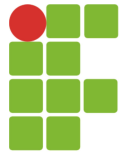
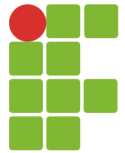


Deques: Acesso na Frente

```
59  void deque_pop_front(deque_t* d){
60      assert(!deque_empty(d));
61      deque_iterator_t it = d->front;
62      d->front = d->front->next;
63      if(deque_size(d)==1){
64          d->back = NULL;
65      }
66      d->destructor(it->data);
67      free(it);
68      d->size--;
69  }
```



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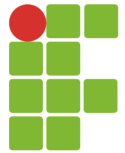
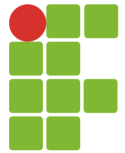


Deques: Acesso na Frente

```
72  void deque_pop_back(deque_t* d){
73      assert(!deque_empty(d));
74      deque_iterator_t it = d->back;
75      d->back = d->back->prev;
76      if(deque_size(d)==1){
77          d->front = NULL;
78      }
79      d->destructor(it->data);
80      free(it);
81      d->size--;
82  }
```



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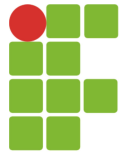
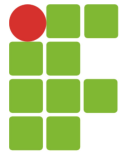


Deques: Limpeza

```
17 void deque_delete(deque_t** d){
18     while(!deque_empty(*d)){
19         deque_pop_front(*d);
20     }
21     free(*d);
22     (*d) = NULL;
23 }
```



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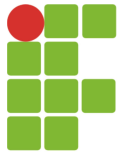
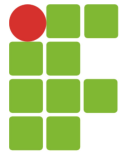


Deques: Análise

Operação	Complexidade
Inserção na frente	$\Theta(1)$
Inserção atrás	$\Theta(1)$
Remoção da frente	$\Theta(1)$
Remoção atrás	$\Theta(1)$
Acesso à frente	$\Theta(1)$
Acesso atrás	$\Theta(1)$



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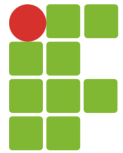
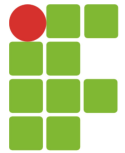


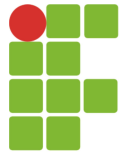
Exemplo de Utilização da Biblioteca

```
6  typedef struct pessoa{
7      char nome[30];
8      char cpf[20];
9      int idade;
10 }pessoa;
```



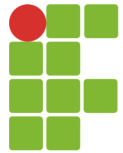
Exemplo de Utilização da Biblioteca

```
12  void* constructor_pessoa(void* data){
13      void* ptr = mallocx(sizeof(pessoa));
14      memcpy(ptr,data,sizeof(pessoa));
15      return ptr;
16  }
```



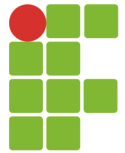
Exemplo de Utilização da Biblioteca

```
35  void destructor_pessoa(void* data){
36      free(data);
37  }
```



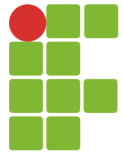
Exemplo de Utilização da Biblioteca

```
18 void my_getline(char* str,size_t size){
19     int i;
20     char c;
21     for(i=0;i<size-1;i++){
22         c = getchar();
23         if(c=='\n'){
24             str[i] = '\0';
25             break;
26         }
27         str[i] = c;
28     }
29     str[size-1]='\0';
30     while(c!='\n'){
31         c = getchar();
32     }
33 }
```



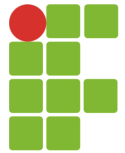
Exemplo de Utilização da Biblioteca

```
39  void cadastra_pessoa(pessoa* p){
40      printf("Nome: ");
41      my_getline(p->nome,30);
42      printf("CPF: ");
43      my_getline(p->cpf,20);
44      printf("Idade: ");
45      scanf("%d%*c",&p->idade);
46  }
```



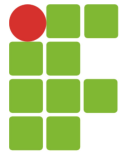
Exemplo de Utilização da Biblioteca

```
48  void imprime_pessoa(const pessoa* p){
49      printf("Nome: ");
50      printf("%s\n",p->nome);
51      printf("CPF: ");
52      printf("%s\n",p->cpf);
53      printf("Idade: ");
54      printf("%d\n",p->idade);
55  }
```



Exemplo de Utilização da Biblioteca

```
57  int main(void){
58      int i;
59      deque_t* d;
60      pessoa p;
61      deque_initialize(&d,constructor_pessoa,destructor_pessoa);
62      for(i=0;i<5;i++){
63          printf("Cadastrando pessoa %d\n",i+1);
64          cadastra_pessoa(&p);
65          if(i%2==0){
66              deque_push_front(d,&p);
67          }
68          else{
69              deque_push_back(d,&p);
70          }
71      }
72      i=0;
```



Exemplo de Utilização da Biblioteca

```
73      while(!deque_empty(d)){
74          printf("\n**Imprimindo pessoa**\n");
75          if(i%2==0){
76              p =  *(pessoa*) deque_front(d);
77              deque_pop_front(d);
78          }
79          else{
80              p =  *(pessoa*) deque_back(d);
81              deque_pop_back(d);
82          }
83          imprime_pessoa(&p);
84          printf("\n");
85          i++;
86      }
87      deque_delete(&d);
88      return 0;
89  }
```