Pointers

Help Sessions

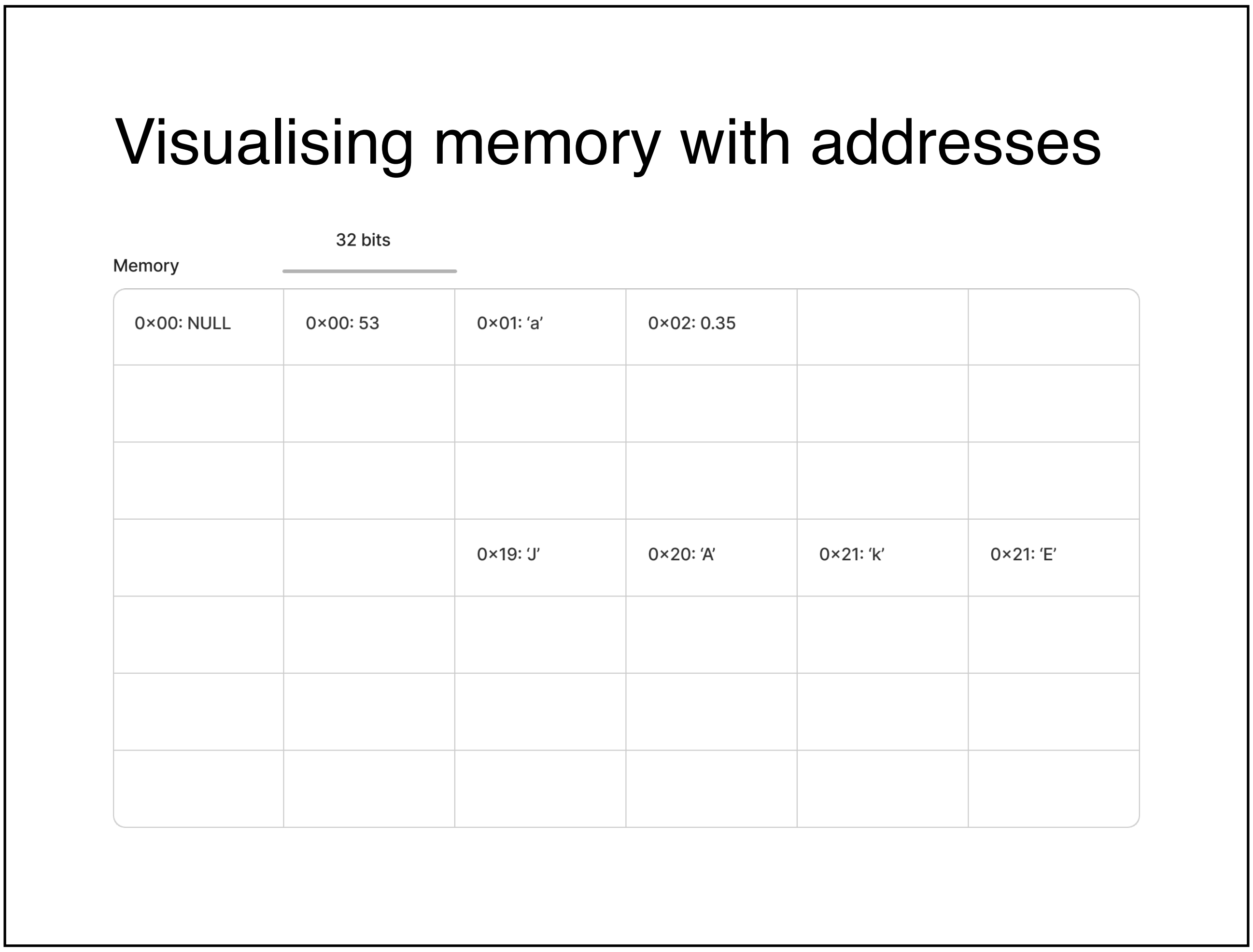
Check timetable!

