

deque

An implementation of a Deque (double-ended queue). The underlying implementation uses a seq.

Note: None of the procs that get an individual value from the Deque should be used on an empty Deque.

If compiled with the `boundChecks` option, those procs will raise an `IndexDefect` on such access. This should not be relied upon, as `-d:danger` or `--checks:off` will disable those checks and then the procs may return garbage or crash the program.

As such, a check to see if the Deque is empty is needed before any access, unless your program logic guarantees it indirectly.

Example:

```
import deque
var a = [10, 20, 30, 40].toDeque
doAssertRaises(IndexDefect, echo a[4])
assert not isEmpty(a)

a.addLast(50)
assert $a == "[10, 20, 30, 40, 50]"
assert a.first == 10
assert a.last == 50
assert len(a) == 5
assert capacity(a) == 8

assert a.popFirst == 10
assert a.popLast == 50
assert a.len == 3
assert a.capacity == 8
assert a.high == 2

a.addFirst(11)
a.addFirst(22)
a.addFirst(33)
a.first = 44
assert a == @[44, 22, 11, 20, 30, 40]

a.shrink(fromFirst = 1, fromLast = 2)
assert a == @[22, 11, 20]
```

Types

Deque[T] = object

A double-ended queue backed with a ringed seq buffer.

To initialize an empty Deque, use the [initDeque proc](#).

Procs

```
proc `$_`[T](deq: Deque[T]): string
```

Turns a Deque into its string representation.

Example:

```
let a = [10, 20, 30].toDeque
assert $a == "[10, 20, 30]"
```

```
proc `&`[T](x, y: sink Deque[T]): Deque[T] {.noSideEffect.}
```

Returns the concatenation of two Deques.

See also:

- [addLast\(var Deque\[T\], sink Deque\[T\]\)](#)
- [&= template](#)

```
proc `&`[T](x: sink Deque[T]; y: sink openArray[T]): Deque[T] {.noSideEffect.}
```

Returns seq y appended to the end of Deque x.

See also:

- [addLast\(var Deque\[T\], sink openArray\[T\]\)](#)
- [&= template](#)

```
proc `&`[T](x: sink Deque[T]; y: sink T): Deque[T] {.noSideEffect.}
```

Returns element y appended to the end of Deque x.

See also:

- [addLast\(var Deque\[T\], T\)](#)
- [&= template](#)

```
proc `&`[T](x: sink openArray[T]; y: sink Deque[T]): Deque[T] {.noSideEffect.}
```

Returns seq x prepended to the beginning of Deque y.

See also:

- [addFirst\(var Deque\[T\], sink openArray\[T\]\)](#)

```
proc `&`[T](x: sink T; y: sink Deque[T]): Deque[T] {.noSideEffect.}
```

Returns element x prepended to the beginning of Deque y.

See also:

- [addFirst\(var Deque\[T\], T\)](#)

```
func `==`[T](deq1, deq2: Deque[T]): bool
```

The == operator for Deque. Returns true if both Deques contains the same values in the same order.

Example:

```
var a, b = initDeque[int]()
a.addFirst(2)
a.addFirst(1)
b.addLast(1)
b.addLast(2)
doAssert a == b
```

```
proc \_\[\][T; U, V: Ordinal](target: Deque[T]; x: HSlice[U, V]): Deque[T] {.
  systemRaisesDefect.}
```

Slice operation for Deques. Returns the inclusive range [target[start .. stop]. If the slice indices are reversed, so will be the data.

```
var s = @[1, 2, 3, 4].toDeque
assert $s[0..2] == "[1, 2, 3]"
assert $s[1..<4] == "[2, 3]"
assert $s[^1..0] == "[4, 3, 2, 1]"
```

```
proc \_\[\][T](deq: Deque[T]; i: BackwardsIndex): T {.inline.}
```

Accesses the backwards indexed i-th element.

deq[^1] is the last element.

Example:

```
let a = [10, 20, 30, 40, 50].toDeque
assert a[^1] == 50
assert a[^4] == 20
doAssertRaises(IndexDefect, echo a[^9])
```

```
proc \_\[\][T](deq: Deque[T]; i: Natural): T {.inline.}
```

Accesses the i-th element of deq.

Example:

```
let a = [10, 20, 30, 40, 50].toDeque
assert a[0] == 10
assert a[3] == 40
doAssertRaises(IndexDefect, echo a[8])
```

```
proc \_\[\][T](deq: var Deque[T]; i: BackwardsIndex): var T {.inline.}
```

Accesses the backwards indexed i-th element and returns a mutable reference to it.

deq[^1] is the last element.

