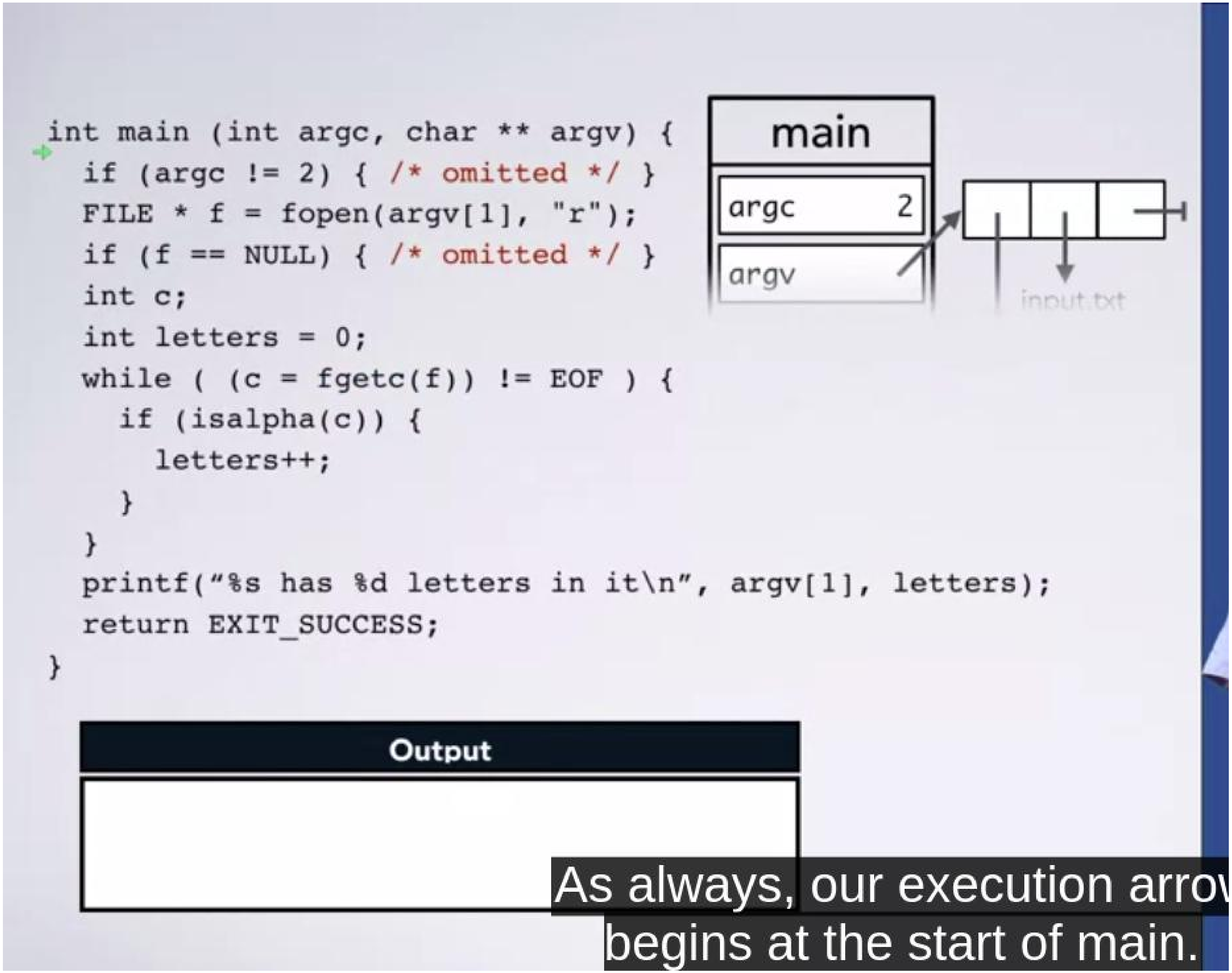
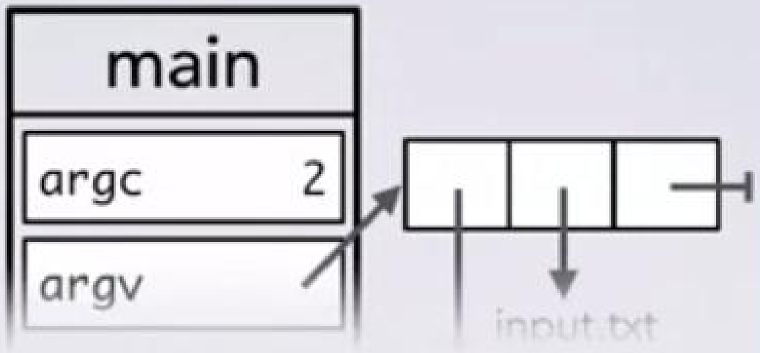


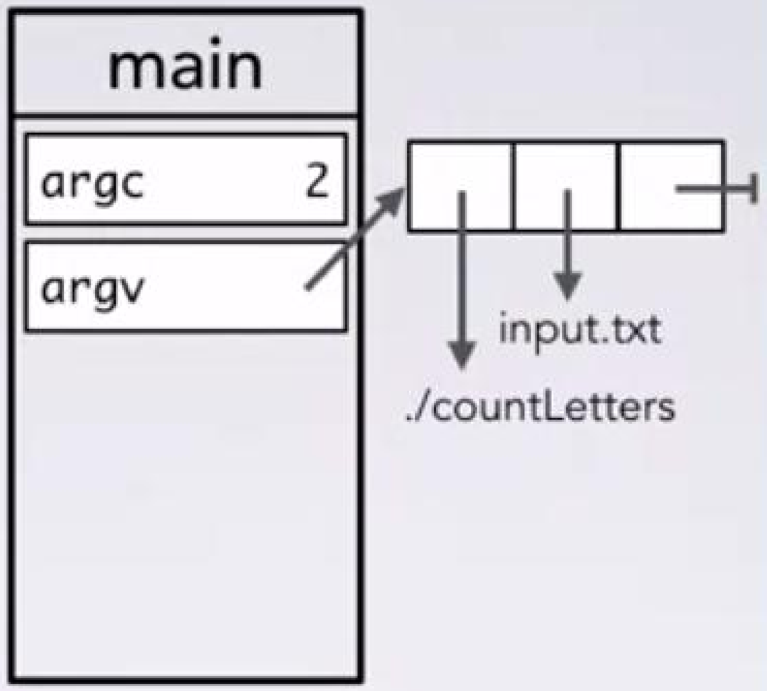
```
int main (int argc, char ** argv) {
  if (argc != 2) { /* omitted */ }
  FILE * f = fopen(argv[1], "r");
  if (f == NULL) { /* omitted */ }
  int c;
  int letters = 0;
  while ( (c = fgetc(f)) != EOF ) {
    if (isalpha(c)) {
      letters++;
    }
  }
  printf("%s has %d letters in it\n", argv[1], letters);
  return EXIT_SUCCESS;
}
```



Output

As always, our execution arro
begins at the start of main.

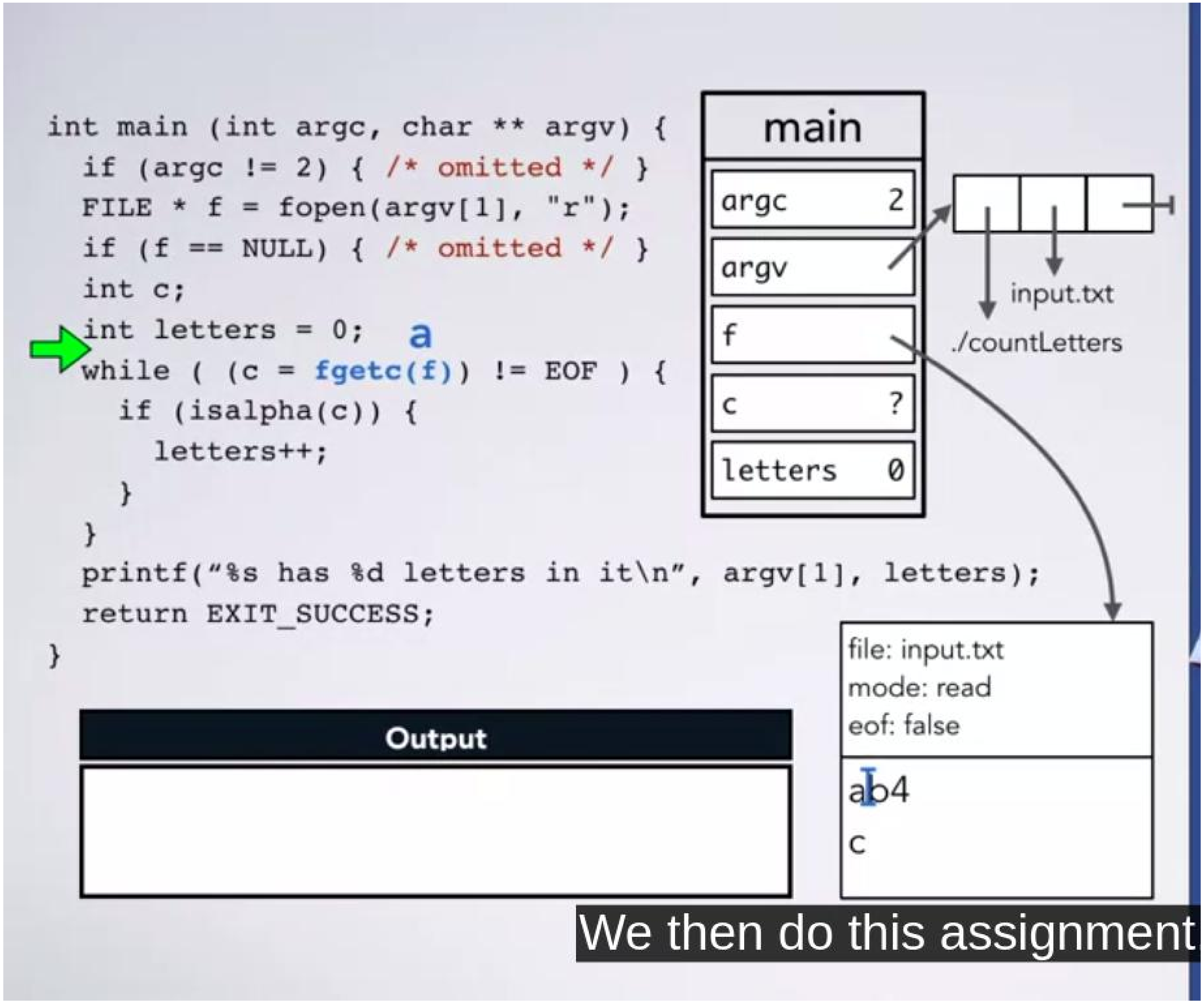
```
int main (int argc, char ** argv) {
  if (argc != 2) { /* omitted */ }
  FILE * f = fopen(argv[1], "r");
  if (f == NULL) { /* omitted */ }
  int c;
  int letters = 0;
  while ( (c = fgetc(f)) != EOF ) {
    if (isalpha(c)) {
      letters++;
    }
  }
  printf("%s has %d letters in it\n", argv[1], letters);
  return EXIT_SUCCESS;
}
```