Revision sessions reminder

Pointers

Memory

- All data (variables) are stored in **memory**
- You can think of memory as a big grid
- Each segment of this grid has a unique identifier



Visualising memory with addresses

Memory

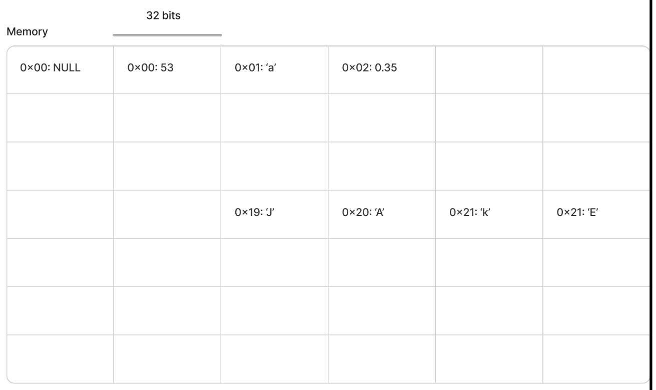
32 bits

0×00: NULL	0×00: 53	0×01: ‘a’	0×02: 0.35		
		0×19: ‘J’	0×20: ‘A’	0×21: ‘k’	0×21: ‘E’

The actual data is stored in binary

So far, we have only dealt with values

- We can also access the address
- By storing that address in a variable, we have a **pointer**



Pointer Syntax

To declare a pointer

```
<type> *<name_of_variable>
```

^ The `*` means don't request the storage to store `<type>`, but requests memory to store a memory address of `<type>`

Syntax example:

```
int *pointer
```

```
struct student *student
```

Visualise pointer declaration

```
// declare a pointer to an integer
int *number; // operating system
returns 0x17
```

[illegible]	[illegible]	[illegible]	[illegible]		
🟩 0×17: 0×1231		0×19: 'J'	0×20: 'A'	0×21: 'k'	0×21: 'E'

Address of **operator** `&`

- What if we want to query what the address of a variable is?
- We can use the address_of operator:

```
&
```

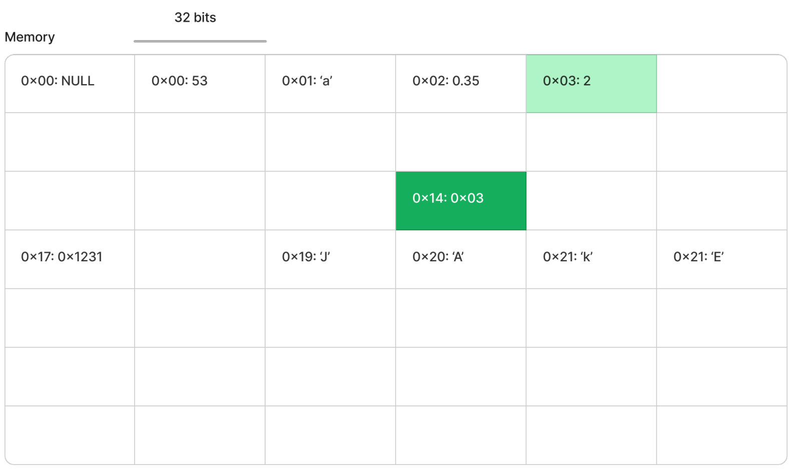
Syntax of address of: `& <variable>`

Example

```
int number = 2;
&number // the address of number
```

```c
int number = 2;


int *pointer_to_number = &number
```



0×00: NULL	0×00: 53	0×01: 'a'	0×02: 0.35	0×03: 2	
			0×14: 0×03		
0×17: 0×1231		0×19: 'J'	0×20: 'A'	0×21: 'k'	0×21: 'E'