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
inc(a[^1])
assert a[^1] == 51
```

```
proc \_\[\][T](deq: var Deque[T]; i: Natural): var T {.inline.}
```

Accesses the i-th element of deq and returns a mutable reference to it.

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
inc(a[0])
assert a[0] == 11
```

```
proc slice[T; U, V: Ordinal](target: var Deque[T]; x: HSlice[U, V];
                             source: openArray[T]) {.systemRaisesDefect.}
```

Slice assignment for Deques from sequences.

If source is longer than the slice, a slice of source is taken to fit. If source is shorter than the slice, target is shortened. If the slice indices are reversed, so will be the data.

Example:

```
var s = @[1, 2, 3, 4, 5].toDeque
s[1 .. ^2] = @[10, 20]
assert s == @[1, 10, 20, 5].toDeque
s[1..0] = @[100, 200]
assert s == @[200, 100, 20, 5].toDeque
```

```
proc slice[T; U, V: Ordinal](target: var Deque[T]; x: HSlice[U, V];
                             source: Deque[T]) {.systemRaisesDefect.}
```

Slice assignment for Deques from Deques.

If source is longer than the slice, a slice of source is taken to fit. If source is shorter than the slice, target is shortened. If the slice indices are reversed, so will be the data.

Example:

```
var s = @[1, 2, 3, 4, 5].toDeque
s[1 .. ^2] = @[10, 20].toDeque
assert s == @[1, 10, 20, 5].toDeque
```

```
proc setBackwards[T](deq: var Deque[T]; i: BackwardsIndex; x: sink T) {.inline.}
```

Sets the backwards indexed i-th element of deq to x.

deq[^1] is the last element.

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
a[^1] = 99
a[^3] = 77
assert $a == "[10, 20, 77, 40, 99]"
```

```
proc set[T](deq: var Deque[T]; i: Natural; val: sink T) {.inline.}
```

Sets the i-th element of deq to val.

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
a[0] = 99
a[3] = 66
assert $a == "[99, 20, 30, 66, 50]"
```

```
proc addFirst[T](deq1: var Deque[T]; deq2: sink Deque[T])
```

Adds `deque2` to the beginning of `deque1` as concatenation.

See also:

- [addLast proc](#)

Example:

```
var a = [1, 2, 3].toDeque
let b = [10, 20, 30].toDeque
a.addFirst(b)
assert $a == "[10, 20, 30, 1, 2, 3]"
```

```
proc addFirst[T](deque1: var Deque[T]; seq2: sink openArray[T])
```

Adds `deque2` to the beginning of `deque1` as concatenation.

See also:

- [addLast proc](#)

Example:

```
var a = [1, 2, 3].toDeque
let b = [10, 20, 30]
a.addFirst(b)
assert $a == "[10, 20, 30, 1, 2, 3]"
```

```
proc addFirst[T](deque: var Deque[T]; item: sink T)
```

Adds an item to the beginning of `deque`.

See also:

- [addLast proc](#)
- [& proc](#)

Example:

```
var a = initDeque[int]()
for i in 1 .. 5:
  a.addFirst(10 * i)
assert $a == "[50, 40, 30, 20, 10]"
```

```
proc addLast[T](deque1: var Deque[T]; deque2: sink Deque[T])
```

Adds `deque2` to the end of `deque1` as concatenation.

See also:

- [addFirst proc](#)
- [& proc](#)
- [&= template](#)

Example:

```
var a = [1, 2, 3].toDeque
let b = [10, 20, 30].toDeque
```

```
a.addLast(b)
assert $a == "[1, 2, 3, 10, 20, 30]"
```

```
proc addLast[T](deq1: var Deque[T]; seq2: sink openArray[T])
```

Adds deq2 to the end of deq1 as concatenation.

See also:

- [addFirst proc](#)
- [& proc](#)
- [&= template](#)

Example:

```
var a = [1, 2, 3].toDeque
let b = @[10, 20, 30]
a.addLast(b)
assert $a == "[1, 2, 3, 10, 20, 30]"
```

```
proc addLast[T](deq: var Deque[T]; item: sink T)
```

Adds an item to the end of deq.

See also:

- [addFirst proc](#)
- [& proc](#)
- [&= template](#)

Example:

```
var a = initDeque[int]()
for i in 1 .. 5:
  a.addLast(10 * i)
assert $a == "[10, 20, 30, 40, 50]"
```

```
proc contains[T](deq: Deque[T]; item: T): bool {.inline.}
```

Returns true if item is in deq or false if not found.