Output

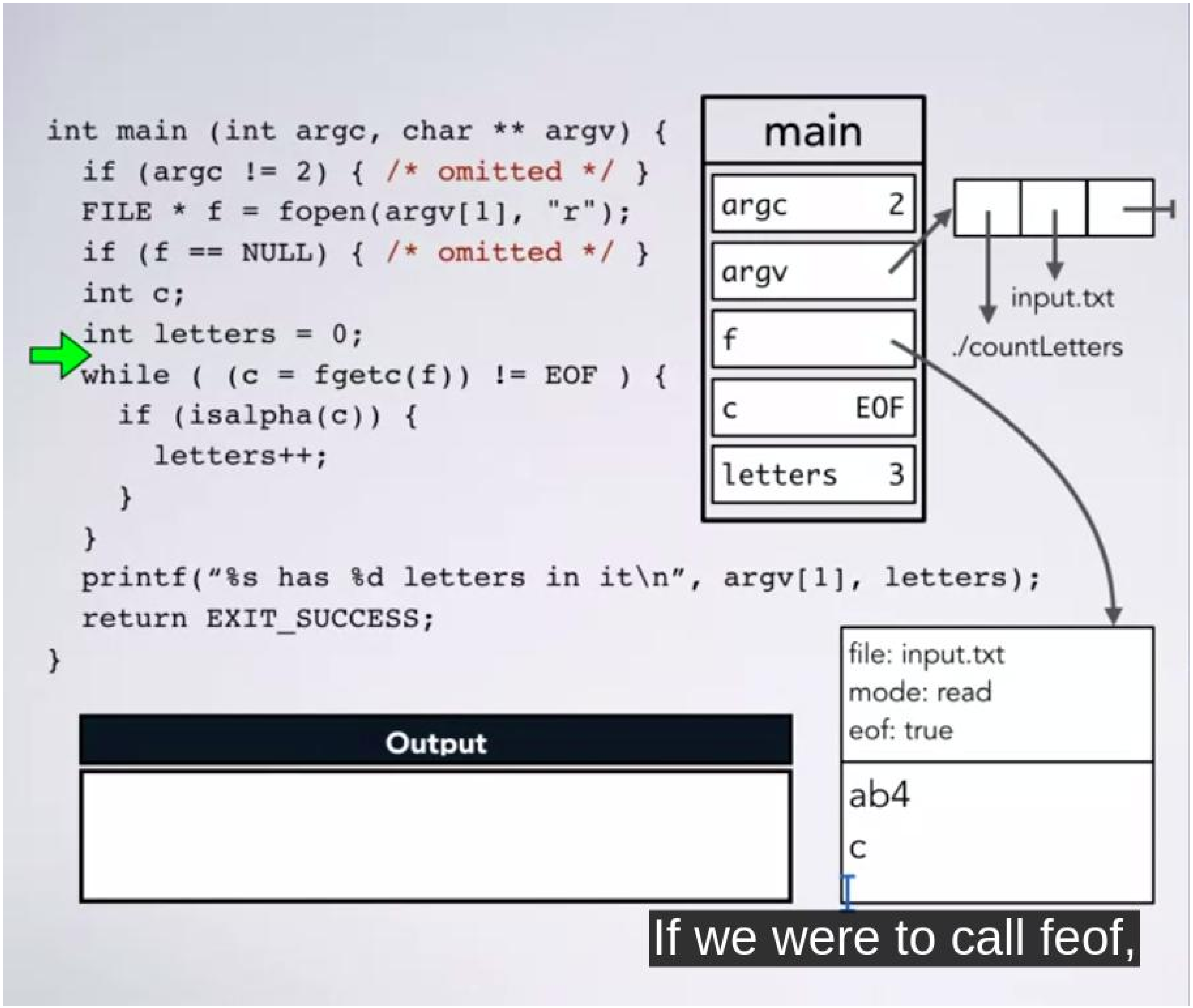
```
```

Now that we have command line ar
main's frame begins with argc



```
int main (int argc, char ** argv) {
  if (argc != 2) { /* omitted */ }
  FILE * f = fopen(argv[1], "r");
  if (f == NULL) { /* omitted */ }
  int c;
  int letters = 0;
  while ( (c = fgetc(f)) != EOF ) {
    if (isalpha(c)) {
      letters++;
    }
  }
  printf("%s has %d letters in it\n", argv[1], letters);
  return EXIT_SUCCESS;
}
```

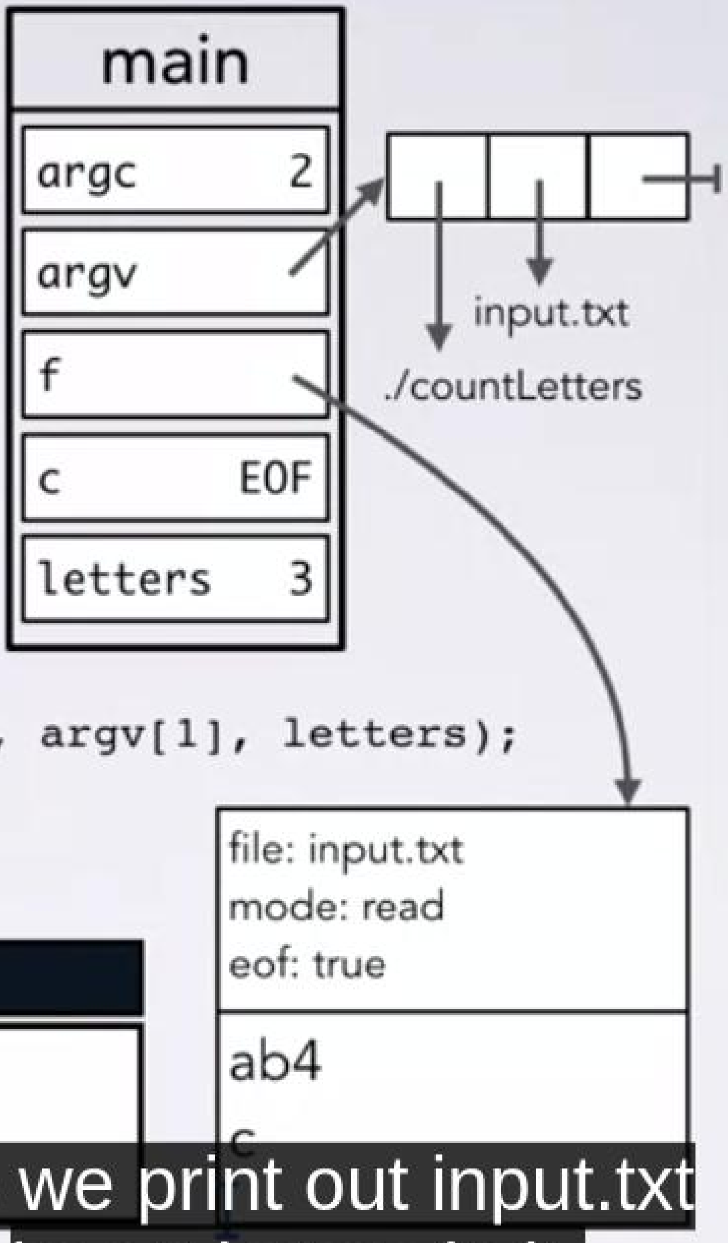
We then do this assignment.



```
int main (int argc, char ** argv) {
  if (argc != 2) { /* omitted */ }
  FILE * f = fopen(argv[1], "r");
  if (f == NULL) { /* omitted */ }
  int c;
  int letters = 0;
  while ( (c = fgetc(f)) != EOF ) {
    if (isalpha(c)) {
      letters++;
    }
  }
  printf("%s has %d letters in it\n", argv[1], letters);
  return EXIT_SUCCESS;
}
```

If we were to call feof,

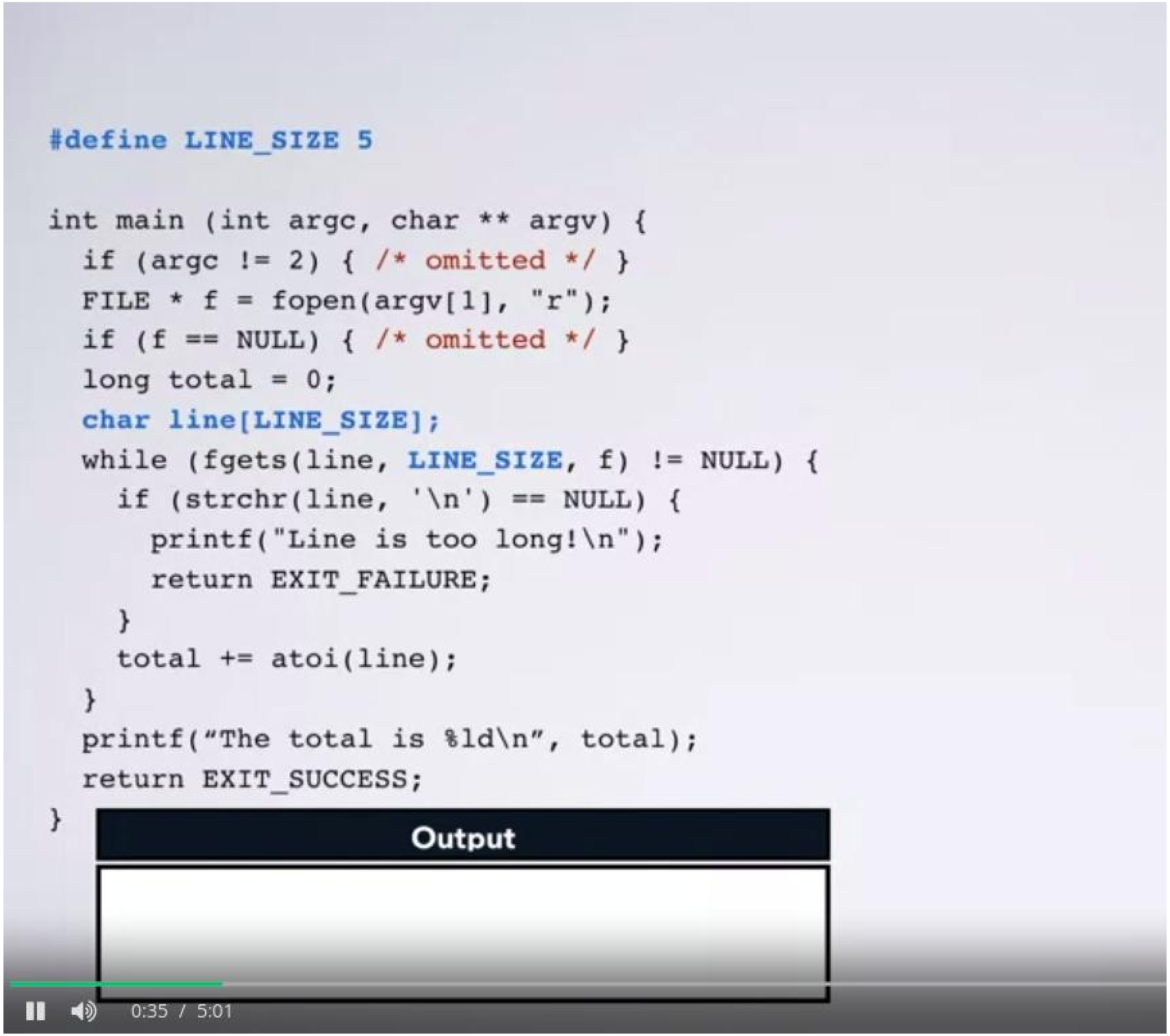
```c
int main (int argc, char ** argv) {
  if (argc != 2) { /* omitted */ }
  FILE * f = fopen(argv[1], "r");
  if (f == NULL) { /* omitted */ }
  int c;
  int letters = 0;
  while ( (c = fgetc(f)) != EOF ) {
    if (isalpha(c)) {
      letters++;
    }
  }
  printf("%s has %d letters in it\n", argv[1], letters);
  return EXIT_SUCCESS;
}
```



Output

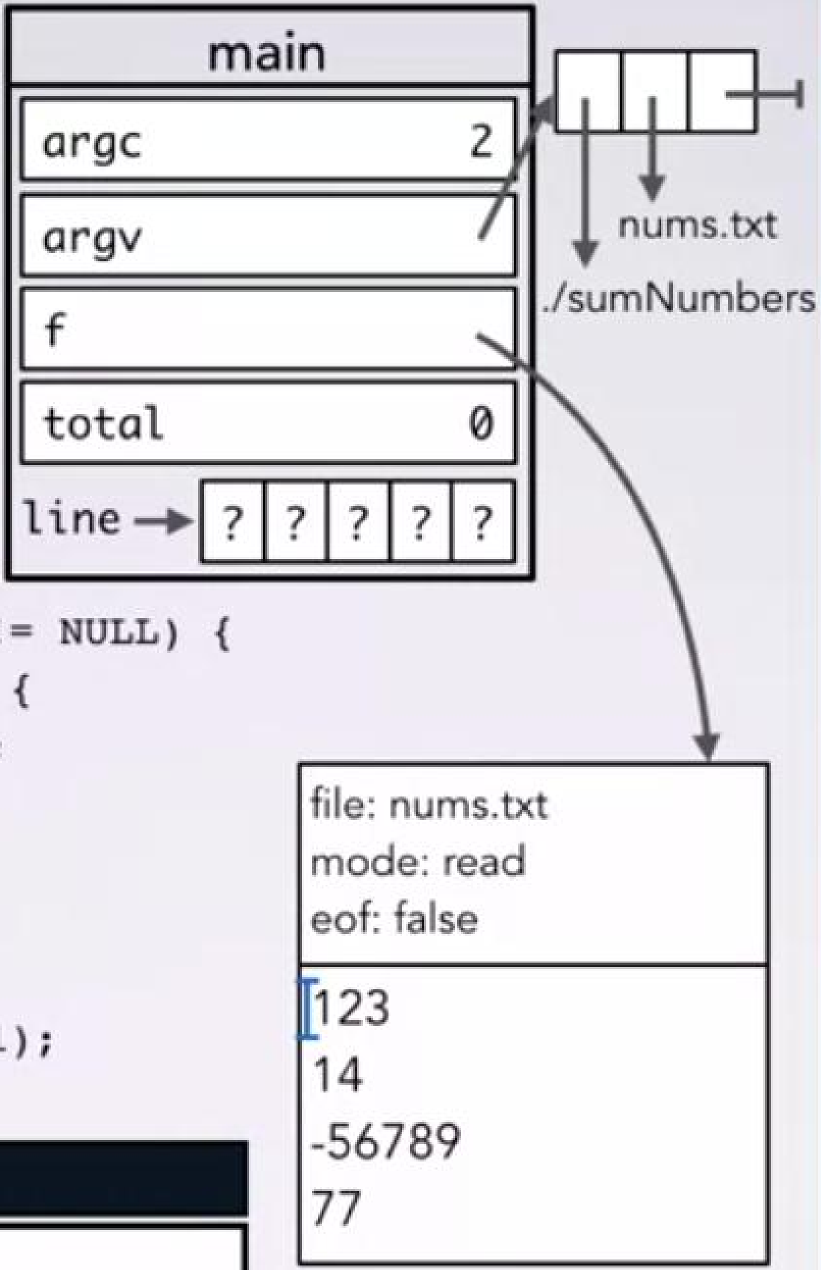
```
input.txt has 3 letters in it
```

So we print out input.txt has 3 letters in it.

