Management

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Project management

the process of shepherding a project from start to finish, including

- planning the sequence of actions to be taken
- defining milestones
- assigning roles to people
- fostering team spirit
- tracking progress
- making adjustments to plans as needed
- reporting to upper management

Milestones vs. millstones

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Brooks' "Hatching a Catastrophe"

- There is a very small difference between a "milestone" and a "millstone"
  - **Milestone**: measures how far we've gone, encourages workers.
  - **Millstone** (around the neck): impedes progress by frustrating workers.
- Game of management: create milestones, not millstones.

Encouraging spirit

- Milestones, not millstones.
- Reward excellence; don't punish shortcomings.
- Match domain of change with domain of responsibility
- Keep the team focused on the mission.
- Remind them of the big picture.
- Manage "without them"

Some illusions of management

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Some illusions of management

- Managers and programmers think they can do each others' jobs.
- Steven Barley: This is **false**! Management and programming take **different skill sets**.
- Management: the big picture
- Programming: the details.

Basics of task management

- Define tasks to be done.
- Estimate time for each task.
- Define precedences between tasks (i.e., what tasks have to be completed before a task starts).
- Estimate project schedule by analyzing task graph.
- Make adjustments as project continues.

Just like cost analysis

- At the end, you have a perfect time estimate!
- As the project progresses, time estimates become more accurate.

Critical Path Method

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Critical Path Method

- A basic tool for project management
- Express task precedences as a **task graph**.
- A -> B means A should precede B.
- Start node: when project starts.
- End node: when project is finished.

Definitions

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Definitions

- **Duration**: how long it takes to do a task.
- **Earliest start time**: earliest time a task can be started = max of earliest completion times for prerequisites.
- **Latest start time**: latest time a task can be started and still finish with minimum completion time for project.
- **Earliest completion time**: earliest start time + task duration.
- **Latest completion time**: latest start time + task duration.
- **Slack time**: latest completion time - earliest completion time = latest start time - earliest start time.

A task is critical if its earliest start time is its latest start time, i.e., slack time = 0!

The critical path theorem

- **Critical tasks do not occur in isolation, but instead lie on a critical path from start to finish.**
- There may be multiple critical paths.
- If any task on a critical path changes in duration, the whole project duration can change.

The critical path algorithm

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The critical path algorithm

Objective: **compute slack time** for every task.

Two phases: **forward scan** and **backward scan**.

Forward scan: complete **earliest** completion time.

Backward scan: compute **latest** completion time.

A task graph

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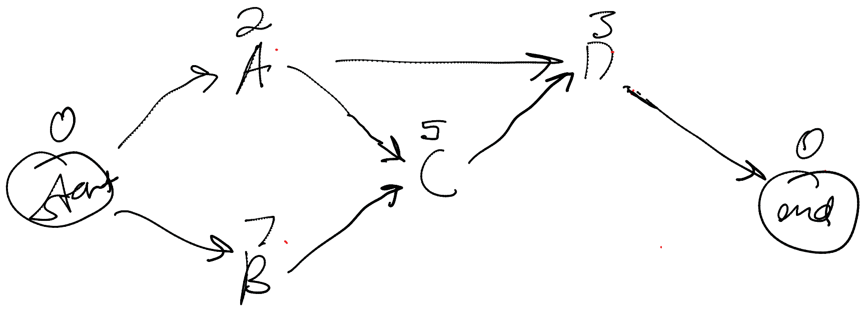

A task graph has a start, end, and intermediate tasks.

Forward algorithm

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Forward scan:

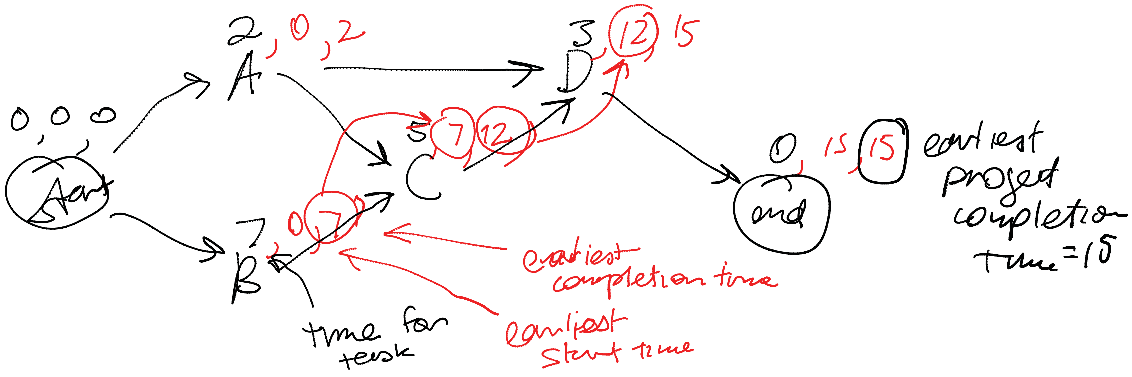
Label each task with its time.

