PERT/CPM

- PERT
  - Program Evaluation and Review Technique
  - Developed by U.S. Navy for Polaris missile project
  - Developed to handle uncertain activity times
- CPM
  - Critical Path Method
  - Developed by Du Pont & Remington Rand
  - Developed for industrial projects for which activity times generally were known
- Today's project management software packages have combined the best features of both approaches.

PERT/CPM

- PERT/CPM is used to plan the scheduling of individual <u>activities</u> that make up a project.
- Projects may have as many as several thousand activities.
- A complicating factor in carrying out the activities is that some activities depend on the completion of other activities before they can be started.

PERT/CPM

- Project managers rely on PERT/CPM to help them answer questions such as:
  - What is the <u>total time</u> to complete the project?
  - What are the <u>scheduled start and finish dates</u> for each specific activity?
  - Which activities are <u>critical</u> and must be completed exactly as scheduled to keep the project on schedule?
  - How long can <u>noncritical activities</u> be delayed before they cause an increase in the project completion time?

Project Network

- A project network can be constructed to model the precedence of the activities.
- The nodes of the network represent the activities.
- The arcs of the network reflect the precedence relationships of the activities.
- A critical path for the network is a path consisting of activities with zero slack.

Example: Frank's Fine Floats

Frank's Fine Floats is in the business of building elaborate parade floats. Frank and his crew have a new float to build and want to use PERT/CPM to help them manage the project .

The table on the next slide shows the activities that comprise the project. Each activity's estimated completion time (in days) and immediate predecessors are listed as well.

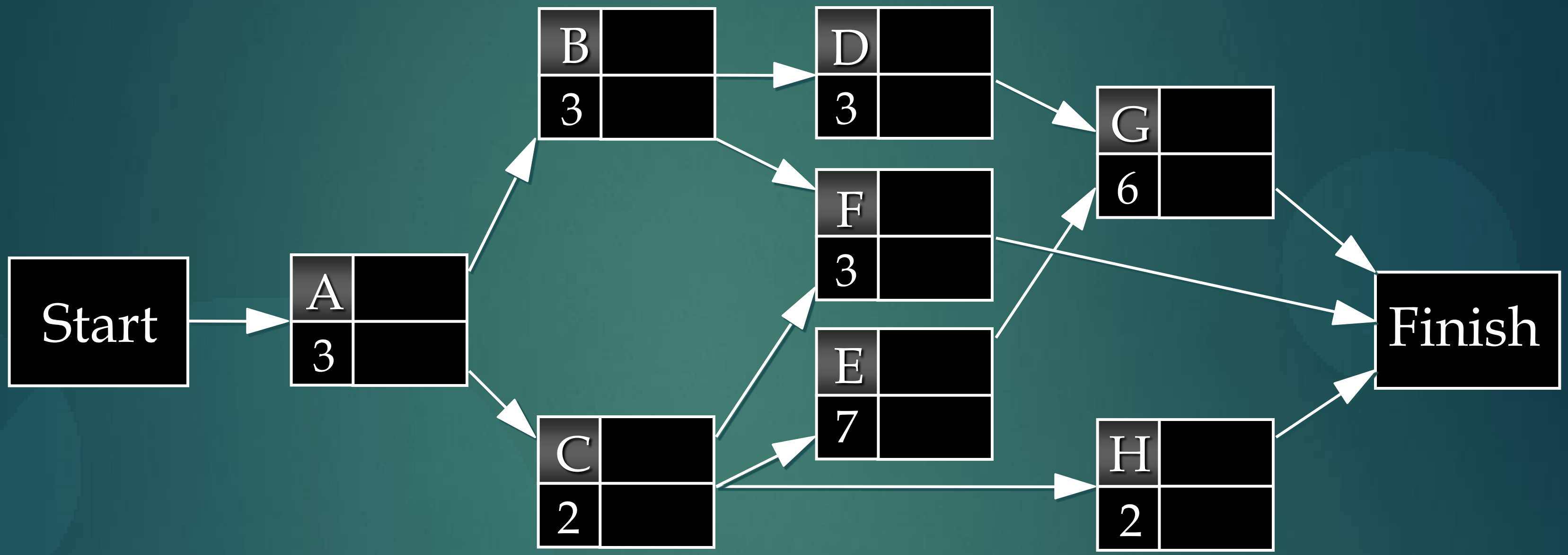
Frank wants to know the total time to complete the project, which activities are critical, and the earliest and latest start and finish dates for each activity.