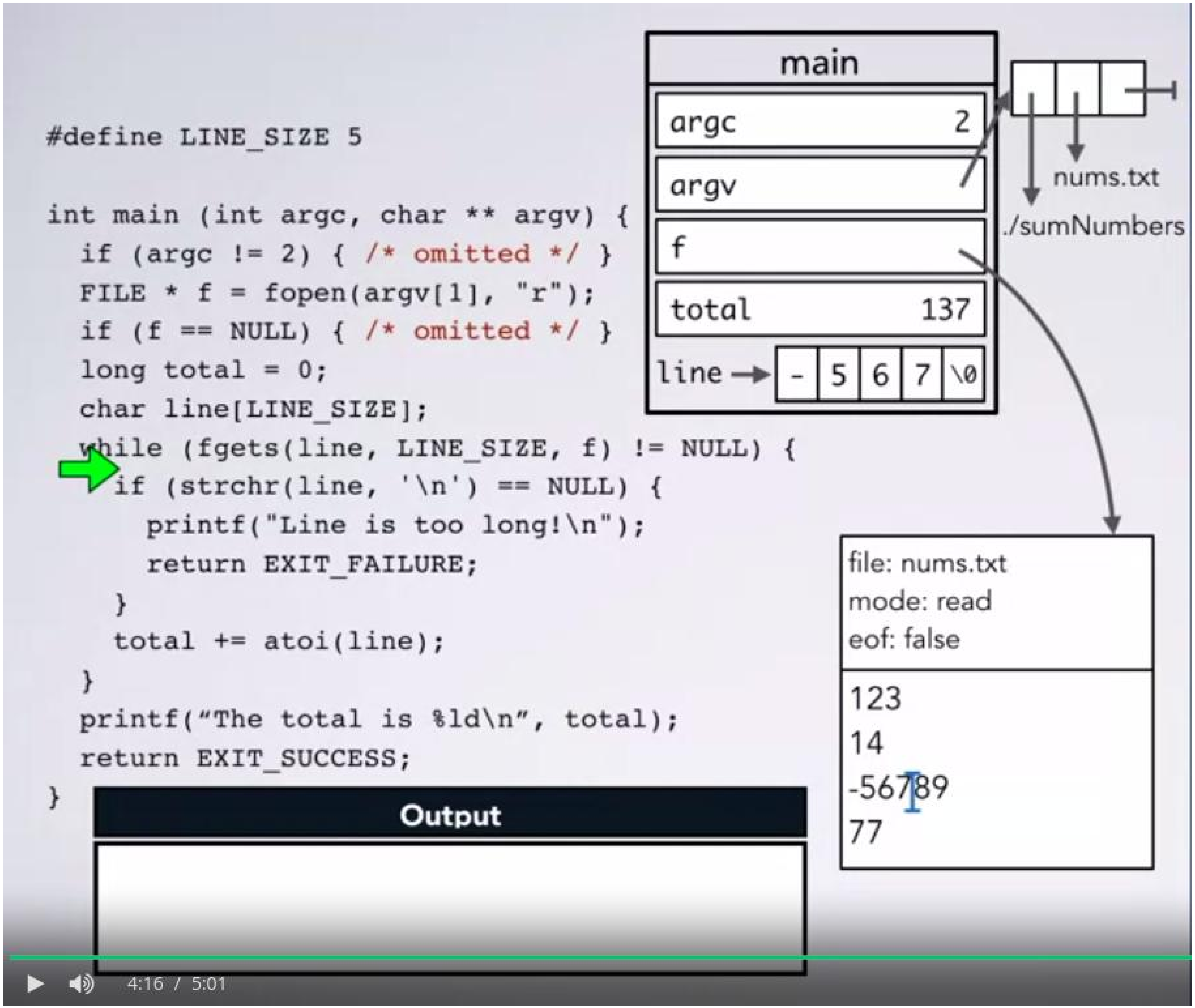


```
#define LINE_SIZE 5

int main (int argc, char ** argv) {
  if (argc != 2) { /* omitted */ }
  FILE * f = fopen(argv[1], "r");
  if (f == NULL) { /* omitted */ }
  long total = 0;
  char line[LINE_SIZE];
  while (fgets(line, LINE_SIZE, f) != NULL) {
    if (strchr(line, '\n') == NULL) {
      printf("Line is too long!\n");
      return EXIT_FAILURE;
    }
    total += atoi(line);
  }
  printf("The total is %ld\n", total);
  return EXIT_SUCCESS;
}
```

```c
#define LINE_SIZE 5

int main (int argc, char ** argv) {
  if (argc != 2) { /* omitted */ }
  FILE * f = fopen(argv[1], "r");
  if (f == NULL) { /* omitted */ }
  long total = 0;
  char line[LINE_SIZE];
  while (fgets(line, LINE_SIZE, f) != NULL) {
    if (strchr(line, '\n') == NULL) {
      printf("Line is too long!\n");
      return EXIT_FAILURE;
    }
    total += atoi(line);
  }
  printf("The total is %ld\n", total);
  return EXIT_SUCCESS;
}
```

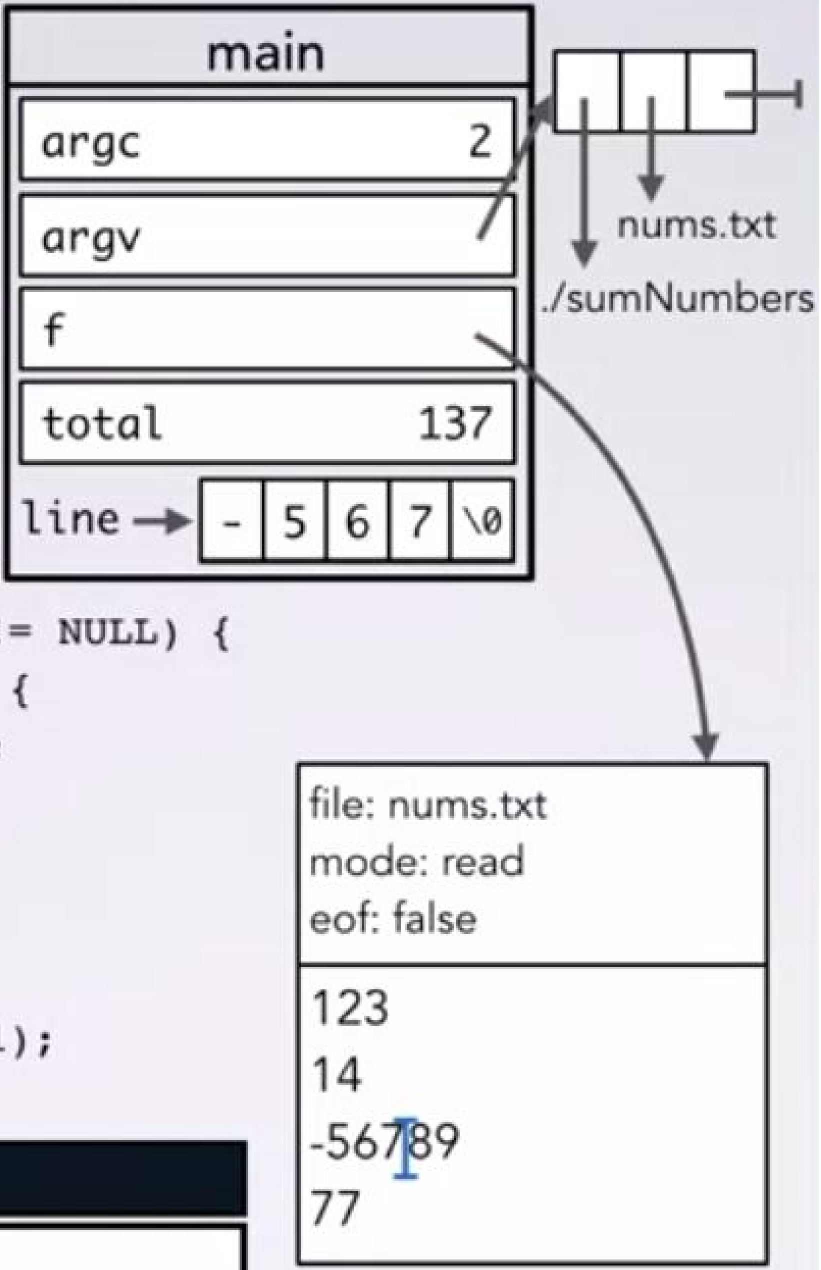


Output



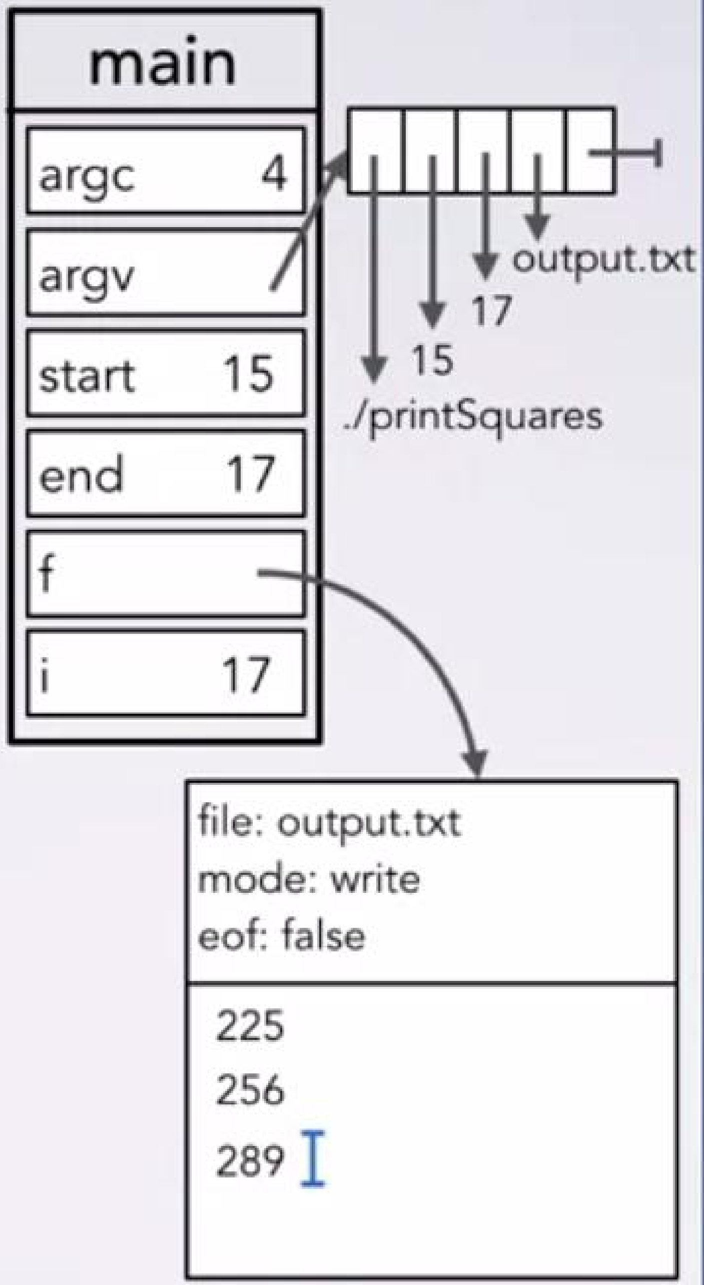
```
#define LINE_SIZE 5

int main (int argc, char ** argv) {
  if (argc != 2) { /* omitted */ }
  FILE * f = fopen(argv[1], "r");
  if (f == NULL) { /* omitted */ }
  long total = 0;
  char line[LINE_SIZE];
  while (fgets(line, LINE_SIZE, f) != NULL) {
    if (strchr(line, '\n') == NULL) {
      printf("Line is too long!\n");
      return EXIT_FAILURE;
    }
    total += atoi(line);
  }
  printf("The total is %ld\n", total);
  return EXIT_SUCCESS;
}
```

```
#define LINE_SIZE 5

int main (int argc, char ** argv) {
  if (argc != 2) { /* omitted */ }
  FILE * f = fopen(argv[1], "r");
  if (f == NULL) { /* omitted */ }
  long total = 0;
  char line[LINE_SIZE];
  while (fgets(line, LINE_SIZE, f) != NULL) {
    if (strchr(line, '\n') == NULL) {
      printf("Line is too long!\n");
      return EXIT_FAILURE;
    }
    total += atoi(line);
  }
  printf("The total is %ld\n", total);
  return EXIT_SUCCESS;
}
```

