Software Project Management

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Project Scheduling cont…

Project monitoring and control

- Once a project gets underway,
  - the project manager monitors the project continuously
    - to ensure that it is progressing as per plan.
- The project manager designates certain key events such as completion of some important activity as a *milestone*.
- A few examples of milestones are
  - Preparation and review of the SRS document
  - Completion of the coding and unit testing etc.

Project monitoring and control

- Once a milestone is reached,
  - the project manager can assume that some measurable progress has been made.
- If any delay in reaching a milestone is predicted,
  - then corrective actions might have to be taken.
- This may entail reworking all the schedules and producing a fresh schedule.

Project monitoring and control

- A PERT chart is especially useful in project monitoring and control.
- A path in this graph is any set of consecutive nodes and edges from the starting node to the last node.
- A *critical path* in this graph is a path along which every milestone is critical to meeting the project deadline.
- In other words, if any delay occurs along a critical path, the entire project would get delayed.

Project monitoring and control

- It is therefore necessary to identify all the critical paths in a schedule,
  - adhering to the schedules of the tasks appearing on the critical paths is of prime importance to meet the delivery date.
- There may be more than one critical path in a schedule.
- The tasks along a critical path are called *critical tasks*.

Project monitoring and control

- The critical tasks need to be closely monitored and corrective actions need to be initiated as soon as any delay is noticed.
- If necessary, a manager may switch resources from a non-critical task to a critical task so that all milestones along the critical path are met.

Critical Path

- Task dependencies define a partial ordering among tasks, i.e.
  - Completion of some tasks must precede the starting time of some other tasks.
- A critical path:
  - along which every milestone is critical to meeting the project deadline.
- A Critical Path is a chain of tasks that determine the duration of the project.

Critical Paths

- A critical path is a sequence of tasks such that
  - a delay in any of the tasks will cause a delay to the entire project.
- There can be more than one critical path in a project.
- It is important for the project manager to be aware of the critical paths in a project:
  - can ensure that tasks on these paths are completed on time.

Critical Paths

- Other tasks may have some room for delay without affecting the entire project.
  - If necessary, the manager may switch resources from a noncritical task to a critical task.
- Several software packages are available for automating the scheduling process:
  - MacProject on Apple Macintosh computer
  - MS-Project on Microsoft Windows Operating System.

CPM and PERT Charts

- While Gantt charts show the different tasks and their durations clearly:
  - they do not show inter-task dependencies explicitly.
  - this shortcoming of Gantt charts is overcome by PERT charts.

Critical Path Method

- Critical Path Method (CPM) is a technique for:
  - Identifying critical paths
  - Managing project.
- The CPM technique is not specific to software engineering
  - has a much wider use.

Critical Path Method

- CPM can assist in answering questions like:
  - What are the critical paths in the project?
  - What is the shortest time in which the project can be completed?
  - What is the earliest (or latest) time a task can be started (or finished) without delaying the project?

Critical Path Method (CPM)

- A path in the activity network graph is any set of consecutive nodes and edges in this graph from the starting node to the last node.
- A critical path consists of a set of dependent tasks that need to be performed in a sequence and which together take the longest time to complete.

Critical Path Method (CPM)

- A critical task is one with a zero slack time.
- A path from the start node to the finish node containing only critical tasks is called a critical path.

Quantities to be calculated in CPM

- Minimum time (MT)
  - Minimum time required to complete the project.
  - Computed by determining the maximum of all paths from start to finish.
- Earliest start time (ES)
  - The time of a task which is the maximum of all paths from the start to this task.
  - The ES for a task is the ES of the previous task plus the duration of the preceding task.

Quantities to be calculated in CPM cont…

- Latest start time (LS)
  - The difference between MT and the maximum of all paths from this task to the finish.
  - Computed by subtracting the duration of the subsequent task from the LS of the subsequent task.

Quantities to be calculated in CPM

- Earliest finish time (EF)
  - The EF for a task is the sum of the earliest start time of the task and the duration of the task.
- Latest finish time (LF)
  - Indicates the latest time by which a task can finish without affecting the final completion time of the project.
  - A task completing beyond its LF would cause project delay.
  - Obtained by subtracting maximum of all paths from this task to finish from MT.

Quantities to be calculated in CPM

- Slack time (ST) (or float time)
  - Total time that a task may be delayed before it will affect the end time of the project.
  - Indicates the *flexibility* in starting and completion of tasks.
  - ST for a task is LS-ES and can equivalently be written as LF-EF.

What data do we need to construct a CPM graph?

