COMP 122/L Lecture 12

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Outline

- Memory instructions
  - **Load** (`ldr`)
  - **Store** (`str`)
- Arrays

Memory Operations

Refresher

You've already seen one form of `ldr` for handling strings

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```
    .data
my_string:
    .asciz "hello"

    .text
ldr r0, =my_string
```

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```
.data
my_string:
  .asciz "hello"

.text
ldr r0, =my_string
```

Puts starting address of "`hello`" in `r0`

-This was used for setting up swi instructions
-While this uses memory, it did so indirectly (the swi instruction actually read the memory, not us)

Putting Integers in Memory

`.word` directive will put a 32-bit integer in memory,
much like `.asciz` will put a string in memory

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```
        .data
my_string:
    .asciz “hello”
first_int:
    .word 42
second_int:
    .word 38
```

Reading Integers From Memory

Step 1: use `ldr` to put its address into a register...

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```
.data
first_int:
   .word 42
second_int:
   .word 38

   .text
ldr r0, =first_int
```

Reading Integers From Memory

Step 2: use `ldr` with `[]` to read the value at the address

```
    .data
first_int:
    .word 42
second_int:
    .word 38

    .text
ldr r0, =first_int
```

Reading Integers From Memory

Step 2: use `ldr` with `[]` to read the value at the address

```
    .data
first_int:
    .word 42
second_int:
    .word 38

    .text
ldr r0, =first_int
ldr r1, [r0]
```

Reading Integers From Memory

Step 2: use `ldr` with `[]` to read the value at the address

```
        .data
first_int:
        .word 42
second_int:
        .word 38

        .text
ldr r0, =first_int
ldr r1, [r0]
```

r1: 42

Writing Integers to Memory

Step 1: use `ldr` to put its address into a register...

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Step 1: use `ldr` to put its address into a register...

```
    .data
first_int:
    .word 42
second_int:
    .word 38

    .text
ldr r0, =first_int
```

Writing Integers to Memory

Step 2: use `str` to write a value at that address

```
    .data
first_int:
    .word 42
second_int:
    .word 38

    .text
ldr r0, =first_int
```

Writing Integers to Memory

Step 2: use `str` to write a value at that address

```
    .data
first_int:
    .word 42    57
second_int:
    .word 38

    .text
ldr r0, =first_int
mov r1, #57
str r1, [r0]
```

Example:

memory_variables.s

Arrays

Specifying Arrays

Only distinction from variables:

multiple values are specified with the `.word` directive

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```
.data
first_int:
   .word 42
```

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Only distinction from variables:
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```
.data
first_int:
  .word 42
array:
  .word 32, 65, 76, 87
```

Accessing Arrays

Basic approach: increment memory address

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Basic approach: increment memory address

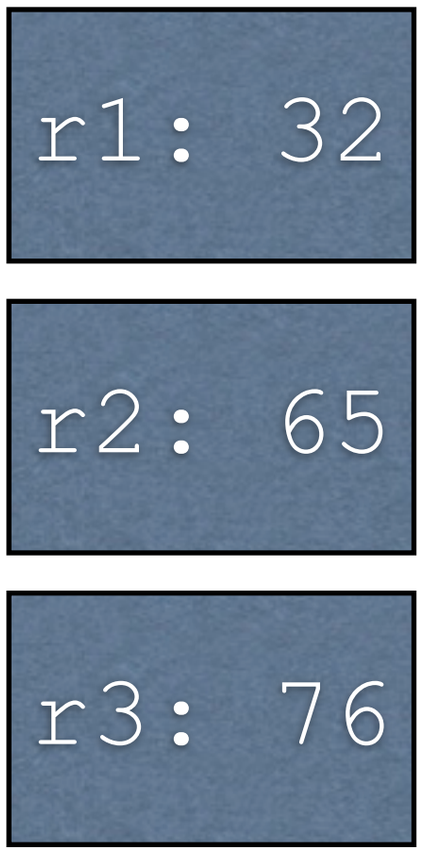
```
   .data
arr:
   .word 32, 65, 76
   .text
ldr r0, =arr
ldr r1, [r0]
add r0, r0, #4
ldr r2, [r0]
add r0, r0, #4
ldr r3, [r0]
```

-Offsets increment by 4 because one word is 4 bytes

Accessing Arrays

Basic approach: increment memory address

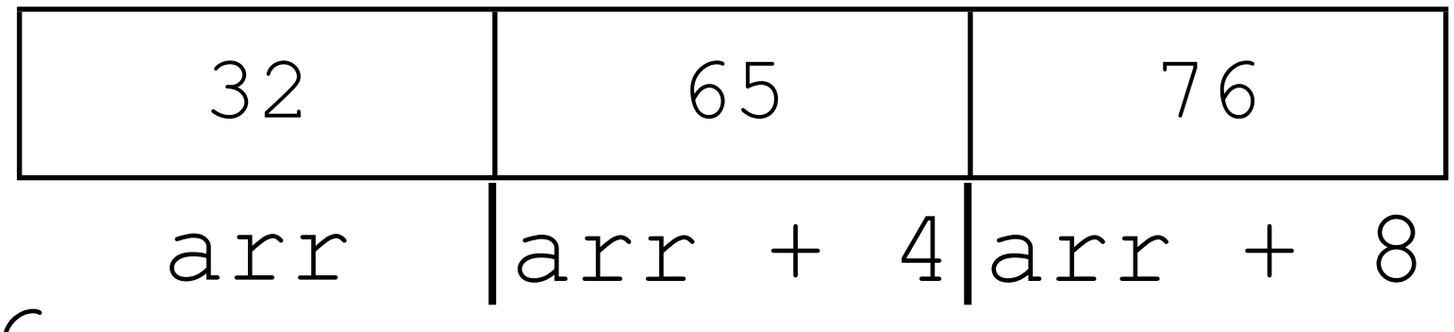
```
   .data
arr:
   .word 32, 65, 76
   .text
ldr r0, =arr
ldr r1, [r0]
add r0, r0, #4
ldr r2, [r0]
add r0, r0, #4
ldr r3, [r0]
```



Accessing Arrays

Basic approach: increment memory address

```
   .data
arr:
   .word 32, 65, 76
   .text
ldr r0, =arr
ldr r1, [r0]
add r0, r0, #4
ldr r2, [r0]
add r0, r0, #4
ldr r3, [r0]
```



r1: 32

r2: 65

r3: 76

-Top right corner shows memory layout in terms of arr

Example:

register_indirect.s

More on Memory Access

`ldr r3, [r0]`

- The above instruction uses the *register indirect addressing mode*
    - Addressing mode: how the processor accesses something
    - Register indirect: Memory access is done through an address in a register
- Many more available: see `register_*.s`

-See also ftp://www.cs.uregina.ca/pub/class/301/ARM-addressing/lecture.html

Array Access Example:

`print_array_fixed_length.s`

Writing to Array Example: write_array_increasing.s

Another Array Access Example:

`print_array_variable_length.s`