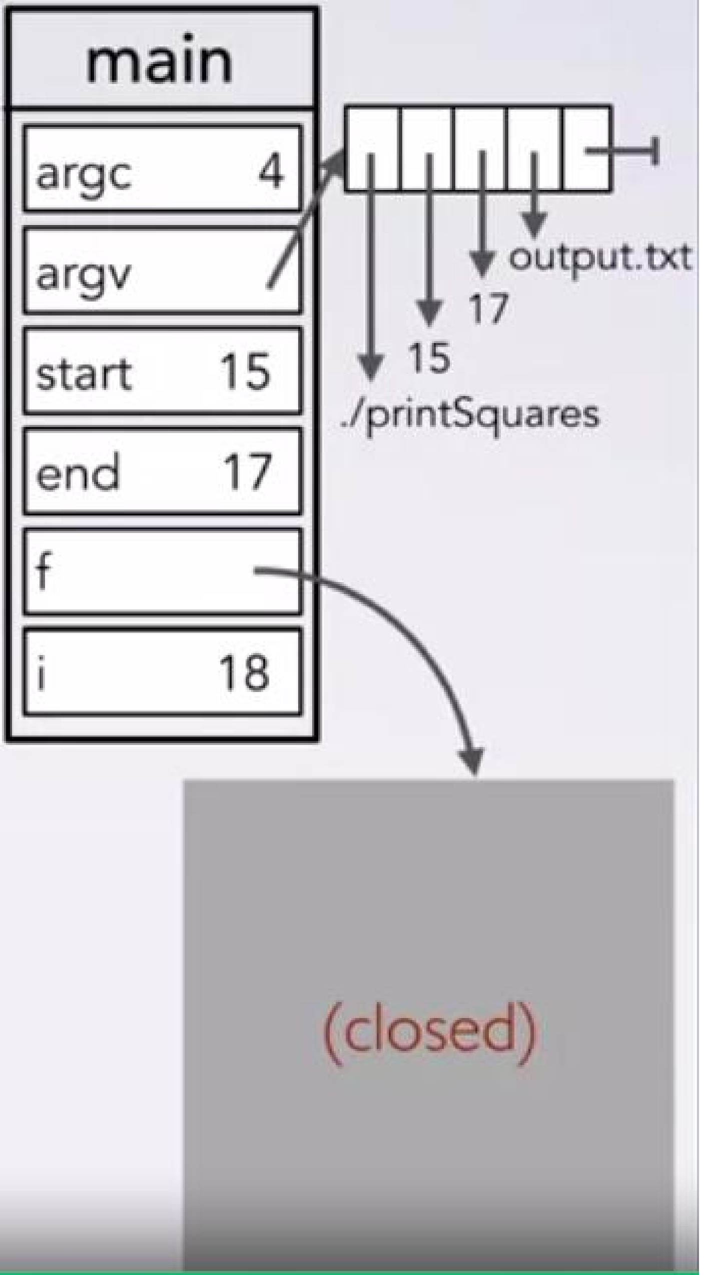


Output

```
int main (int argc, char ** argv) {
  if (argc != 4) { /* omitted */ }
  int start = atoi(argv[1]);
  int end = atoi(argv[2]);
  FILE * f = fopen(argv[3], "w");
  if (f == NULL) { /* omitted */ }
  for (int i = start; i <= end; i++) {
    fprintf(f, "%d\n", i*i);
  }
  //fclose discussed in next section
  if (fclose(f) != 0) { /* omitted */ }
  return EXIT_SUCCESS;
}
```

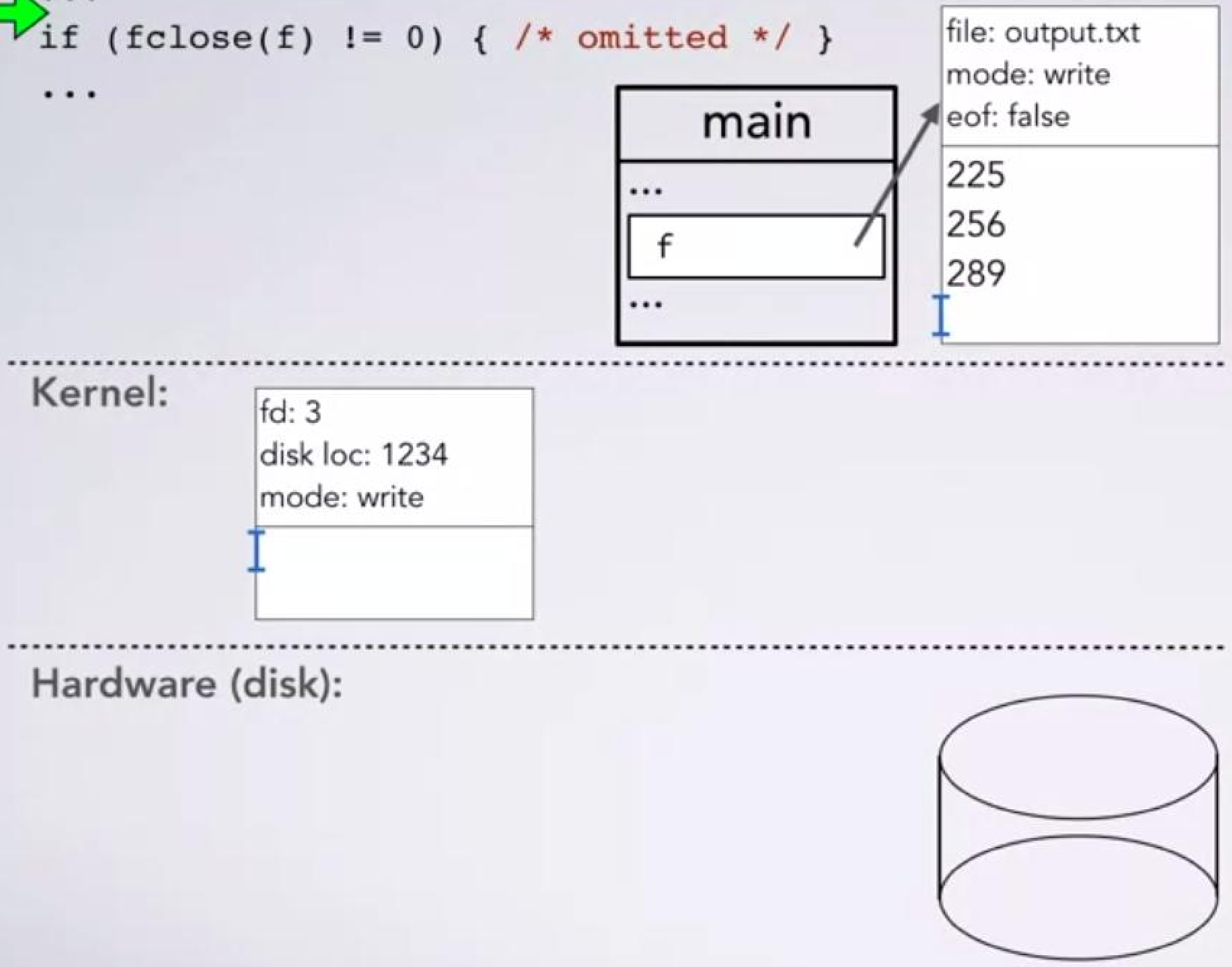


```
int main (int argc, char ** argv) {
  if (argc != 4) { /* omitted */ }
  int start = atoi(argv[1]);
  int end = atoi(argv[2]);
  FILE * f = fopen(argv[3], "w");
  if (f == NULL) { /* omitted */ }
  for (int i = start; i <= end; i++) {
    fprintf(f, "%d\n", i*i);
  }
  //fclose discussed in next section
  if (fclose(f) != 0) { /* omitted */ }
  return EXIT_SUCCESS;
}
```

