CSc 352
exec and fork

Benjamin Dicken

Exec Functions

- Replaces the currently-running executable with a new one in the same process
- Several varieties

```
$ man exec
```

```c
#include <stdio.h>
#include <unistd.h>
int main() {
  printf("hi!\n");
  char* arguments[] = {NULL};
  char* environment[] = {NULL};
  int value = execve("./a.out", arguments, environment);
  if (value == -1) {
    printf("Failed to execute\n");
  }
  return 0;
}
```

Fork function

- Create a new process as a duplicate of the current one
- Parent / Child relationship
- Returns PID of child to the parent, 0 to the child

```
$ man fork
```

```c
#include <stdio.h>
#include <unistd.h>
int main() {
  printf("hi!\n");
  int pid = fork();
  if (pid != 0) {
    printf("Parent: hello\n");
    sleep(10);
    printf("Parent: goodbye\n");
  } else {
    printf("Child: hello\n");
    sleep(10);
    printf("Child: goodbye\n");
  }
  return 0;
}
```

Fork and Exec

Why are these system calls useful?

How could these be used **together** to do interesting things?

```c
#include <stdio.h>
#include <unistd.h>
int main() {
  printf("hi!\n");
  int pid = fork();
  if (pid != 0) {
    printf("I'm the parent\n");
    sleep(10);
  } else {
    printf("I'm the child\n");
    char* arguments[] = {NULL};
    char* environment[] = {NULL};
    int value = execve("./some_other_executable", arguments, environment);
    if (value == -1) {
      printf("Failed to execute\n");
    }
  }
  return 0;
}
```

```c
#include <stdio.h>
#include <unistd.h>
int main() {
  printf("hi!\n");
  char* arguments[] = {NULL};
  char* environment[] = {NULL};
  sleep(2);
  fork();
  int value = execve("./proc", arguments, environment);
  if (value == -1) {
    printf("Failed to execute\n");
  }
  sleep(100);
  return 0;
}
```

Other functions

kill: send signals to processes based on pid

```
$ man kill
```

getpid: get pid of current process

```
$ man getpid
```

waitpid: wait for princess with pid to complete

```
$ man waitpid
```

```c
int main(int argc, char* argv[]) {

  char* file_name = argv[1];
  char* search_term = argv[2];

  // Figure out file size
  FILE* to_search = fopen(file_name, "r");
  fseek(to_search, 0, SEEK_END);
  uint64_t size = ftell(to_search);
  rewind(to_search);

  uint64_t read = 0;
  uint64_t count = 0;
  uint64_t lines = 0;
  char line[256];
  while( fgets(line, 256, to_search) ) {
    lines += 1;
    if ( strstr(line, search_term) != NULL ) {
      count += 1;
    }
    read += strlen(line);
    if (read > size) { break; }
  }

  printf("Matching line count: %lu\n", count);
  printf("Total lines processed: %lu\n", lines);

  return 0;
}
```

What does this do?

