Lecture #22

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Graphs & Networks

- Subgraphs
- Graph coloring
- Activity networks
- Route problems
- Network flow
- Visibility graph problems
- Covering problems

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Project Management

- Service organizations have to take on large, complex projects at some point
  - An airline opening new routes or pulling a jumbo jet out of service for major maintenance – large expenses if tasks are delayed
  - Department store – installing new inventory control system – lost sales and large ordering costs if timetables unmet
  - A hospital modernizing operating rooms

Project Management

- Elements:
  - Planning
  - Scheduling
  - Control
- Aid to planning – work breakdown structure (WBS), which is a hierarchical tree – tasks required to achieve the objective
- Divides work into manageable components such as tasks, subtasks, and work elements

WBS

1.0 Move the hospital (Project)
- 1.1 Move patients (Task)
  - 1.1.1 Arrange for ambulance (Subtask)
    - 1.1.1.1 Prepare patients for move
    - 1.1.1.2 Box patients personnel effects
- 1.2 Move furniture
  - 1.2.1. Contract with moving company
    - •
    - •
    - •

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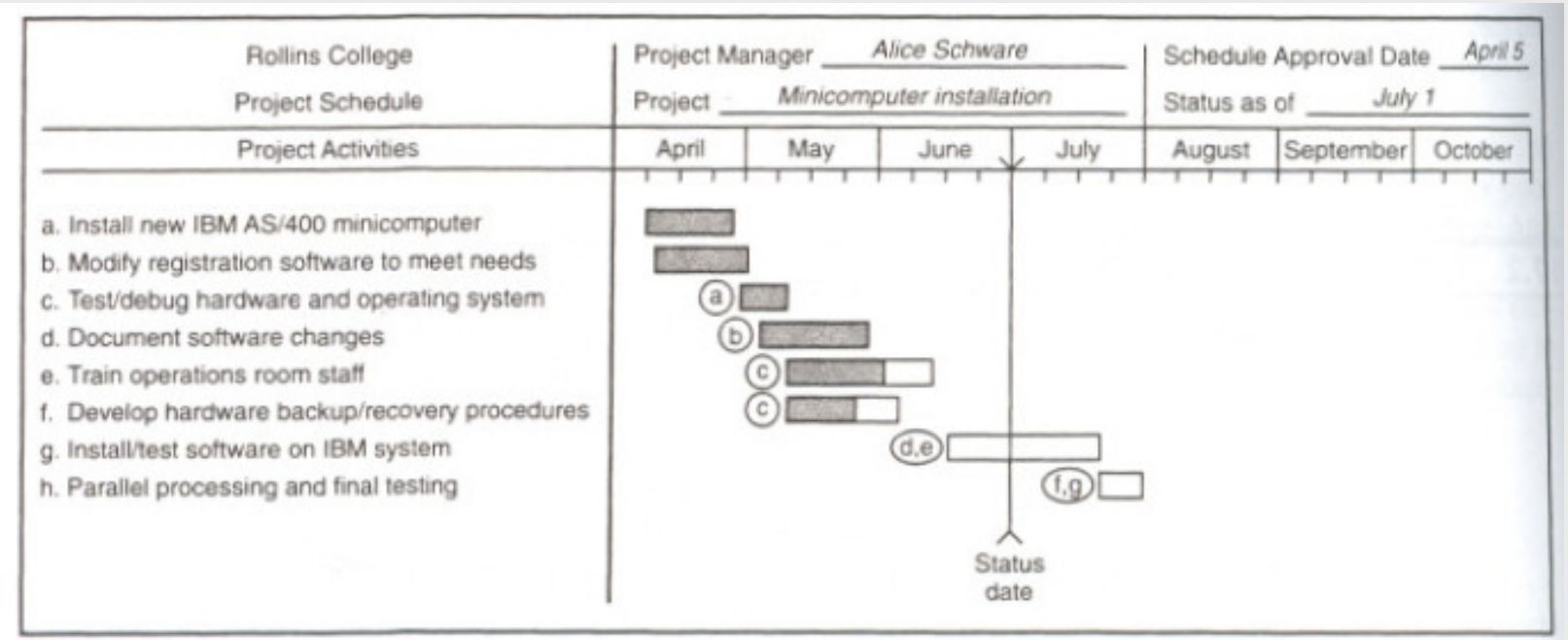
Project Scheduling

- Project Scheduling: determine the project activities in the time sequence in which they have to be performed
- Materials and people needed at each stage of production are computed, and the time each activity will take is also determined
  - Gantt charts

Gantt Chart



Circled items represent precedence relationships (for example, activity c, test/debug hardware, may not begin until activity a, which is circled, is completed).

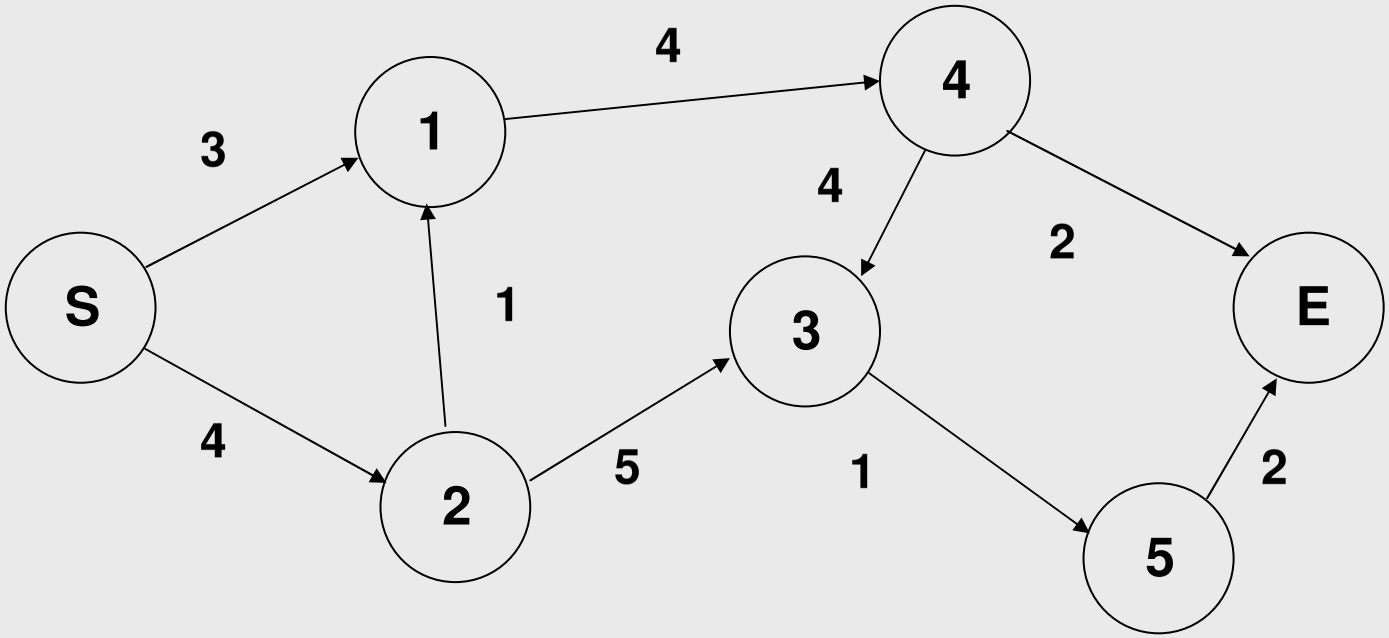
- Reflects time estimates and can be easily understood
- Horizontal bars for each activity
- Letters on left of each bar – activities that precede it

Project Scheduling

- Gantt charts not easily updated
- Don't adequately illustrate interrelationships between activities and resources
- CPM (Critical Path Method) & PERT (Program Evaluation Review Technique) are two widely used network techniques – they have the ability to consider precedence relationships and interdependency of activities

Activity Network

- Arcs – activities
- Nodes – events
- Event – requires completion all events



Critical Path Method

- CPM is an approach to determine the start and finish dates for individual activities in a project
- A result of this method is the identification of a critical path, or chain of crucial activities throughout project

