Review Problem 1

- Programming languages have many instructions, but they fall under a few basic types. One is arithmetic (+, -, *, /, etc). What are the others?

shift

Control flow
- Compare >, !=
- function calls
- if-then, goto, Return

assign

object/variable declarations + allocation

loops: for, while

Libraries: file I/O, graphics.

Assembly Language

Readings: 2.1-2.7, 2.9-2.10, 2.14
Green reference card

Assembly language

- Simple, regular instructions – building blocks of C, Java & other languages
- Typically one-to-one mapping to machine language

Our goal

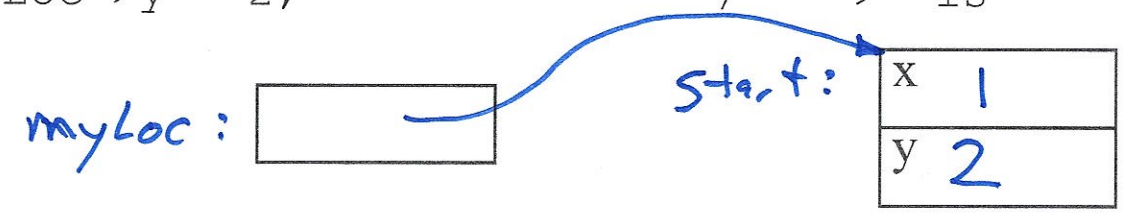
- Understand the basics of assembly language
- Help figure out what the processor needs to be able to do

Not our goal to teach complete assembly/machine language programming

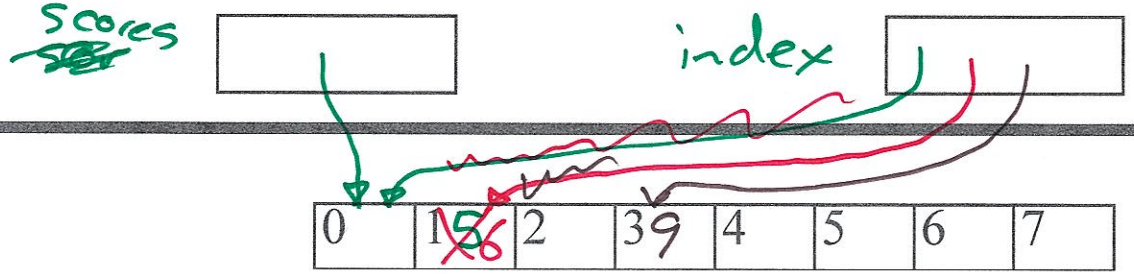
- Floating point
- Procedure calls
- Stacks & local variables

Aside: C/C++ Primer

```
struct coord { int x, y; };  /* Declares a type                    */
struct coord start;          /* Object with two slots, x and y     */
start.x = 1;                 /* For objects "." accesses a slot    */
struct coord *myLoc;         /* "*" is a pointer to objects        */
myLoc = &start;              /* "&" returns thing's location       */
myLoc->y = 2;                /* "->" is "*" plus "."               */
```




```
int scores[8];               /* 8 ints, from 0..7 */
scores[1]=5;                 /* Access locations in array */
int *index = scores;         /* Points to scores[0] */
index++;                     /* Next scores location */
(*index)++;                  /* "*" works in arays as well */
index = &(scores[3]);        /* Points to scores[3] */
*index = 9;
```



ARM Assembly Language

The basic instructions have four components:

- Operator name
- Destination
- 1st operand
- 2nd operand

```
ADD <dst>, <src1>, <src2>      // <dst> = <src1> + <src2>
SUB <dst>, <src1>, <src2>      // <dst> = <src1> - <src2>
```