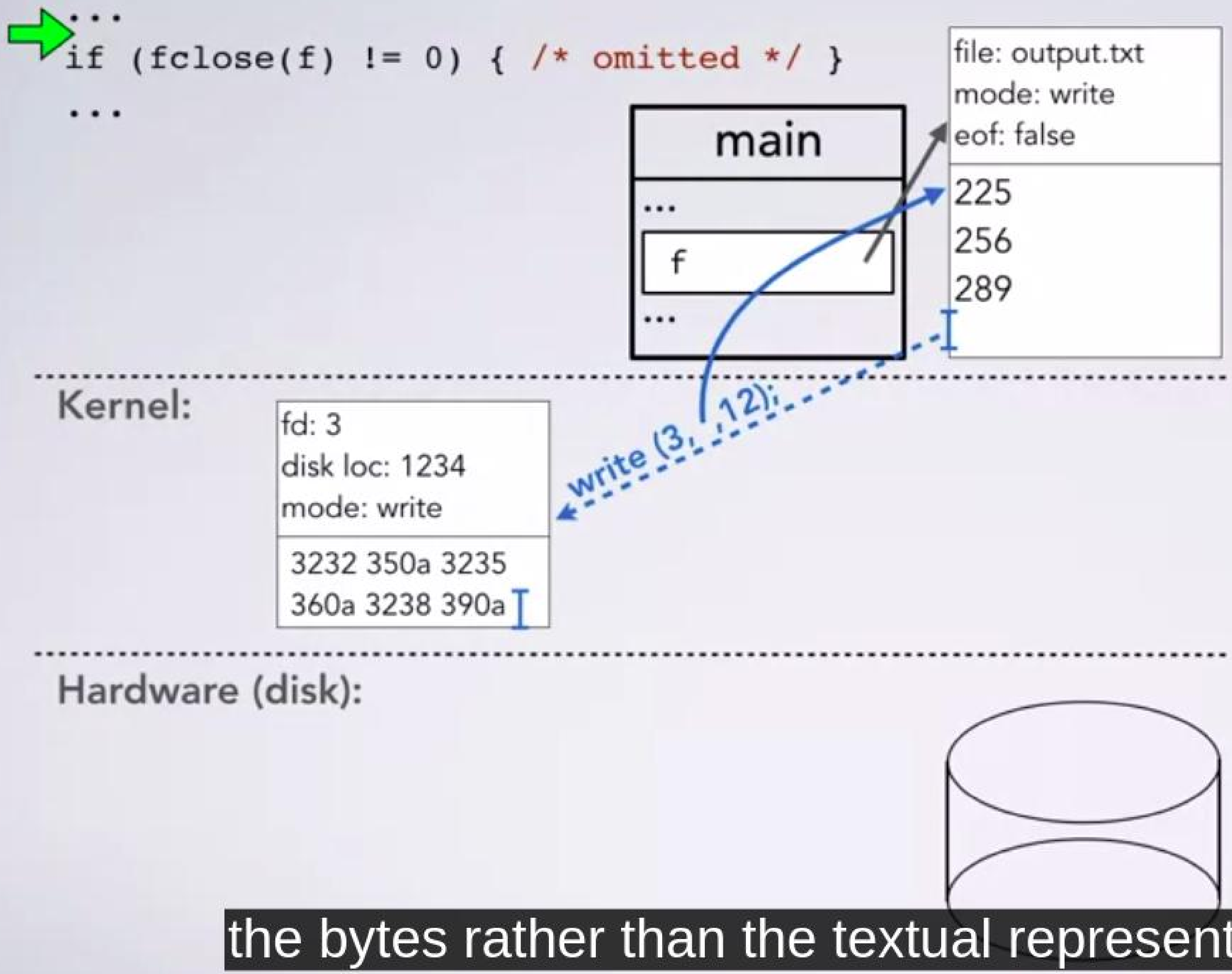


2:05 / 2:19

```
...
if (fclose(f) != 0) { /* omitted */ }
...
```

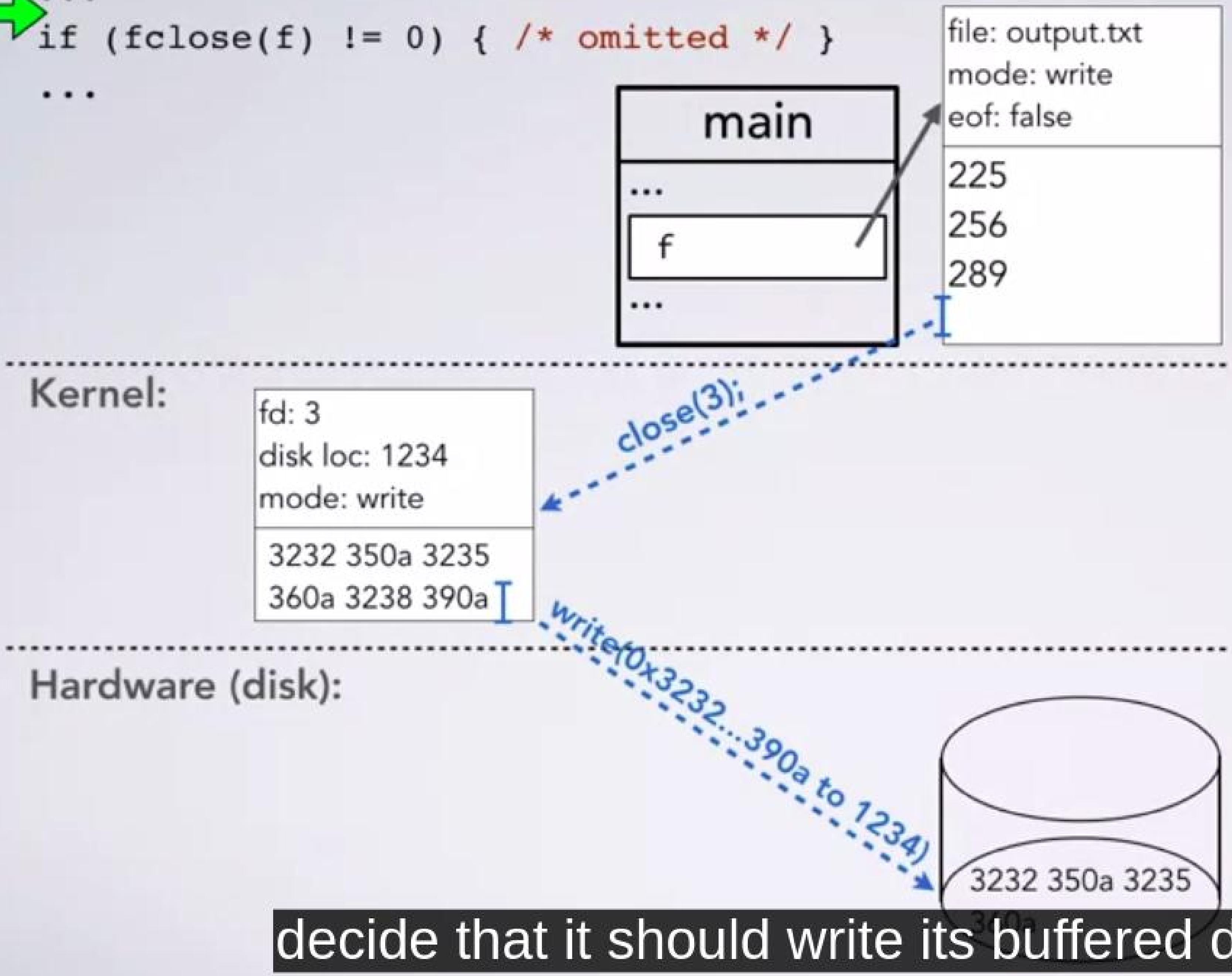


```
...
if (fclose(f) != 0) { /* omitted */ }
...
```

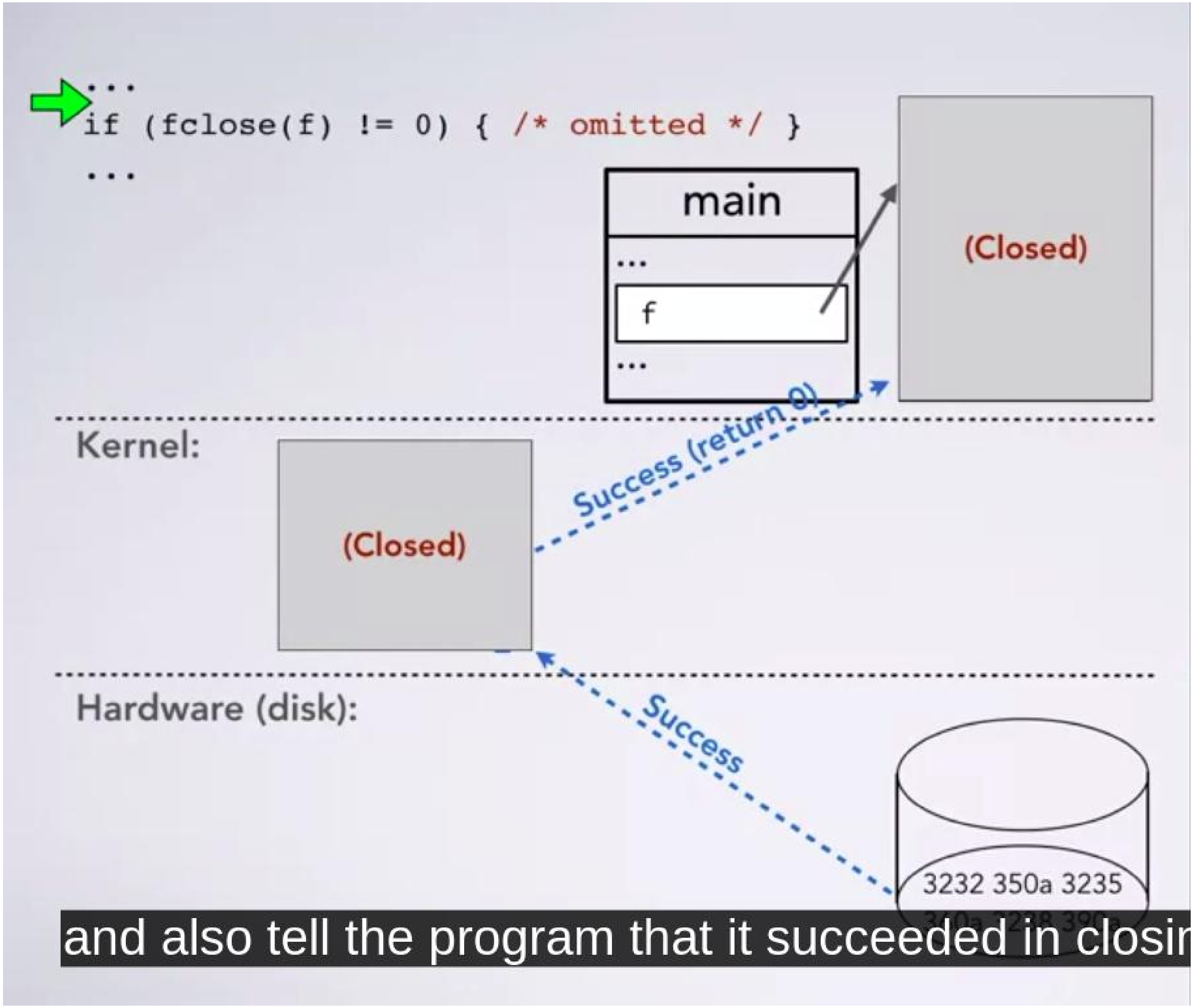


the bytes rather than the textual representa

```
...
if (fclose(f) != 0) { /* omitted */ }
...
```

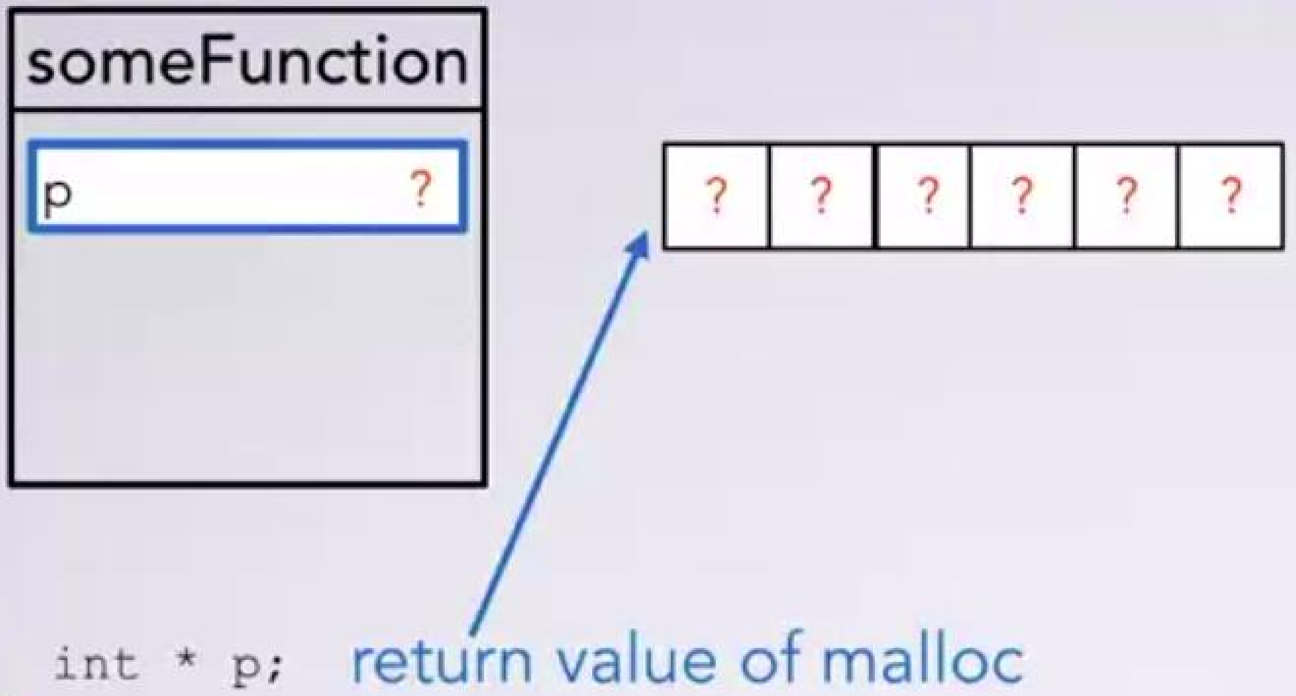


decide that it should write its buffered da



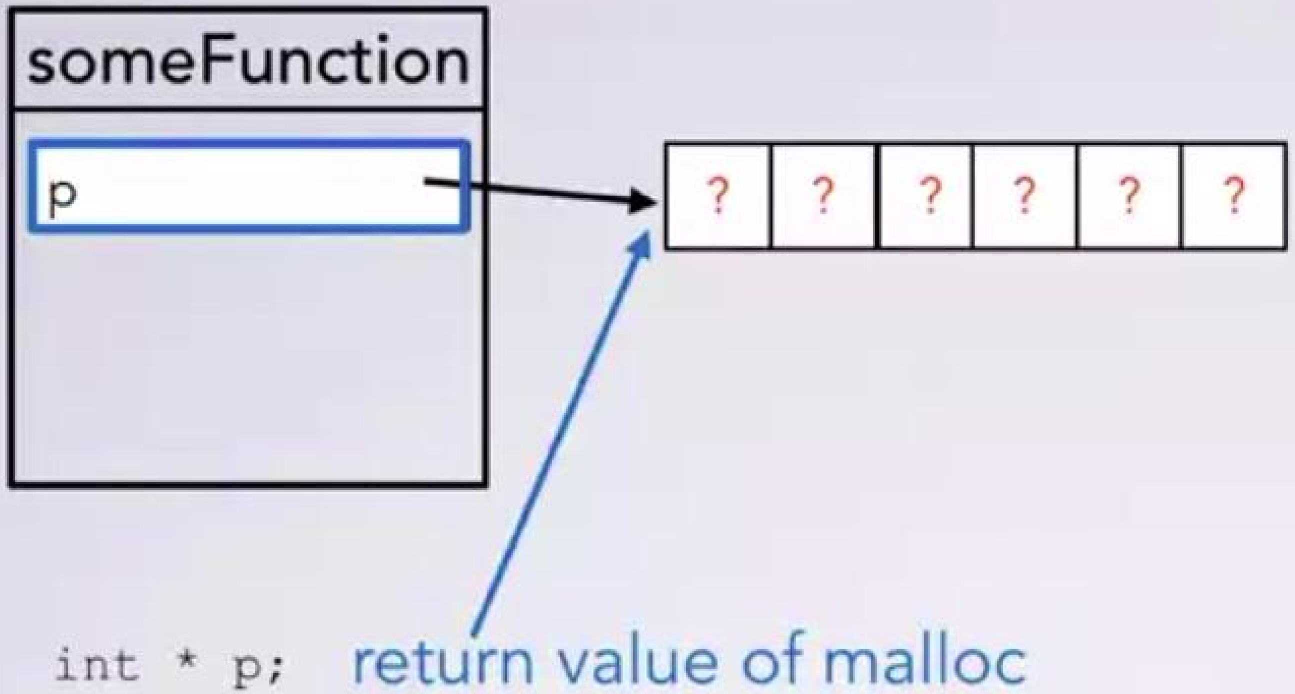
```
...
if (fclose(f) != 0) { /* omitted */ }
...
```

