CS 359 – Programming Paradigms

PEX 4 – PERT

Final Submission Due: Start of Class Lesson 40, 12 December

Help Policy:

AUTHORIZED RESOURCES: Any, except another cadet's program.
NOTE:

- Never copy another person's work and submit it as your own.
- Do not jointly create a program.
- You must document all help received from sources other than your instructor or instructor-provided course materials (including your textbook).
- **DFCS will recommend a course grade of F for any cadet who egregiously violates this Help Policy or contributes to a violation by others.**

Documentation Policy:

- You must document all help received from any source other than your instructor.
- The documentation statement must explicitly describe WHAT assistance was provided, WHERE on the assignment the assistance was provided, and WHO provided the assistance.
- If no help was received on this assignment, the documentation statement must state "NONE."
- If you checked answers with anyone, you must document with whom on which problems. You must document whether or not you made any changes, and if you did make changes you must document the problems you changed and the reasons why.
- **Vague documentation statements must be corrected before the assignment will be graded and will result in a 5% deduction on the assignment.**

Turn-in Policies:

- On-time turn-in is at the specific time listed above.
- Late penalties accrue at a rate of 25% per 24-hour period past the on-time turn-in date and time. The late penalty is a cap on the maximum grade that may be awarded for late work.
- There is no early turn-in bonus or extra credit for this assignment.

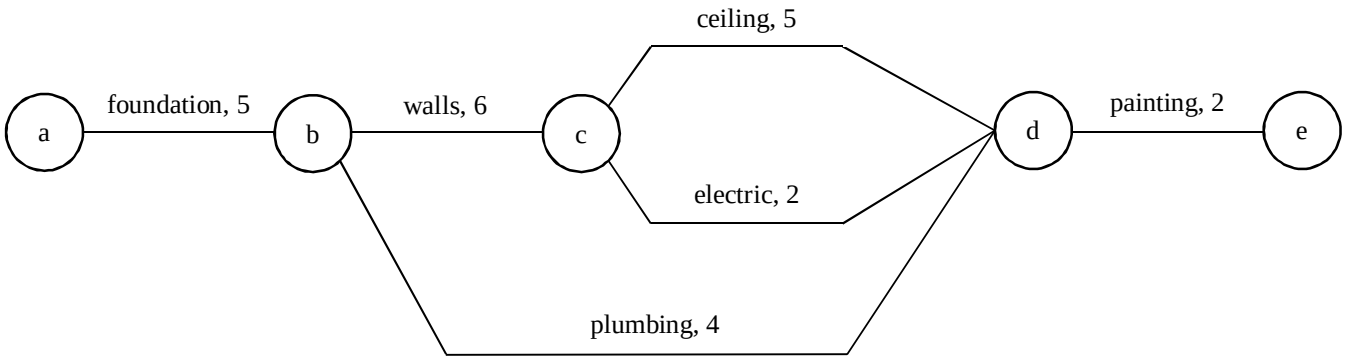
1. OBJECTIVES

- Expand your range of programming language competence
- Be able to define and use Prolog facts and rules
- Be able to use the Prolog list structure
- Be able to create, test, and debug a medium sized Prolog program
- Be able to represent a PERT chart using Prolog and obtain relevant information from it

2. BACKGROUND

Your task for this exercise is to write a collection of Prolog fact and rule statements to implement a PERT chart. Program Evaluation and Review Technique is a project management technique designed to analyze and represent the tasks involved in completing a given project, especially the time needed to complete each task, and to identify the minimum time needed to complete the total project. A PERT chart is a tool that facilitates this analysis. Consecutive events in a PERT chart are linked by activities. The events are presented in a logical sequence and no activity can commence until its immediately preceding event is competed.

For example, consider the following diagram with tasks involved in building a house:



The idea is that it takes five days to pour the foundation, and only after the foundation is done can work begin on the walls and plumbing. It takes six days to build the walls, and only after the walls are finished can work begin on the ceiling and electric. Etc.

A PERT ***event*** is a point that marks the start or completion of one or more activities. It consumes no time and uses no resources. In the diagram above, a, b, c, d, and e are events. One event must be designated as the ***start event*** and one event must be designated as the ***end event*** (a and e in the diagram above).

A PERT ***activity*** is a task necessary to move from one event to another. An activity does consume time and resources. In the diagram above, foundation, walls, ceiling, electric, plumbing, and painting are activities. The numbers represent the time required to complete the activity (days in this example; resources are ignored in this exercises).

A ***predecessor event*** immediately precedes an activity and a ***successor event*** immediately follows an activity. In the diagram above, the plumbing activity's predecessor event is b and successor event is d.