Example: Frank's Fine Floats

Activity	Description	Immediate Predecessors	Completion Time (days)
A	Initial Paperwork	---	3
B	Build Body	A	3
C	Build Frame	A	2
D	Finish Body	B	3
E	Finish Frame	C	7
F	Final Paperwork	B,C	3
G	Mount Body to Frame	D,E	6
H	Install Skirt on Frame	C	2

Example: Frank's Fine Floats

- Project Network



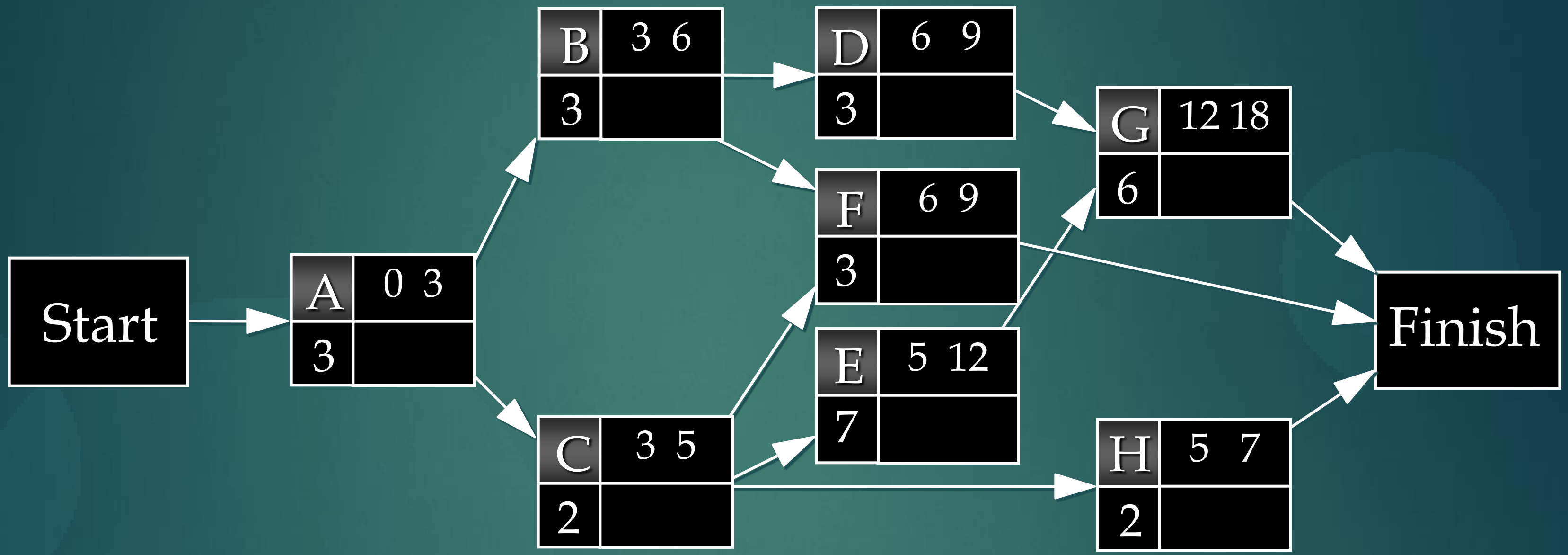
Earliest Start and Finish Times

- Step 1: Make a forward pass through the network as follows: For each activity *i* beginning at the Start node, compute:
  - Earliest Start Time = the maximum of the earliest finish times of all activities immediately preceding activity *i*. (This is 0 for an activity with no predecessors.)
  - Earliest Finish Time = (Earliest Start Time) + (Time to complete activity *i*).

