Network Models---Project Management

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MSDS 460

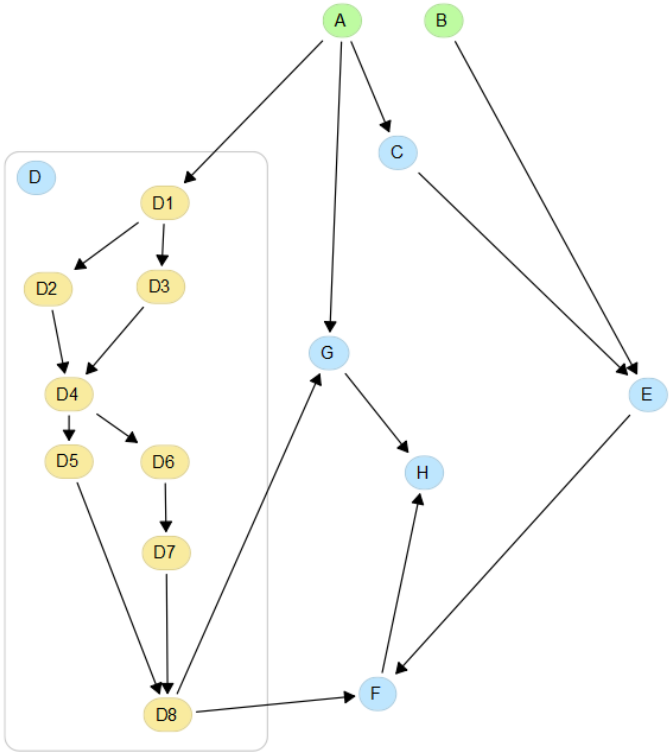
Assignment 2 - October 20, 2024

Part 1: Problem Setup

Project tasks and dependencies

Task Id	Task	Predecessor Task ID
A	Describe product	
B	Develop marketing strategy	
C	Design brochure	A
D	Develop product prototype	
D1	Requirements analysis	A
D2	Software design	D1
D3	System design	D1
D4	Coding	D2, D3
D5	Write documentation	D4
D6	Unit testing	D4
D7	System testing	D6
D8	Package deliverables	D5, D7
E	Survey potential market	B, C
F	Develop pricing plan	D8, E
G	Develop implementation plan	A, D8
H	Write client proposal	F, G

Directed Graph Diagram



Cost Calculations

Contractor Hourly Rates:

Role	Hourly Rate
Project Manager	$110
Frontend Developer	$95
Backend Developer	$105
Data Engineer	$100
Data Scientist	$110

Total hours and cost by task:

Total hours presented below are not actual project hours as they do not account for task dependencies. Refer to the solution section for details on actual project hours.

			Total Hours			Total Cost		
Task Id	Task	Predecessor Task ID	Best Case	Expected	Worst Case	Best Case	Expected	Worst Case
A	Describe product		10	15	20	$1,100	$1,650	$2,200
B	Develop marketing strategy		12	18	24	$1,320	$1,980	$2,640
C	Design brochure	A	8	12	16	$880	$1,320	$1,760
D	Develop product prototype		195	245	335	$18,955	$24,080	$32,280
D1	Requirements analysis	A	20	25	35	$2,140	$2,660	$3,730
D2	Software design	D1	30	40	50	$3,060	$4,070	$5,080
D3	System design	D1	40	50	70	$3,060	$4,070	$5,080
D4	Coding	D2, D3	45	55	75	$4,550	$5,570	$7,590
D5	Write documentation	D4	20	25	35	$2,050	$2,570	$3,610
D6	Unit testing	D4	15	20	30	$1,530	$2,035	$3,045
D7	System testing	D6	15	18	25	$1,525	$1,845	$2,570
D8	Package deliverables	D5, D7	10	12	15	$1,040	$1,260	$1,575
E	Survey potential market	B, C	10	16	20	$1,100	$1,760	$2,200
F	Develop pricing plan	D8, E	8	10	16	$880	$1,100	$1,760
G	Develop implementation plan	A, D8	5	7	10	$535	$755	$1,070
H	Write client proposal	F, G	3	5	7	$330	$550	$770
	Total		**251**	**328**	**448**	**$25,100**	**$33,195**	**$44,680**

Refer to the project-plan-rehmani.xlsx document for detail breakdown by contract role.

