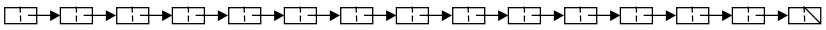

CSE 373: Data Structures and Algorithms

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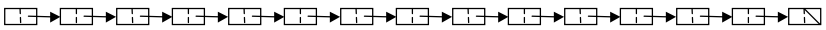
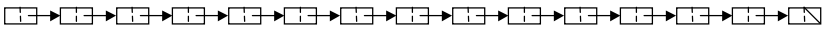
University of Washington
Spring 1999

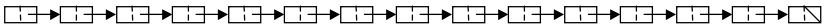


What is a Data Structure?



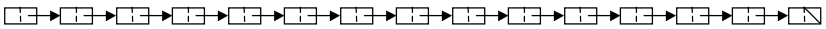
data structure –

Observation



- Data is an attribute common to all programs
  - programs *process, manipulate, store, display, gather*
  - data may be *information*, *numbers*, *images*, *sound*
- Each program must decide how to store data
- Choice influences program at every level:
  - execution speed
  - memory requirements
  - maintenance (debugging, extending, etc.)

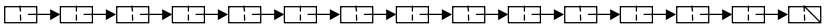
Course Goals



- To introduce several standard data structures
- To teach how data structures are evaluated
- To determine when each structure is useful

- To give you the ability to design, build, and evaluate your own data structures

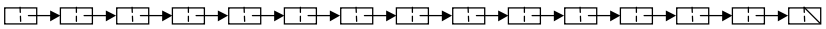
What about Algorithms?



algorithm – a description of a process useful for completing a specific task

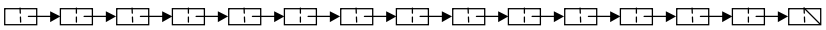
Algorithms are often closely tied to the selection of a data structure (in this class anyway).

C Data Types



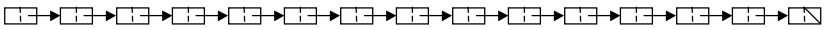
- *basic types:*
  - **`char`**, **`int`**, **`double`**, etc.
  - pointers (*e.g.*, **`char *`**, **`int *`**, **`double *`**)
- *compound types:*
  - arrays (*e.g.*, **`int [26]`**, **`double [100][100]`**)
  - structures (e.g., **`struct { int x,y; double len; }`**)

Building Data Structures

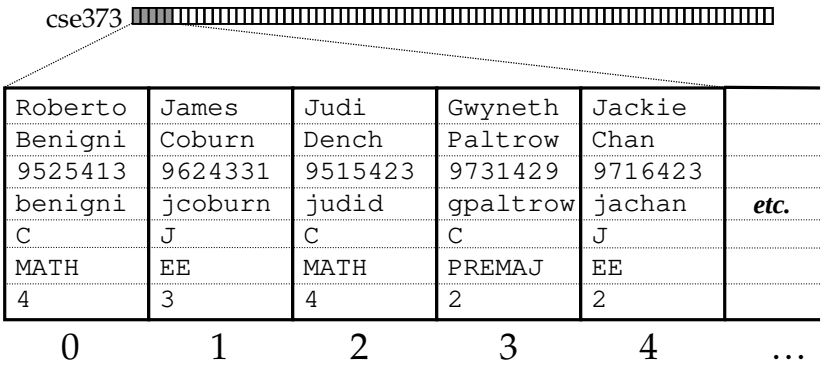


```
typedef char name[32];
typedef enum {BIOCHM, ECON, EE, MATH, PREMAJ} dept;
typedef struct _student {
          name first, last;
          int UWID;
          name email;
          char college;
          dept major;
          int class;
        } student;
typedef student class[80];
```

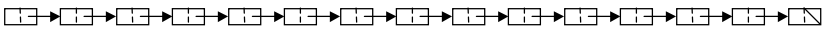

Data Structure `class`



```
class cse373;
```



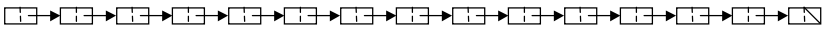
Abstract Data Types (ADTs)



abstract data type –

Is the **`class`** type an ADT?

Example: `FindMajor()`



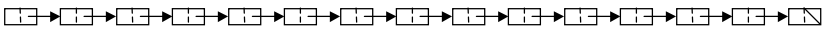
`void FindMajor(class,dept);`

- takes a class and a department as arguments
- prints all the students in the class in that major

How would **`FindMajor()`** be implemented for our current **`class`** implementation?

Could changing **`class`** improve the performance of **`FindMajor()`**?

ADT Tensions

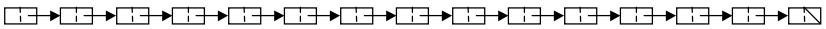


Ideal: a fast, elegant ADT that uses little memory

Generates tensions:

- time *vs.* space
- performance *vs.* elegance
- generality *vs.* simplicity
- one operation's performance *vs.* another's

Another Example



- Spring registry ADT for UW – stores which students are taking which classes
- Supported operations:

```
int TakingClass(int UWID,int SLN);
```

  - tells if the student is taking the course specified by SLN

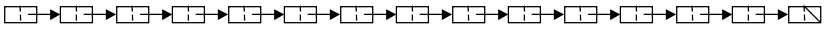
```
void PrintSchedule(int UWID);
```

  - prints the schedule of the student

```
class MakeClassList(int SLN);
```

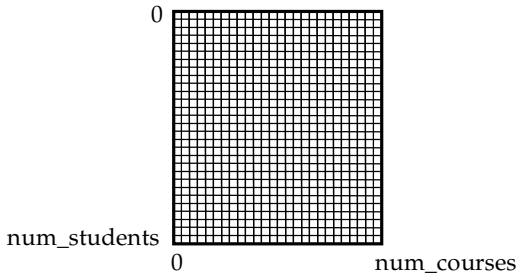
  - creates a **`class`** type for the given SLN

A Naive Implementation

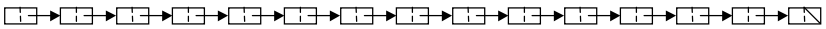


```
const int num_courses = 7000;
const int num_students = 33000;

typedef int registry[num_students][num_classes];
```



Evaluating this Implementation

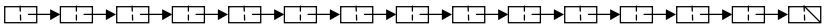


What are the advantages of this implementation?

What are the disadvantages?

How could we improve the implementation?

The Myth of ADTs



Not a perfect black box:

- knowing how an ADT will be used can lead to a good choice of implementation
- also, knowledge of an ADT's implementation may change how a client uses it

But... ADTs are still a useful concept

Use motivates design