- To construct a CPM graph,
  - a list of tasks and their durations are required.
  - Also, for each task a list of tasks upon which it depends is required.
  - A task may depend on more than one task.
- Project task details can be given in the form of a table.

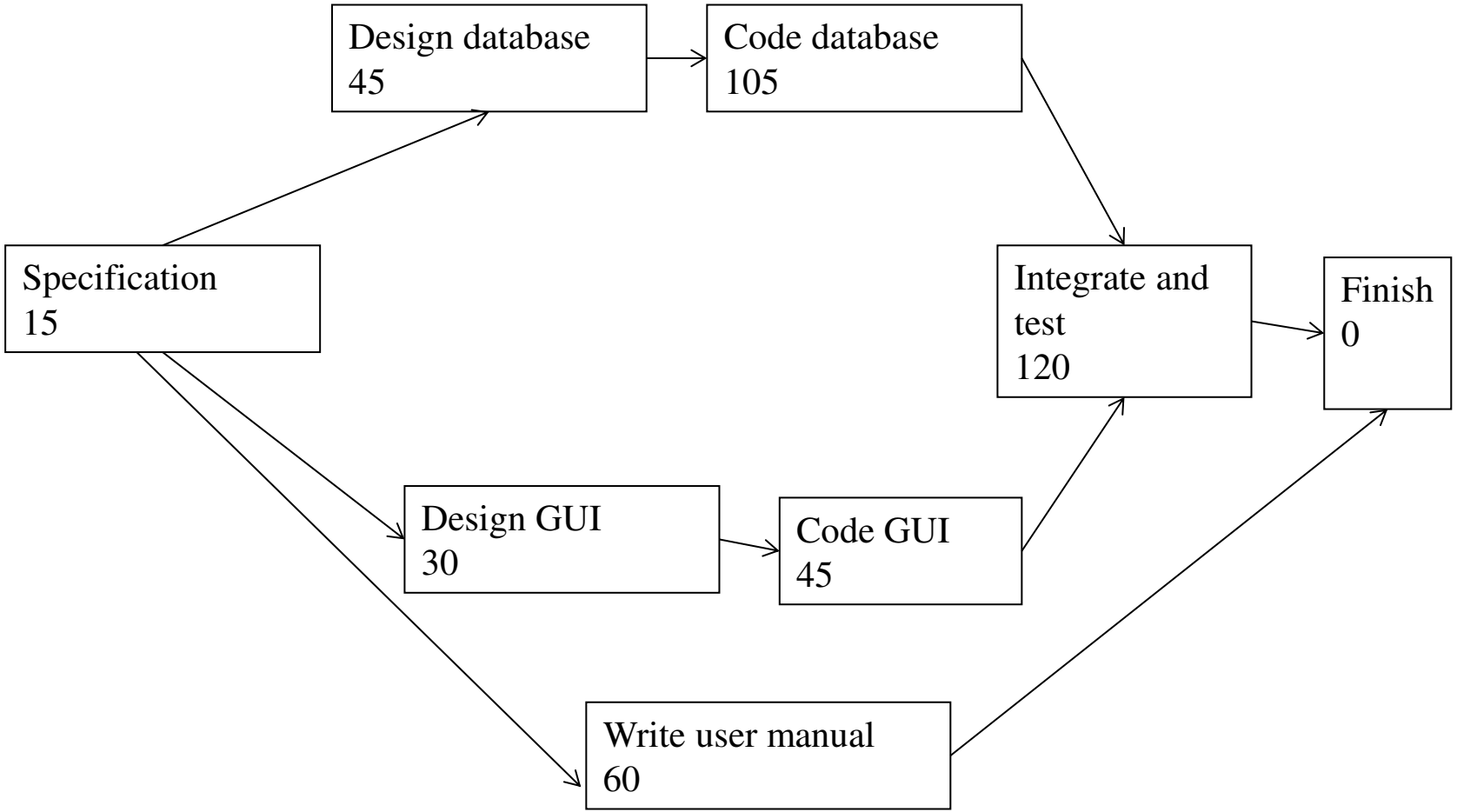
How do we work out the various start and finish times for tasks?

- Minimum time to complete project (MT) = Maximum of all paths from start to finish
- Earliest start time (ES) of a task = Maximum of all paths from start to this task
- Earliest finish time (EF) of a task = ES + duration of the task
- Latest finish time (LF) of a task = MT - Maximum of all paths from this task to finish
- Slack time = LS - ES = LF - EF

What are the float time (or slack time) of tasks?

- Float time (or slack time) is the total time that a task may be delayed
  - before it will affect the end time of the project.
- The float times indicate the "flexibility" in starting and completion of tasks:
- A critical activity is an activity with zero (0) slack or float time.

Example - Activity Network for MIS



Activity on Node Network

- Activities are represented as nodes (boxes).
- The lines between nodes represent dependencies.

Example: MIS problem

- Compute ES and EF for each task
  - Use the rule: ES is equal to the largest EF of the immediate predecessors
- Compute LS and LF for each task
  - Use the rule: LF is equal to the smallest LS of the immediate successors
- Compute ST for each task
  - Use the rule: ST=LF-EF

Project parameters (ES & EF) for MIS problem

Task	ES	EF
Specification	0	15
Design data base	15	60
Design GUI part	15	45
Code data base	60	165
Code GUI part	45	90
Integrate and test	165	285
Write user manual	15	75

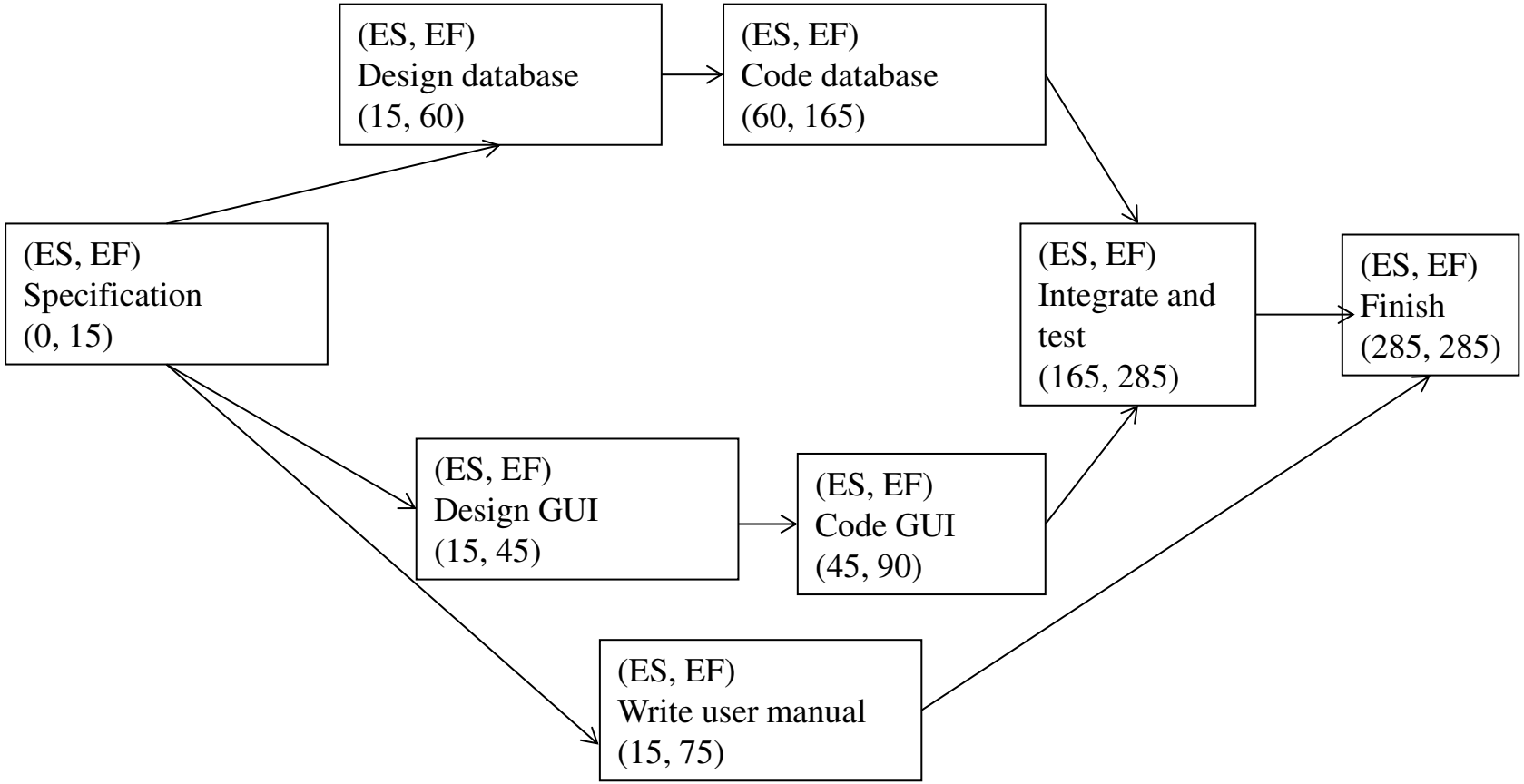
Project parameters (LS & LF) for MIS problem