A ***path*** is a series of activities that connect the start event to the end event. The ***critical path*** is the longest possible continuous path from the start event to the end event. The critical path determines the total time required for the project. In the diagram above, [foundation, walls, ceiling, painting] is the critical path.

The ***float time*** of an activity is a measure of the excess time available to complete an activity. That is, it is the amount of time an activity can be delayed without causing delay in any subsequent activities. A ***critical activity*** is an activity with a float time of zero. In the diagram above, plumbing's float time is 7.

The ***lead time*** of an activity is the time prior to project completion by which an activity must be completed. In the diagram above, the lead time for completing the walls is 7.

3. FACT FORMAT

There are many ways a PERT chart could be represented in Prolog. For the purposes of this exercise, it will be very helpful if everyone uses the same representation. Thus, the format of the following facts that represent the sample PERT chart in this document should be used when representing your PERT charts:

```
event( a ).                    activity( a, b, foundation, 5 ).
event( b ).                    activity( b, c, walls, 6 ).
event( c ).                    activity( b, d, plumbing, 4 ).
event( d ).                    activity( c, d, ceiling, 5 ).
event( e ).                    activity( c, d, electric, 2 ).
                               activity( d, e, painting, 2 ).
start( a ).
end( e ).
```

Do not forget to include the appropriate fact header comments for each of the above facts. See the Prolog Programming Standards document.

4. PROGRAMMING EXERCISE

Implement the remaining functionality described in the background section of this document. Specifically, you are to write Prolog rules for **`time/2`**, **`longer_path/3`**, **`critical_path/2`**, **`float_time/2`**, ~~**`critical_activities/0`**~~, and **`lead_time/2`**.

The following demonstrates the use of each of these rules:

```
?- time( [foundation, walls, ceiling, painting], 18 ).
true.
?- time( [foundation, walls, ceiling, painting], Time ).
Time = 18.
?- time( [plumbing, painting], Time ).
Time = 6.
?- time( [], Time ).
Time = 0.
?- longer_path( a, e, 16 ).
true ;
false.
?- longer_path( a, e, 20 ).
false.
?- longer_path( b, d, 4 ).
true ;
true ;
false.
?- critical_path( [foundation, walls, ceiling, painting], 18 ).
true ;
false.
?- critical_path( Path, Time ).
Path = [foundation, walls, ceiling, painting],
Time = 18 ;
false.
?- float_time( plumbing, 7 ).
true ;
false.
```

```
?- float_time( plumbing, Time ).
Time = 7 ;
false.
?- float_time( walls, Time ).
Time = 0 ;
false.
?- critical_activities.
foundation
walls
ceiling
painting
false.
?- lead_time( walls, 7 ).
true ;
false.
?- lead_time( walls, Time ).
Time = 7 ;
false.
```

5. PROGRAMMING EXERCISE – HELPFUL HINTS

The required **`critical_path`** rule has two parameters, the path and the time. You will find it useful to define another **`critical_path`** rule with four parameters, the start event, end event, path, and time.

Make use of the built-in predicate **`not`**. Specifically, you might use it in combination with the **`longer_path`** rule: **`not( longer_path( Start, End, Time ) )`**

6. SUBMISSION REQUIREMENTS

- **INCLUDE AN APPROPRIATE DOCUMENTATION STATEMENT IN YOUR MOODLE SUBMISSION.**
- For the final PEX turn in, you must submit three separate files:
  - **`pex4Diagram.pdf`** – This file will contain a your small PERT diagram
  - **`pex4Diagram.pl`** – This file will contain your facts for your small PERT diagram
  - **`pex4Rules.pl`** - This file will contain all your rules required by instructions above
- To create a PDF from a Powerpoint, click File->Save As->Save As Type-> PDF. From OneNote, File->Save As->Page->Select Format->PDF
- Create a folder on your system with everything you would like to be graded and *name this folder* with *your own last name*.
- Zip the entire folder to a file with the name **`Lastname.zip`**, using your own last name.
- Use the website to submit a **single zip file** containing everything you would like to be graded.

CS 359 – PEX 4 – Grade Sheet Name:_____

Criteria		Points
path/32 rule		11
time/2 rule		11
longer_path/3 rule		11
critical_path/2 rule		13
float_time/2 rule		13
lead_time/2 rule		11
	Subtotal:	**70**
Adjustments	**All code meets specified standards:**	**– 6**
	Vague/Missing Documentation:	**– 3**
	Submission Requirements Not Followed:	**– 3**
	Late Penalties:	**25/50/75%**
	Total w/adjustments:	

Comments from Instructor: