

1. Module Bitv. This module implements bit vectors, as an abstract datatype t . Since bit vectors are particular cases of arrays, this module provides the same operations as module *Array* (Sections 2 up to 6). It also provides bitwise operations (Section 9) and conversions to/from integer types.

In the following, **false** stands for bit 0 and **true** for bit 1.

type t

2. Creation, access and assignment. (*Bitv.create* n b) creates a new bit vector of length n , initialized with b . (*Bitv.init* n f) returns a fresh vector of length n , with bit number i initialized to the result of (f i). (*Bitv.set* v n b) sets the n th bit of v to the value b . (*Bitv.get* v n) returns the n th bit of v . *Bitv.length* returns the length (number of elements) of the given vector.

val *create* : $int \rightarrow bool \rightarrow t$

val *init* : $int \rightarrow (int \rightarrow bool) \rightarrow t$

val *set* : $t \rightarrow int \rightarrow bool \rightarrow unit$

val *get* : $t \rightarrow int \rightarrow bool$

val *length* : $t \rightarrow int$

3. *max_length* is the maximum length of a bit vector (System dependent).

val *max_length* : int

4. Copies and concatenations. (*Bitv.copy* v) returns a copy of v , that is, a fresh vector containing the same elements as v . (*Bitv.append* $v1$ $v2$) returns a fresh vector containing the concatenation of the vectors $v1$ and $v2$. *Bitv.concat* is similar to *Bitv.append*, but catenates a list of vectors.

val *copy* : $t \rightarrow t$

val *append* : $t \rightarrow t \rightarrow t$

val *concat* : $t\ list \rightarrow t$

5. Sub-vectors and filling. (*Bitv.sub* v *start* *len*) returns a fresh vector of length *len*, containing the bits number *start* to *start* + *len* - 1 of vector v . Raise *Invalid_argument* "Bitv.sub" if *start* and *len* do not designate a valid subvector of v ; that is, if *start* < 0, or *len* < 0, or *start* + *len* > *Bitv.length* a .

(*Bitv.fill* v *ofs* *len* b) modifies the vector v in place, storing b in elements number *ofs* to *ofs* + *len* - 1. Raise *Invalid_argument* "Bitv.fill" if *ofs* and *len* do not designate a valid subvector of v .

(*Bitv.blit* *v1* *o1* *v2* *o2* *len*) copies *len* elements from vector *v1*, starting at element number *o1*, to vector *v2*, starting at element number *o2*. It *does not work* correctly if *v1* and *v2* are the same vector with the source and destination chunks overlapping. Raise *Invalid_argument* "*Bitv.blit*" if *o1* and *len* do not designate a valid subvector of *v1*, or if *o2* and *len* do not designate a valid subvector of *v2*.

```
val sub : t → int → int → t
val fill : t → int → int → bool → unit
val blit : t → int → t → int → int → unit
```

6. Iterators. (*Bitv.iter* *f* *v*) applies function *f* in turn to all the elements of *v*. Given a function *f*, (*Bitv.map* *f* *v*) applies *f* to all the elements of *v*, and builds a vector with the results returned by *f*. *Bitv.iteri* and *Bitv.mapi* are similar to *Bitv.iter* and *Bitv.map* respectively, but the function is applied to the index of the element as first argument, and the element itself as second argument.

(*Bitv.fold_left* *f* *x* *v*) computes *f* (... (*f* (*f* *x* (*get* *v* 0)) (*get* *v* 1)) ...) (*get* *v* (*n* - 1)), where *n* is the length of the vector *v*.

