Computer Science I

Basics

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Outline

1. Introduction
2. Variables & Operators
3. Basic I/O
4. Exercises
5. Noninteractive Input
6. Toolkit: Linters

Part I: Introduction

Overview, Compiling, Elements of a Program

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- A *programming language* is a formal language that specifies a set of instructions that can be used in a program
- We write programs in a code (text) editor or Integrated Development Environment (IDE)
- Source code is is *compiled* and run on a particular *operating system*

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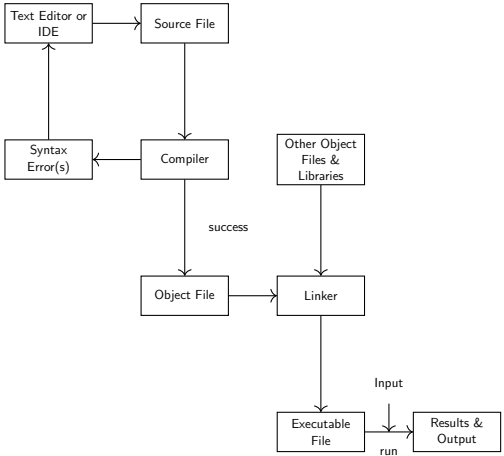
$$\text{source} \rightarrow \text{assembly} \rightarrow \text{machine}$$

Compiling



Demonstration

- Edit a source file, `hello.c`
- Assemble:
  `gcc -S hello.c`
- Compile:
  `gcc -c hello.c`
- View binary/hex:
  `hexdump -C hello.o`
- All in one: `gcc hello.c`
- Run: `./a.out`

Example


```c
/**
 * Author: Chris Bourke
 * Date: November 2, 2016
 *
 * This program converts miles to kilometers
 */
#include <stdlib.h>
#include <stdio.h>

#define KMS_PER_MILE 1.60934

int main(int argc, char **argv) {

  double miles, kms;

  printf("Please enter miles: ");

  scanf("%lf", &miles);

  kms = KMS_PER_MILE * miles;

  printf("%f miles is equal to %f kilometers\n", miles, kms);

  return 0;
}
```

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- Multiple line comments:

```
1  /* This is a multiline
2     comment. */
```

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- "Doc-style" comments:

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- Code should be self-documenting, code itself should tell the *how*

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- Begin with a hash `#`
- Macros: `#define a b`
- Macro usage: defining constants; avoiding "magic" numbers
- Including libraries:

```
1  #include <stdlib.h>
2  #include <stdio.h>
3  #include <math.h>
```

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- Math functions: `sqrt`, `sin`, `pow`

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- In general, whitespace does not affect a program
- Keywords: `int`, `double`, `return`

Part II: Variables & Operators

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- The *scope* of a variable is the section(s) of code in which it exists

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Integers

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- Can represent values:

$$-2^{31} = -2,147,483,648 \leq x \leq 2,147,483,647 = 2^{31} - 1$$

- Examples:

```
1  int x;
2  int numberOfStudents = 42;
3  int golfScore = -3;
```

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Floating Point Numbers

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$$3895.434 \rightarrow 3.895434 \times 10^{3}$$

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- Examples:

```
1  double pi = 3.14159;
2  double totalCost = 3219.32;
```

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- Examples:

```
1  char firstInitial = 'C';
2  char response = 'y';
```

ASCII TABLE

Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char
0	0	[NULL]	32	20	[SPACE]	64	40	@	96	60	`
1	1	[START OF HEADING]	33	21	!	65	41	A	97	61	a
2	2	[START OF TEXT]	34	22	"	66	42	B	98	62	b
3	3	[END OF TEXT]	35	23	#	67	43	C	99	63	c
4	4	[END OF TRANSMISSION]	36	24	$	68	44	D	100	64	d
5	5	[ENQUIRY]	37	25	%	69	45	E	101	65	e
6	6	[ACKNOWLEDGE]	38	26	&	70	46	F	102	66	f
7	7	[BELL]	39	27	'	71	47	G	103	67	g
8	8	[BACKSPACE]	40	28	(	72	48	H	104	68	h
9	9	[HORIZONTAL TAB]	41	29	)	73	49	I	105	69	i
10	A	[LINE FEED]	42	2A	*	74	4A	J	106	6A	j
11	B	[VERTICAL TAB]	43	2B	+	75	4B	K	107	6B	k
12	C	[FORM FEED]	44	2C	,	76	4C	L	108	6C	l
13	D	[CARRIAGE RETURN]	45	2D	-	77	4D	M	109	6D	m
14	E	[SHIFT OUT]	46	2E	.	78	4E	N	110	6E	n
15	F	[SHIFT IN]	47	2F	/	79	4F	O	111	6F	o
16	10	[DATA LINK ESCAPE]	48	30	0	80	50	P	112	70	p
17	11	[DEVICE CONTROL 1]	49	31	1	81	51	Q	113	71	q
18	12	[DEVICE CONTROL 2]	50	32	2	82	52	R	114	72	r
19	13	[DEVICE CONTROL 3]	51	33	3	83	53	S	115	73	s
20	14	[DEVICE CONTROL 4]	52	34	4	84	54	T	116	74	t
21	15	[NEGATIVE ACKNOWLEDGE]	53	35	5	85	55	U	117	75	u
22	16	[SYNCHRONOUS IDLE]	54	36	6	86	56	V	118	76	v
23	17	[ENG OF TRANS. BLOCK]	55	37	7	87	57	W	119	77	w
24	18	[CANCEL]	56	38	8	88	58	X	120	78	x
25	19	[END OF MEDIUM]	57	39	9	89	59	Y	121	79	y
26	1A	[SUBSTITUTE]	58	3A	:	90	5A	Z	122	7A	z
27	1B	[ESCAPE]	59	3B	;	91	5B	[	123	7B	{
28	1C	[FILE SEPARATOR]	60	3C	<	92	5C	\	124	7C	|
29	1D	[GROUP SEPARATOR]	61	3D	=	93	5D	]	125	7D	}
30	1E	[RECORD SEPARATOR]	62	3E	>	94	5E	^	126	7E	~
31	1F	[UNIT SEPARATOR]	63	3F	?	95	5F	_	127	7F	[DEL]