Mark start's earliest start time and earliest completion time as 0.

From left to right (start to finish),

- If a task's predecessors are marked with their earliest completion times,
    - its earliest start time is the **maximum** of **predecessor earliest completion times** and
    - its earliest completion time is its earliest start time plus its duration.

At the end, every node is labeled with its earliest start and completion times.



Start at beginning
Compute earliest start time and earliest completion time.

Backward algorithm

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Backward scan:

Mark end's latest start time and latest completion time as its earliest start time and completion time.

From right to left (finish to start),

- If a task's **successors** are marked with latest start time,
    - □ its **latest completion time** is the **minimum** of **successor latest start times** and
    - □ its latest start time is its latest completion time minus its duration.

At the end, every node is labeled with its latest start and completion times.

Backward scan example

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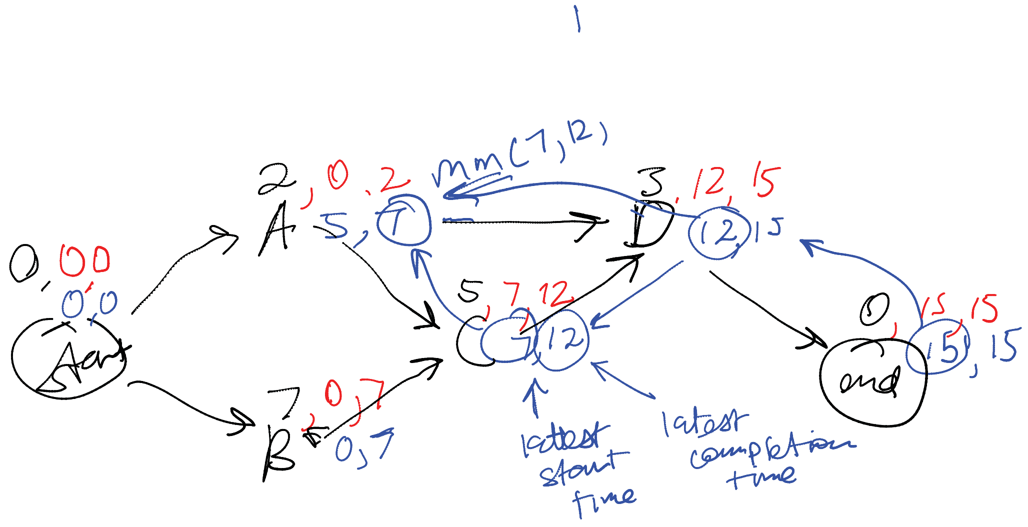

Start at end
Compute latest completion and start times from end to beginning

The critical path

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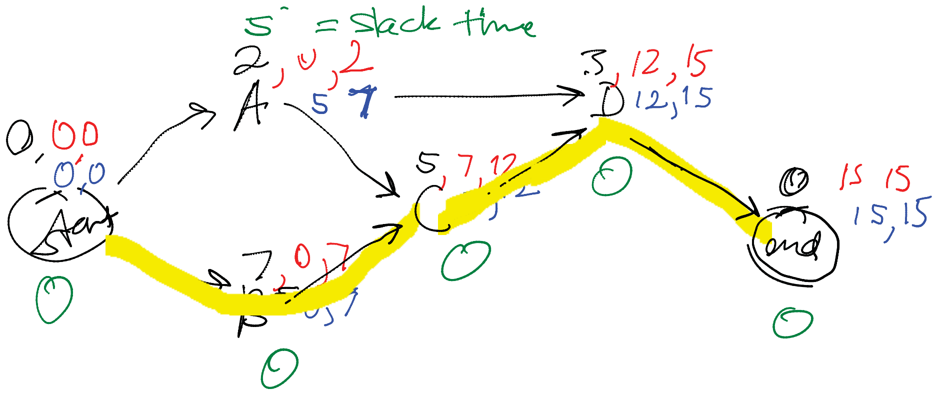

A critical path has earliest start time = latest start time.

