

ECS30: char, printf, scanf, overflow, random numbers

...

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1/13/17

char type

ascii.c

- char literal examples

`'A'` `'0'` `'t'` `'\t'` (for tab)

- `char c = 'a';`
- char is generally 8 bits (1 byte)
- char is an 8-bit int converted via ASCII table (other encodings, ex UTF-8)
- Ex. 64th entry of ASCII
`'@'` has int value
10000000 ($2^8 = 64$)

| Dec | Hx | Oct | Html | Chr |
|-----|----|-----|-------|-----|
| 64 | 40 | 100 | @ | @ |
| 65 | 41 | 101 | A | A |

Format Specifiers & printf/scanf

typeformatspecifiers.c

- Tells `printf` what type is being printed

`%d` for `int`

`%lf` for `double`

`%c` for `char`

```
int dozen = 12;
double pi = 3.14159265359;
char lastVowel = 'u';
printf("%d, %lf, %c\n", dozen, pi, lastVowel);
}
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Type casting & printf

intprintf.c

Probably not what you want:

```
int sixtyfour = 64;
printf("Without explicit type conversion:\n");
printf("sixtyfour as an int: %d\n", sixtyfour);
printf("sixtyfour as a char: %c\n", sixtyfour);
printf("sixtyfour as a double: %f\n", sixtyfour);
```

Type casting & printf

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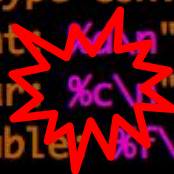
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Asks printf to print
an int as a char



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The correct way:

```
int nine = 9;
printf("With explicit type conversion:\n");
printf("nine as an int: %d\n", nine);
printf("nine as a char: %c\n", '0' + (char) nine);
printf("nine as a double: %f\n", (double) nine);
```

Type casting & printf

`intprintf.c`

What's happening on line 13?

```
'0' + (char) nine
```

1. `int` addition
(implicit conversion)
2. Which `ints`?

Type casting & printf

intprintf.c

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| Dec | Hx | Oct | Html | Chr |
|-----|----|-----|-------|-----|
| 48 | 30 | 060 | 0 | 0 |
| 49 | 31 | 061 | 1 | 1 |
| 50 | 32 | 062 | 2 | 2 |
| 51 | 33 | 063 | 3 | 3 |
| 52 | 34 | 064 | 4 | 4 |
| 53 | 35 | 065 | 5 | 5 |
| 54 | 36 | 066 | 6 | 6 |
| 55 | 37 | 067 | 7 | 7 |
| 56 | 38 | 070 | 8 | 8 |
| 57 | 39 | 071 | 9 | 9 |

Type casting & printf

intprintf.c

What's happening on line 13?

`'0' + (char) nine`

1. `int` addition
(implicit conversion)
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`'0'` is 48

`int nine = 9;`

`(char) nine` is 57

And $57 - 48 = 9$

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Representation of `ints` and `doubles`

- Internally, stored as sequences of bits (*binary digits*)
- `int`
 - All bits used to represent binary number
- `double`
 - 3 parts: sign (+/-), mantissa (significant digits), exponent
 - $\text{double } x = (\text{sign +/-}) \times \text{mantissa} \times 2^{\text{exponent}}$

| | | |
|-------|---------|---------|
| 1 bit | 52 bits | 11 bits |
|-------|---------|---------|

Overflow

`integeroverflow.c`

Numbers are represented with finite # of bits

- `int` has a min and max value.
 - Exceeding the range is an *integer overflow error*
- Floats only have a finite precision (some numbers are too small to represent accurately).
 - Wrong calculations due to finite precision are *numerical errors*
 - We won't discuss numerical error more in this class; deep topic

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Random Number Generation

- Random number generator `rand`
 - Not actually random: `rand` gets next number (between 0 and `RAND_MAX`) in a fixed sequence

`notrandom.c`

Random Number Generation

- Random number generator `rand`
 - Not actually random: `rand` gets next number (between 0 and `RAND_MAX`) in a fixed sequence
 - Sequence is determined by *seed value* sent to `srand`
 - Seed by `time` to get truly random numbers

`random.c`

Random Number Generation

Specifying the range of random numbers

1. Seed with `srand` and `time`
2. Use `rand` to generate numbers
3. Use `mod` to restrict range, e.g. numbers between 0 and 9:

```
rand() % 10
```

Between 1 and 10:

```
1 + rand() % 10
```

Further Reading (optional)

- [Article](#) on integer overflow

References:

- [printf](#), [scanf](#)
- [printf](#) [format specifiers](#)
- [scanf](#) [format specifiers](#)