Structs & Alignment

CSE 351 Autumn 2023

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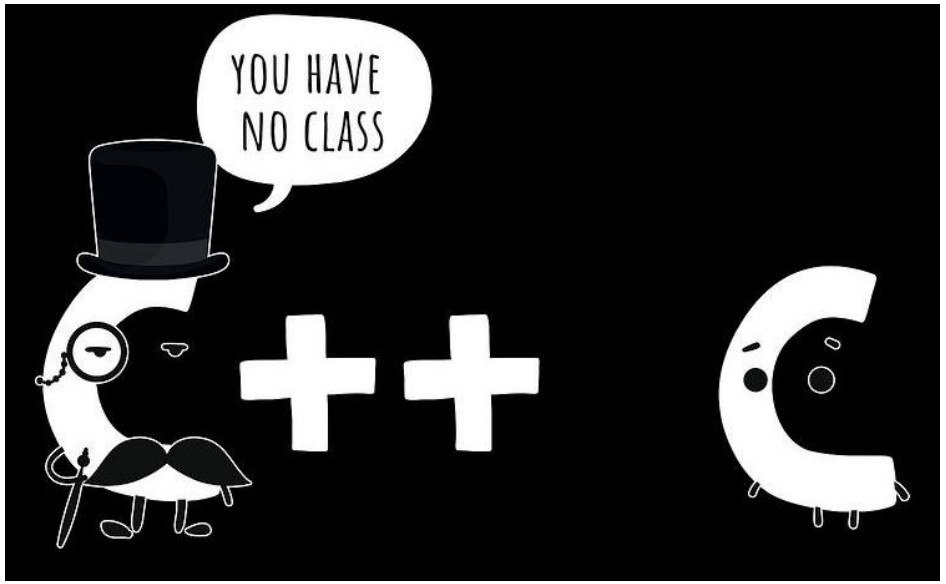

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Relevant Course Information

- Lab 2 due tonight
- Lab 3 released next Monday (10/30)
  - A shorter lab, due Friday, 11/10
- hw13 due next Wednesday (11/1)

- **Take-home Midterm** (11/2 – 11/4)
  - Instructions will be posted on Ed Discussion
  - Gilligan's Island Rule: discuss high-level concepts and give hints, but not solving the problems together
  - We will be available on Ed Discussion (private posts only) and support hours to answer clarifying questions

Structs & Alignment

Lesson Summary (1/2)

- Structures
  - Allocate bytes for fields in order declared by programmer – can make choices to minimize memory allocations
  - Pad in middle to satisfy individual element alignment requirements (K)
  - Pad at end to satisfy overall struct alignment requirement (K_{max})

Lesson Summary (2/2)

- Terminology:
  - Structs: tags and fields, `.` and `->` operators
  - Typedef
  - Alignment, internal fragmentation, external fragmentation

- Learning Objectives:
  - Analyze the memory layout of a struct and minimize its impact on program memory usage.
  - Create, access, and modify array and struct elements in C.

- What lingering questions do you have from the lesson?

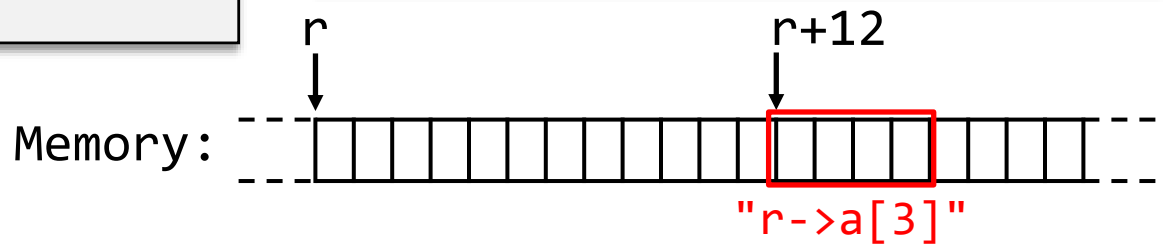
Structs & Alignment – Context

Struct Pointers

- Pointers store addresses, which all "look" the same
  - Lab 0 Example: struct instance `Scores` could be treated as array of `int`s of size 4 via pointer casting
  - A struct pointer doesn't *have* to point to a declared instance of that struct type
- Different struct fields may or may not be meaningful, depending on what the pointer points to
  - This will be important for Lab 5!

```
long get_a3(struct rec* r) {
  return r->a[3];
}
```

```
  movl  12(%rdi), %rax
  ret
```



Structs & Alignment – Practice

Group Work Time

- During this time, you are encouraged to work on the following:
  1) If desired, continue your discussion
  2) Work on the lesson problems (solutions at the end of class)
  3) Work on the homework problems

- Resources:
  - You can revisit the lesson material
  - Work together in groups and help each other out
  - Course staff will circle around to provide support

Practice Questions (1/2)

```
struct ll_node {
  long data;
  struct ll_node* next;
} n1, n2;
```

tag; fields; two instances; $K_{max}=8$

- How much space does (in bytes) does an instance of `struct ll_node` take? 16 B

- Which of the following statements are syntactically valid?
  - ✓ `n1.next = &n2;`
  - ✗ `n2->data = 351;`
  - ✓ `n1.next->data = 333;`
  - ✗ `(&n2)->next->next.data = 451;`

• for struct instances (inst), -> for struct pointers (ptr)

Practice Questions (2/2)

- Minimize the size of the struct by re-ordering the fields:

```
struct old {
  int i;
  short s[3];
  char *c;
  float f;
};
```

K: 4, 2, 8, 4 → $K_{max} = 8$

```
struct new {
  int    i;
  float  f;
  char * c;
  short  s[3];
};
```

could also switch these (internal vs. external frag)

  - What is the minimum size of `struct new`?

A. 22 bytes **B. 24 bytes**

C. 28 bytes D. 32 bytes