Usually used via the in operator. It is the equivalent of `deq.find(item) >= 0`.

Example:

```
let q = [7, 9].toDeque
assert 7 in q
assert q.contains(7)
assert 8 notin q
```

```
proc delete[T; U, V: Ordinal](target: var Deque[T]; x: HSlice[U, V]) {.
  systemRaisesDefect.}
```

Deletes the elements at slice x, moving down all elements higher than that.

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
a.delete(1..2)
```

```
assert $a == "[10, 40, 50]"
assert a.len == 3
```

```
proc delete[T](deq: var Deque[T]; where: BackwardsIndex) {.systemRaisesDefect.}
```

Deletes the element at backwards index where, moving down all elements higher than that.

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
a.delete(^2)
assert $a == "[10, 20, 30, 50]"
assert a.len == 4
```

```
proc delete[T](deq: var Deque[T]; where: Natural) {.systemRaisesDefect.}
```

Deletes the element at where, moving down all elements higher than that.

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
delete(a, 3)
assert $a == "[10, 20, 30, 50]"
assert a.len == 4
```

```
proc dropFirst[T](deq: var Deque[T]) {.inline.}
```

Removes the first element of the deq.

See also:

- [popFirst proc](#)
- [dropLast proc](#)

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
assert $a == "[10, 20, 30, 40, 50]"
a.dropFirst
assert $a == "[20, 30, 40, 50]"
```

```
proc dropLast[T](deq: var Deque[T]) {.inline.}
```

Removes the last element of the deq.

See also:

- [dropFirst proc](#)
- [popLast proc](#)

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
assert $a == "[10, 20, 30, 40, 50]"
a.dropLast
assert $a == "[10, 20, 30, 40]"
```

```
proc first[T](deq: Deque[T]): T {.inline.}
```

Returns the first element of deq, but does not remove it from the Deque.

See also:

- [first proc](#) which returns a mutable reference
- [last proc](#)

Example:

```
let a = [10, 20, 30, 40, 50].toDeque
assert $a == "[10, 20, 30, 40, 50]"
assert a.first == 10
assert len(a) == 5
```

```
proc first[T](deq: var Deque[T]): var T {.inline.}
```

Returns a mutable reference to the first element of deq, but does not remove it from the Deque.

See also:

- [first proc](#)
- [last proc](#)

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
first(a) = 99
assert $a == "[99, 20, 30, 40, 50]"
inc a.first
assert $a == "[100, 20, 30, 40, 50]"
```

```
proc first=[T](deq: var Deque[T]; item: sink T) {.inline.}
```

Alters the first element of deq.

See also:

- [first proc](#)
- [last proc](#)

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
a.first = 99
assert $a == "[99, 20, 30, 40, 50]"
```

```
func hash[T](deq: Deque[T]): Hash
```

Hashing of Deque.

```
proc initDeque[T](initialSize: Natural = defaultInitialSize): Deque[T]
```

Creates a new empty Deque of capacity initialSize. The length of a newly created Deque will be 0. Capacity is always a power of two, with a minimum of two.

(default and capacity: [defaultInitialSize](#)).

See also:

- [newDeque proc](#)
- [toDeque proc](#)

Example:

```
var deq1 = initDeque[int](6)
assert capacity(deq1) == 8
assert len(deq1) == 0
```

```
proc insert[T](target: var Deque[T]; source: sink Deque[T]; pos: Natural)
```

Insert source Deque into target Deque in front of position pos.

```
proc insert[T](target: var Deque[T]; source: sink openArray[T]; pos: Natural)
```

Insert source sequence into target Deque in front of position pos.

```
proc insert[T](target: var Deque[T]; source: sink T; pos: Natural)
```

Insert source element into target Deque in front of position pos.

```
proc last[T](deq: Deque[T]): T {.inline.}
```

Returns the last element of deq, but does not remove it from the Deque.

See also:

- [last proc](#) which returns a mutable reference
- [first proc](#)

Example:

```
let a = [10, 20, 30, 40, 50].toDeque
assert $a == "[10, 20, 30, 40, 50]"
assert a.last == 50
assert len(a) == 5
```

```
proc last[T](deq: var Deque[T]): var T {.inline.}
```

Returns a mutable reference to the last element of deq, but does not remove it from the Deque.

See also:

- [first proc](#)
- [last proc](#)

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
a.last() = 99
assert $a == "[10, 20, 30, 40, 99]"
inc a.last
assert $a == "[10, 20, 30, 40, 100]"
```

```
proc last=[T](deq: var Deque[T]; item: sink T) {.inline.}
```

Alters the last element of deq.