Task	LS	LF
Specification	0	15
Design data base	15	60
Design GUI part	90	120
Code data base	60	165
Code GUI part	120	165
Integrate and test	165	285
Write user manual	225	285

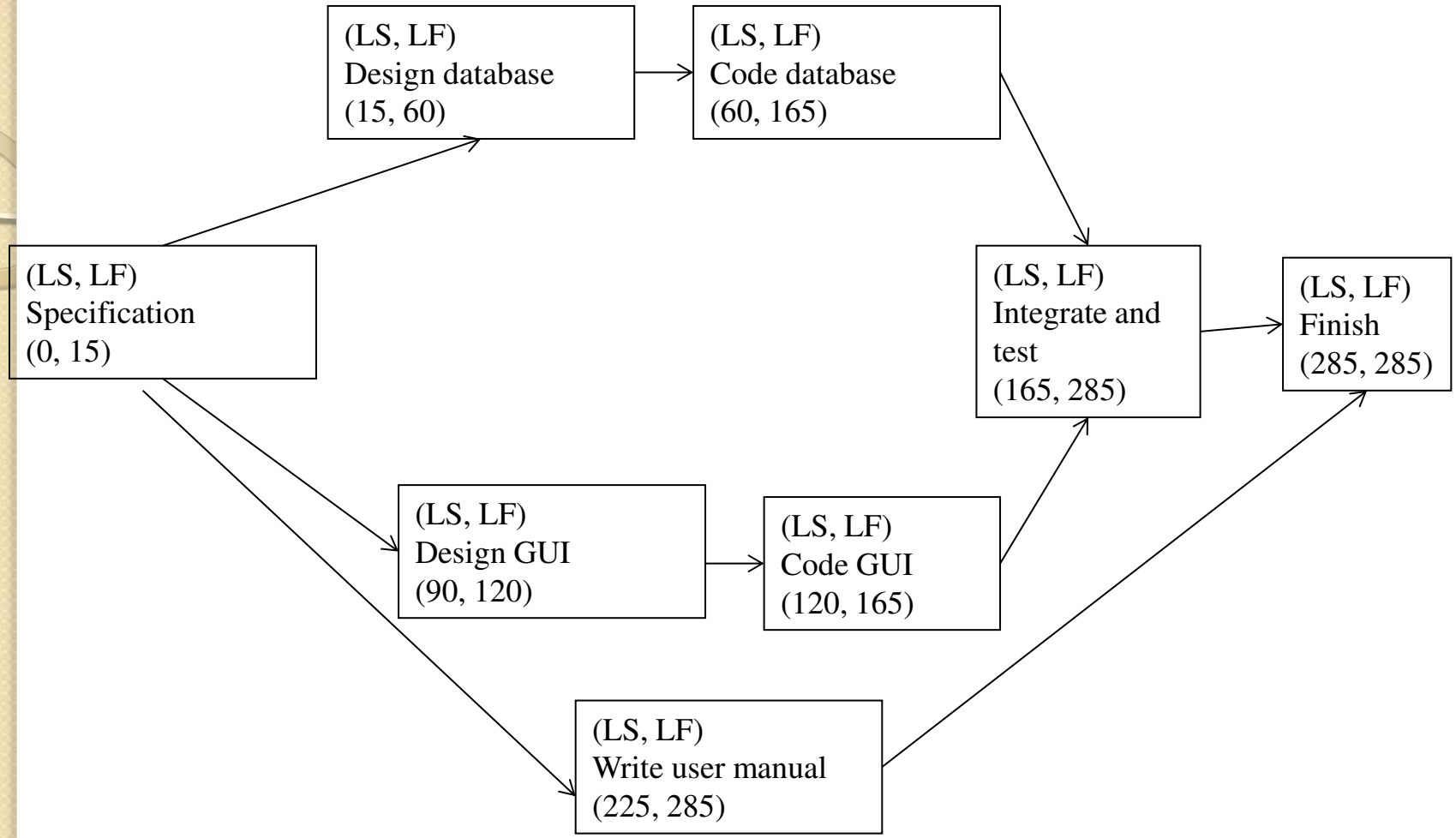
Slack Times for MIS problem

Task	ES	EF	LS	LF	ST
Specification	0	15	0	15	0
Design data base	15	60	15	60	0
Design GUI part	15	45	90	120	75
Code data base	60	165	60	165	0
Code GUI part	45	90	120	165	75
Integrate and test	165	285	165	285	0
Write user manual	15	75	225	285	210

