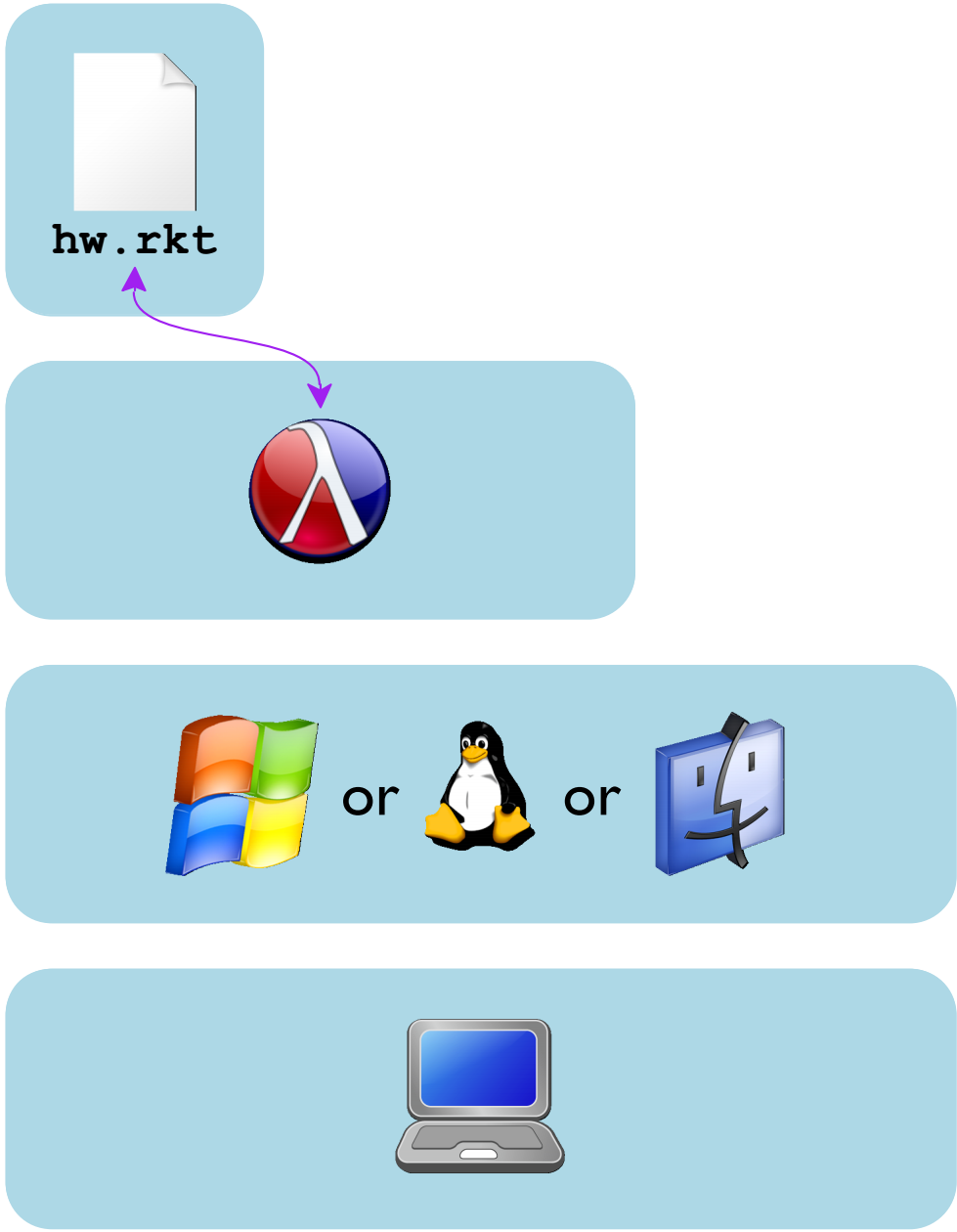
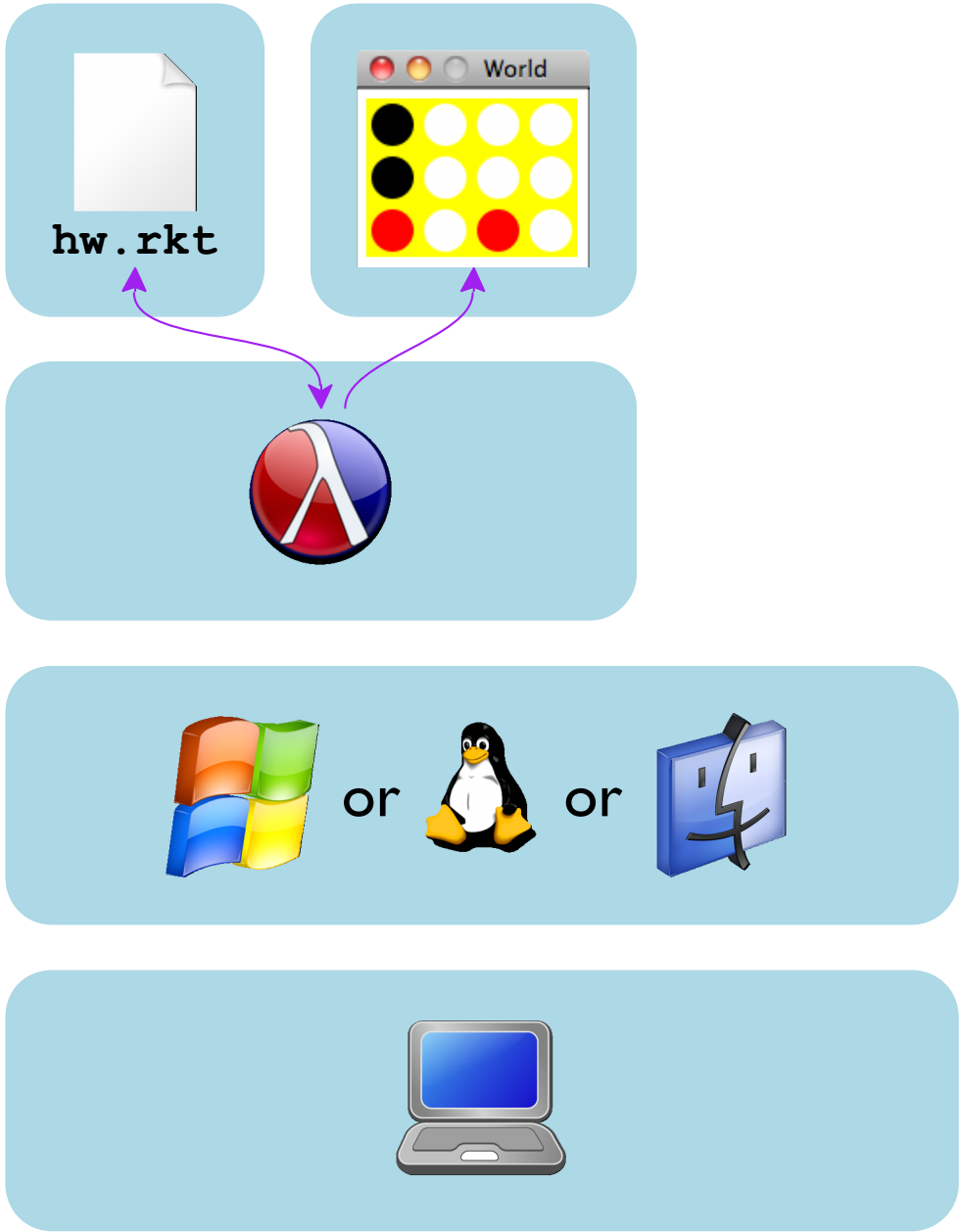
