Arrays and Structures

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What is an Array? (Sec. 2.1)

```c
int arr[30];
```

很多放東西的空格
有編號的置物櫃

有編號的置物櫃
下有系统的整理
方便记录
同频放一起
如拿（编排）
如收时
int a[30];
int* b = (int*)malloc(sizeof(int) * 30);

a[3] = 1; /* *(a+3) = 1; */
b[2] = 5; /* *(b+2) = 5; */

printf("%d", a[1]); /* printf("%d", *(a+1)); */

- simple computation of locations
  - constant time retrieving
  - constant time storing
Arrays: from Implementation to Abstraction

**C Implementation View**

(One-dimensional) array is a **block of consecutive memory** that
- holds a list of $N$ elements
- allows users to retrieve the $k$-th element
- allows users to store to the $k$-th location

**An Abstract View**

Abstract (one-dimensional) array
- holds a list of $N$ elements
- allows users to retrieve the $k$-th element
- allows users to store to the $k$-th location

**different implementations:**
- different space/time complexity
Dense Array versus Sparse Array

one abstract array, two possible implementations

```java
def dense[10] = {1, 3, 0, 0, 0, 0, 0, 0, 0, 2};
def sparse[3][2] = {{0, 1}, {1, 3}, {9, 2}};
```

- **dense array**: store everything (consecutively), needs 10 positions
  - space: $O(N)$ for a length-$N$ array
  - retrieving: $O(1)$
  - storing: $O(1)$
  - creating: $O(1)$

- **sparse array**: store only non-zero (index, element) pairs, needs 3 pairs
  - space: $O(E)$ for $E$ elements, better than $O(N)$ if $E$ small
  - retrieving: $O(\log E)$ if index ordered (HOW?)
  - storing: ???
  - creating: ???

**note**: often use array to mean dense array only
Concrete Data Type (Sec. 1.4)

array consists of ...
- objects: a set of \((\text{index}, \text{element})\) pairs (== a list of elements)
- actions: retrieve, store, create which sets/gets the objects

- concrete data type: the **actual outcome** of the type
  - object representation + action implementation
  - for actual coding, per-platform optimization, etc.

(dense 1-D) array in C
- object representation: a block of consecutive memory, with a chunk representing each \(\text{element}\) element for each \(\text{index}\)
- action implementation: \([\cdot]\) for retrieving and storing, \(\text{malloc}\) for creating, etc.
Abstract Data Type (Sec. 1.4)

- array consists of ...
  - objects: a set of \((index, element)\) pairs (== a list of elements)
  - actions: retrieve, store, create which sets/gets the objects

- abstract data type: the **pseudo essence** (**contract**) of the type
  - object specification + action specification
  - for illustration, high-level analysis, etc.

abstract 1-D array

- object specification: \((index, element)\) pairs with \(index \in \{0, \cdots, N - 1\}\)
- action specification:
  - \(\text{retrieve}(index)\) returns the \(element\) associated with \(index\);
  - \(\text{store}(index, element)\) sets \(element\) to be associated with \(index\);
  - \(\text{create}(N)\) creates the objects, etc.
  - (sometimes with time/space constraints)

will usually look at abstract data type first before going concrete
Reading Assignment

be sure to go ask the TAs or me if you are still confused