The project completion time is the maximum of the Earliest Finish Times at the Finish node.

Example: Frank's Fine Floats

- Earliest Start and Finish Times

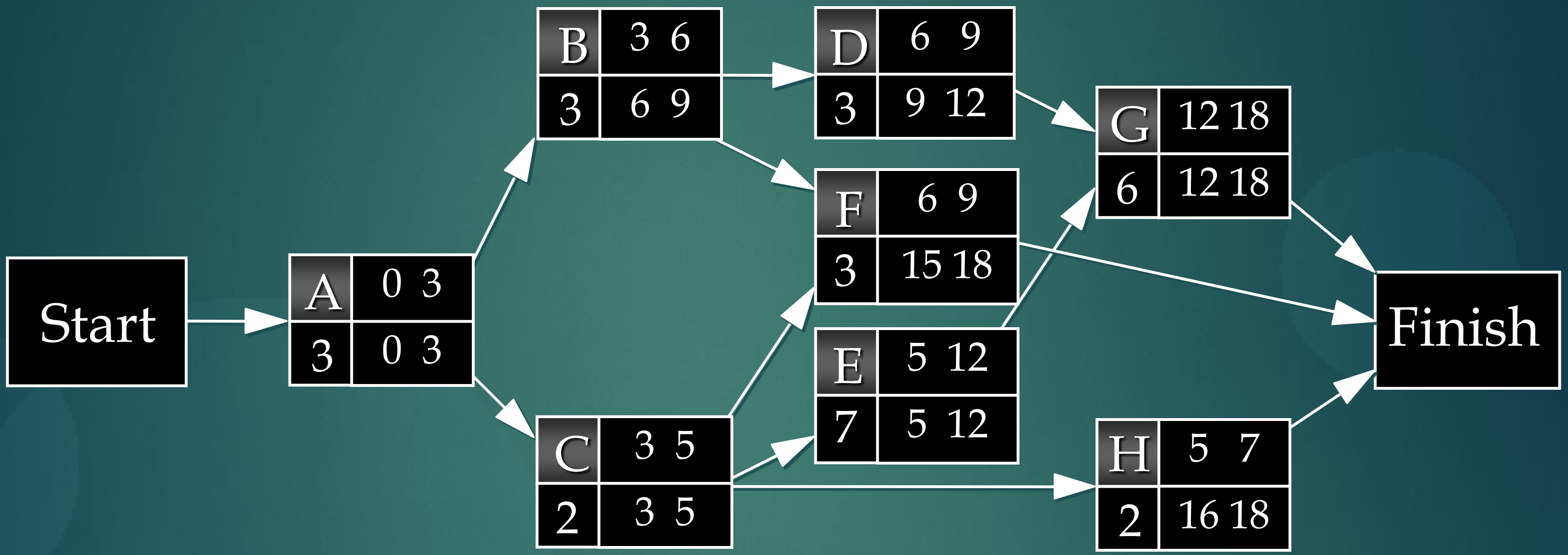


Latest Start and Finish Times

- Step 2: Make a backwards pass through the network as follows: Move sequentially backwards from the Finish node to the Start node. At a given node, *j*, consider all activities ending at node *j*. For each of these activities, *i*, compute:
  - Latest Finish Time = the minimum of the latest start times beginning at node *j*. (For node *N*, this is the project completion time.)
  - Latest Start Time = (Latest Finish Time) - (Time to complete activity *i*).

Example: Frank's Fine Floats

- Latest Start and Finish Times



Determining the Critical Path

- Step 3: Calculate the slack time for each activity by:

  Slack = (Latest Start) - (Earliest Start), or

  = (Latest Finish) - (Earliest Finish).

