CS 33

Intro to Machine Programming

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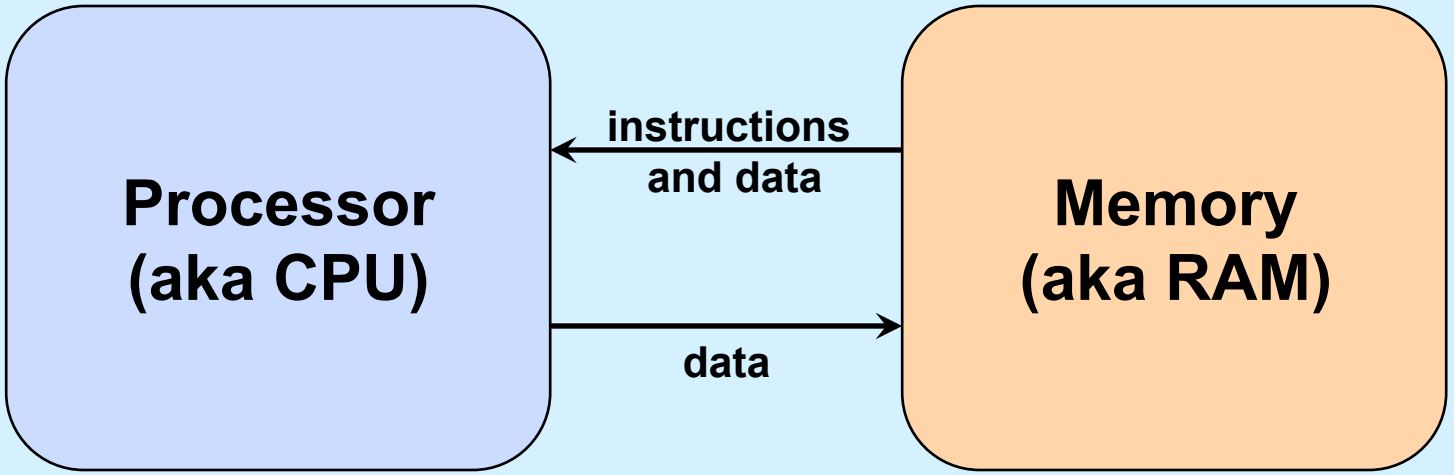
Machine Model