Assumptions:

- All contractors will be working remotely and would use their own hardware (laptops, monitors ...)
- All contractors have at least 10 years of experience
- Best Case = all stories/features are completed with no major issues or blocks.
- Expected Case = all storied/features are completed with some issues and blocks which are resolved in time.
- Worst Case = storied/features experience major challenges and delays (internal or external).
- The tasks breakdown above allocates total hours required for each task (best, expected, worst) and then provides individual roles contribution towards that total.

Part 2: Model Specification

Linear Program Setup

Decision Variables

Start time for each task identified.

- S = start time
- i = tasks (A to H)
- C = project completion time

Objective Function

Minimize total project time. Since all contracts charge the same rate for additional hours, minimizing time will minimize cost.

Constraints

- Each task can only start when the predecessor task is finished
- Project completes after the last task H is finished

Part 3: Programming

Refer to the Rehmani_assignment2.py file for details on the code.

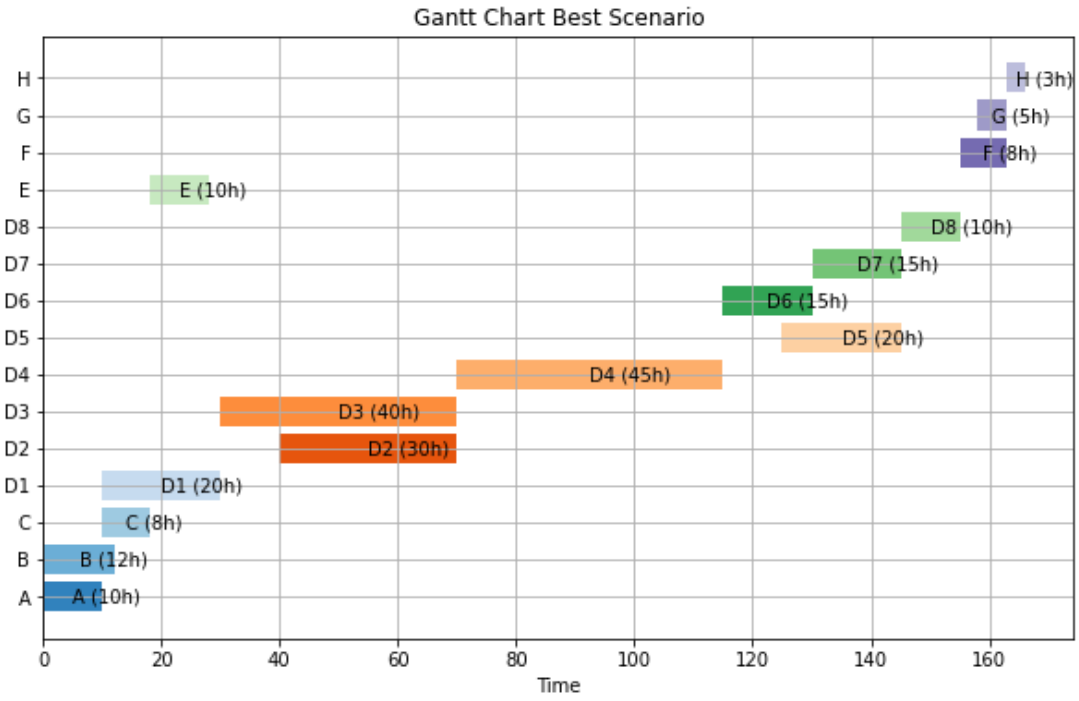
Part 4: Solution

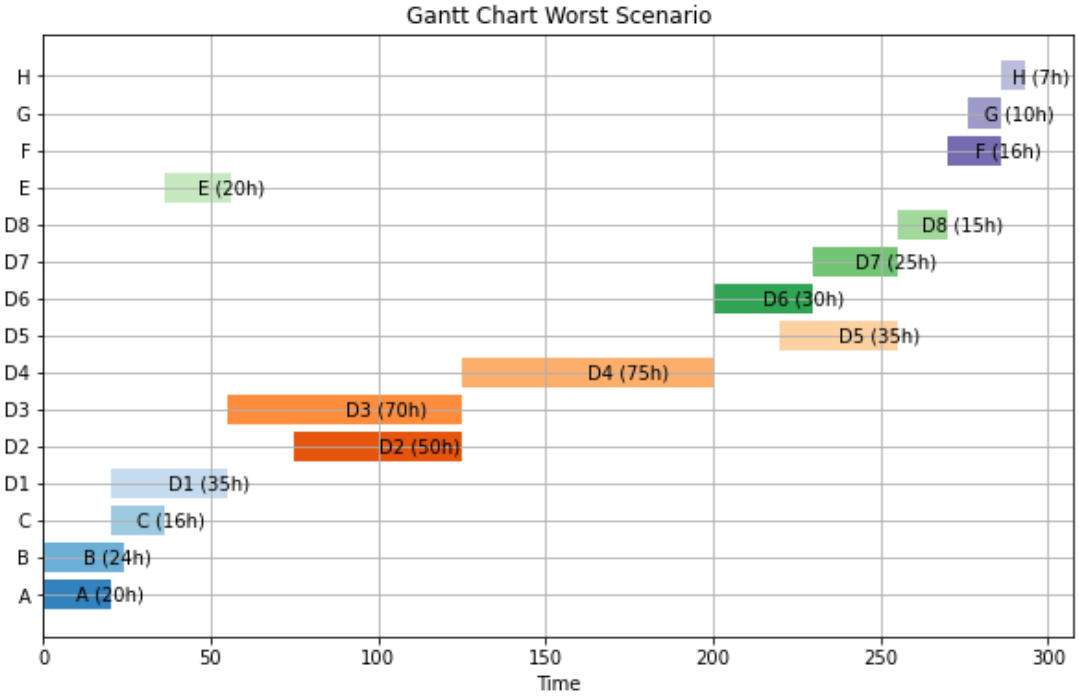
Best Scenario	**Worst Scenario**	**Expected Scenario**
Status: Optimal	Status: Optimal	Status: Optimal
Start A = 0.0	Start A = 0.0	Start A = 0.0
Start B = 0.0	Start B = 0.0	Start B = 0.0
Start C = 10.0	Start C = 20.0	Start C = 15.0
Start_D1 = 10.0	Start_D1 = 20.0	Start_D1 = 15.0
Start_D2 = 40.0	Start_D2 = 75.0	Start_D2 = 50.0
Start_D3 = 30.0	Start_D3 = 55.0	Start_D3 = 40.0
Start_D4 = 70.0	Start_D4 = 125.0	Start_D4 = 90.0
Start_D5 = 125.0	Start_D5 = 220.0	Start_D5 = 158.0
Start_D6 = 115.0	Start_D6 = 200.0	Start_D6 = 145.0
Start_D7 = 130.0	Start_D7 = 230.0	Start_D7 = 165.0
Start_D8 = 145.0	Start_D8 = 255.0	Start_D8 = 183.0
Start_E = 18.0	Start_E = 36.0	Start_E = 27.0
Start F = 155.0	Start F = 270.0	Start F = 195.0
Start G = 158.0	Start G = 276.0	Start G = 198.0
Start H = 163.0	Start H = 286.0	Start H = 205.0
Total Project Time = 166.0	Total Project Time = 293.0	Total Project Time = 210.0