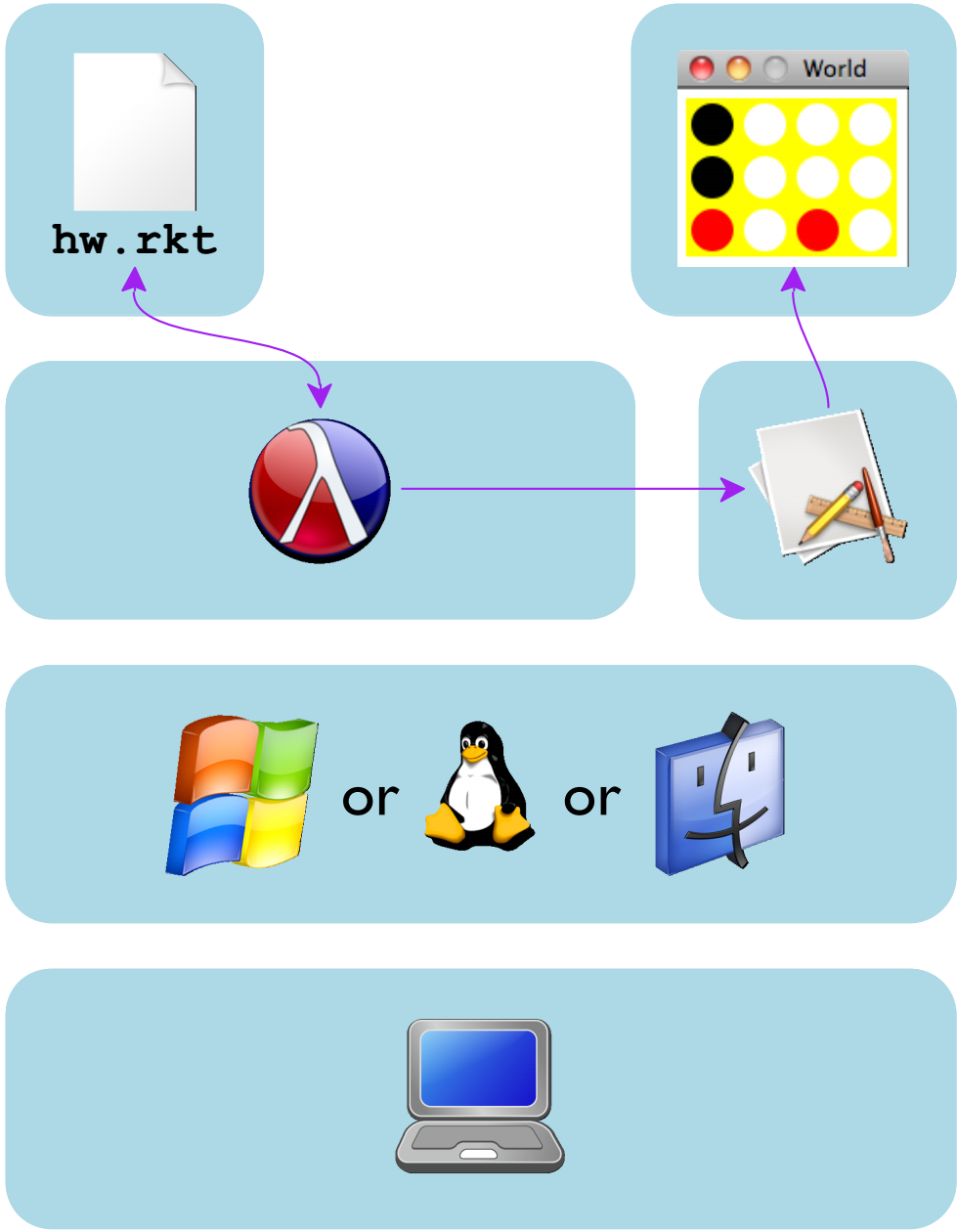
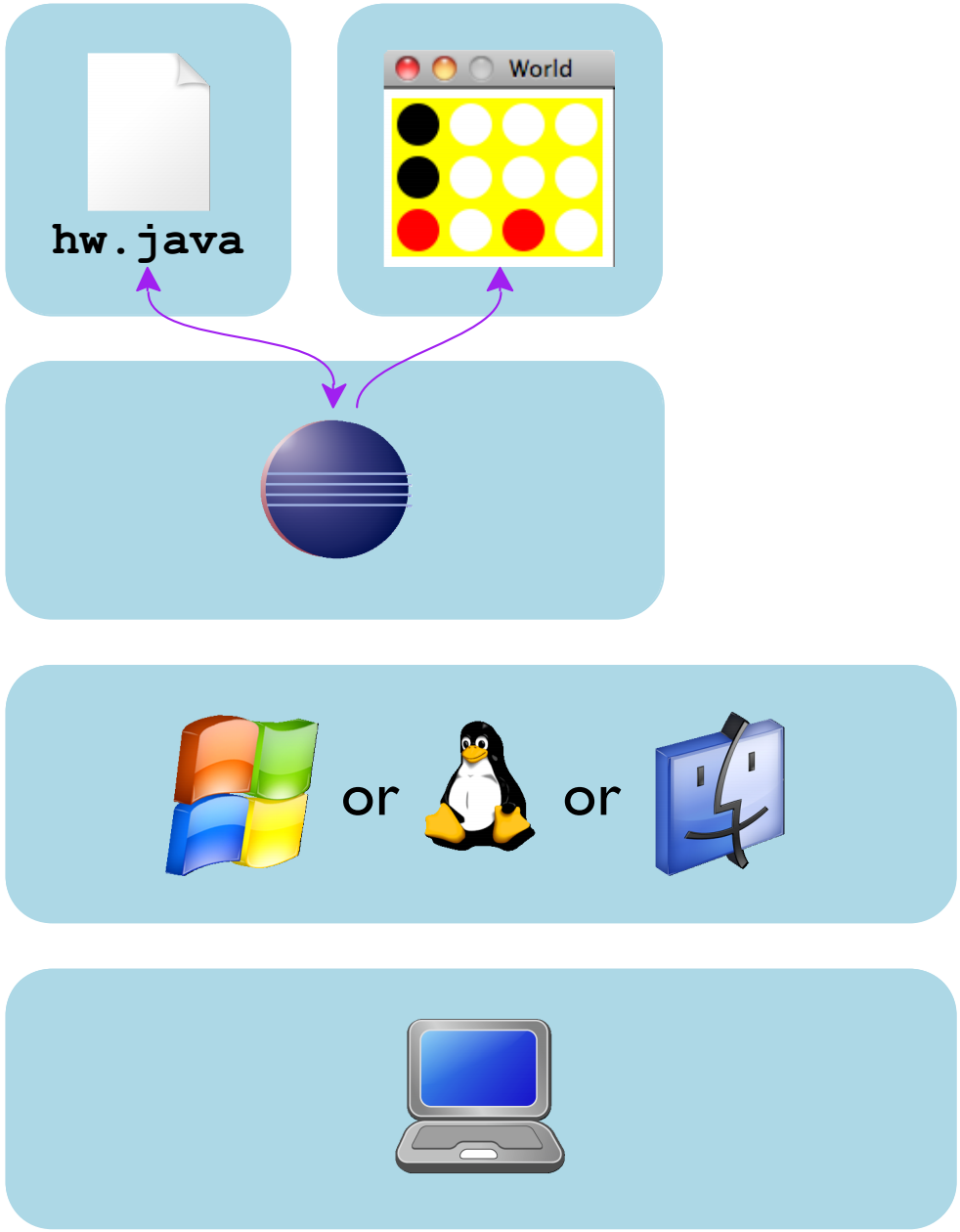