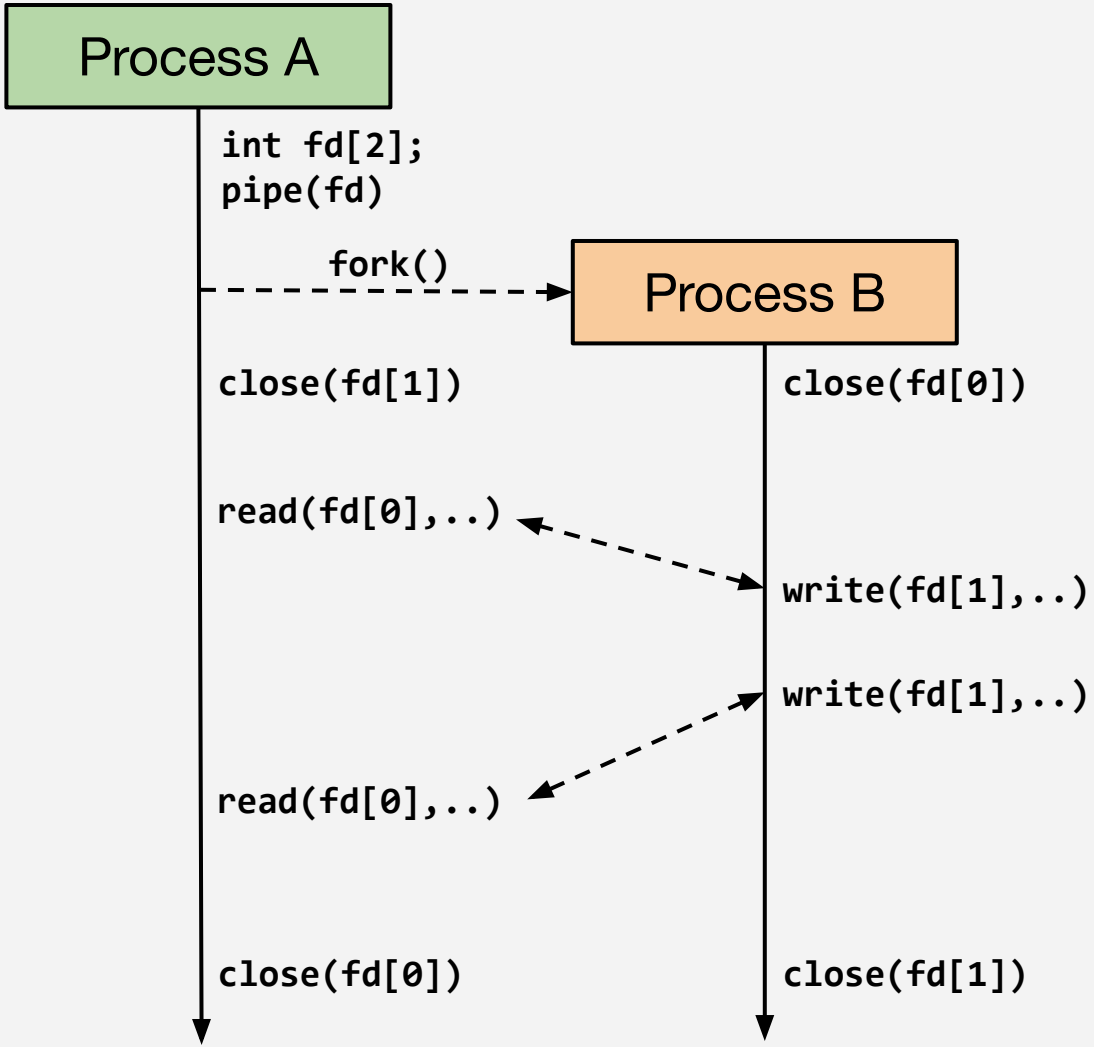
```c
int main(int argc, char* argv[]) {

  char* file_name = argv[1];
  char* search_term = argv[2];

  // Figure out file size
  FILE* to_search = fopen(file_name, "r");
  fseek(to_search, 0, SEEK_END);
  uint64_t size = ftell(to_search);
  rewind(to_search);

  uint64_t read = 0;
  uint64_t count = 0;
  uint64_t lines = 0;
  char line[256];
  while( fgets(line, 256, to_search) ) {
    lines += 1;
    if ( strstr(line, search_term) != NULL ) {
      count += 1;
    }
    read += strlen(line);
    if (read > size) { break; }
  }

  printf("Matching line count: %lu\n", count);
  printf("Total lines processed: %lu\n", lines);

  return 0;
}
```