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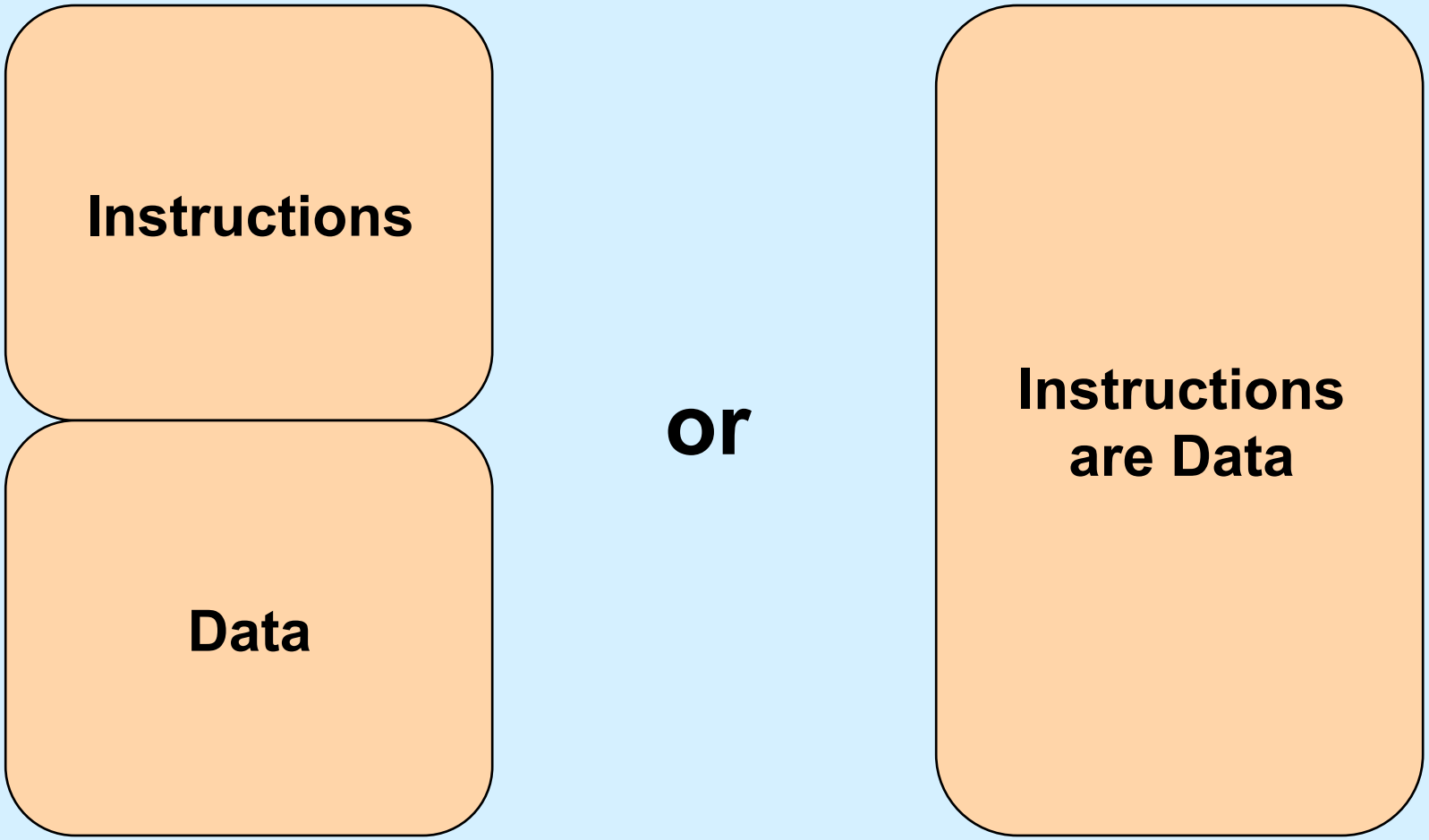
Memory



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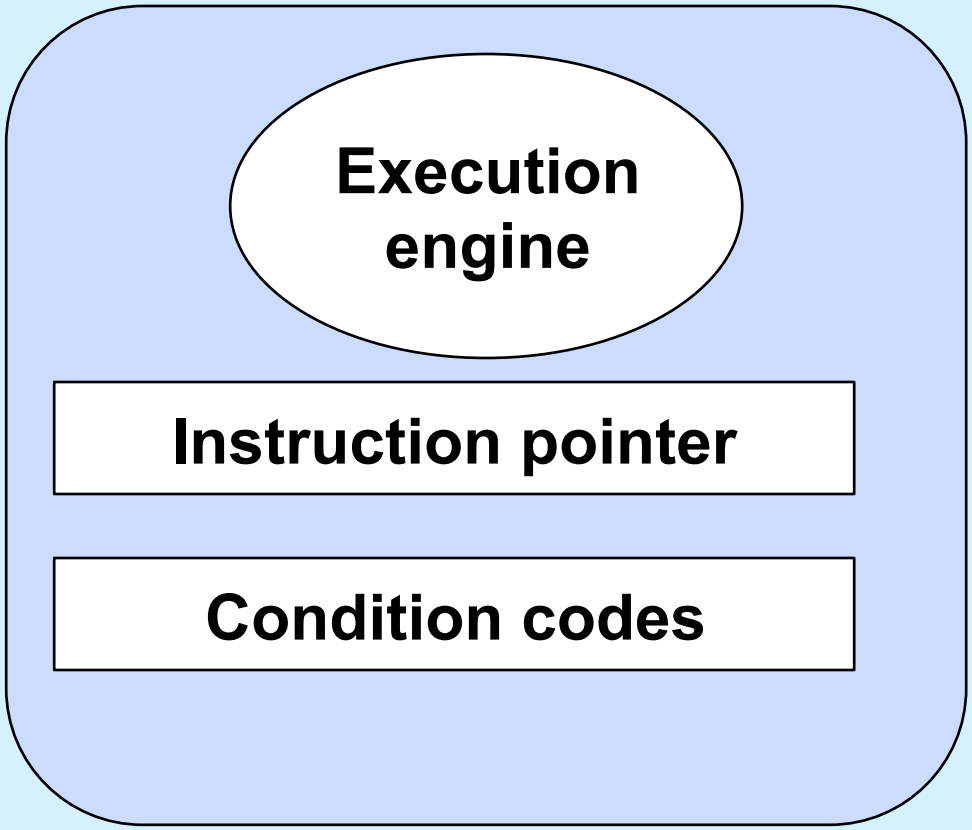
Processor: Some Details



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Processor: Basic Operation

```
while (forever) {
  fetch instruction IP points at
  decode instruction
  fetch operands
  execute
  store results
  update IP and condition code
}
```


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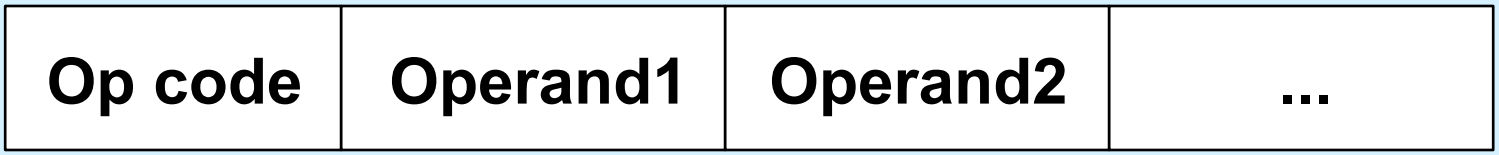
Instructions ...



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Operands

- Form
  - immediate vs. reference
    - » value vs. address
- How many?
  - 3
    - » add a,b,c
      - c = a + b
  - 2
    - » add a,b
      - b += a

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Operands (continued)

- Accumulator
  - special memory in the processor
    - » known as a *register*
    - » fast access
  - allows single-operand instructions
    - » add a
      - acc += a
    - » add b
      - acc += b

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From C to Assembler ...

```
a = (b + c) * d;
```

```
    mov   b,%acc
    add   c,%acc
    mul   d,%acc
    mov   %acc,a
```

```
if (a<b)
    c = 1;
else
    d = 1;
```

```
    cmp   a,b
    jge   .L1
    mov   $1,c
    jmp   .L2
.L1
    mov   $1,d
.L2
```

immediate operand

immediate operand

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Condition Codes

- Set of flags including status of most recent operation:
  - zero flag
    - » result was or was not zero
  - sign flag
    - » result was or was not negative (sign bit is or is not set)
  - overflow flag
    - » for values treated as signed
  - carry flag
    - » for values treated as unsigned
- Set implicitly by arithmetic instructions
- Set explicitly by compare instruction
  - cmp a,b
    - » sets flags based on result of b-a

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Jump Instructions

- Unconditional jump
  - just do it
- Conditional jump
  - to jump or not to jump determined by condition-code flags
  - field in the op code indicates how this is computed
  - in assembler language, simply say
    - » je
      - jump on equal
    - » jne
      - jump on not equal
    - » jgt
      - jump on greater than
    - » etc.