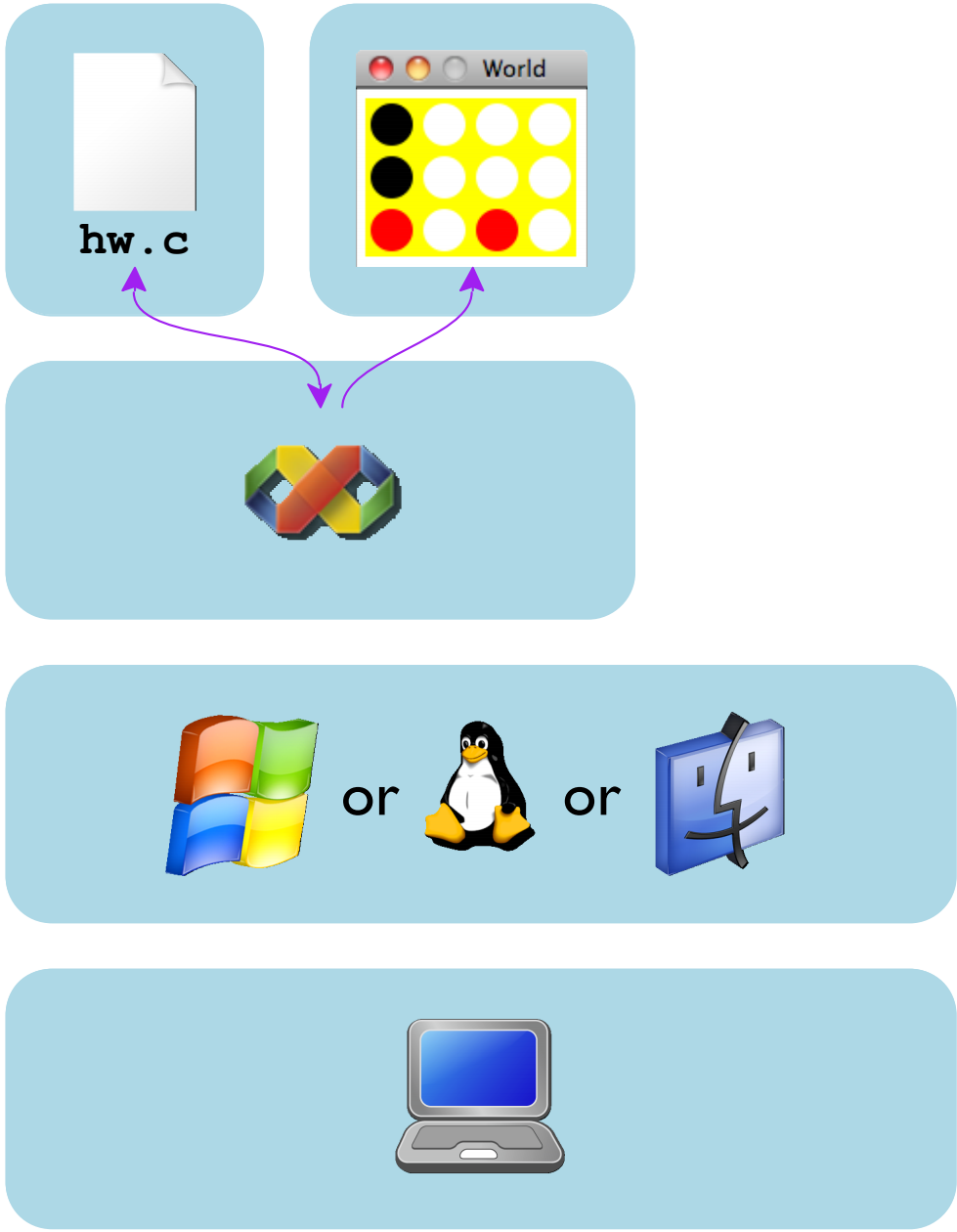
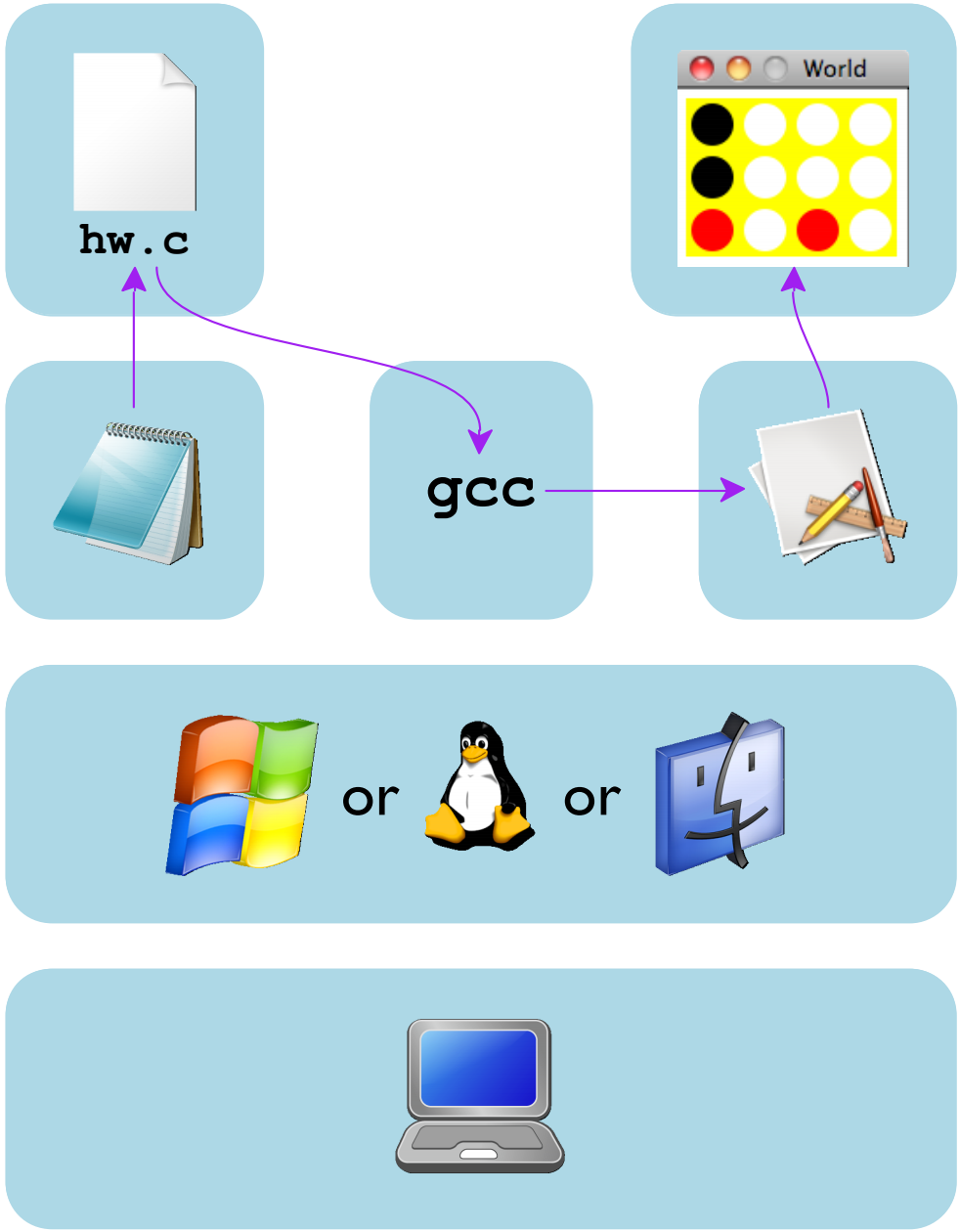