Example: Frank's Fine Floats

- Activity Slack Time

Activity	ES	EF	LS	LF	Slack
A	0	3	0	3	0 (crit.)
B	3	6	6	9	3
C	3	5	3	5	0 (crit.)
D	6	9	9	12	3
E	5	12	5	12	0 (crit.)
F	6	9	15	18	9
G	12	$\boxed{18}$	12	18	0 (crit.)
H	5	7	16	18	11

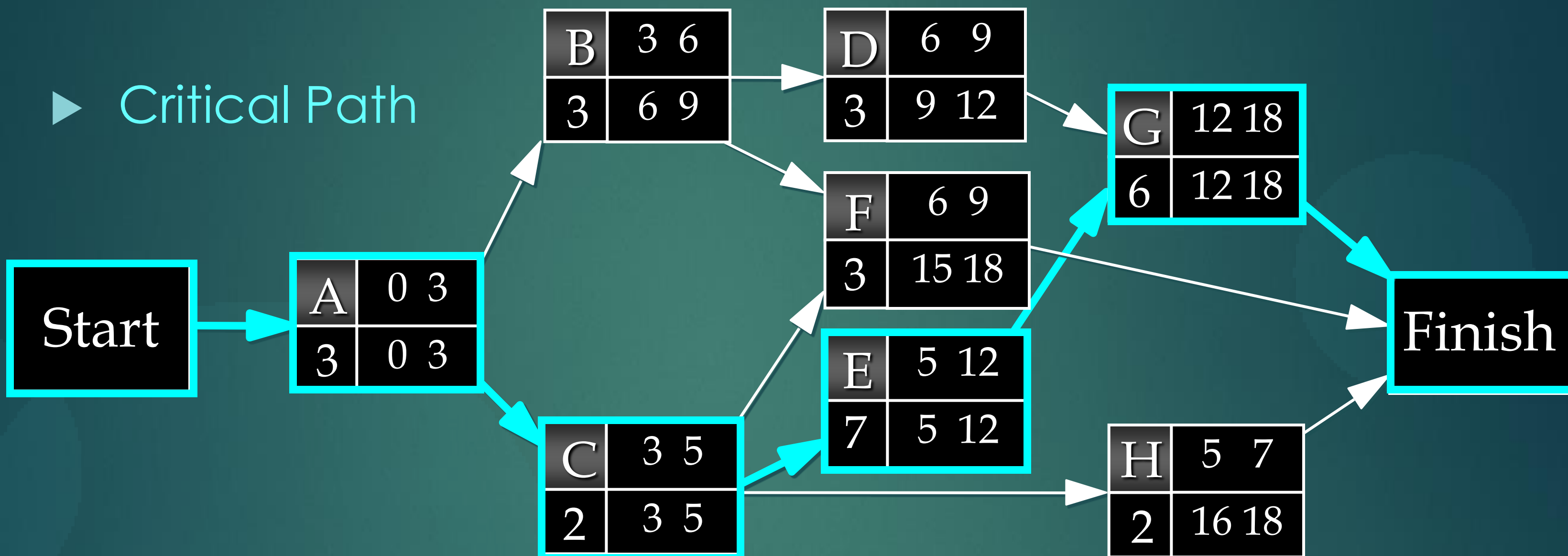
Example: Frank’s Fine Floats

- Determining the Critical Path

  - A critical path is a path of activities, from the Start node to the Finish node, with 0 slack times.
  - Critical Path: A – C – E – G
  - The project completion time equals the maximum of the activities’ earliest finish times.
  - Project Completion Time: 18 days

