

# AL FM Discrete

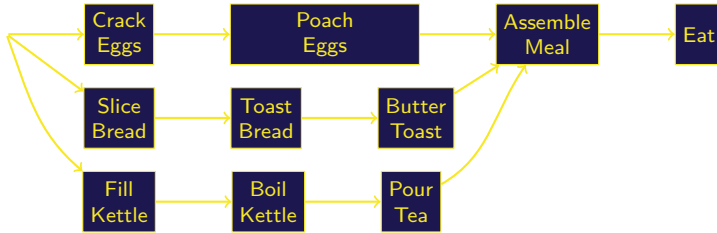
## Critical Path Analysis: Activity Networks

Who? T. Bretschneider

When? April 27, 2021

# Outline

# Eating Breakfast



You want to make and eat your breakfast in the shortest time possible.

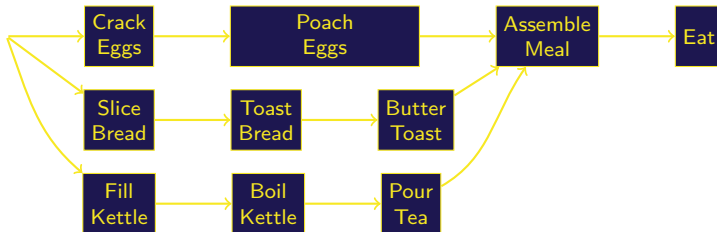
Problem

*Why should you crack the eggs immediately.*

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*Why is there some flexibility in when you start slicing the bread.*

## Eating Breakfast



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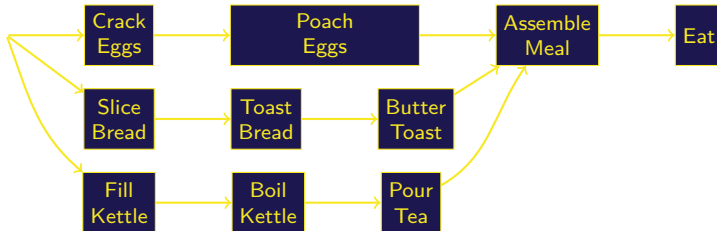
Solution

*Because without cracking the eggs you cant start poaching them and this will put back the time of assembling and eating the meal.*

Problem

*Why is there some flexibility in when you start slicing the bread.*

## Eating Breakfast



You want to make and eat your breakfast in the shortest time possible.

**Problem** *Why should you crack the eggs immediately.*

**Solution** *Because without cracking the eggs you cant start poaching them and this will put back the time of assembling and eating the meal.*

**Problem** *Why is there some flexibility in when you start slicing the bread.*

**Solution** *Because as long as the toast is buttered in time to assemble the meal then it doesn't.*

# Precedence Table and Activity Networks I

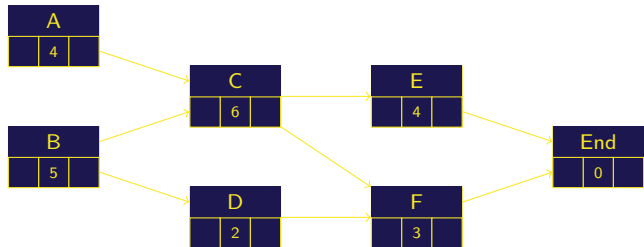
## Definition

A **precedence table** shows the duration of activities and their dependence on each other.

Activity	Immediately preceding activities	Duration / hours
A	—	4
B	—	5
C	A,B	6
D	B	2
E	C	4
F	C,D	4
F	C,D	3

## Definition

We can translate a precedence table into an **activity network** where the directed arcs represent a dependence on a preceding activity.



## Precedence Table and Activity Networks II

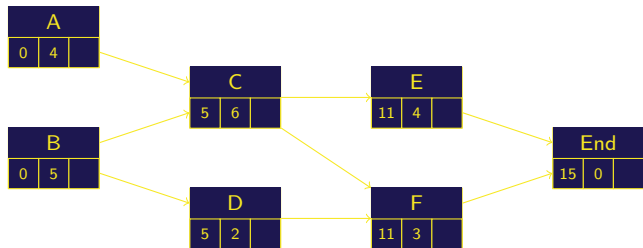
Note that the middle box is for the duration and we shall see that the left and right boxes are for the earliest start time and latest finish time respectively.

# Determining Earliest Start Times

## Definition

Make a 'forward pass' through the network moving onto an activity when all of its preceding activities have been completed.

The **earliest start time** is the maximum of the earliest start times + duration of all the preceding activities.



Activities that don't depend on any others can all start at the beginning and hence get a 0 in the 'Earliest Start Time' box.