hw.rkt
or
or

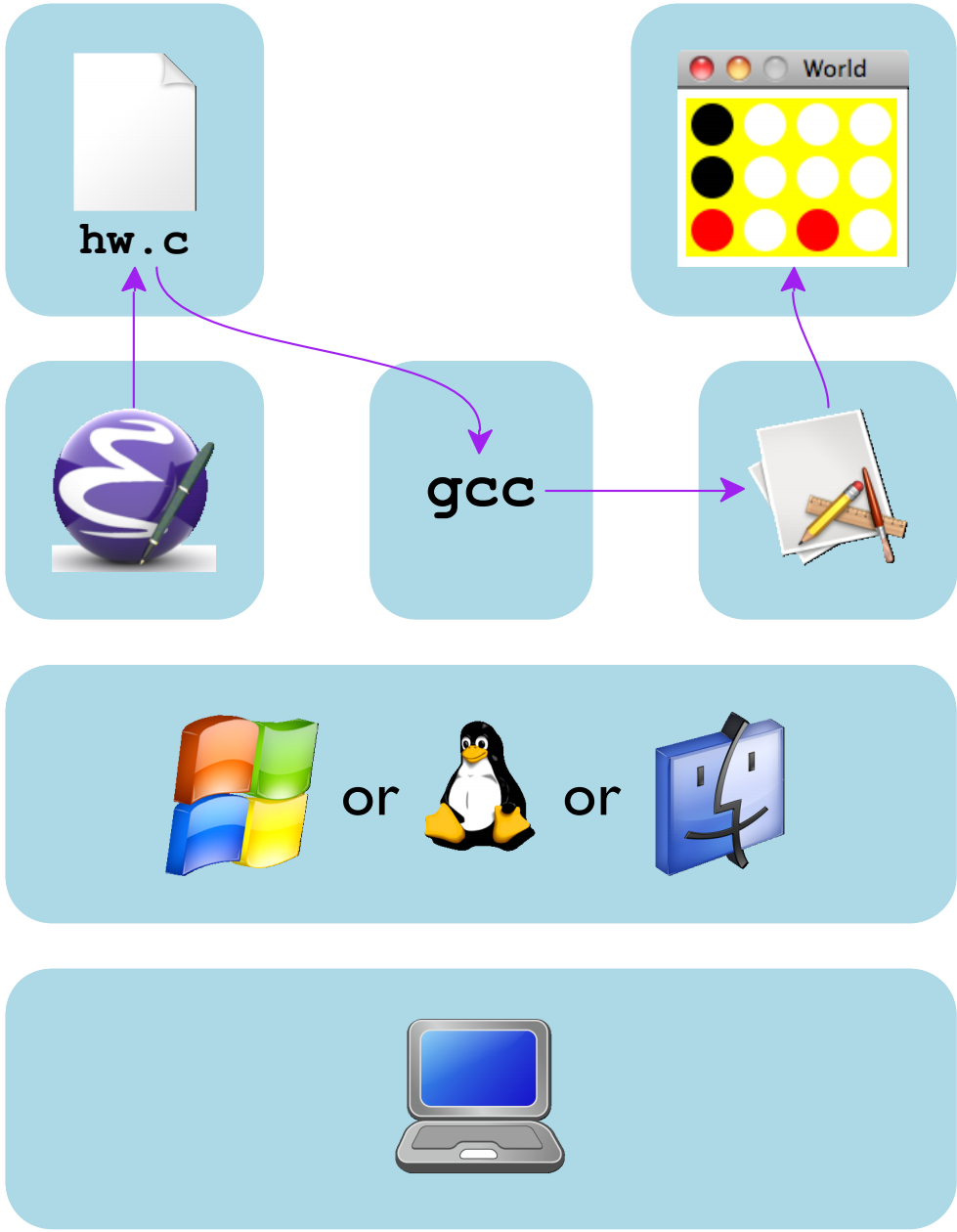

hw.rkt
World
or
or

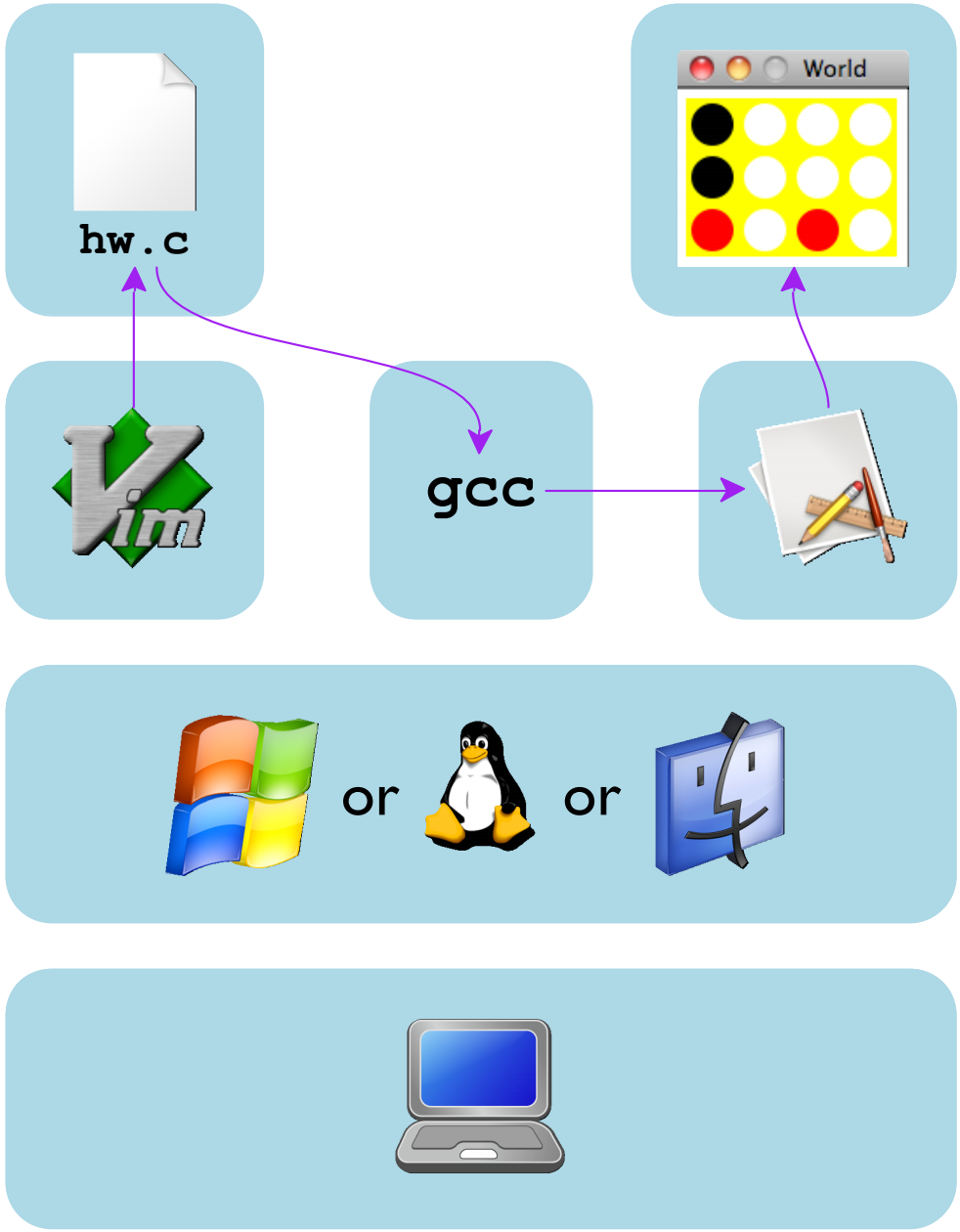

hw.rkt
World
or
or

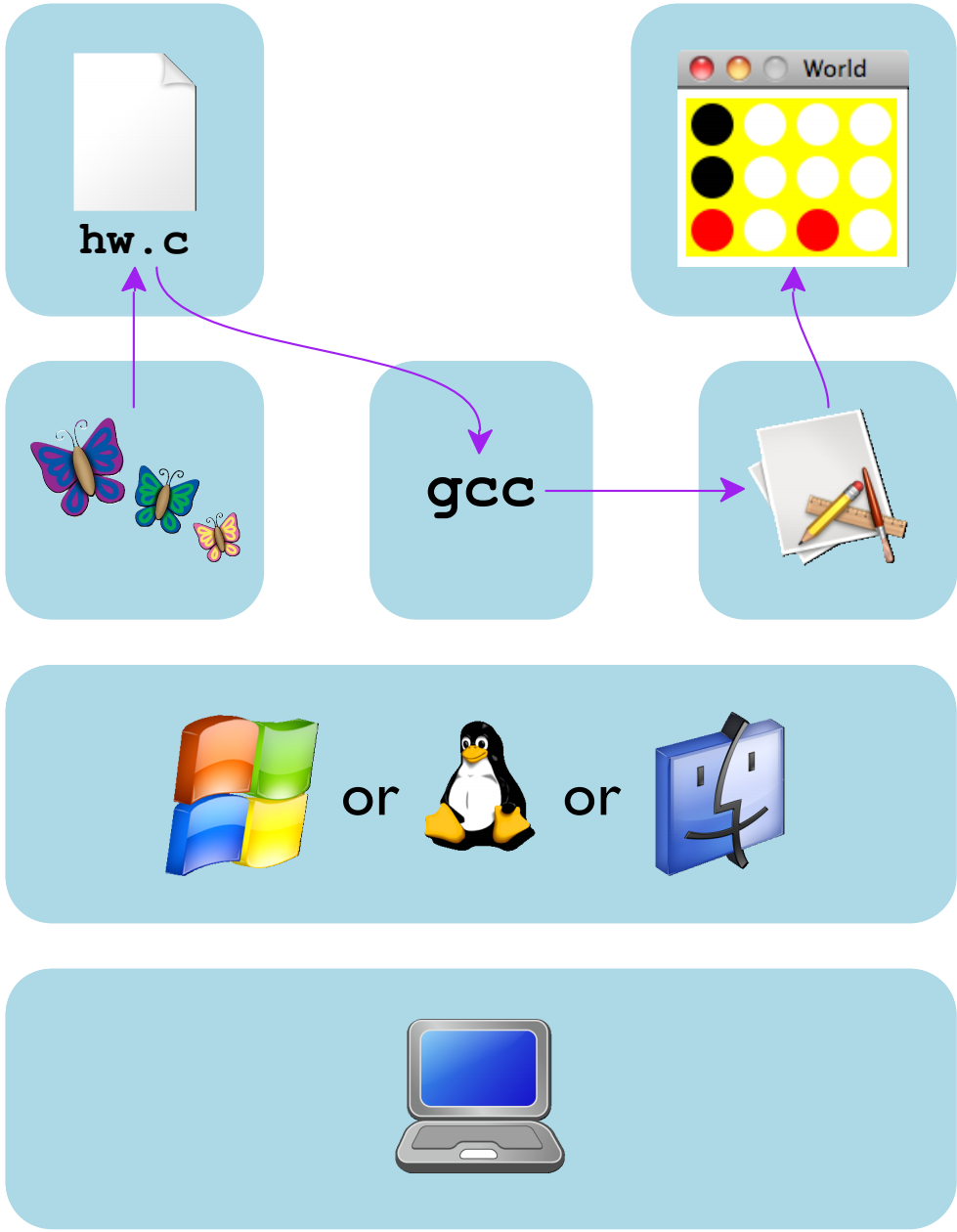

hw.java
World
or
or


hw.c
World
or
or


hw.c
World
gcc
or
or


hw.c
World
gcc
or
or


hw.c
World
gcc
or
or


hw.c
World
gcc
or
or

Installing gcc

- Windows: install Cygwin with **`gcc-core`** and **`libmpfr1`** packages
- Mac OS X: install Apple developer tools
- Linux: install **`gcc`** package

C Program that Succeeds at Nothing

```
int main() {
  return 0;
}
```

Copy

Compile and Run

```
% gcc x.c
% ./a.out
```

under Windows, it's **`a.exe`** instead of **`a.out`**

```
% gcc -o x x.c
% ./x
```

under Windows, it's actually **`x.exe`**, but just **`x`** works

C Program that Fails at Nothing

```
int main() {
  return 1;
}
```

Copy

a non- 0 result reports failure

Enabling Warnings

```
% gcc -Wall -o x x.c
% ./x
```

C Program that Prints, But Makes gcc Complain

```
int main() {
  printf("Hi\n");
  return 0;
}
```

Copy

Language within a language: Inside a string, `\n` means "newline" — and that's true for C, Java, Racket, and most languages