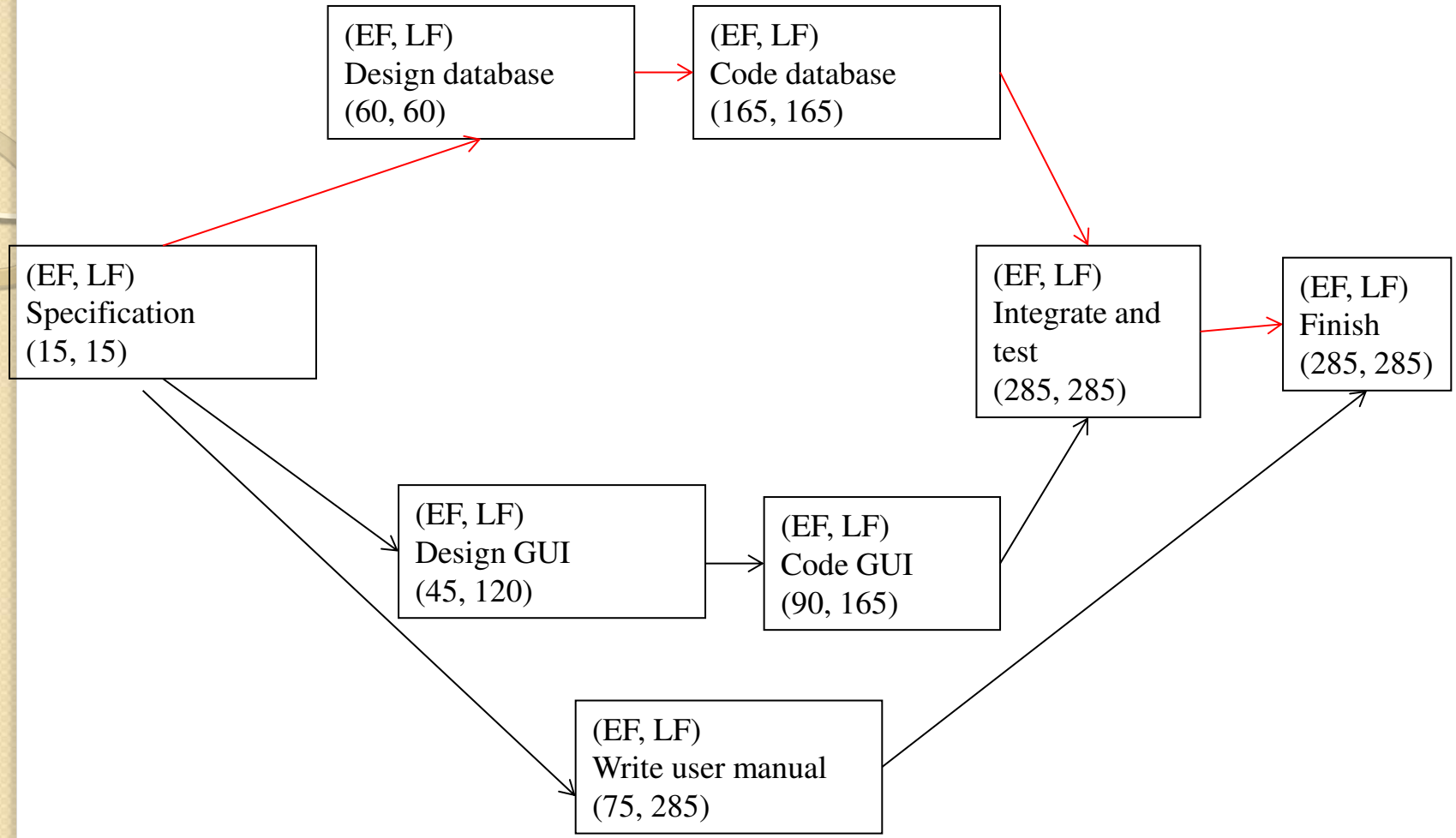
ES and EF for MIS problem



LS and LF for MIS problem



Critical Path for MIS problem



Summary

- We have discussed Critical Path Method (CPM).
- Solved an example to find the critical path.

References :

1. B. Hughes, M. Cotterell, R. Mall, *Software Project Management*, Sixth Edition, McGraw Hill Education (India) Pvt. Ltd., 2018.
2. R. Mall, *Fundamentals of Software Engineering*, Fifth Edition, PHI Learning Pvt. Ltd., 2018.

Thank you