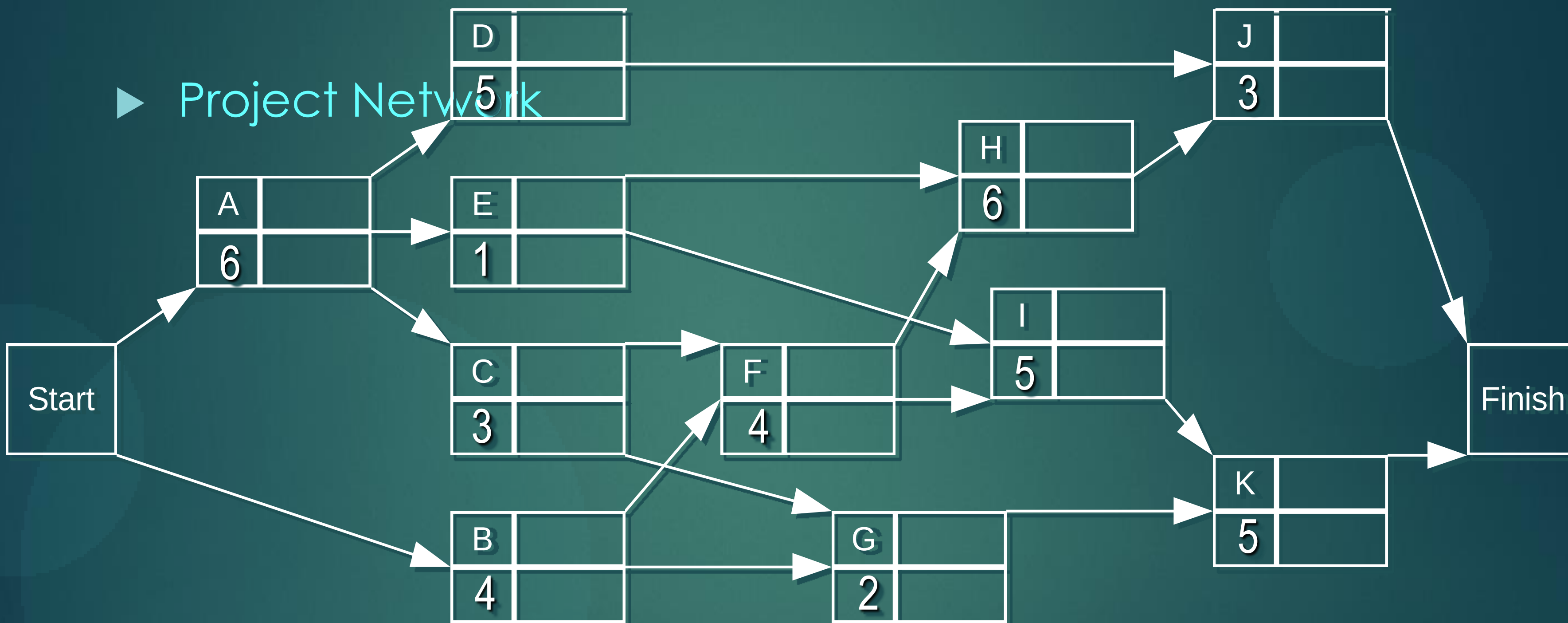
Example: Frank's Fine Floats

- Critical Path



Example: ABC Associates

- Project Network



Example: ABC Associates

- Earliest/Latest Times and Slack

Activity	ES	EF	LS	LF	Slack
A	0	6	0	6	0 *
B	0	4	5	9	5
C	6	9	6	9	0 *
D	6	11	15	20	9
E	6	7	12	13	6
F	9	13	9	13	0 *
G	9	11	16	18	7
H	13	19	14	20	1
I	13	18	13	18	0 *
J	19	22	20	23	1
K	18	$\boxed{23}$	18	23	0 *

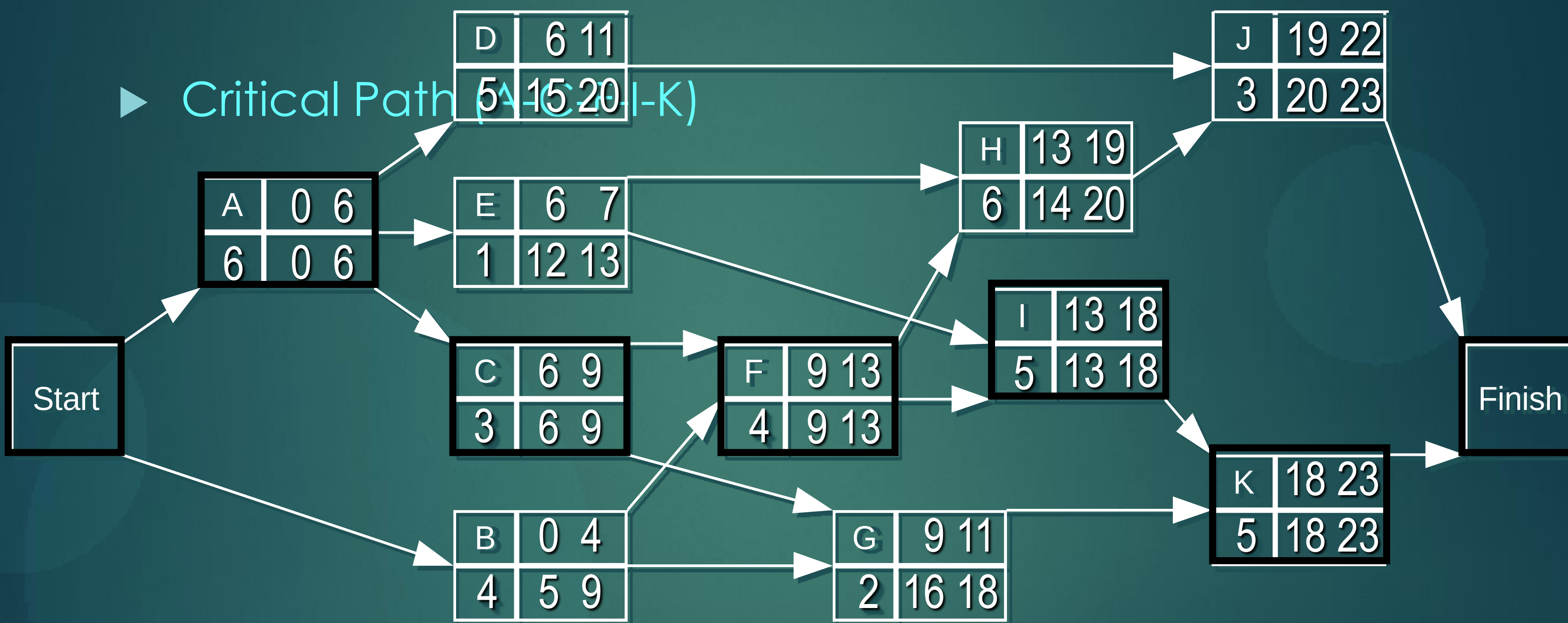
Example: ABC Associates

- Determining the Critical Path

  - A critical path is a path of activities, from the Start node to the Finish node, with 0 slack times.
  - Critical Path: A – C – F – I – K
  - The project completion time equals the maximum of the activities' earliest finish times.
  - Project Completion Time: 23 hours