Every path is critical

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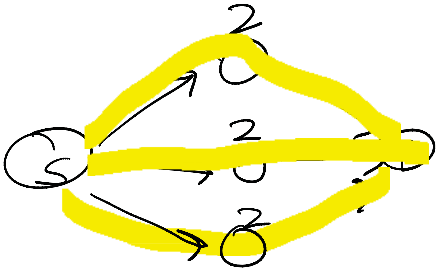

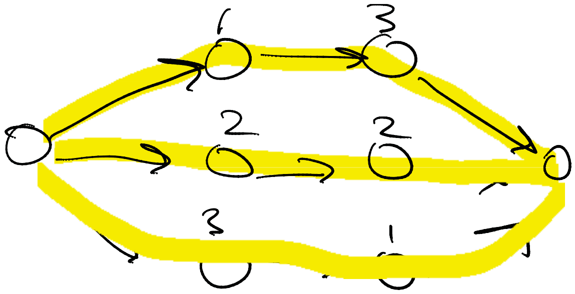

Criticality

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Task criticality determines

- Which estimates have to be the **most accurate**.
- How accurate other estimates have to be to stay on schedule.

CPM and PERT

- CPM: Critical Path Method
  - input: task times and precedences
  - output: minimum completion time, slack time, etc.
- PERT: Program Evaluation and Review Technique
  - input: task time probability distributions and precedences
  - output: probability distribution of minimum completion time, slack time, etc.

How (advanced) PERT works

- Assign a normally-distributed probability distribution $n(\mu,\sigma)$ to each task:
  - μ=mean completion time
  - σ=standard deviation of completion time
  - $n(\mu,\sigma)(t) = \exp(-(t-\mu)^2/\sigma^2)$
- Compute the PDF of the earliest start time and latest start time from the PDF of the task completion times!

If we have two tasks in sequence, and they're independent, then the probability that the two take time t is the integral of the product of PDF(t1)*PDF(t2), for all t=t1+t2 (convolution)

Displaying progress

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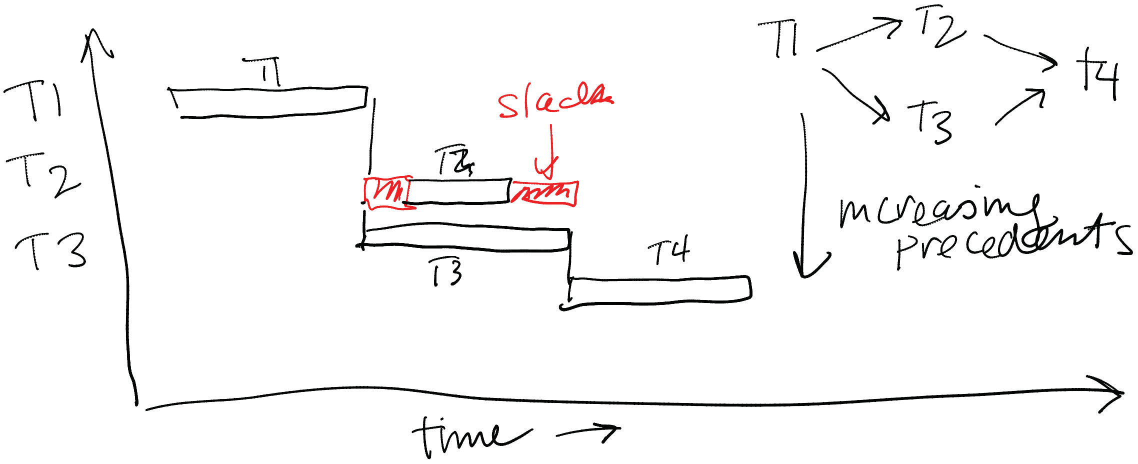
Displaying progress

- Common tool for displaying progress: GANTT chart
- Project tasks are on Y.
- Elapsed time is on X.
- Durations are marked as shaded boxes.


T1
T2
T3
T1
T2
slack
T3
T4
time →
T1
T2
T3
T4
increasing precedents