(*Bitv.fold_right* *f* *a* *x*) computes *f* (*get* *v* 0) (*f* (*get* *v* 1) (... (*f* (*get* *v* (*n* - 1)) *x*) ...)), where *n* is the length of the vector *v*.

```
val iter : (bool → unit) → t → unit
val map : (bool → bool) → t → t
val iteri : (int → bool → unit) → t → unit
val mapi : (int → bool → bool) → t → t
val fold_left : (α → bool → α) → α → t → α
val fold_right : (bool → α → α) → t → α → α
val foldi_left : (α → int → bool → α) → α → t → α
val foldi_right : (int → bool → α → α) → t → α → α
```

7. *iteri_true* *f* *v* applies function *f* in turn to all indexes of the elements of *v* which are set (i.e. *true*); indexes are visited from least significant to most significant.

```
val iteri_true : (int → unit) → t → unit
```

8. *gray_iter* *f* *n* iterates function *f* on all bit vectors of length *n*, once each, using a Gray code. The order in which bit vectors are processed is unspecified.

```
val gray_iter : (t → unit) → int → unit
```

9. Bitwise operations. *bwand*, *bwor* and *buxor* implement logical and, or and exclusive or. They return fresh vectors and raise *Invalid_argument* "*Bitv.xxx*" if the two vectors do not have the same length (where *xxx* is the name of the function). *bwnot* implements

the logical negation. It returns a fresh vector. *shiffl* and *shiftr* implement shifts. They return fresh vectors. *shiffl* moves bits from least to most significant, and *shiftr* from most to least significant (think *lsl* and *lsr*). *all_zeros* and *all_ones* respectively test for a vector only containing zeros and only containing ones.

```
val bw_and : t → t → t
val bw_or  : t → t → t
val bw_xor : t → t → t
val bw_not : t → t
```

```
val shiffl : t → int → t
val shiftr : t → int → t
```

```
val all_zeros : t → bool
val all_ones  : t → bool
```

10. Conversions to and from strings.

With least significant bits first.

```
module L : sig
  val to_string : t → string
  val of_string  : string → t
  val print     : Format.formatter → t → unit
end
```

With most significant bits first.

```
module M : sig
  val to_string : t → string
  val of_string  : string → t
  val print     : Format.formatter → t → unit
end
```

11. Input/output in a machine-independent format. The following functions export/import a bit vector to/from a channel, in a way that is compact, independent of the machine architecture, and independent of the OCaml version. For a bit vector of length n , the number of bytes of this external representation is $4 + \text{ceil}(n/8)$ on a 32-bit machine and $8 + \text{ceil}(n/8)$ on a 64-bit machine.

```
val output_bin : out_channel → t → unit
val input_bin  : in_channel  → t
```

12. Conversions to and from lists of integers. The list gives the indices of bits which are set (ie true).

```

val to_list : t → int list
val of_list : int list → t
val of_list_with_length : int list → int → t

```

13. Interpretation of bit vectors as integers. Least significant bit comes first (ie is at index 0 in the bit vector). *to_* functions truncate when the bit vector is too wide, and raise *Invalid_argument* when it is too short. Suffix *_s* means that sign bit is kept, and *_us* that it is discarded.

type *int* (length 31/63 with sign, 30/62 without)

```

val of_int_s : int → t
val to_int_s : t → int
val of_int_us : int → t
val to_int_us : t → int
(* type Int32.t (length 32 with sign, 31 without) *)
val of_int32_s : Int32.t → t
val to_int32_s : t → Int32.t
val of_int32_us : Int32.t → t
val to_int32_us : t → Int32.t
(* type Int64.t (length 64 with sign, 63 without) *)
val of_int64_s : Int64.t → t
val to_int64_s : t → Int64.t
val of_int64_us : Int64.t → t
val to_int64_us : t → Int64.t
(* type Nativeint.t (length 32/64 with sign, 31/63 without) *)
val of_nativeint_s : Nativeint.t → t
val to_nativeint_s : t → Nativeint.t
val of_nativeint_us : Nativeint.t → t
val to_nativeint_us : t → Nativeint.t

```

14. Only if you know what you are doing...

```

val unsafe_set : t → int → bool → unit
val unsafe_get : t → int → bool

```