See also:

- [first proc](#)
- [last proc](#)

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
a.last = 99
assert $a == "[10, 20, 30, 40, 99]"
```

```
proc newDeque[T](initialSize: Natural = defaultInitialSize): Deque[T]
```

Creates a new empty Deque of capacity `initialSize`. The length of a newly created Deque will be 0. Capacity is always a power of two, with a minimum of two.

(default capacity: [defaultInitialSize](#)).

See also:

- [initDeque proc](#)
- [toDeque proc](#)

Example:

```
var deq1 = newDeque[int]()
assert capacity(deq1) == defaultInitialSize
assert len(deq1) == 0
```

```
proc popFirst[T](deq: var Deque[T]): T {.inline, discardable.}
```

Removes and returns the first element of the `deq`.

See also:

- [popLast proc](#)
- [shrink proc](#)

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
assert $a == "[10, 20, 30, 40, 50]"
assert a.popFirst == 10
assert $a == "[20, 30, 40, 50]"
```

```
proc popLast[T](deq: var Deque[T]): T {.inline, discardable.}
```

Removes and returns the last element of the `deq`.

See also:

- [popFirst proc](#)
- [shrink proc](#)

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
assert $a == "[10, 20, 30, 40, 50]"
assert a.popLast == 50
assert $a == "[10, 20, 30, 40]"
```

```
proc reverse[T](target: var Deque[T])
```

Reverses target in place.

```
proc reversed[T](source: Deque[T]): Deque[T]
```

Returns a reversed copy of source.

```
proc rotL[T](deq: var Deque[T]; howMany: Natural = 1) {.inline.}
```

Rotate each element of deq howMany places to the left, wrapping around. Default is one.

See also:

- [rotR proc](#)

Example:

```
var deq = @[1, 2, 3, 4, 5]
deq.rotL
assert deq == @[2, 3, 4, 5, 1]
rotL(deq, 3)
assert deq == @[5, 1, 2, 3, 4]
```

```
proc rotR[T](deq: var Deque[T]; howMany: Natural = 1) {.inline.}
```

Rotate each element of deq howMany places to the right, wrapping around. Default is one.

See also:

- [rotL proc](#)

Example:

```
var deq = @[1, 2, 3, 4, 5]
deq.rotR
assert deq == @[5, 1, 2, 3, 4]
rotR(deq, 2)
assert deq == @[3, 4, 5, 1, 2]
deq.rotR(0)
assert deq == [3, 4, 5, 1, 2].toDeque
```

```
proc setCap[T](target: var Deque[T]; length: Natural)
```

Sets the capacity of target to length, shrinking or growing as needed. Capacity will always be a power of two.

```
proc setLen[T](target: var Deque[T]; length: Natural)
```

Sets the length of target to length, increasing its capacity if needed.

```
proc shrink[T](deq: var Deque[T]; fromFirst = 0; fromLast = 0)
```

Removes fromFirst elements from the front of the Deque and fromLast elements from the back.

If the supplied number of elements exceeds the total number of elements in the Deque, the Deque will remain empty.

See also:

- [clear template](#)
- [dropFirst proc](#)
- [dropLast proc](#)

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
assert $a == "[10, 20, 30, 40, 50]"
a.shrink(fromFirst = 2, fromLast = 1)
assert $a == "[30, 40]"
```

```
proc toDeque[T](x: sink openArray[T]): Deque[T]
```

Creates a new Deque that contains the elements of x (in the same order).

See also:

- [initDeque proc](#)
- [newDeque proc](#)
- [toDeque template](#)
- [@@ template](#)

Example:

```
let a = toDeque([7, 8, 9])
assert len(a) == 3
assert $a == "[7, 8, 9]"
```

Iterators

```
iterator backwards[T](deq: Deque[T]): T {.inline.}
```

Yields each element of deq in reverse order.

See also:

- [items iterator](#)
- [backwardsMut iterator](#)

Example:

```
let thisDeq = [1, 2, 3, 4, 5].toDeque
var thatDeq = [6].toDeque
for item in backwards(thisDeq):
  thatDeq.addLast(item)
assert thisDeq == [1, 2, 3, 4, 5].toDeque
assert thatDeq == [6, 5, 4, 3, 2, 1].toDeque
```

```
iterator backwardsMut[T](deq: var Deque[T]): var T {.inline.}
```

Yields in reverse order a mutable version of every element of deq.