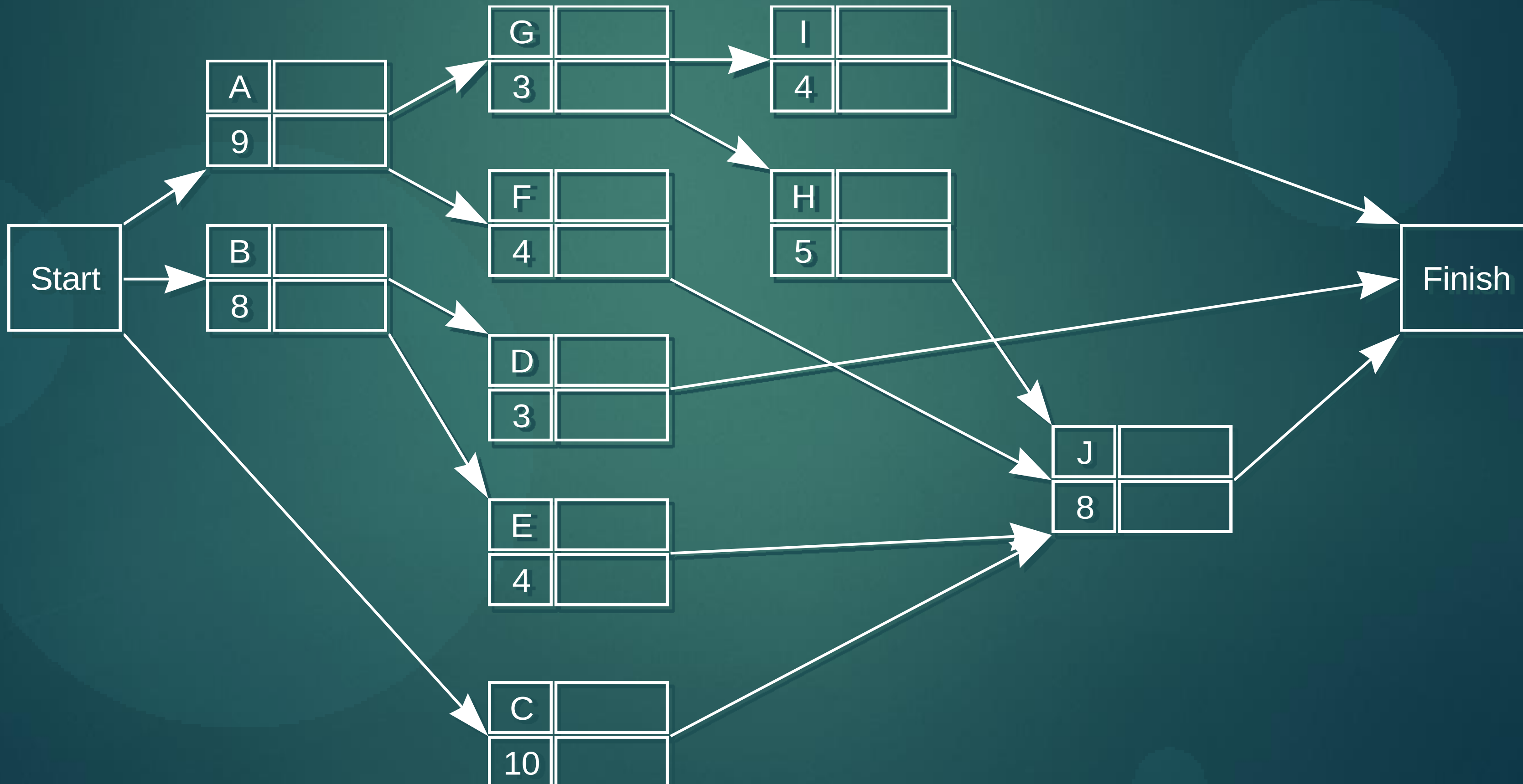
Example: ABC Associates

- Critical Path (A-C-F-I-K)



Example: How Are We Doing?

- Consider the following project network:



Example: How Are We Doing?

- Earliest/Latest Times

Activity	ES	EF	LS	LF	Slack
A	0	9	0	9	0 *
B	0	8	5	13	5
C	0	10	7	17	7
D	8	11	22	25	14
E	8	12	13	17	5
F	9	13	13	17	4
G	9	12	9	12	0 *
H	12	17	12	17	0 *
I	12	16	21	25	9
J	17	$\boxed{25}$	17	25	0 *