C Program that Prints, And Keeps gcc Happy

```
#include <stdio.h>

int main() {
  printf("Hi\n");
  return 0;
}
```

Copy

#include is similar to **require** or **import**

C Program that Prints a Number

```
#include <stdio.h>

int main() {
  printf("Ten and ten make %d\n", 10+10);
  return 0;
}
```

Copy

Language within a language within a language: In a string passed to **`printf`**,

`%d` means "print the next integer"
`%f` means "print the next double"
`%s` means "print the next string"
`%p` means "print the next address"
`%c` means "print the next character"

Hexadecimal Numbers

```
#include <stdio.h>

int main() {
  printf("Hex 10 and hex 10 make %d\n",
         0x10 + 0x10);
  return 0;
}
```

Copy

0x starts a base-16 number

Everything is a Number

```
#include <stdio.h>

int main()
{
  printf("%p %p\n", main, printf);
  return 0;
}
```

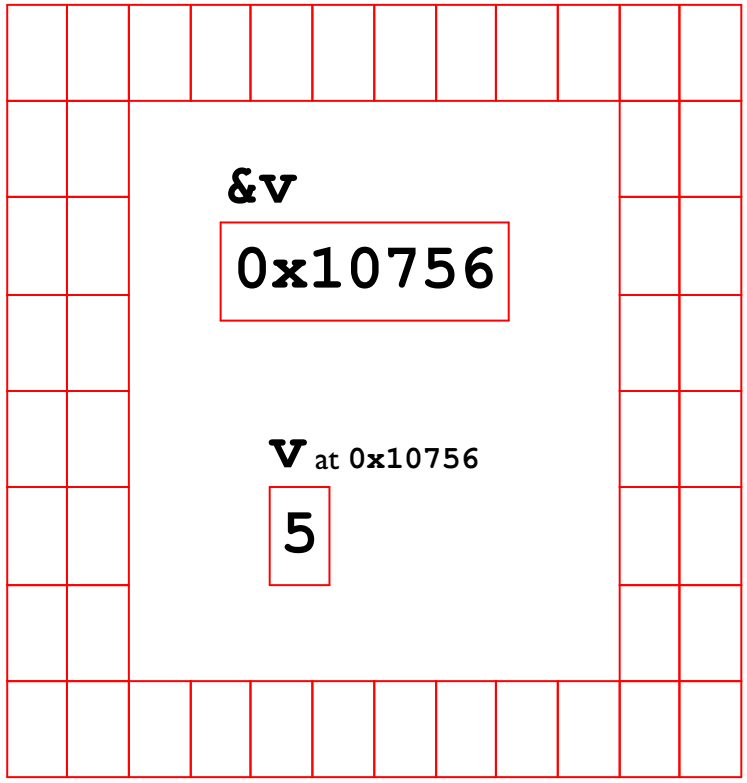
Copy

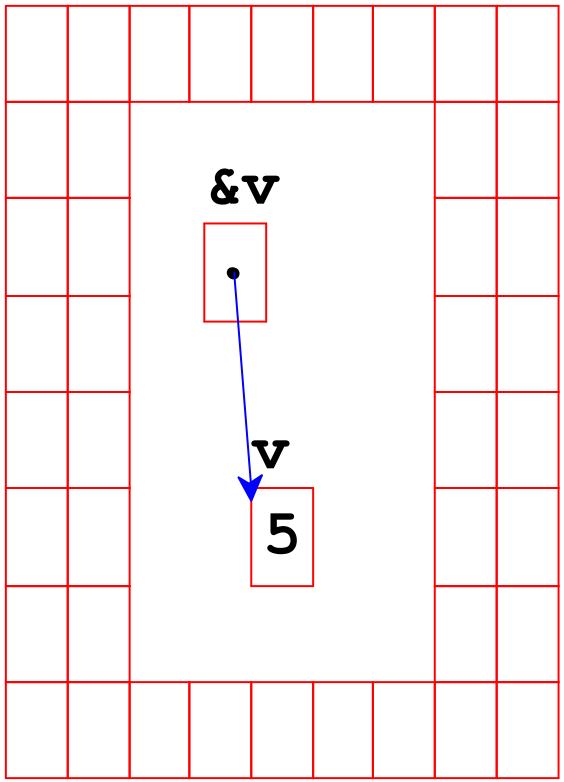
Variables Live in Memory

```
#include <stdio.h>

int main() {
  int v = 5;

  printf("At %p is %d\n", &v, v);
  return 0;
}
```

