IS12 - Introduction to Programming

Lecture 8:
Data Types and Expressions in C

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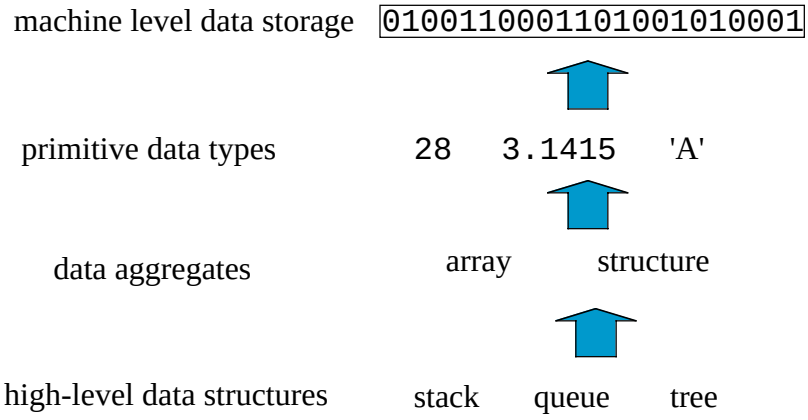
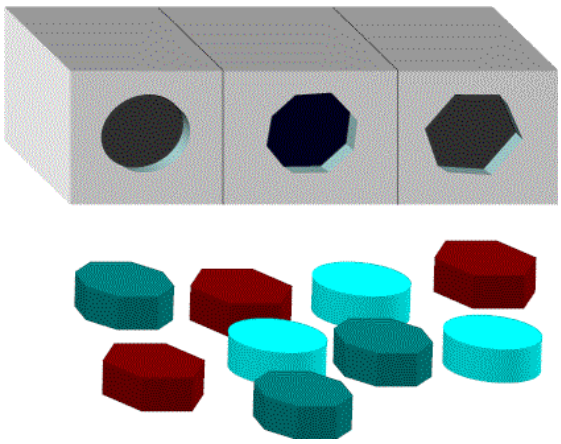
From Data to Data Structures



On each level...

- We do not want to be concerned with the way to represent objects of this level via objects of lower level
- We want to be concerned with the semantics of data on this level.
  - What is it?
  - What we can do with it?

Primitive Data Types



Primitive Data Types

- Integer data

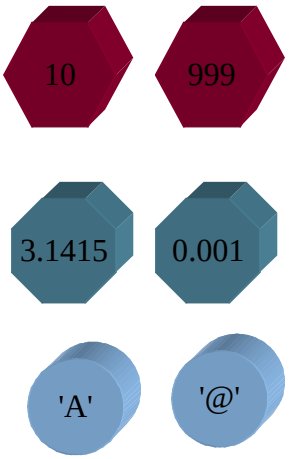
  1, 10, -999, 1000

- Floating point data

  3.1415, -0.001, 2.0

- Characters

  'A', 'B', '_', '@'



Primitive data can be printed

```
/* Example: Printing primitive data with printf */

#include <stdio.h>

void main()
{
   printf("Hello, World!\n");
   printf("Here are integers: %d %d\n", 10, 99);
   printf("Here are floats: %f %f\n", 3.1415, 0.001);
   printf("Here are characters: %c %c\n", 'A', '@');
}
```

How `printf` works

- Simple form - prints a string
  ```
  printf("Some String\n");
  ```
  – Note special symbols \t and \n
- Regular form
  ```
  printf("..%d..%f..%c..\n",
  Expr1, Expr2, Expr3);
  ```
  – % specifications should match expressions

Expressions?

- What is an expression?
- Anything that can have a *value*
- In C almost anything is an expression
- Expressions can have values of different type
- A literal constant is an expression:

  4 3.1415 99 'A' 0.0001

More control over printing

```
#include <stdio.h>

void main()
{
   printf("Hello, World!\n");
   printf("Integer: %5d\n", 10);
   printf("Float: %4.2f\n", 3.1415);
   printf("Characters: %c\n", 'A');
   printf("Mix: %08d %8.5f %c\n", 99, 0.001, '@');

}
```

Summary of print control

- %d prints a *decimal* integer value
- %6d prints a decimal integer at least 6 char wide (leading blanks may be printed)
- %f prints a floating point value
- %6f prints a floating point at least 6 char wide
- %.2f prints a floating point value with exactly 2 digits after decimal point
- %6.2f prints a floating point at least 6 char wide and 2 digits after decimal point

Arithmetic operations

```
#include <stdio.h>

void main()
{
  printf("Let's calculate!\n");
  printf("1234 + 4321 = %5d\n", 1234 + 4321);
  printf("2 * 3.1415 = %7.1f\n", 2 * 3.1415);
  printf("5/2 = %d\n", 5 / 2); /* int division */
  printf("5.0 / 2 = %f\n", 5.0 / 2);
                          /* type  conversion */
  printf("5 %% 2 = %d\n", 5 % 2); /* remainder */
}
```

Type conversion

- Automatic type conversion
  - If operands are of the same type, the result will be of this type too
  - If operands are of different types, they will be converted to the “broader” type (I.e., int to float) before the calculation
- Later we will learn about *assignment conversion* and *casting*

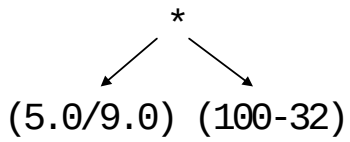
Multi-step calculations

```
/* Temperature Converter */

#include <stdio.h>

void main()
{
  printf("100 Fahrenheit = %6.2f Celsius\n",
     (5.0 / 9.0 ) * (100 - 32));
}
```

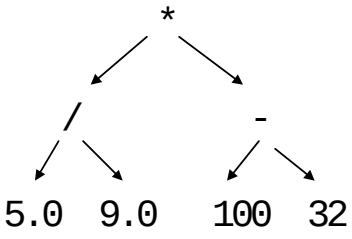
Example with brackets

```
(5.0/9.0)*(100-32)
```

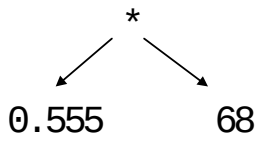
Example with brackets



Example with brackets



Example with brackets



Example with brackets

37.77

Order of calculation

- Operations have priorities (* and / have higher priority than + and -)
- Within operators of the same priority the order is defined by their *associativity*
- Use brackets when you need to change the default order of calculations or when you are not sure
- Learn precedence/associativity table! (K&R2, p.53; D&D, p. 44; Perry, insert)

Precedence of operators

- * / % → third priority
- + - → fourth priority

- `3 + 12 * 6` ≡ `3 + (12 * 6)`
- `1.2 * 2 + 3` ≡ `(1.2 * 2) + 3`
- `3 - 99 % 5` ≡ `3 - (99 % 5)`

Associativity of operators

- `*  /  %` → left to right
- `+  -` → left to right

- `3 * 12 * 6` ≡ `(3 * 12) * 6`
- `1.2 * 2 / 3` ≡ `(1.2 * 2) / 3`
- `3 / 9 % 5 * 2` ≡ `((3 / 9) % 5) * 2`

Before next lecture:

- Do reading assignment
  - Perry, Chapter 2 (starting from "Kinds of Data"); Chapter 4; Chapter 9 (first reading)
- Run Classroom Examples
- Check your understanding on quizzes
- Check yourself by working with exercises in WADEIn system