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- Bad: `var1` `somevalue`

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  - An arithmetic expression

Assignment Operator
Examples


```
1  //declare an int variable and set it to 10:
2  int a;
3  a = 10;
4  //or
5  int a = 10;
6
7  double c = 10.5 + a * 2 - 10 / 2;
```

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  - `12 % 6` results in `0`

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- Examples:

```
1  (a + 10) * (b - c)
2  (a * b) + (c / d)
```

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- Not the same type of variables; sometimes they are *incompatible*
- Example:

```
1  //okay:
2  int a = 10;
3  double x = 10;
4
5  //in C, this results in truncation
6  int b = 3.14;  //b has the value 3
```

Truncation

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- Especially important with respect to division:

```
1  int a = 10;
2  int b = 20;
3
4  double c = a / b;  //results in 0.0
5
6  //explicit type cast:
7  double d = a / (double) b; //results in 0.5
```

Part III: Basic Input/Output

Basic Input/Output

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- Standard input/output library: `stdio.h`
- Standard input: keyboard, use `scanf`
- Standard output: "console" or terminal, use `printf`

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  - `double` : use `%lf`
  - `char` : use `%c`
- Second argument: variable to store the value into
- *You must place an ampersand in front of the variable*

Basic Input
Examples


```c
int a;
double x;

//prompt the user for an integer
printf("enter an integer: ");
scanf("%d", &a);
printf("%d\n", a);

//prompt for a double:
printf("enter a value: ");
scanf("%lf", &x);
printf("%f\n", x);
```

Basic Output

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  - `char`: use `%c`
- Multiple placeholders may be used

Basic Output

- `printf`: Print Formatted
- First argument: a string containing content and formatted *placeholder*:
  - `int`: use `%d`
  - `double`: use `%f`
  - `char`: use `%c`
- Multiple placeholders may be used
- Each subsequent argument will replace each placeholder

Basic Output
Examples


```
1  int a = 10;
2  double x = 3.14;
3  char initial = 'C';
4
5  printf("a = %d, x = %f and my initial is %c\n", a, x, initial);
```

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- A negation can be used to justify left: `%-10.2f`

Formatting Floats

Examples


```
1  double pi = 3.1415926;
2
3  printf("%f", pi);
4  printf("%.3f", pi);
5  printf("%.5f", pi);
6  printf("%10.2f", pi);
7  printf("%4.4f", pi);
8  printf("%-10.2f", pi);
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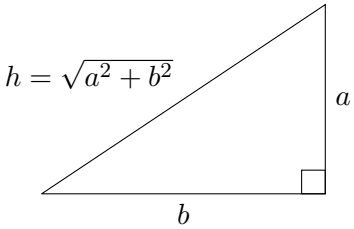
Part IV: Exercises

Exercise

Write a program to read in three values from the user and print their average.

Exercise

Write a program that prompts the user for the length of two sides of a right triangle and outputs the length of its hypotenuse using the Pythagorean Theorem:



Exercise

Write a program to calculate mileage reimbursement. Read in the beginning and ending odometer values as well as a per-mile rate from the user and display the total distance travelled as well as the total reimbursement.

Exercise

Write a program to convert a number of days into years (assume 365), weeks, and days. For example, if the user enters 1,000 days, it would display "2 years, 38 weeks, 4 days."

Part V: Noninteractive Input

Using Command Line Arguments

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- Demonstration

Part VI: Toolkit Demo – Linters

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