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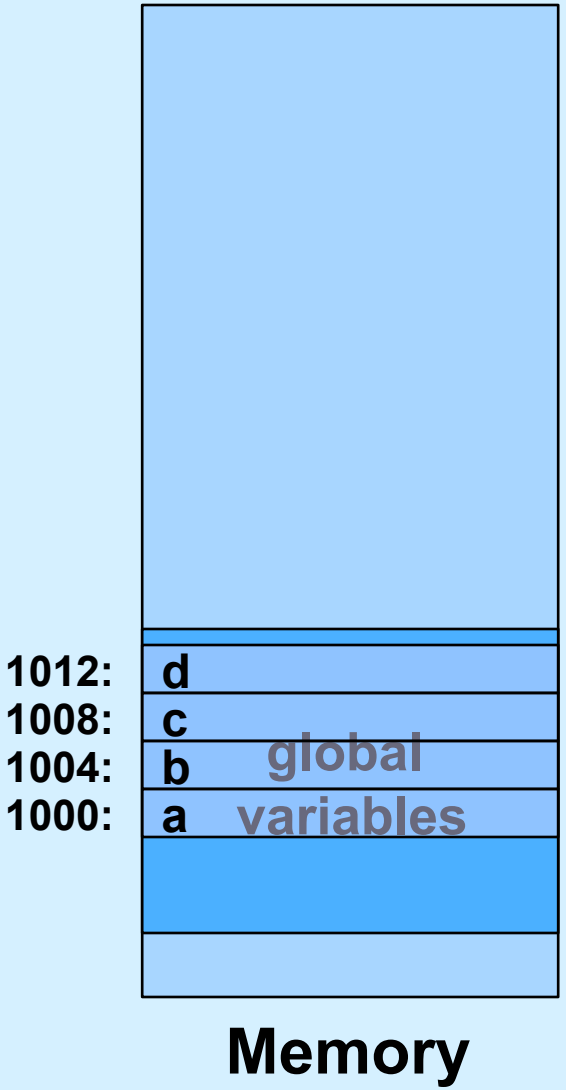
Addresses

```
int a, b, c, d;

int main() {
    a = (b + c) * d;
    ...
}
```

```
mov   b,%acc
add   c,%acc
mul   d,%acc
mov   %acc,a
```

```
mov   1004,%acc
add   1008,%acc
mul   1012,%acc
mov   %acc,1000
```



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Addresses

```
int b;

int func(int c, int d) {
    int a;
    a = (b + c) * d;
    ...
}
```

```
    mov    ?,%acc
    add    ?,%acc
    mul    ?,%acc
    mov    %acc,?
```

- One copy of *b* for duration of program's execution
  - *b*'s address is the same for each call to *func*
- Different copies of *a*, *c*, and *d* for each call to *func*
  - addresses are different in each call

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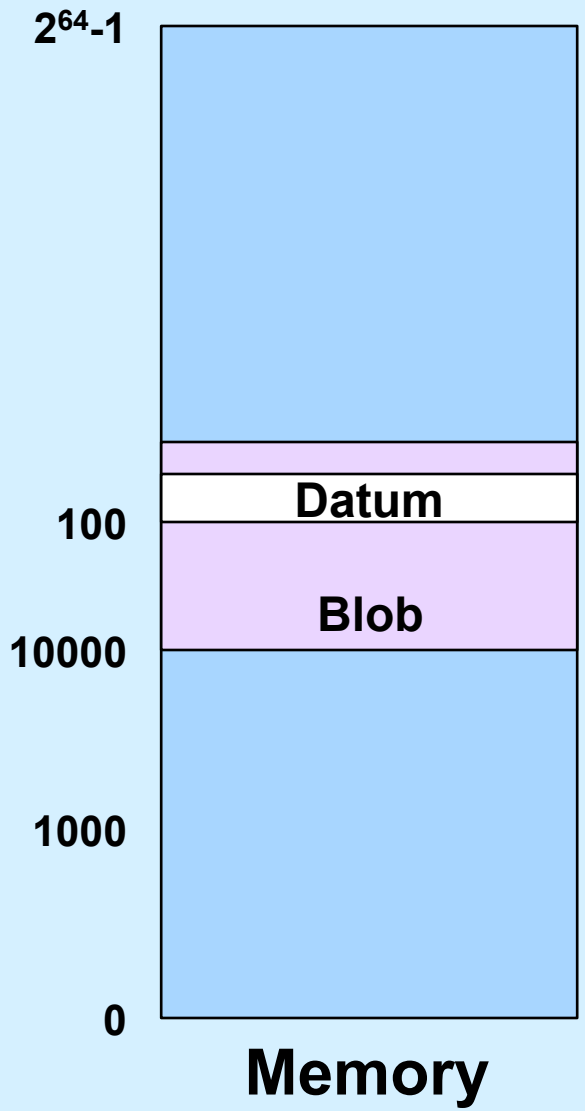
Relative Addresses