and also tell the program that it succeeded in closi



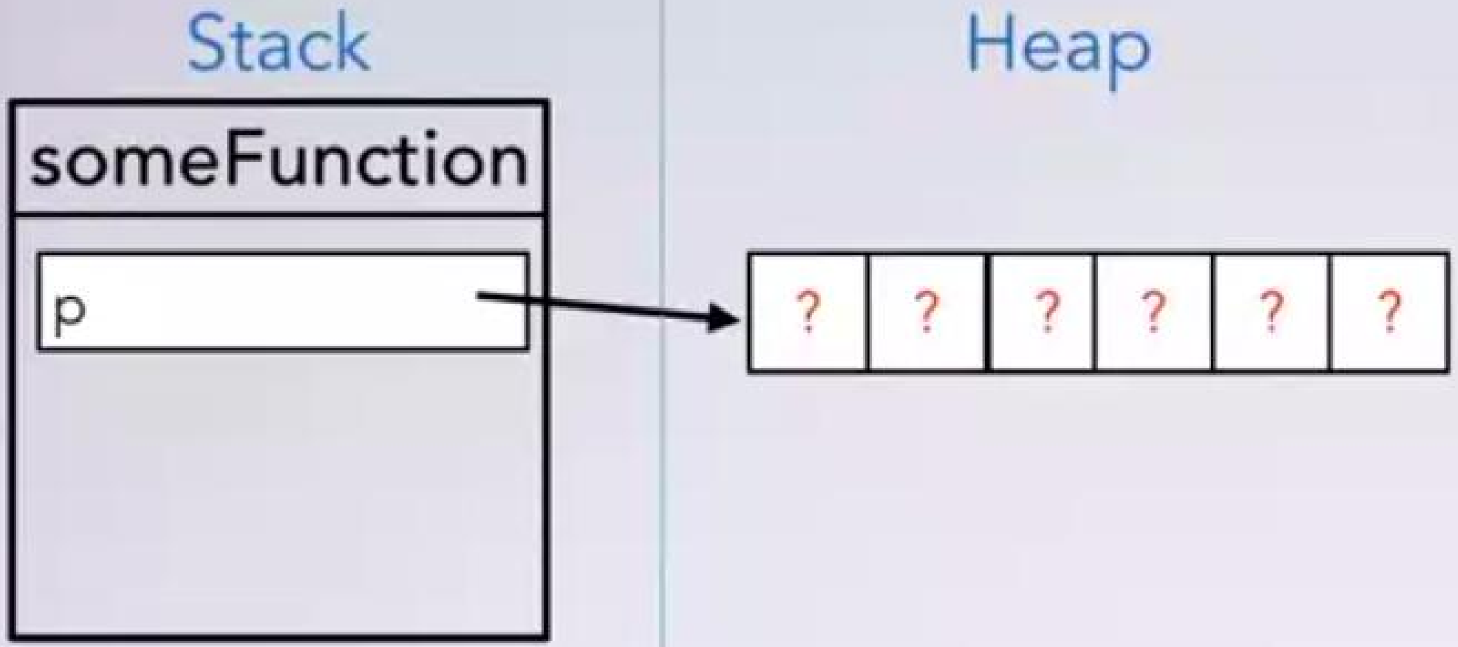
```
int * p;
p = malloc (6 * sizeof(*p));


..........
return;
```

So, let's draw that box.



```
int * p;
p = malloc (6 * sizeof(*p));



.........
return;
```

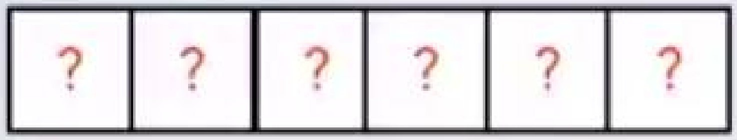
which is the value of the function call i



```
int * p;
p = malloc (6 * sizeof(*p));



.........
return;
```

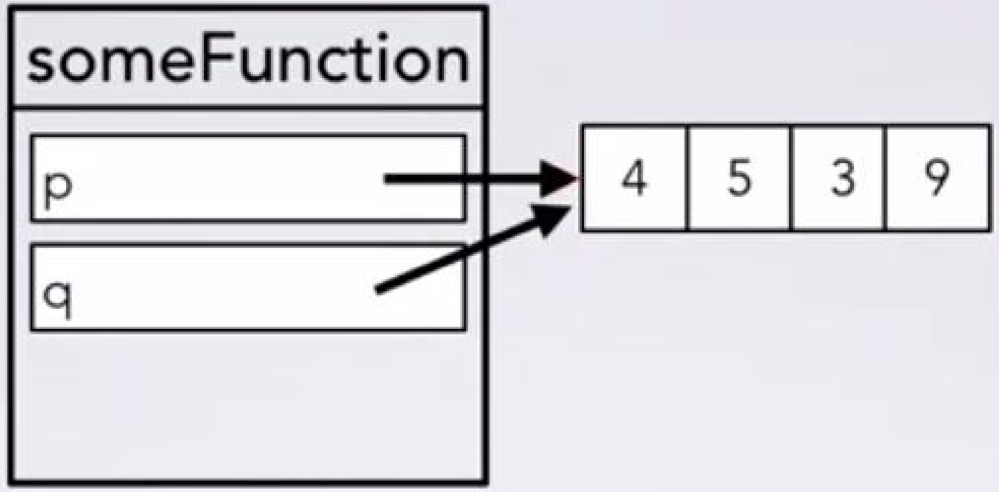
Stack

Heap



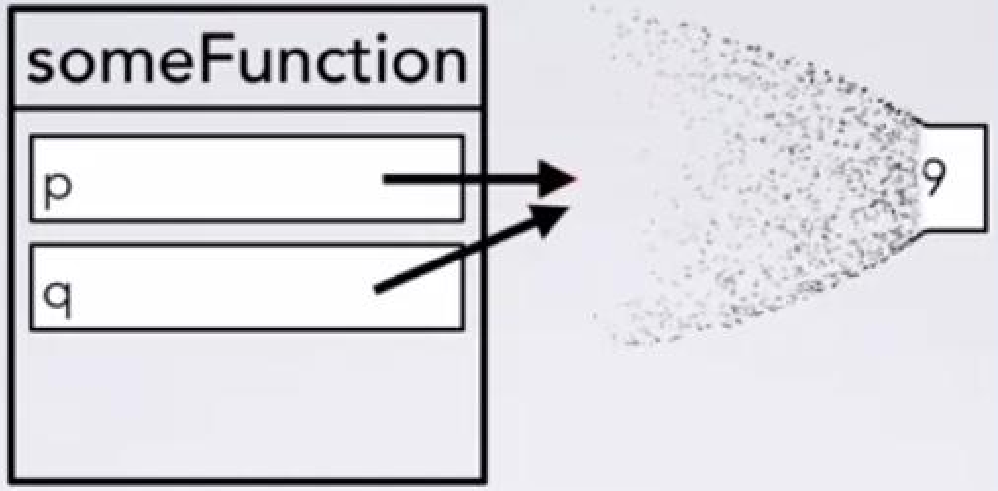
```
int * p;
p = malloc (6 * sizeof(*p));



.........
return;
```

```
int * p = malloc(4 * sizeof(*p));
p[0] = 4;
p[1] = 5;
p[2] = 3;
p[3] = 9;
int * q = p;

//......

ree(p);
```



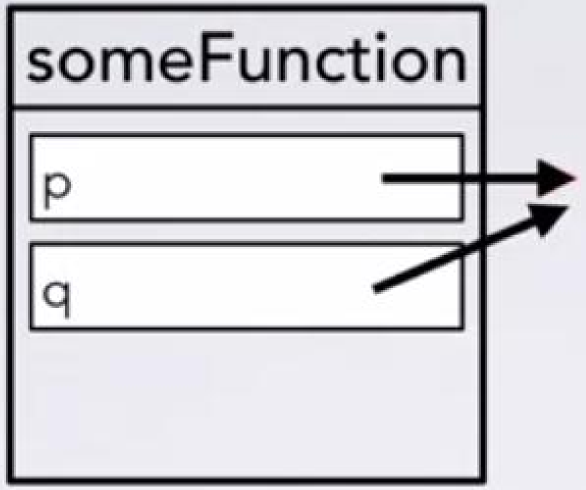
Free p does not actually affect th
but rather the memory that p poin

```
int * p = malloc(4 * sizeof(*p));
p[0] = 4;
p[1] = 5;
p[2] = 3;
p[3] = 9;
int * q = p;

//......

 ree(p);
```



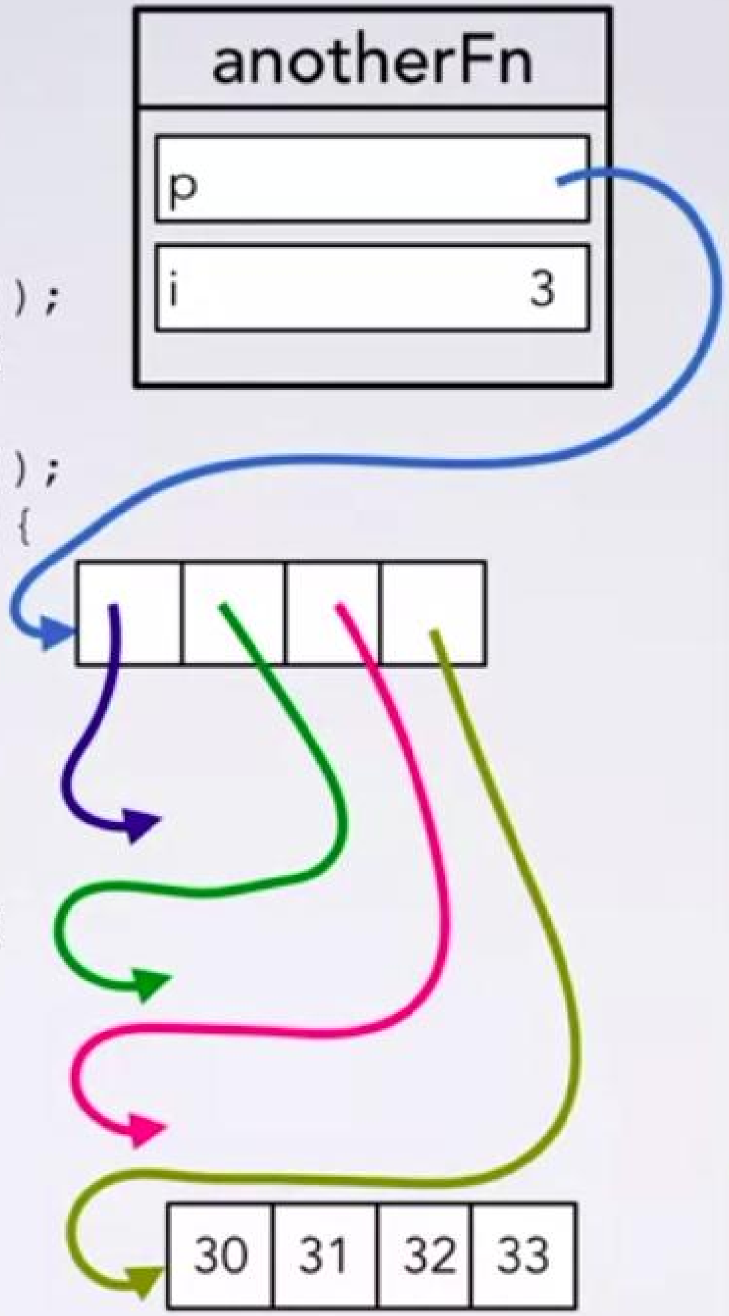
Freeing this memory destroys that
leaves p dangling.

```
int * p = malloc(4 * sizeof(*p));
p[0] = 4;
p[1] = 5;
p[2] = 3;
p[3] = 9;
int * q = p;

//......

free(p);
```

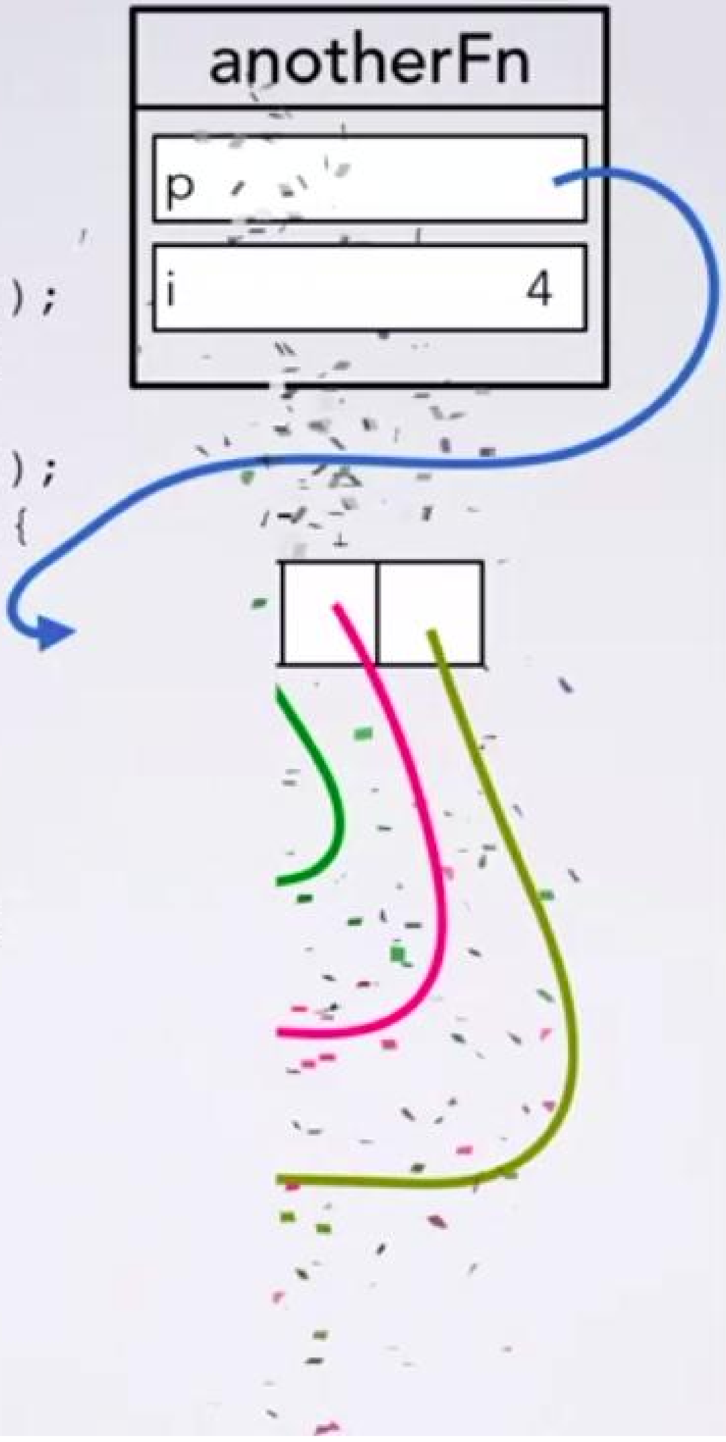


as with any dangling pointer.

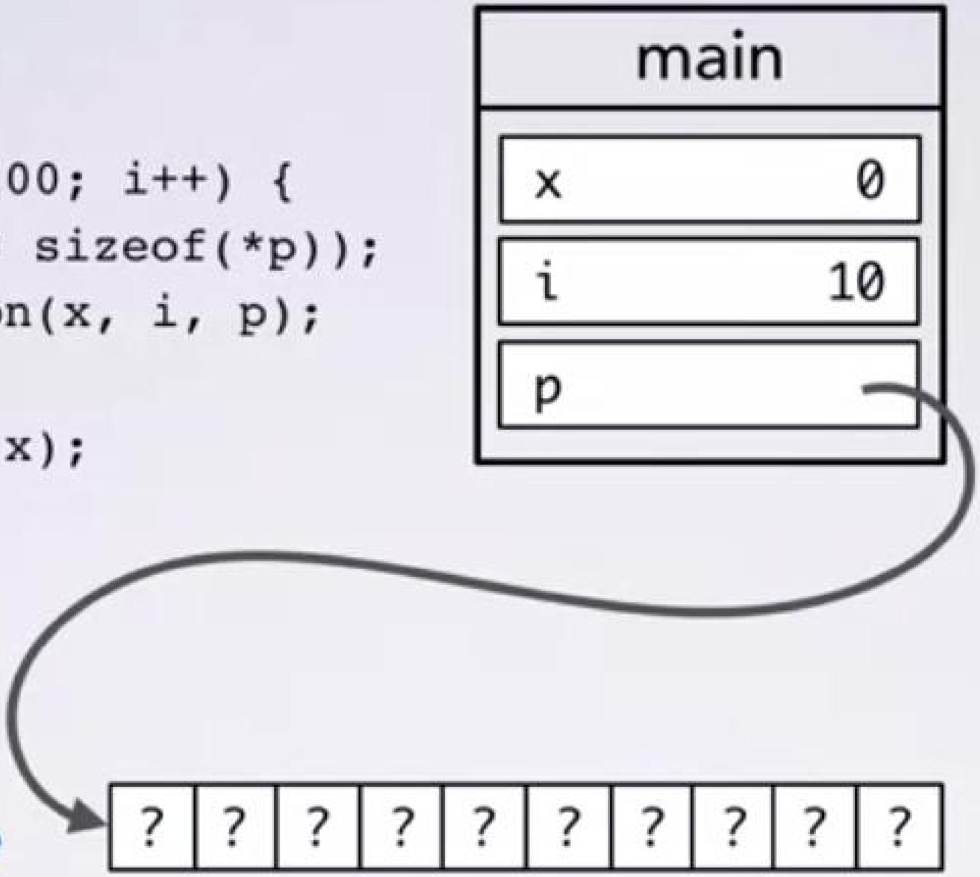
```
int ** p = malloc(4 * sizeof(*p));
for (size_t i = 0; i < 4; i++) {
  size_t s = i + 1;
  p[i] = malloc(s *sizeof(*p[i]));
  for (size_t j = 0; j < s; j++){
    p[i][j] = i*10 + j;
  }
}

//......

for (size_t i = 0; i < 4; i++) {
   free(p[i]);
}
free(p);
```



```
int ** p = malloc(4 * sizeof(*p));
for (size_t i = 0; i < 4; i++) {
  size_t s = i + 1;
  p[i] = malloc(s *sizeof(*p[i]));
  for (size_t j = 0; j < s; j++){
    p[i][j] = i*10 + j;
  }
}

//......

for (size_t i = 0; i < 4; i++) {
   free(p[i]);
}
free(p);
```

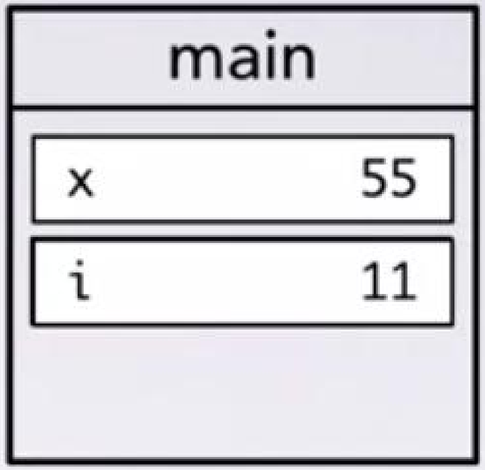


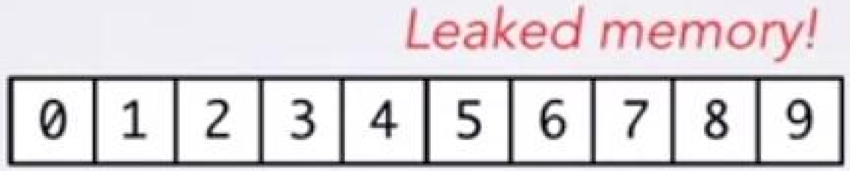
```
int main (void) {
  int x = 0;
  for (int i = 10; i < 100; i++) {
    int * p = malloc(i * sizeof(*p));
    x = doSomeComputation(x, i, p);
  }
  printf("Answer %d\n", x);
  return EXIT_SUCCESS;
}
```



Example without free

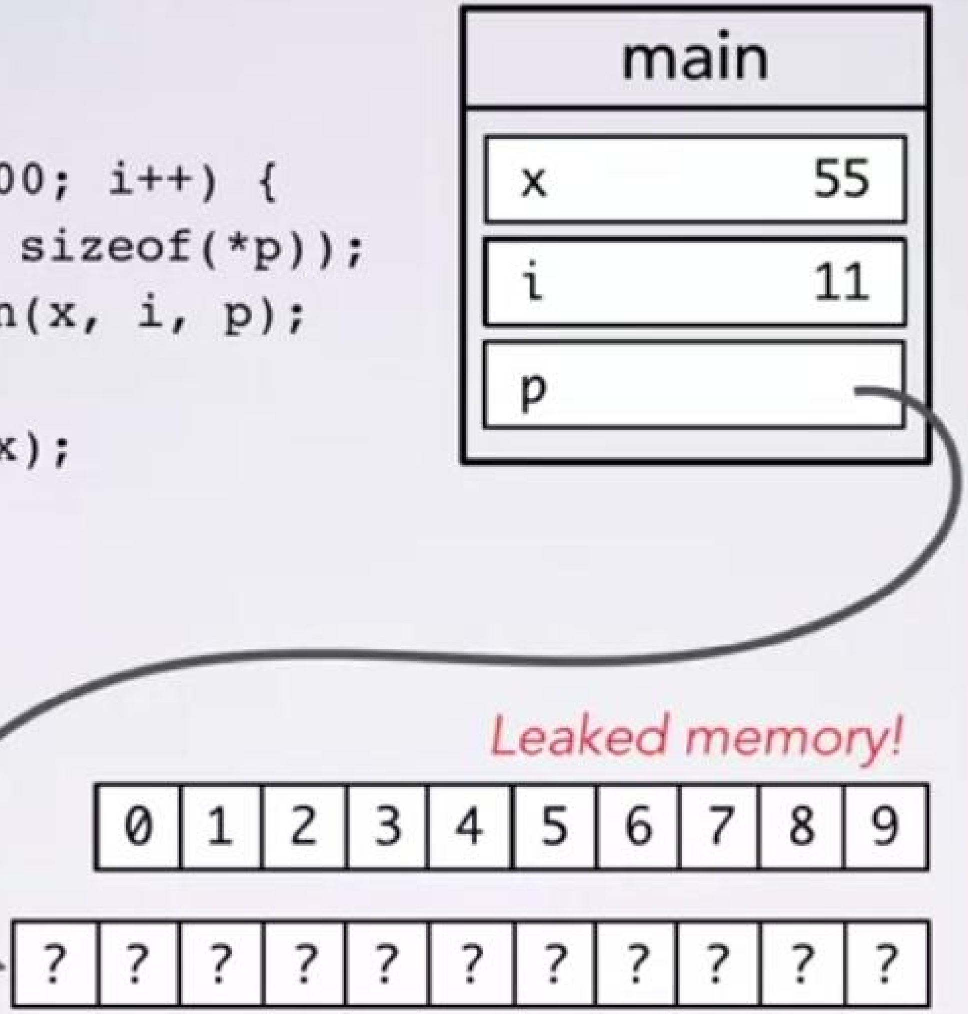
```
int main (void) {
  int x = 0;
  for (int i = 10; i < 100; i++) {
    int * p = malloc(i * sizeof(*p));
    x = doSomeComputation(x, i, p);
  }
  printf("Answer %d\n", x);
  return EXIT_SUCCESS;
}
```





Example without free

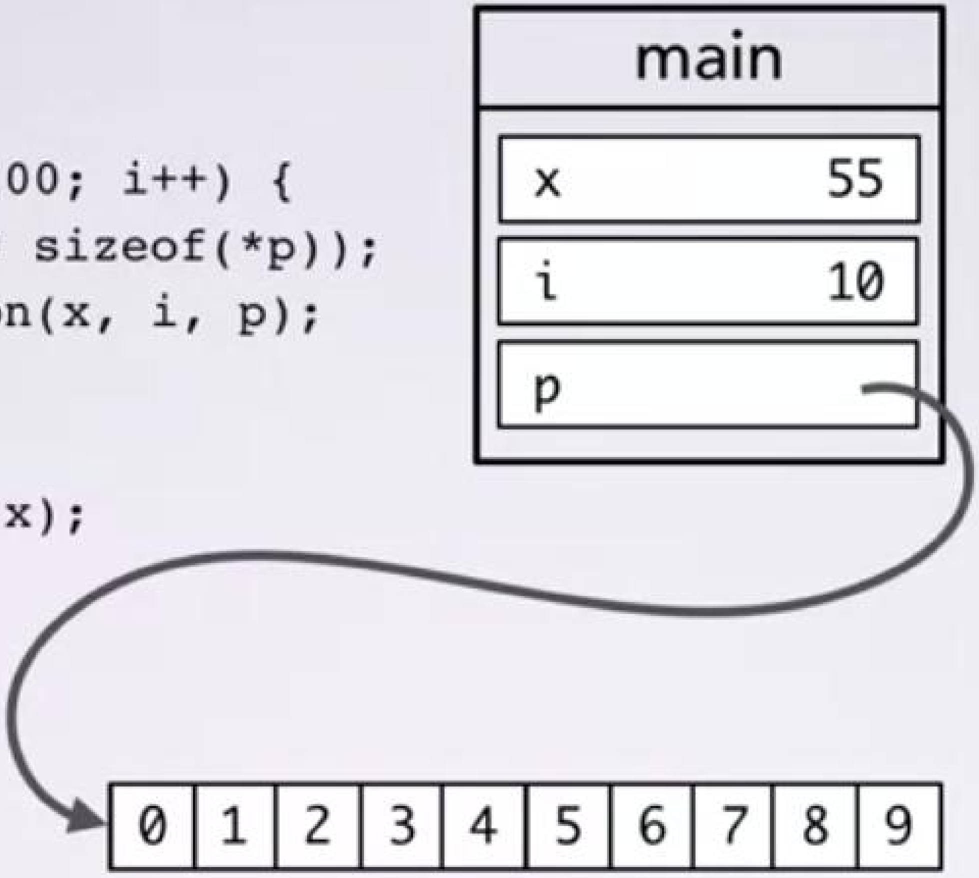
```
int main (void) {
  int x = 0;
  for (int i = 10; i < 100; i++) {
    int * p = malloc(i * sizeof(*p));
    x = doSomeComputation(x, i, p);
  }
  printf("Answer %d\n", x);
  return EXIT_SUCCESS;
}
```



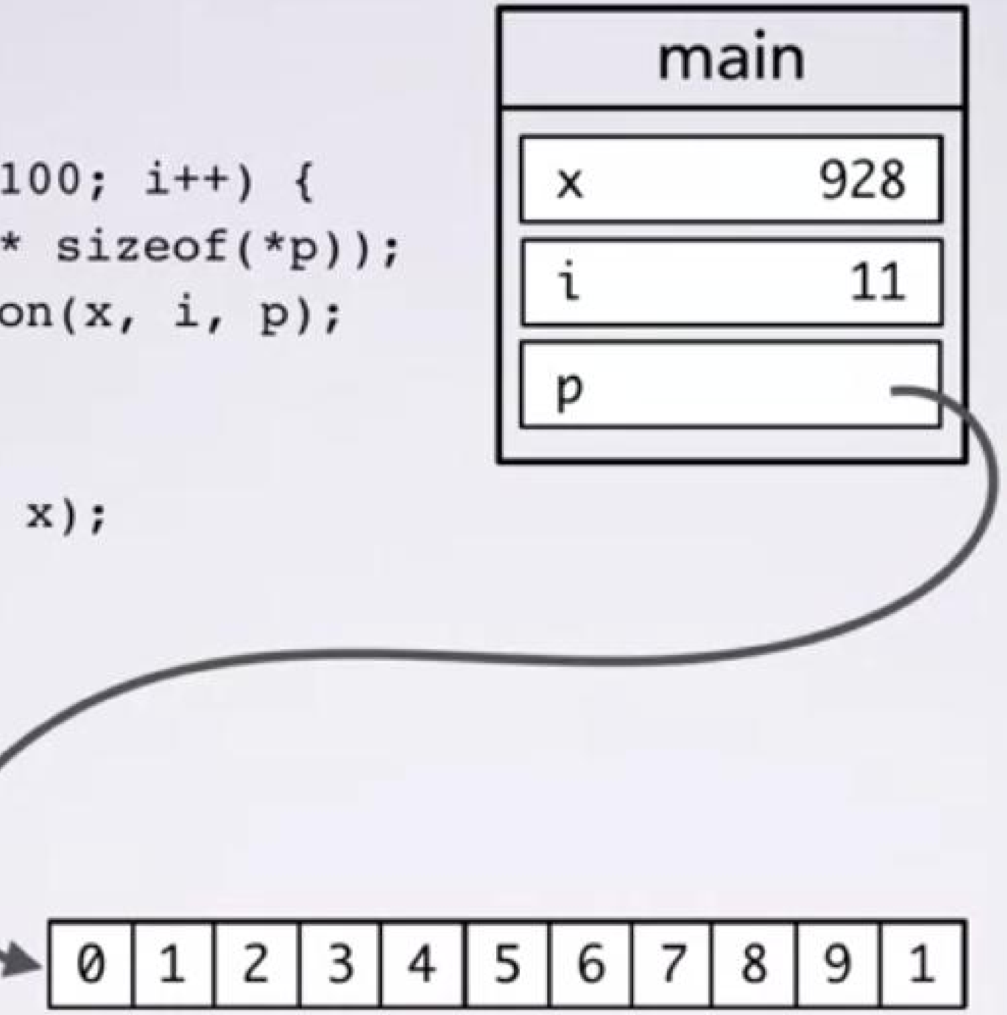
Example without free

```
int main (void) {
  int x = 0;
  for (int i = 10; i < 100; i++) {
    int * p = malloc(i * sizeof(*p));
    x = doSomeComputation(x, i, p);
    free(p);
  }
  printf("Answer %d\n", x);
  return EXIT_SUCCESS;
}
```

Example with free

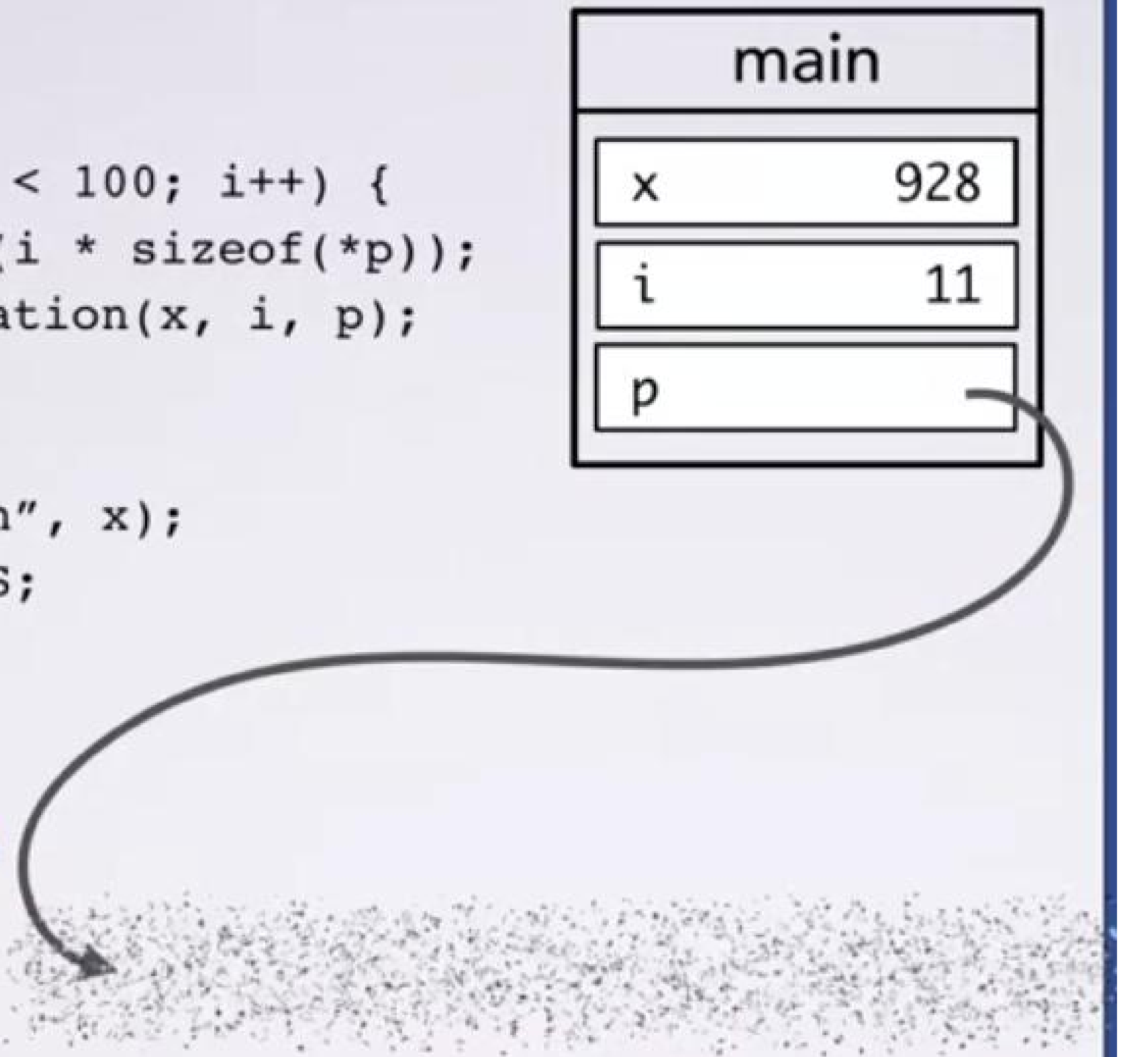


```
int main (void) {
  int x = 0;
  for (int i = 10; i < 100; i++) {
    int * p = malloc(i * sizeof(*p));
    x = doSomeComputation(x, i, p);
    free(p);
  }
  printf("Answer %d\n", x);
  return EXIT_SUCCESS;
}
```



Example with free

```
int main (void) {
  int x = 0;
  for (int i = 10; i < 100; i++) {
    int * p = malloc(i * sizeof(*p));
    x = doSomeComputation(x, i, p);
    free(p);
  }
  printf("Answer %d\n", x);
  return EXIT_SUCCESS;
}
```



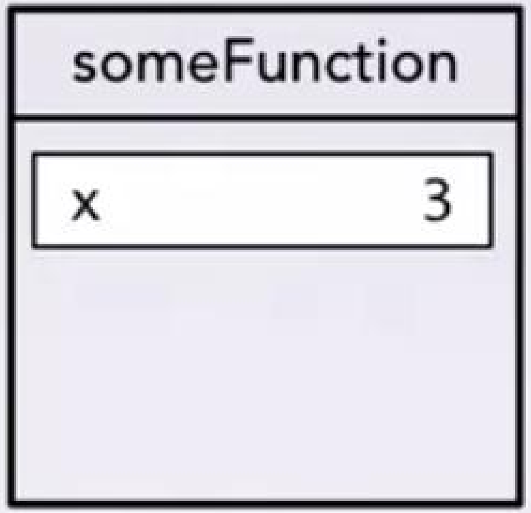
Example with free

Double Free

```
int * p = malloc(4 * sizeof(*p));
int * q = p;
...
free(q);
...
free(p);
```

Free Memory Not in the Heap

```
int x = 3;
int * p = &x;
…
free(p);
```


someFunction
x
3