Copy

& as an operator means "the address of"


&v
0x10756
v at 0x10756
5


&v
v
5

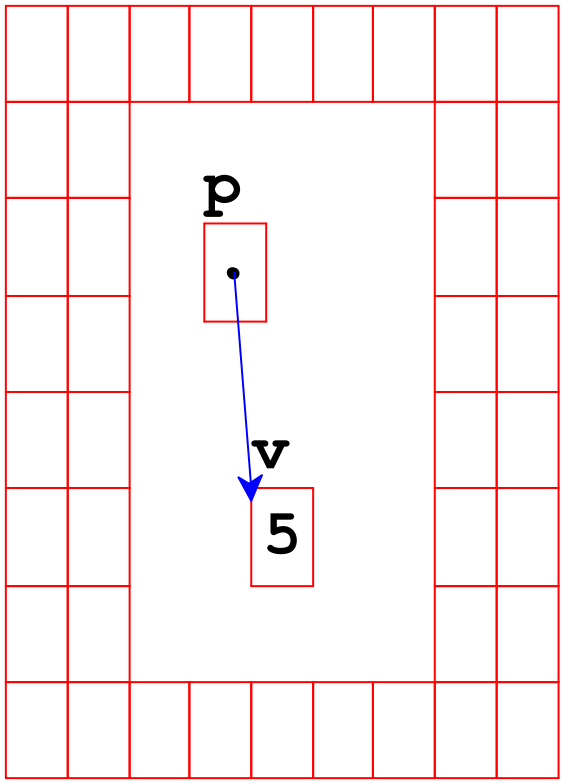
Variables Live in Memory

```
#include <stdio.h>

int main()
{
  int v = 5;
  int* p = &v;

  v = 6;
  printf("At %p is %d\n", p, *p);
  return 0;
}
```

Copy

* in a type means “the address of a”

* as an operator means “value at the address”


p
v
5

Changing Memory can Change Variables

```
#include <stdio.h>

int main() {
  int v = 5;
  int* p = &v;

  *p = 7;
  printf("V at end: %d\n", v);
  return 0;
}
```

Copy

Array Notation Also Looks in an Address

```
#include <stdio.h>

int main() {
  int v = 5;
  int* p = &v;

  printf("At %p is %d\n", p, p[0]);
  return 0;
}
```

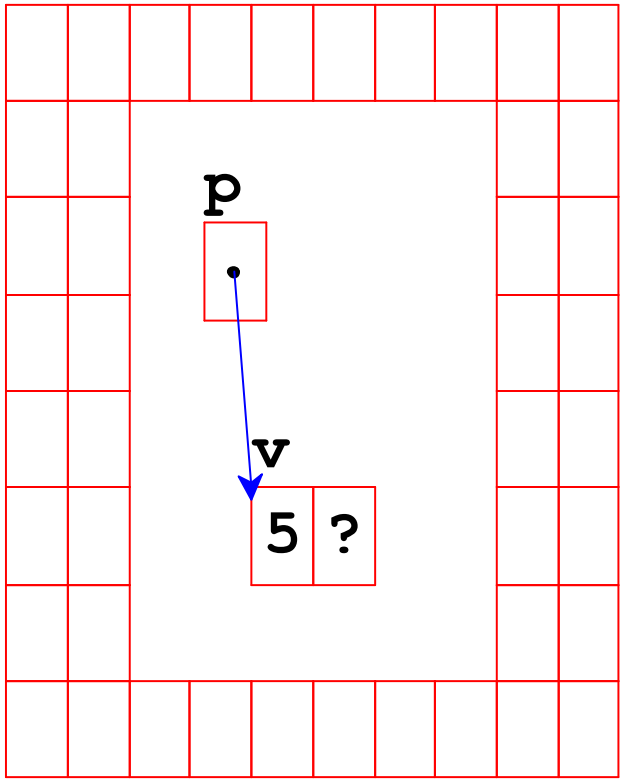
Copy

Address Arithmetic

```
#include <stdio.h>

int main() {
  int v = 5;
  int* p = &v;

  printf("At %p is %d\n", p+1, p[1]);
  return 0;
}
```

Copy

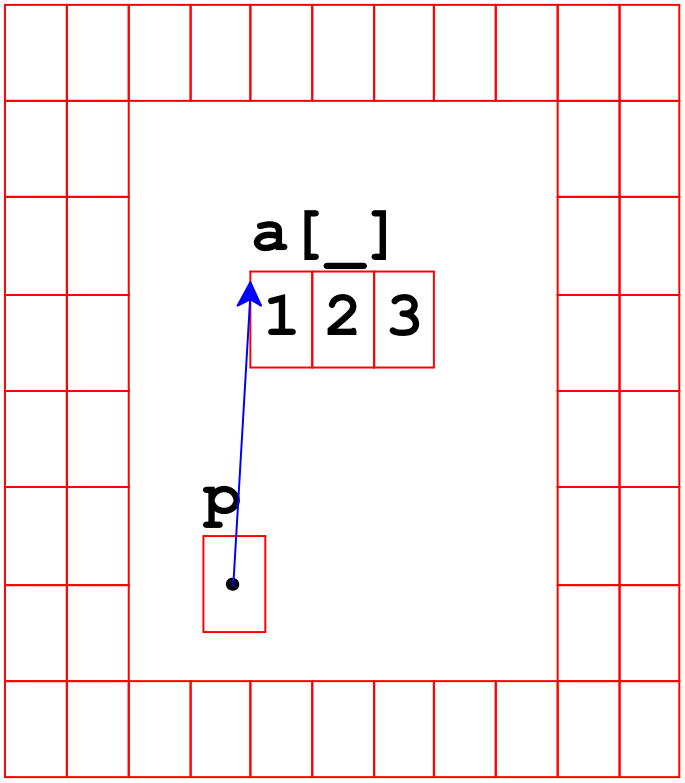
The result is unpredictable


p
v
5
?

Arrays Takes up Memory

```
#include <stdio.h>

int main() {
  int a[3] = { 1, 2, 3 };
  int* p = a;

  printf("%d, %d, %d\n",
         a[0], p[1], *(p + 2));
  return 0;
}
```

Copy

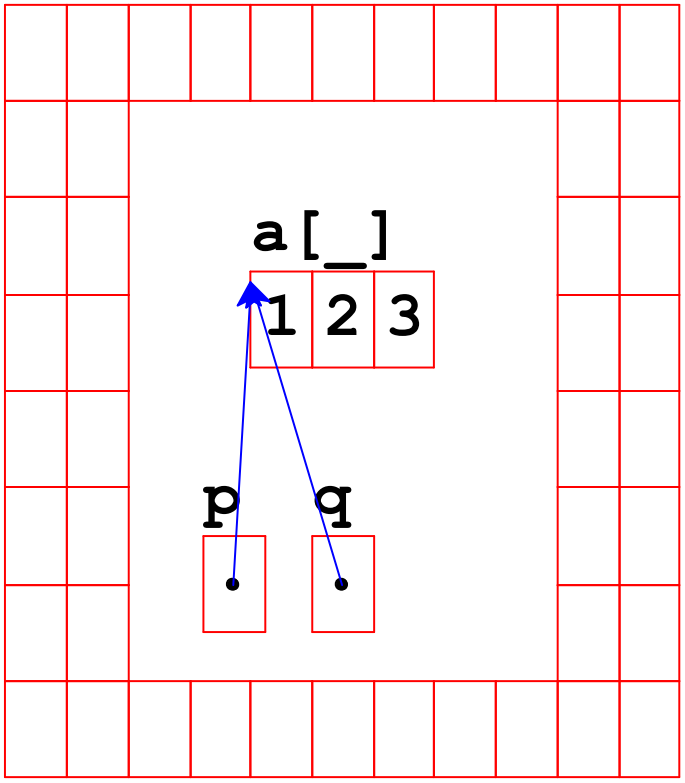

a[_]
1 2 3
p

Array Names Are a Little Strange

```
#include <stdio.h>

int main() {
  int a[3] = { 1, 2, 3 };
  int* p = a;
  int* q = &a;

  printf("%p = %p, but not %p\n",
         p, q, &p);
  return 0;
}
```

Copy

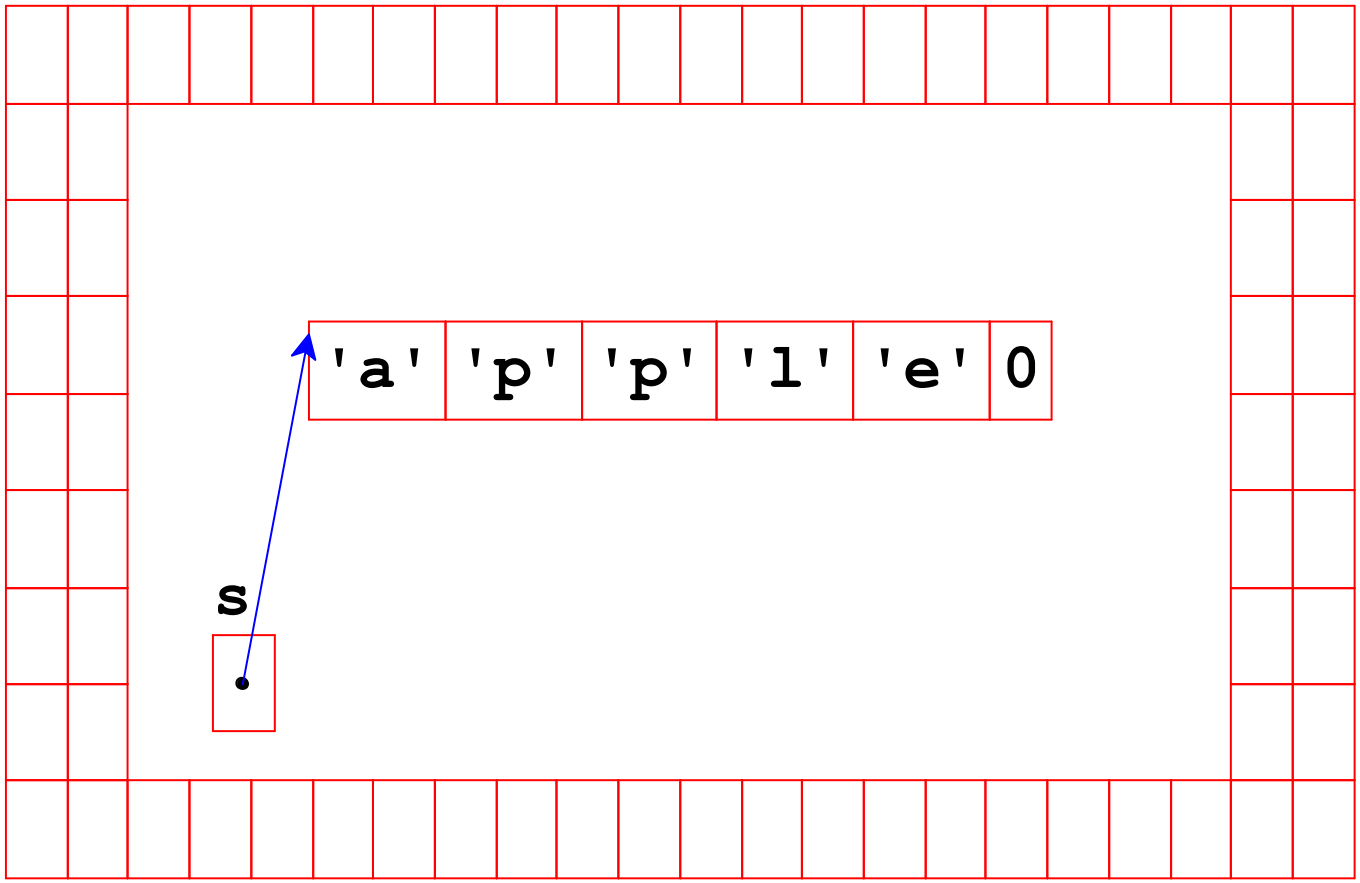
Special treatment of sized-array names makes `[]`-expression notation consistent