- Absolute address
  - actual location in memory
- Relative address
  - offset from some other location

- Blob's absolute address is 10000
- Datum's relative address (to Blob) is 100
  - its absolute address is 10100



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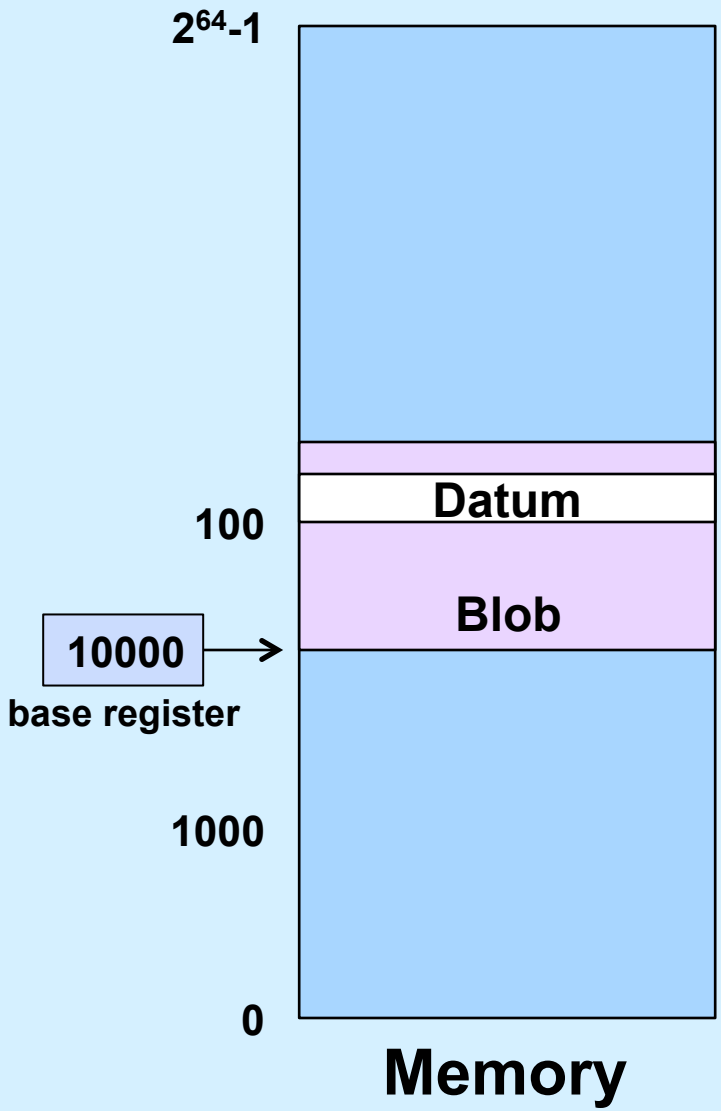
Base Registers

```
mov $10000, %base
mov $10, 100(%base)
```