The minimum completion time for this activity is therefore 15 hours.

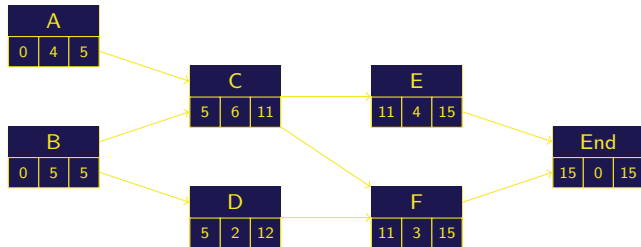


# Determining the Latest Finish Times

## Method

We now make a 'backward' pass through the network to find the latest finish times if we are to complete the task in the minimum completion time.

Starting at the end, the latest finish time is the minimum of the latest finish time of any dependent activities subtract their duration.

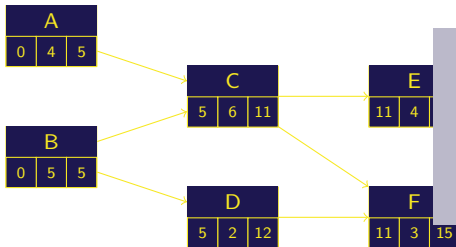


## Float I

**Definition** The **float** of an activity is the 'slack time'

$$\text{Float} = (\text{Latest Finish Time} - \text{Earliest Start Time}) - \text{Duration}.$$

**Definition** If an activity has no float it is called **critical**. In other words, if the activity is to finish in the minimum completion time, there is no flexibility about when this activity starts.



Activity	Float	Critical
A	1	No
B	0	Yes
C	0	Yes
D	5	No
E	0	Yes
F	1	No

**Definition** The critical activities for the **critical path** through the network. The length of the **critical path** is the minimum completion time of the project. Such a critical path will always exist, although there may be more than one but all critical paths will have the same length.

# Project Management

- The non-critical activities don't have to be undertaken in their minimum duration. This means that their duration can be increased without affecting the overall completion time of the project which will often decrease costs.
- More resource (e.g. more workers) can be invested in the critical activities, reducing their duration and speeding up the overall completion time.

## Reducing Cost

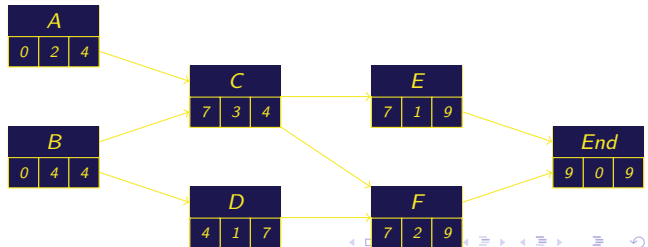
### Problem

What is the minimum extra cost from the original planned duration of this project so that it can be completed as quickly as possible?

Activity	Immediately preceding activities	Original Duration (in hours)	Cost of reducing duration by 1 hour
A		4	100
B		5	200
C	A,B	6	100
D	B	2	300
E	C	4	200
F	C,D	5	200

### Solution

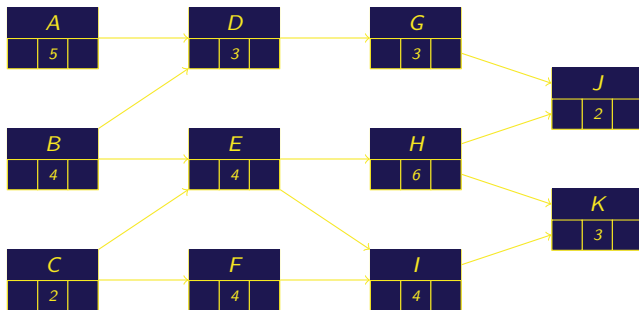
Activity network with the minimum duration:



## Past Paper Question 1

### Problem

*Deva Construction Ltd undertakes a small building project.*



- Complete the activity network for the building project.
- Deva Construction Ltd is able to reduce the duration of a single activity to 1 hour by using specialist equipment.  
State, with a reason, which activity should have its duration reduced to 1 hour in order to minimise the completion time for the building project.
- State one limitation in the building project used by Deva Construction Ltd.  
Explain how this limitation affect the project.

## Past Paper Question II

**Solution** *Reducing the duration of activity E to 1 reduces the project completion time to 14 hours, whereas all other activities reduce the project completion time to 15 hours or more.*

**Solution** *Time between one activity ending and the next starting is not taken into account, as workers may need to travel to a different location. The travelling time will cause subsequent activities to be delayed, increasing the project completion time.*