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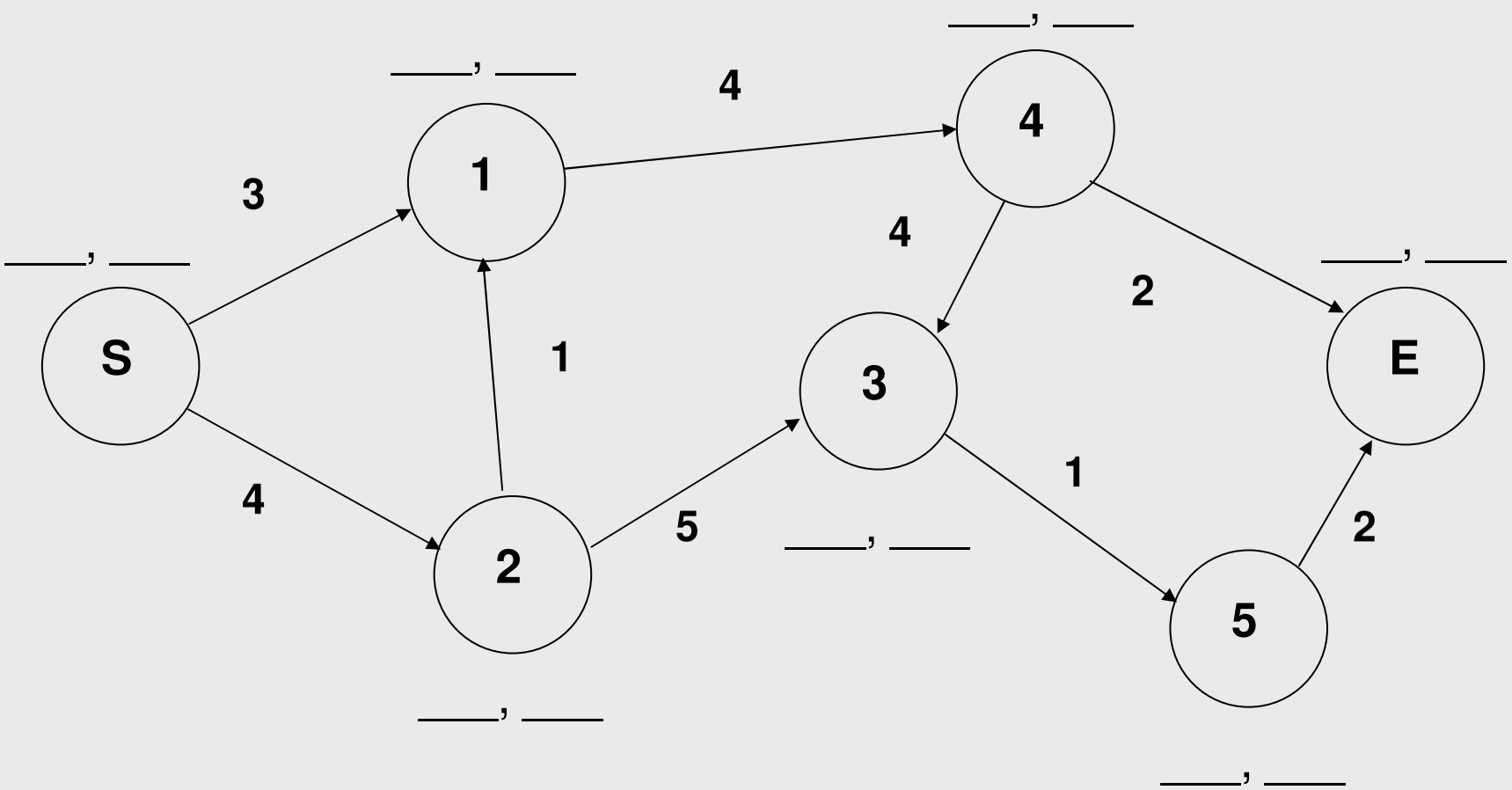
CPM



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Critical Path Method

Item	Symbol	Definition
Activity duration	*t*	The expected duration of an activity
Early start	*ES*	The earliest time an activity can begin if all previous activities are begun at their earliest times
Early finish	*EF*	The earliest time an activity can be completed if it is started at its early start time
Late start	*LS*	The latest time an activity can begin without delaying the completion of the project
Late finish	*LF*	The latest time an activity can be completed if it is started at its latest start time
Total slack	*TS*	The amount of time an activity can be delayed without delaying the completion of the project

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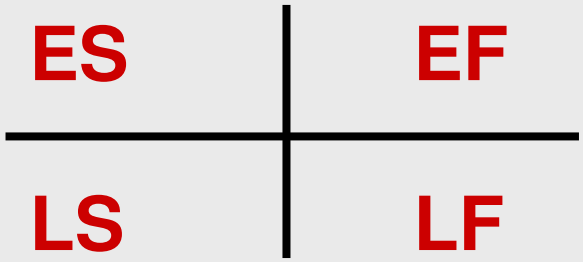
Critical Path Method

	$ES = EF_{predecessor}$	(max)	(1)
	$EF = ES + t$		(2)
	$LF = LS_{successor}$	(min)	(3)
	$LS = LF - t$		(4)
	$TS = LF - EF$		(5)
or	$TS = LS - ES$		(6)