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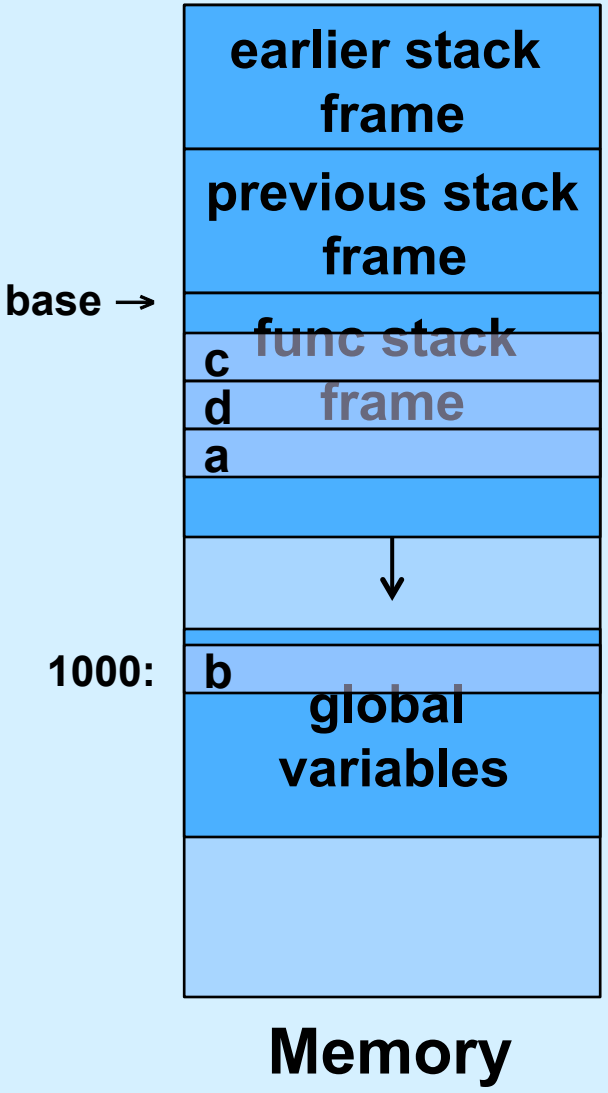
Addresses

```
int b;

int func(int c, int d) {
    int a;
    a = (b + c) * d;
    ...
}
```

```
    mov   1000,%acc
    add   c_rel(%base),%acc
    mul   d_rel(%base),%acc
    mov   %acc,a_rel(%base)
```



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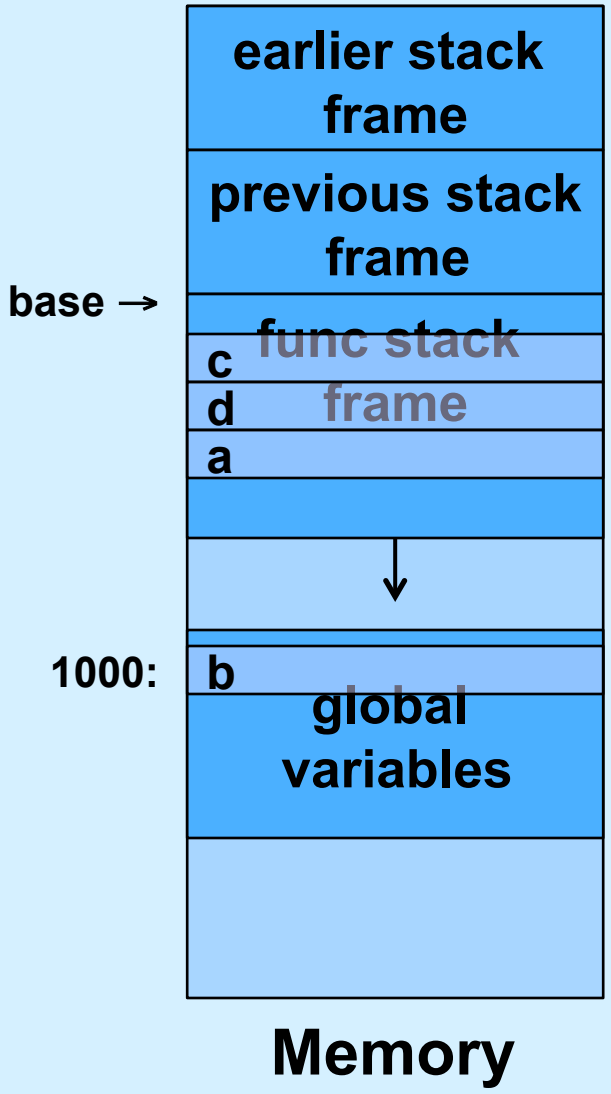
Quiz

Suppose the value in *base* is 10,000 and *c_rel* is -8. What is the address of *c*?

