# Computer Science I

## Encapsulation

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# Outline

1. Introduction
2. Using Structures
3. Structures with Functions & Arrays

# Part I: Introduction

# Structures

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- Real-world entities are made up of multiple aspects (data)
- Examples: Person, Team, Bank Account, etc.
- In code we can define *objects* that *encapsulate* multiple pieces of data

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C only provides *weak* encapsulation (only grouping of data).

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- Modern convention: `UpperCamelCasing` for structure names, `lowerCamelCasing` for fields

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  ```
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  ```
- Demonstration

# Using Structures

```c
Student s;
s.nuid = 12345678;
s.firstName = (char *) malloc(sizeof(char) * 10);
strcpy(s.firstName, "Katherine");
s.lastName = (char *) malloc(sizeof(char) * 8);
strcpy(s.lastName, "Johnson");
s.gpa = 3.9;
s.dateOfBirth.year = 1918;
s.dateOfBirth.month = 9;
s.dateOfBirth.day = 26;
```

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# Part III: Structures with Functions & Arrays

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- Entire structure is copied to the call stack
- Pass by reference: only a pointer is copied
- Demonstration

# Demo

```
void printStudent(const Student *s) {

  char *str = studentToString(s);
  printf("%s\n", str);
  //clean up after yourself:
  free(str);
  //printf("%s, %s (%08d), %.2f\n", s->lastName, s->firstName, s->nuid,
  return;
}

char * studentToString(const Student *s) {
  char buffer[1000];
  sprintf(buffer, "%s, %s (%08d), %.2f", s->lastName, s->firstName, s->
  char *result = (char *) malloc( (strlen(buffer)+1) * sizeof(char));
  strcpy(result, buffer);
  return result;
}
```

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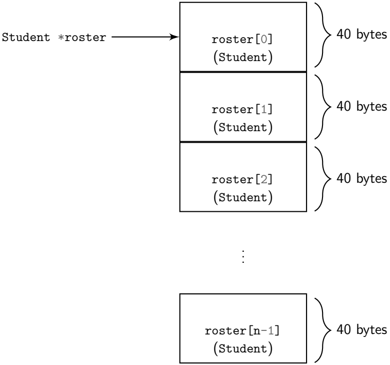
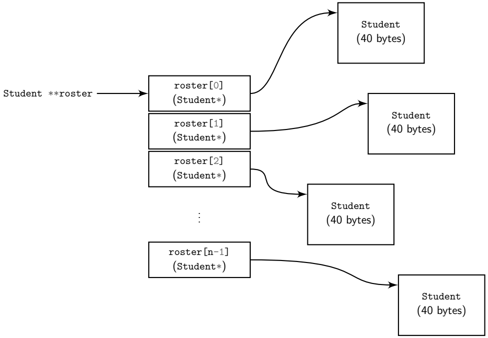
```
Student *roster = (Student *) malloc(sizeof(Student) * n);
```



# Arrays of Structure Pointers

```c
Student **roster = (Student **) malloc(sizeof(Student*) * n);
...
roster[i] = (Student *) malloc(sizeof(Student));
```



Student **roster

roster[0]
(Student*)

roster[1]
(Student*)

roster[2]
(Student*)

⋮

roster[n-1]
(Student*)

Student
(40 bytes)

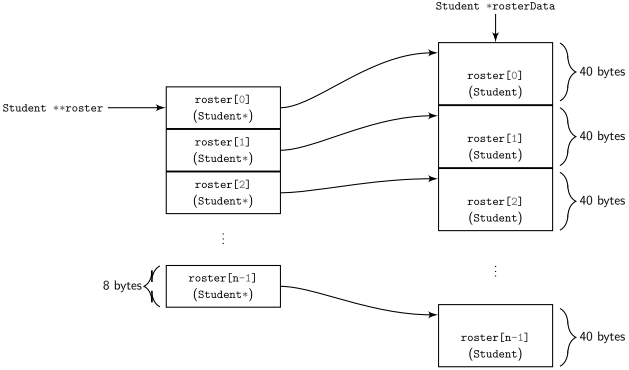
Student
(40 bytes)

Student
(40 bytes)

Student
(40 bytes)

# Hybrid Solution

```
Student **roster = (Student **) malloc(sizeof(Student*) * n);
Student *rosterData = (Student *) malloc(sizeof(Student) * n);
...
roster[i] = &rosterData[i];
```


Student *rosterData
Student **roster
roster[0]
(Student*)
roster[1]
(Student*)
roster[2]
(Student*)
⋮
8 bytes
roster[n-1]
(Student*)
roster[0]
(Student)
40 bytes
roster[1]
(Student)
40 bytes
roster[2]
(Student)
40 bytes
⋮
roster[n-1]
(Student)
40 bytes