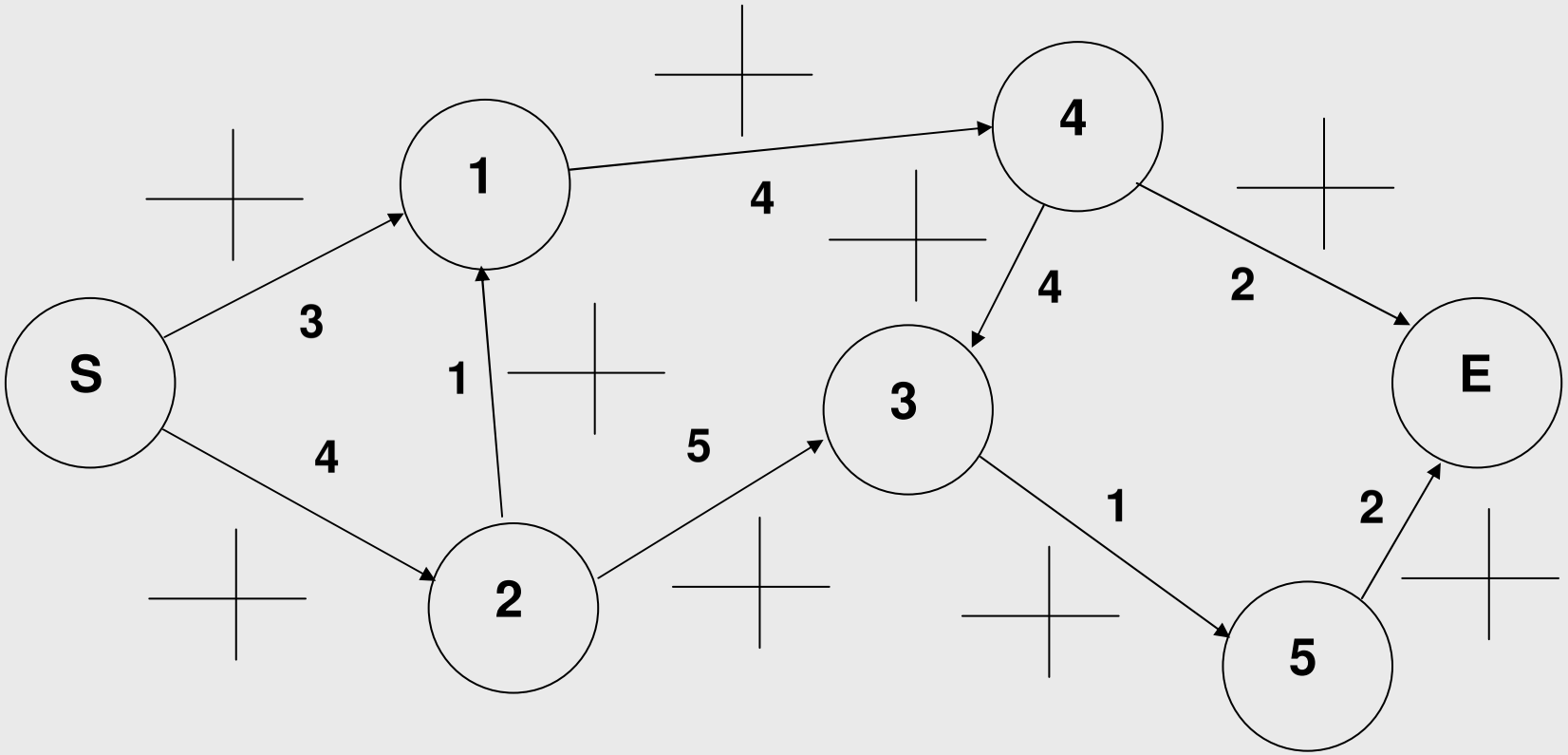
More on CPM

- Associated with each activity is a cross to be filled in with the activity schedule times, which are calculated as follows:

$$TS = LS - ES$$



More CPM



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More on Activity Networks

- In many cases t values are assumed to be deterministic (i.e., constant)
- In other cases, expected duration is mean of known probability distributions
- PERT Approach – Beta Dist.
  - 3 time estimates
  - Most likely time (M), optimistic time (O), and pessimistic time (P)
  - For each activity: Mean = (O + 4M + P) / 6
  - For each activity: Std Dev = (P – O) / 6
  - Add variances along path
  - End up with Mean and S.D. of Completion Time