a) 9992
b) 9996
c) 10,004
d) 10,008




```
mov    1000,%acc
add    c_rel(%base),%acc
mul    d_rel(%base),%acc
mov    %acc,a_rel(%base)
```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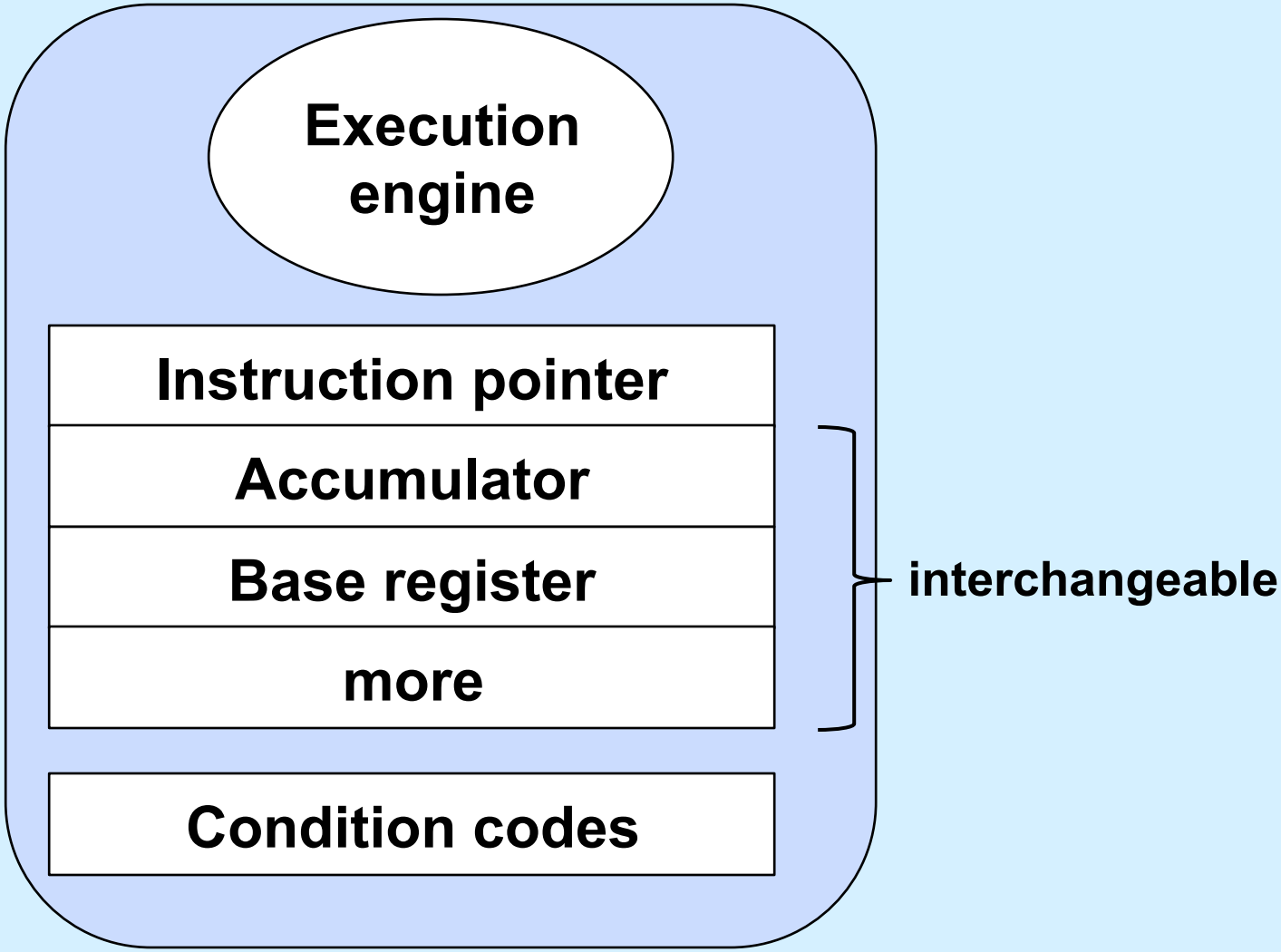
Registers



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