Dereferencing

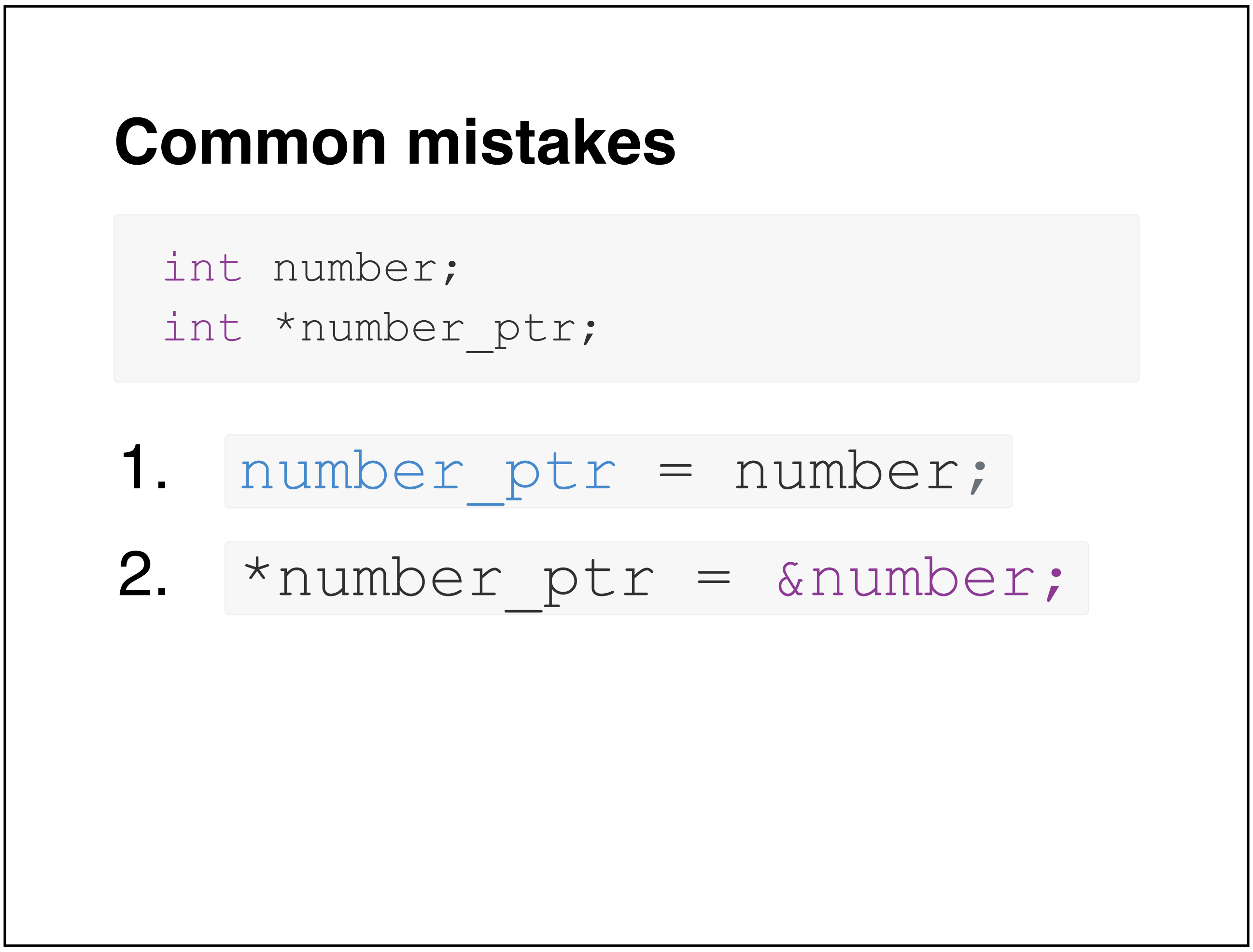
- Dereferencing is simply accessing the value at the address of a pointer
- It uses the `*` symbol again (which causes confusion)
- `*my_int_pointer` -> will get the integer at the address location

Three components to pointers in code

```
int main(void) {
    // Declare an integer
    int my_age = 23;

    // Declare an integer pointer
    // Assign it the address of my_age
    int *pointer_to_my_age = &my_age;

    // Print out the address and value at the
pointer
    printf("Pointer is: %p value is: %d\n",
pointer_to_my_age, *pointer_to_my_age)
    return 0;
}
```



Common mistakes

```c
int number;
int *number_ptr;
```

1. `number_ptr = number;`
2. `*number_ptr = &number;`

1- number_ptr is a pointer, we can't assign it an actual value directly

2- We are assigning the address_of a variable to a dereferenced pointer (so an address)

Syntax cheat sheet

- Declare a pointer: `int *int_pointer;`
- Address of: `&my_variable;`
- Dereference (Get the value at a pointer): `*int_pointer;`

Demo

Goals:

- ☐ Create a variable
- ☐ Get the address of that variable
- ☐ Create a pointer variable
    - ☐ Use it!

But JAKE, why are they *USEFUL*

– Let's look at an example with pointers and parameters

How can we edit a variable within a function?

Pass by reference*

```c
#include <stdio.h>

void change_value(int *x) {
        *x = *x * 2;
    }

int main(void) {
  int x = 5;
  change_value(&x);
  printf("%d\n", x);

  return 0;
}
```

– Technically pass-reference-by-value but it's fine!

In the previous example, by passing the memory address, we can change the value *in place* and main will point to the updated value!

pointers and arrays 🤯

```
void double_array_of_ints(int data[], int size)
{
    for (int I = 0; I < size; I++) {
        data[i] = data[i] * 2;
}

int main(void) {
    int data[5] = {1, 2, 3, 4, 5};
    double_array_of_ints(data, 5);
    //is data doubled?
}
```

^ does data in main contain the doubled values?

How?

Arrays decay to pointers

– Arrays point to the memory location whcih contains the first element
– As arrays are contiguous, we can then move through the memory sequentially to find the next values
– Very cool!

Feedback

https://forms.office.com/r/K3PjvWebtD