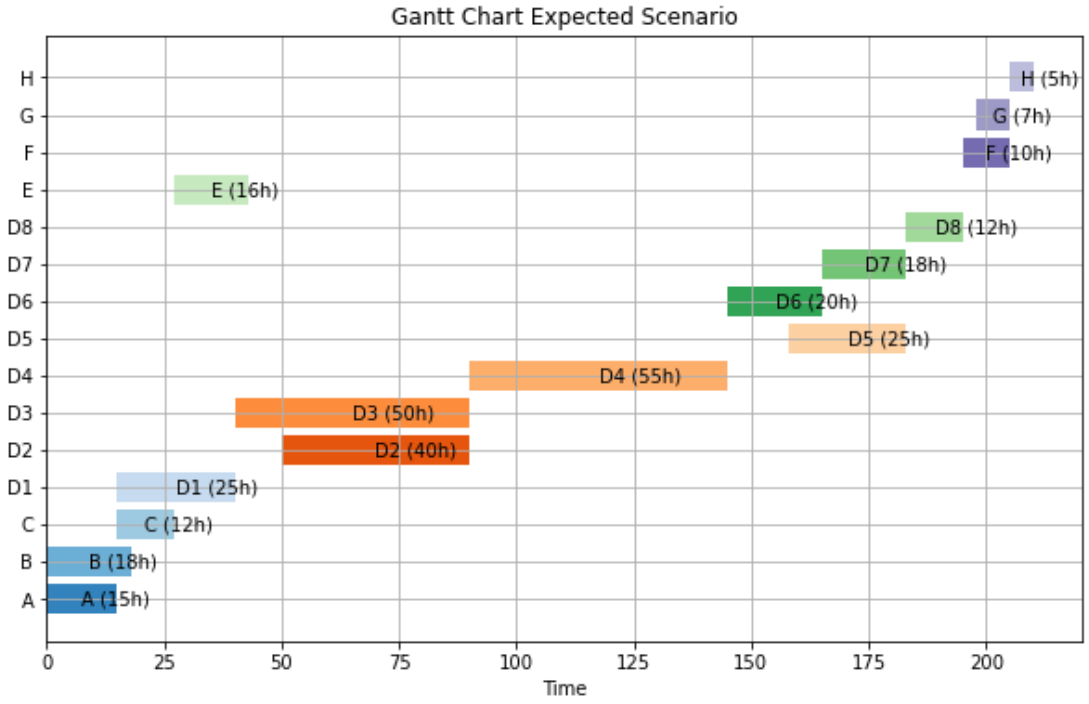
Solution Notes

- All three scenarios correctly show start for task A, B as 0 since they have no predecessors.

- The rest of the tasks across all the scenarios seem to show the correct dependencies modeled.
- All three scenarios correctly identify the project end time as Task H Start Time + Task H Hours.
- Critical Path (Highlighted): A → D1 → D2 → D4 → D5 → D8 → G → H







Part 5: Overview

The consumer-focused recommendation system has a series of dependent tasks that impact the project completion time. The best-case scenario where no issues are encountered and all project requirements are completed in time, the project would take around 166 hours total costing $25,100. The worst-case scenario where the project has issues and unexpected blocks, the project may take as much as 293 hours with a cost of around $44,680. However, the more likely scenario with expected project duration and cost are 210 hours with $33,195. The estimated cost of the prototype for the three different scenarios are $18,995 (Best), $32,280 (Worst) and $24,080 (Expected). The prototypes for each scenario can be delivered at:

- Best: 155 hours (145 + 10)
- Worst: 270 hours (255 + 15)
- Expected: 195 hours (183 + 12)

The project time and cost maybe reduced if a dedicated business analyst is brought on the project team to complete the dependent tasks sooner and not use the more costly rate of a Project Manager and Data Scientist to complete certain analysis tasks.