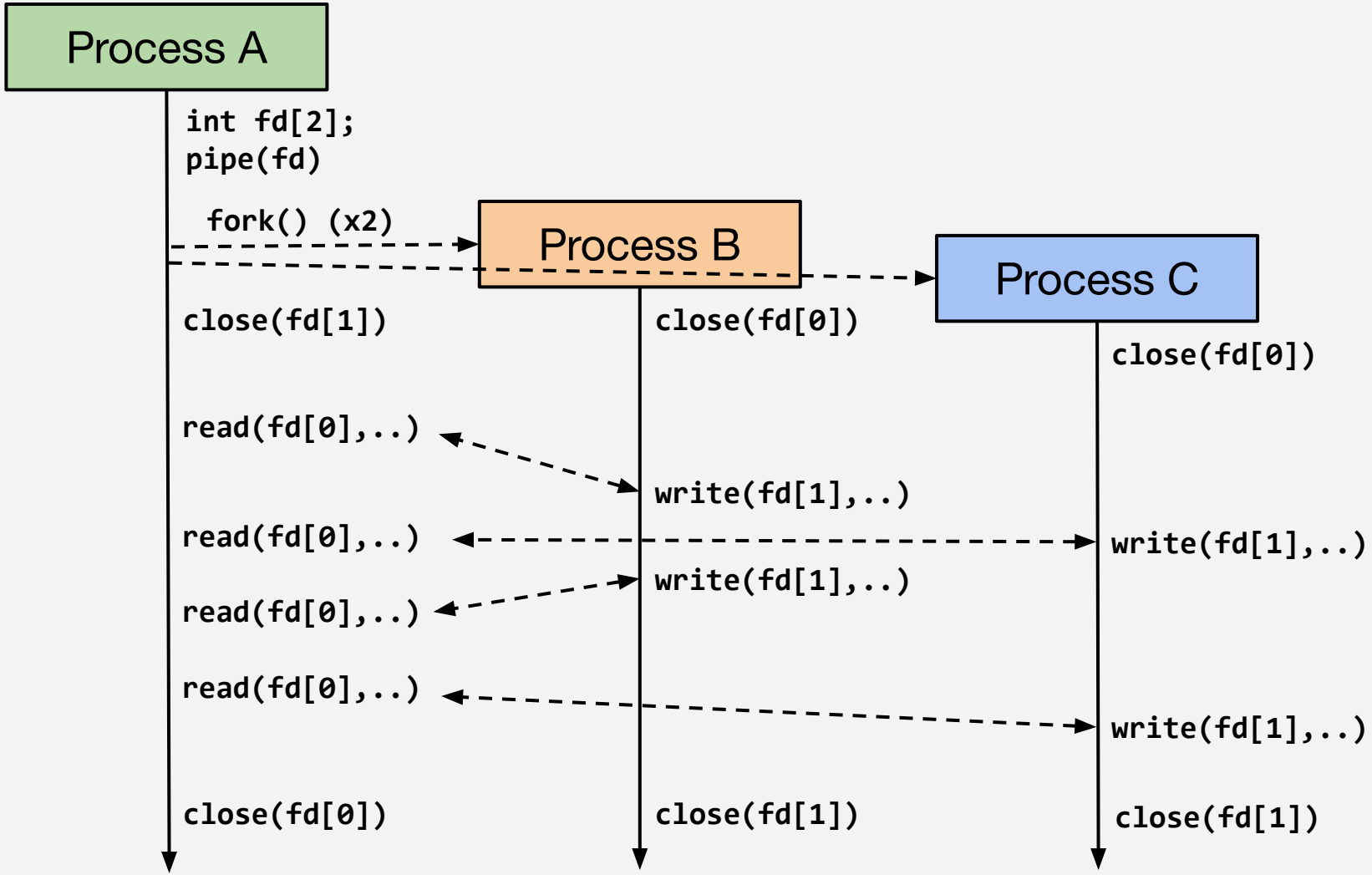
How can we make it perform better with fork and exec?

Communicating Between Processes

- Use the **pipe** function.
- **pipe** accepts an array of two file descriptors
  - one is a read-end, one is a write end
- One process can write to the pipe, another can read.

```
$ man pipe
```


Process A
int fd[2];
pipe(fd)
fork()
Process B
close(fd[1])
close(fd[0])
read(fd[0],..)
write(fd[1],..)
write(fd[1],..)
read(fd[0],..)
close(fd[0])
close(fd[1])


Process A
int fd[2];
pipe(fd)
fork() (x2)
Process B
Process C
close(fd[1])
close(fd[0])
close(fd[0])
read(fd[0],..)
write(fd[1],..)
read(fd[0],..)
write(fd[1],..)
write(fd[1],..)
read(fd[0],..)
read(fd[0],..)
write(fd[1],..)
close(fd[0])
close(fd[1])
close(fd[1])

Communicate between parent and child processes

```c
int pipe_descriptors[2];
 int status = pipe(pipe_descriptors);
 if (status < 0) {
   fprintf(stderr, "BAD.\n");
   return 1;
 }

 int process_id = fork();

 if (process_id != 0) { // Parent
   close(pipe_descriptors[1]); // Close write
   char message[10];
   read(pipe_descriptors[0], message, sizeof(char)*10); // Receive message
   printf("Message from child: %s\n", message);
   close(pipe_descriptors[0]); // Close read
 } else { // Child
   close(pipe_descriptors[0]); // Close read
   char send[10] = "LOLZ\0";
   write(pipe_descriptors[1], send, sizeof(char)*10); // Send message
   close(pipe_descriptors[1]); // Close write
 }
```

```
Matching line count: 7129
Matching line count: 7129
Matching line count: 7121
Matching line count: 7121
```

```
Matching line count: 28500
```

How can we go from this to this with multiple processes?

Timing

How does C program performance compare to other languages?

Python? Java?