Simple format: easy to implement in hardware

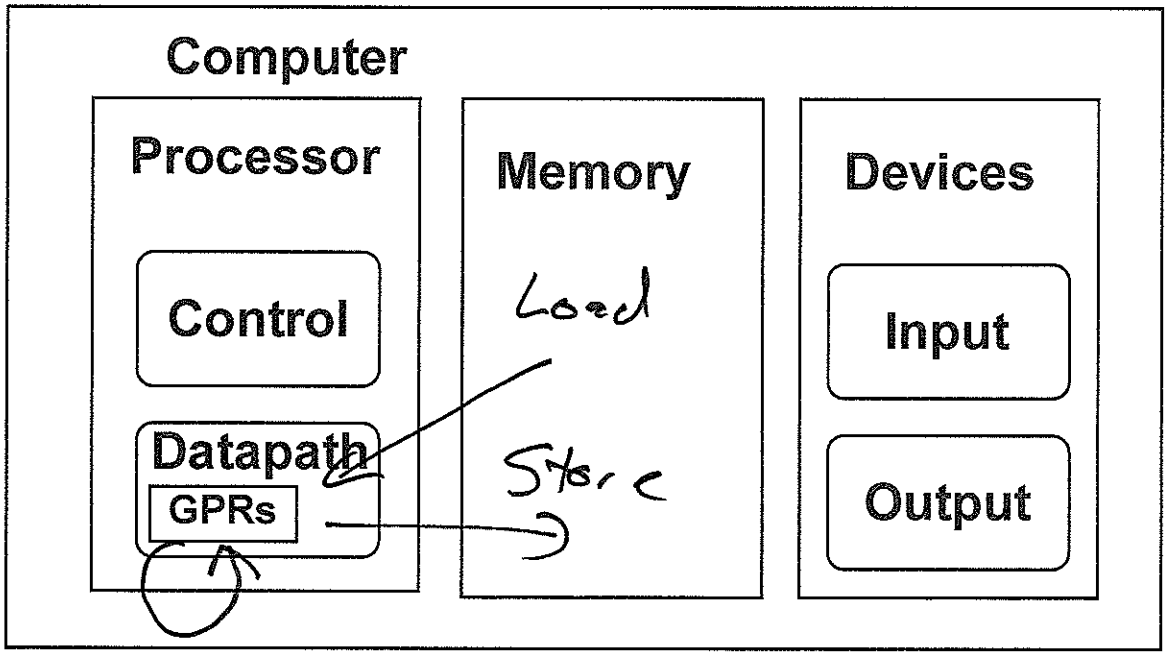
More complex: `A = B + C + D - E`

```
ADD t1, B, C
ADD t1, t1, D
SUB A, t2, E
```

```
ADD t1, B, C
SUB t2, D, E
ADD A, t1, t2
```

Operands & Storage

For speed, CPU has 32 general-purpose registers for storing most operands
For capacity, computer has large memory (multi-GB)

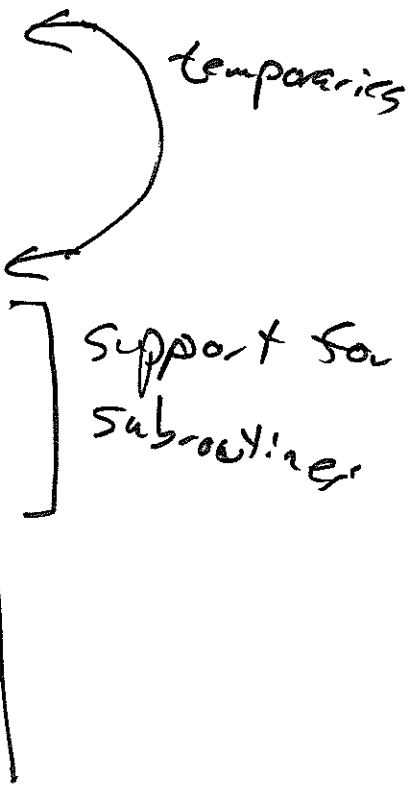


Load/store operation moves information between registers and main memory
All other operations work on registers

Registers

32x 64-bit registers for operands

Register	Function	Comment
X0-X7	Function arguments/Results	
X8	Result, if a pointer	
X9-X15	Volatile Temporaries	Not saved on call
X16-X17	Linker scratch registers	Don't use them
X18	Platform register	Don't use this
X19-X27	Temporaries (saved across calls)	Saved on call
X28	Stack Pointer	
X29	Frame Pointer	
X30	Return Address	
X31	Always 0	No-op on write



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