CSC 112: Computer Operating Systems
Lecture 2

Processes and Threads Exercises

Department of Computer Science,
Hofstra University

Wait() I

```
int main() {
    int i;

    for (i = 0; i < 2; i++) {
        pid_t pid = fork();

        if (pid == 0) {
            // Child process
            printf("Hello %d\n", i);
            return 0;  // Exit child process
        } else if (pid > 0) {
            // Parent process
           wait(NULL);  // Wait for immediate child to
terminate
        }
    }

    printf("Parent exiting\n");
    return 0;
}
```

- Due to the use of wait(NULL), the parent waits for each child to complete before creating another child. This enforces sequential execution, meaning there is no interleaving between outputs from different iterations.
  - Hello 0
  - Hello 1
  - Parent exiting

Wait() I with exec()

```
int main() {
    int i;

    for (i = 0; i < 2; i++) {
        pid_t pid = fork();

        if (pid == 0) {
            // Child process
            printf("Hello %d\n", i);
            exec(SOME_COMMAND); //SOME_COMMAND is a
Linux command that does not print anything
            printf("Hello again %d\n", i);
          return 0;  // Exit child process
        } else if (pid > 0) {
            // Parent process
            wait(NULL);  // Wait for immediate child to
terminate
        }
    }

    printf("Parent exiting\n");
    return 0;
}
```

- In Child process: exec() replaces the current process image with a new program called SOME_COMMAND. The child process will execute the command and terminate. The code following it (e.g., printf("Child\n")) will not be executed because it is now running SOME_COMMAND, not the code shown in the text box.
- Output:
  - Hello 0
  - Hello 1
  - Parent exiting

Wait() II

```
int main() {
    int i;

    for (i = 0; i < 2; i++) {
        pid_t pid = fork(); // Create a child process

        if (pid == 0) {
            // Child process
            printf("Hello %d\n", i);
            return 0; // Exit child process
        } else if (pid > 0) {
            // Parent process continues to next
iteration
            continue;
        }
    }

    // Parent process waits for all child processes to
terminate
    for (i = 0; i < 2; i++) {
        wait(NULL); // Wait for a child process to
terminate
    }

    printf("Parent exiting\n");
    return 0;
}
```

- Since the parent does not wait immediately after creating each child, the outputs of "Hello" messages from children can interleave. However, due to the final waiting loop (wait(NULL)), "Parent exiting" is always printed last.
- Two possible outputs:
  - Hello 0
  - Hello 1
  - Parent exiting
- Or
  - Hello 1
  - Hello 0
  - Parent exiting

Wait() III

```
int main() {
    int i;

    for (i = 0; i < 2; i++) {
        pid_t pid = fork();

        if (pid == 0) {
            // Child process
            printf("Hello from Child %d\n", i);
            return 0;  // Exit child process
        } else if (pid > 0) {
            // Parent process
            printf("Hello from Parent %d\n", i);
            wait(NULL);  // Wait for immediate child to
terminate
           printf("Hello from Parent again %d\n", i);
        }
    }

    printf("Parent exiting\n");
    return 0;
}
```

- Output: 4 possible outputs
- 1) These 2 statements interleaved in any order:
  - Hello from Parent 0
  - Hello from Child 0
- 2) Hello from Parent again 0
- 3) These 2 statements interleaved in any order:
  - Hello from Parent 1
  - Hello from Child 1
- 4) Hello from Parent again 1
- Parent exiting

Wait() IV

```
int main() {
    int i;

    for (i = 0; i < 2; i++) {
        pid_t pid = fork();

        if (pid == 0) {
            // Child process
            printf("Hello from Child %d\n", i);
            return 0;  // Exit child process
        } else if (pid > 0) {
            // Parent process
           continue();
        }
    }

    // Parent process waits for all child processes to
terminate
    for (i = 0; i < 2; i++) {
        printf("Hello from Parent %d\n", i);
        wait(NULL); // Wait for a child process to
terminate
        printf("Hello from Parent again %d\n", i);
    }
    printf("Parent exiting\n");
    return 0;
}
```

- These statements interleaved in some order:
  - Hello from Parent 0
  - Hello from Child 0
  - Hello from Parent 1
  - Hello from Child 1
  - Hello from Parent again 0
  - Hello from Parent again 1
- With constraints:
  - Each "Parent X" and "Child X" message pair appears before the corresponding "Parent again X" message, i.e.,
  - “Hello from Parent 0”, “Hello from Child 0” must appear before “Hello from Parent again 0”
  - “Hello from Parent 1”, “Hello from Child 1” must appear before “Hello from Parent again 1”
- A final "Parent exiting" message printed last.