See also:

- [mitems iterator](#)
- [backwards iterator](#)

Example:

```
var thisDeq = [1, 2, 3, 4, 5].toDeque
var thatDeq = [12].toDeque
var otherDeq = @[6]
for item in backwardsMut(thisDeq):
  otherDeq.addFirst(item)
  item *= 2
  thatDeq.addLast(item)
assert thisDeq == [2, 4, 6, 8, 10].toDeque
assert thatDeq == [12, 10, 8, 6, 4, 2].toDeque
assert otherDeq == @[1, 2, 3, 4, 5, 6]
```

iterator [backwardsPairs](#)[T](deq: Deque[T]): tuple[key: int, val: T] {.inline.}

Yields every (position, value)-pair of deq in reverse order.

See also:

- [pairs iterator](#)

Example:

```
import std/sequtils
let a = [10, 20, 30].toDeque
assert toSeq(a.backwardsPairs) == @[(2, 30), (1, 20), (0, 10)]
```

iterator [items](#)[T](deq: Deque[T]): T {.inline.}

Yields every element of deq.

See also:

- [mitems iterator](#)
- [backwards iterator](#)

Example:

```
let a = [10, 20, 30, 40, 50].toDeque
var b: seq[int]
for item in a: b.add(item)
assert b == @[10, 20, 30, 40, 50]
assert $a == "[10, 20, 30, 40, 50]"
```

iterator [mitems](#)[T](deq: var Deque[T]): var T {.inline.}

Yields every element of deq, which can be modified.

See also:

- [items iterator](#)
- [backwardsMut iterator](#)

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
assert $a == "[10, 20, 30, 40, 50]"
for x in mitems(a):
  x = 5 * x - 1
```

```
assert $a == "[49, 99, 149, 199, 249]"
```

```
iterator pairs[T](deq: Deque[T]): tuple[key: int, val: T] {.inline.}
```

Yields every (position, value)-pair of deq.

See also:

- [backwardsPairs iterator](#)

Example:

```
import std/sequtils
let a = [10, 20, 30].toDeque
assert toSeq(a.pairs) == @[ (0, 10), (1, 20), (2, 30) ]
```

Templates

```
template `@@`[T](deq: Deque[T]): Deque[T]
```

Returns a copy of deq.

See also:

- [toDeque template](#)

```
template `@@`[T](x: openArray[T]): Deque[T]
```

Creates a new Deque that contains the elements of x (in the same order).

See also:

- [toDeque proc](#)

Example:

```
let thisDeq = @@[1, 2, 3]
assert thisDeq == [1, 2, 3].toDeque
assert $thisDeq == "[1, 2, 3]"
```

```
template capacity[T](deq: Deque[T]): int
```

Returns the maximum capacity of the sequence backing deq. Capacity is always a power of two.

Example:

```
var deq = [1, 2, 3, 4].toDeque
assert deq.len == deq.capacity
deq.addLast(5)
assert deq.len == 5
assert deq.capacity == 8
```

```
template clear[T](deq: var Deque[T])
```

Resets the Deque so that it is empty, but retains its capacity.

See also:

- [reset template](#)

Example:

```
var a = [10, 20, 30, 40, 50].toDeque
assert $a == "[10, 20, 30, 40, 50]"
clear(a)
assert len(a) == 0
assert capacity(a) == 8
```

```
template high[T](deq: Deque[T]): int
```

Returns the highest valid index in deq. This is the same as `len(deq) - 1`. If deq is empty, will return -1.

```
template isEmpty[T](deq: Deque[T]): bool
```

Returns true if deq is empty, false otherwise.

```
template len[T](deq: Deque[T]): int
```

Returns the number of elements in deq.

```
template low[T](deq: Deque[T]): int
```

Returns the lowest valid index in deq, normally 0. If deq is empty, will return -1.

```
template reset[T](deq: var Deque[T]; maxCap: Natural = defaultInitialSize)
```

This is a documentation comment. Resets deq so it is empty and sets its capacity to maxCap. Capacity is always a power of two.

See also:

- [clear template](#)
- [defaultInitialSize constant](#)

```
template rotateLeft[T](deq: var Deque[T]; howMany: Natural = 1)
```

See also:

- [rotL proc](#)

```
template rotateRight[T](deq: var Deque[T]; howMany: Natural = 1)
```

See also:

- [rotR proc](#)

```
template toDeque[T](deq: Deque[T]): Deque[T]
```

Returns a copy of deq.

See also:

- [toDeque proc](#)
- [@@ template](#)