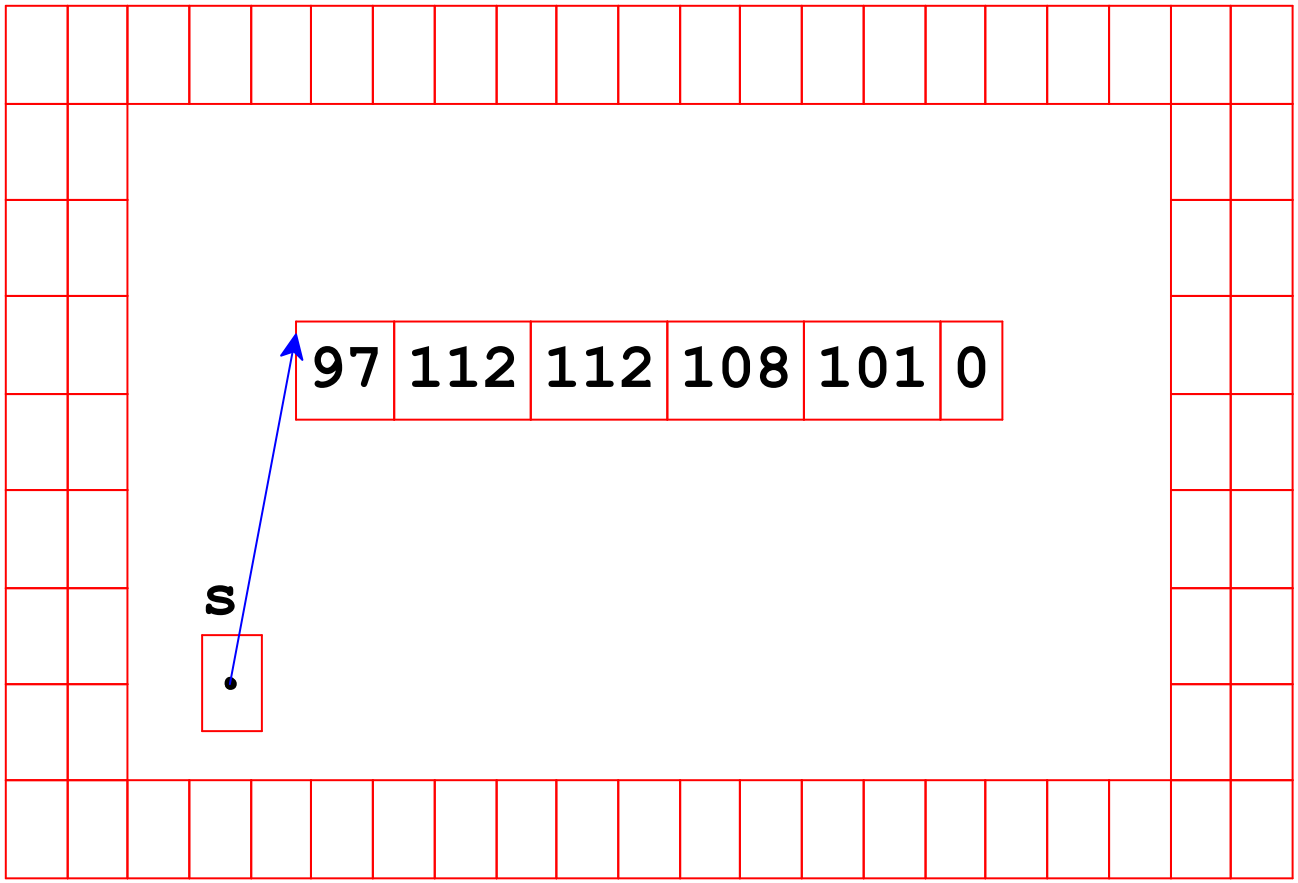

a[_]
1 2 3
p
q

A String is an Array of Characters

```
#include <stdio.h>

int main() {
  char* s = "apple";

  printf("%s: %c, %c, %c\n",
         s, s[0], s[1], *(s + 3));
  return 0;
}
```

Copy


'a'
'p'
'p'
'l'
'e'
0
s


97
112
112
108
101
0
s

Characters are Just Numbers

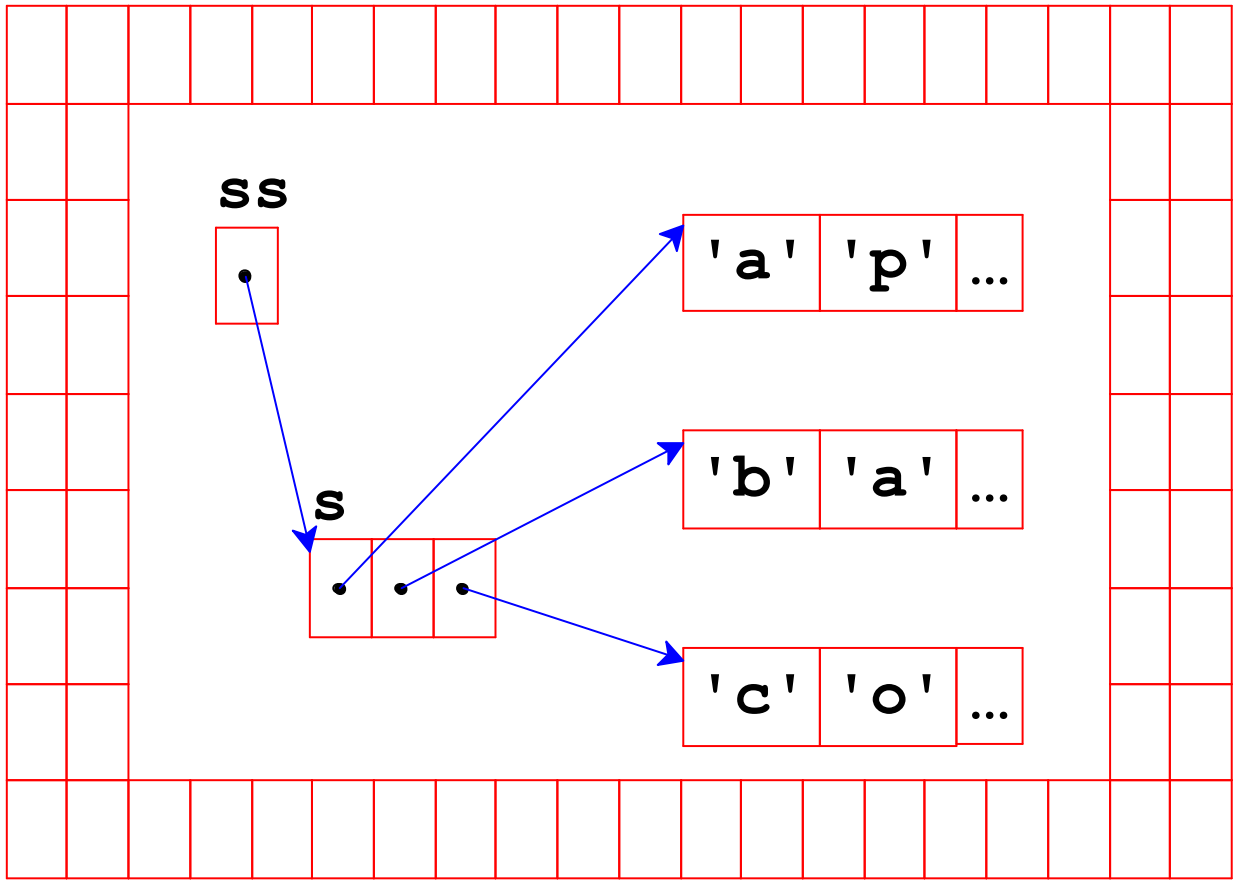
```
#include <stdio.h>

int main() {
  char* s = "apple";

  printf("%s: %d, %d, %d\n",
         s, s[0], s[1], *(s + 3));
  return 0;
}
```

Copy

Arrays of Strings

```
#include <stdio.h>

int main() {
  char* s[3] = { "apple",
                 "banana",
                 "coconut" };
  char **ss = s;

  printf("%s (%c...), %s, %s\n",
         ss[0], ss[0][0], ss[1], s[2]);
  return 0;
}
```

Copy


ss
s
'a'
'p'
...
'b'
'a'
...
'c'
'o'
...

Using Command-Line Arguments

```
#include <stdio.h>
#include <stdlib.h>

int main(int argc, char** argv) {
  int a, b;

  a = atoi(argv[1]);
  b = atoi(argv[2]);

  printf("%d\n", a + b);

  return 0;
}
```

Copy

Sizes of Numbers

Each "box" in your machine's memory holds a number between -128 and 127

or 0 to 255, depending on how you look at it

- a **`char`** takes up one of them
- a **`short`** takes up two of them (-32768 to 32767)
- an **`int`** takes up four of them (-2147483648 to 2147483647)
- a **`long`** takes up four or eight, depending
- an address takes up four or eight, depending
  `char*`, **`int*`**, **`char**`**, etc.

Pointer Arithmetic

```
#include <stdio.h>

int main() {
  char cs[2] = {0, 1};
  int  is[2] = {0, 1};

  printf("Goes up by 1: %p, %p\n", cs, cs+1);
  printf("Goes up by 4: %p, %p\n", is, is+1);

  return 0;
}
```

Copy

Computing Sizes

```
#include <stdio.h>

int main()
{
  char cs[2] = {0, 1};

  printf("char size is %d\n", sizeof(char));
  printf("char size is %d\n", sizeof(cs[0]));
  printf("cs size is %d\n", sizeof(cs));
  printf("address size is %d\n", sizeof(&cs));
  return 0;
}
```

Copy

The **`sizeof`** operator works on types or variables

Allocation

```
#include <stdio.h>
#include <stdlib.h>

int main() {
  int* a;

  a = (int*)malloc(100 * sizeof(int));
  a[99] = 5;
  printf("array at %p ends in %d\n", a, a[99]);

  return 0;
}
```

Copy

More C: For Loops

```
#include <stdio.h>
#include <stdlib.h>

int main(int argc, char** argv) {
  int i;
  int sum = 0;

  for (i = 1; i < argc; i++) {
    sum += atoi(argv[i]);
  }
  printf("%d\n", sum);

  return 0;
}
```

Copy

... just like Java

More C: Defining Functions

```
#include <stdio.h>
#include <stdlib.h>

int twice(int n) {
  return n + n;
}

int main(int argc, char** argv) {
  printf("%d\n", twice(atoi(argv[1])));
  return 0;
}
```

Copy

... just like Java