Computer System Engineering
50.005
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Operating Systems - Programming Assignment
Objective: Process Tree Management

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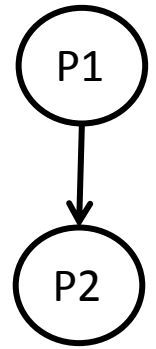
The Goal of this project

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

Control dependency: A process must terminate before successor can begin

eg. P1 gives waits for time to start (let's say 3pm), and terminates

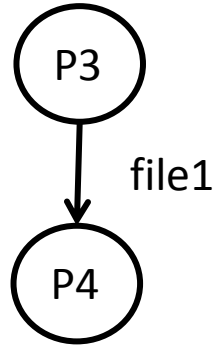
P2 starts only when P1 has terminated



Control dependency

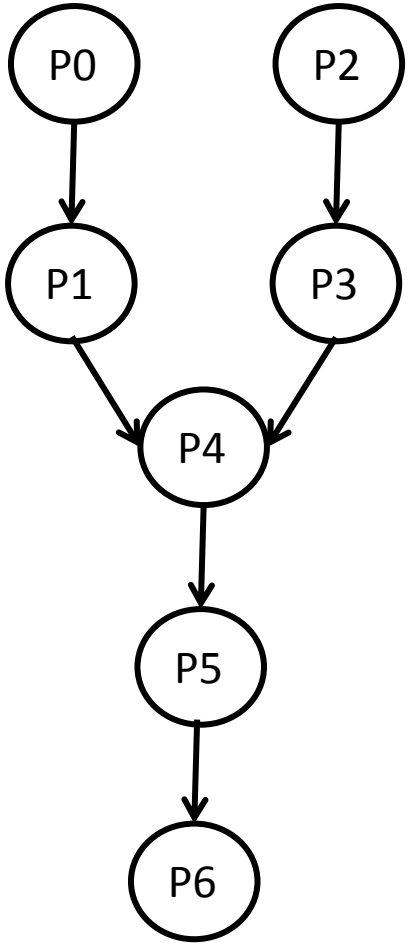
- Data dependency: A process requires input from another process before it can start

eg. P3 produces output file1 and P4 takes input from file1



Data dependency

Example1



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

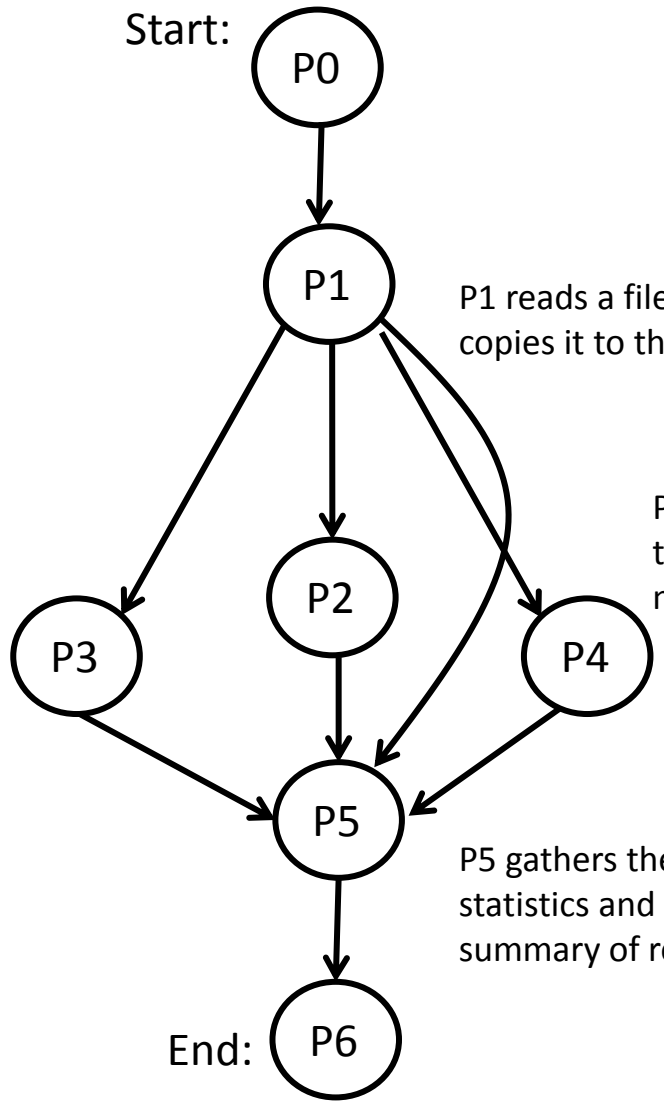
Input file format:
<program> : <child nodes> : <input> : <output>

Eg. Process 1 can only start after Process 0 has finished. After Process 1 finishes, Processes 2 and 3 can be run in parallel.

Example:
sleep 10:1:stdin:stdout
echo "Process P1 running. Dependency to P4 is cleared.":4:stdin:out1.txt
sleep 15:3:stdin:stdout
echo "Process P3 running. Dependency to P4 is cleared.":4:stdin:out2.txt
cat out1.txt out2.txt:5:stdin:cat-out.txt
grep 3:6:cat-out.txt:grep-out.txt
wc -l:none:grep-out.txt:wc-out.txt

Example2

Input file format:
<program> : <child nodes> : <input> : <output>



P1 reads a file from arg1 and copies it to the output file

P2, P3 and P4 match certain keywords to see which appears in the most number of lines in the source file.

P5 gathers the results, compares the statistics and prints out overall summary of results

Example:
sleep 1:1:stdin:stdout
cat ATaleOfTwoCities:2 3 4 5:stdin:outentirebook.txt
grep Paris:5:ATaleOfTwoCities:outParis.txt
grep London:5:ATaleOfTwoCities:outLondon.txt
grep city:5:ATaleOfTwoCities:outcity.txt
wc outcity.txt outParis.txt outLondon.txt outentirebook.txt:none:stdin:sink.txt

Steps

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

2. 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[MAXLENGTH]; // prog + arguments
   char input[MAXLENGTH]; // filename
   char output[MAXLENGTH]; // filename5.
   int children [MAX_CHILDREN]; //childrens' IDs
   int parents [MAX_PARENTS]; //parents' IDs
   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 for a process to finish executing

Useful classes and methods (Java)

Parsing of input file: BufferedReader, String

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 for a process to finish executing

Input/Output Redirection

You can choose any possible way to redirect you 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
- Decide which language do you prefer based on your background
  - Java or C language
- Read the tasks one by one and use the starting code provided on eDimension
- Assignment weightage: 5% of final course grade
- Due date: end of recess week (Sun 10th March, 11:59pm)
- Don’t hesitate to ask for help from the instructors in the lab!
- Complete the assignment with features and upload the Java or C program along with README file, your name and ID to eDimension before the above due date.