Computer System Engineering
50.005
Dr. David Yau

OS Programming Assignment
Process Tree Management

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The Goal of this project

➔ **To execute a group of processes that have control and data dependencies between each other.**

Control dependencies: a process cannot be started until another process finishes.

predecessor and successor

Data dependencies: a process requires input from another process before it can start.

cat file.txt

Example

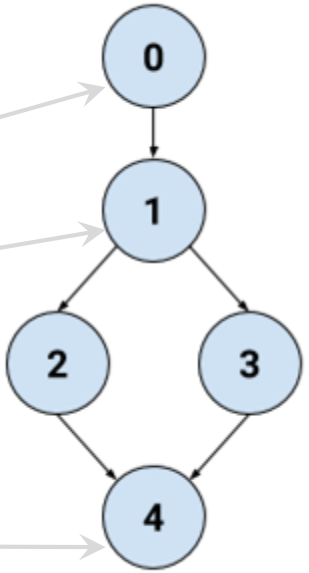
- A **text file** will represent the structure of the graph. Each node will be represented by a line in the following format:

Input file format:

<program>:<child nodes>:<input>:<output>

Example:

```
echo hi there:1:stdin:echo-out.txt
echo wazzup:2 3:stdin:echo2-out.txt
cat:4:echo-out.txt:cat-1.txt
cat:4:echo2-out.txt:cat-2.txt
cat cat-1.txt cat-2.txt:none:stdin:sink.txt
```



Each **node** in the graph represents a *process*, and the **edges** represent *dependency relations* between processes.

e.g. Process 1 can only start after Process 0 finishes. After Process 1 finishes, Processes 2 and 3 can be run in parallel.

Steps

1. **Parse the text file** containing the graph of processes.

2. **Construct a data structure** to represent the graph of processes.

3. **Execute the processes in the correct order**, such that dependency relations between processes are properly met.

Useful functions (C)

Parsing of input file: **`strtok()`**

Process tree representation: **`node`** struct

```
typedef struct node {
  int id;// corresponds to line number in graph text file
  char prog[MAX_LENGTH];// prog + arguments
  char input[MAX_LENGTH];// filename
  char output[MAX_LENGTH];// filename
  int children[MAX_CHILDREN];// children IDs
  int num_children;// how many children this node has
  int status;// ineligible/ready/running/finished
  pid_t pid;// Process id when it's running
} node_t;
```

Process execution: **`fork()`**, **`exec()`**, **`dup2()`**, **`waitpid()`**

- **`fork()`** can be used to create a new process, and **`exec()`** to run a program within the newly forked process.
- **`dup2()`** can be used to redirect the input and output for a process.
- **`waitpid()`** can be used to wait for a process to finish executing.

Useful classes and methods (Java)

Parsing of input file: **`BufferedReader`**, **`String`**

Process tree representation: **`ProcessGraph`**, **`ProcessGraphNode`**

Process execution: **`ProcessBuilder`**, **`Process`**, **`Thread`**

- ➔ **`ProcessBuilder.redirectInput()`** and **`ProcessBuilder.redirectOutput()`** can be used to set the input and output file for a process
- ➔ **`Process.waitFor()`** can be used to wait for a process to finish executing.

Input/Output Redirection

- You can choose any possible way to redirect your input and output, suggested examples:
  - system (cat file1.txt > file2.txt)
  - “ls -l | wc -l”
  - dup2 in C
  - ProcessBuilder.redirectInput() and ProcessBuilder.redirectOutput() in Java

Instructions

- Download the assignment package from eDimension.
  - The package includes the instruction handout and sample input and output files to test your code.
- Assignment weightage: 10% of final course grade
- Due date: end of recess week (Sun 13 March, 11:59 PM)
- Submit your Java/C source code to eDimension, along with a README file, your name and ID.
- Collaboration between maximum two students is permitted, If you are working in a group, write the group members names and IDs, and only one of you need to submit the project.

```
/* Programming Assignment 1
* Authors : Full Name1, Full Name2
* IDs : Student ID1,ID2
Date : dd/mm/yyyy */
```

- GOOD LUCK ! ☺