

# **UNIVERSITY INSTITUTE OF COMPUTING**

## **MASTER OF COMPUTER APPLICATIONS**

### **DESIGN AND ANALYSIS OF ALGORITHMS**

#### **24CAT-611**



**UNIT-2**

**DISCOVER . LEARN . EMPOWER**

# DESIGN AND ANALYSIS OF ALGORITHMS

## Course Outcome

CO Number	Title	Level
CO3	Apply and analyze important algorithmic design paradigms and their applications	Understand
CO4	Implement the major graph algorithms to model engineering problems	Understand

- **Divide and Conquer:** General method, Binary search, Advantages and disadvantages of divide and conquer, Decrease and conquer approach: Topological sort



# Topics to be covered

- Greedy Method
- Coin Change Problem
- Knapsack Problem
- Job Sequencing with deadlines



# Job sequencing Problem

- The sequencing of jobs on a single processor with deadline constraints is called as Job Sequencing with Deadlines.

Here-

- You are given a set of jobs.
- Each job has a defined deadline and some profit associated with it.
- The profit of a job is given only when that job is completed within its deadline.
- Only one processor is available for processing all the jobs.
- Processor takes one unit of time to complete a job.



# Job Sequencing Problem

## Approach to Solution-

- A feasible solution would be a subset of jobs where each job of the subset gets completed within its deadline.
- Value of the feasible solution would be the sum of profit of all the jobs contained in the subset.
- An optimal solution of the problem would be a feasible solution which gives the maximum profit.
- Complexity of this algorithm is  $O(n^2)$ .



## **Greedy Algorithm-**

- Greedy Algorithm is adopted to determine how the next job is selected for an optimal solution.
- The greedy algorithm described below always gives an optimal solution to the job sequencing problem-

## **Step-01:**

- Sort all the given jobs in decreasing order of their profit.



## Step-02:

- Check the value of maximum deadline.
- Draw a Gantt chart where maximum time on Gantt chart is the value of maximum deadline.

## Step-03:

- Pick up the jobs one by one.
- Put the job on Gantt chart as far as possible from 0 ensuring that the job gets completed before its deadline.



# Contd..

- Let us consider a set of given jobs as shown in the following table. We have to find a sequence of jobs, which will be completed within their deadlines and will give maximum profit. Each job is associated with a deadline and profit.

Job	J <sub>1</sub>	J <sub>2</sub>	J <sub>3</sub>	J <sub>4</sub>	J <sub>5</sub>
Deadline	2	1	3	2	1
Profit	60	100	20	40	20





# Contd...

- To solve this problem, the given jobs are sorted according to their profit in a descending order. Hence, after sorting, the jobs are ordered as shown in the following table.

Job	J <sub>2</sub>	J <sub>1</sub>	J <sub>4</sub>	J <sub>3</sub>	J <sub>5</sub>
Deadline	1	2	2	3	1
Profit	100	60	40	20	20



# Method to solve

- From this set of jobs, first we select  $J_2$ , as it can be completed within its deadline and contributes maximum profit.
- Next,  $J_1$  is selected as it gives more profit compared to  $J_4$ .
- In the next clock,  $J_4$  cannot be selected as its deadline is over, hence  $J_3$  is selected as it executes within its deadline.
- The job  $J_5$  is discarded as it cannot be executed within its deadline.
- Thus, the solution is the sequence of jobs ( $J_2, J_1, J_3$ ), which are being executed within their deadline and gives maximum profit.
- Total profit of this sequence is  $100 + 60 + 20 = 180$ .



# Example

Jobs	J1	J2	J3	J4	J5	J6
Deadlines	5	3	3	2	4	2
Profits	200	180	190	300	120	100

Fig 1: Example of job sequencing problem

## Step-01:

Sort all the given jobs in decreasing order of their profit-

Jobs	J4	J1	J3	J2	J5	J6
Deadlines	2	5	3	3	4	2
Profits	300	200	190	180	120	100

Fig 2: Profit in decreased order



# Contd...

## Step-02:

Value of maximum deadline = 5.

So, draw a Gantt chart with maximum time on Gantt chart = 5 units as shown-

Now,

We take each job one by one in the order they appear in Step-01.

We place the job on Gantt chart as far as possible from 0.

## Step-03:

We take job J4.

Since its deadline is 2, so we place it in the first empty cell before deadline 2 as-

# Contd...

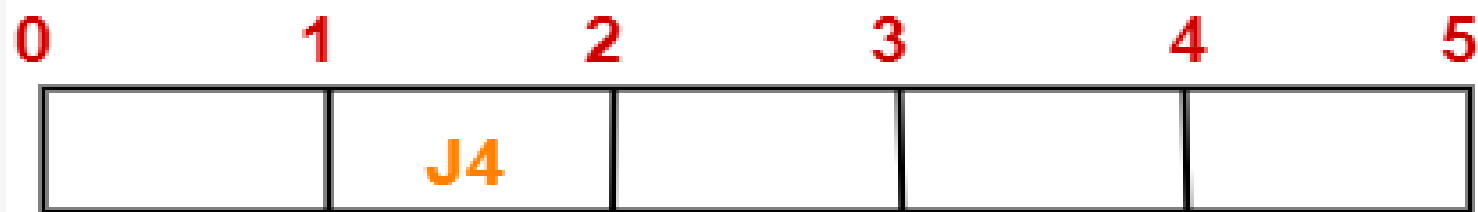


Fig 3: Gant Chart

# Contd...

## Step-04:

We take job J1.

Since its deadline is 5, so we place it in the first empty cell before deadline 5 as-

## Step-05:

We take job J3.

Since its deadline is 3, so we place it in the first empty cell before deadline 3 as-



# Contd...



Fig 4: Gant Chart after update



## Step-06:

We take job J2.

Since its deadline is 3, so we place it in the first empty cell before deadline 3.

Since the second and third cells are already filled, so we place job J2 in the first cell as-

## Step-07:

Now, we take job J5.

Since its deadline is 4, so we place it in the first empty cell before deadline 4 as-

# Contd...

Now,

The only job left is job J6 whose deadline is 2.

All the slots before deadline 2 are already occupied.

Thus, job J6 can not be completed.

The optimal schedule is-

**J2 , J4 , J3 , J5 , J1**

This is the required order in which the jobs must be completed in order to obtain the maximum profit.

Maximum earned profit

= Sum of profit of all the jobs in optimal schedule

=  $180 + 300 + 190 + 120 + 200$

= 990 units

# Contd...

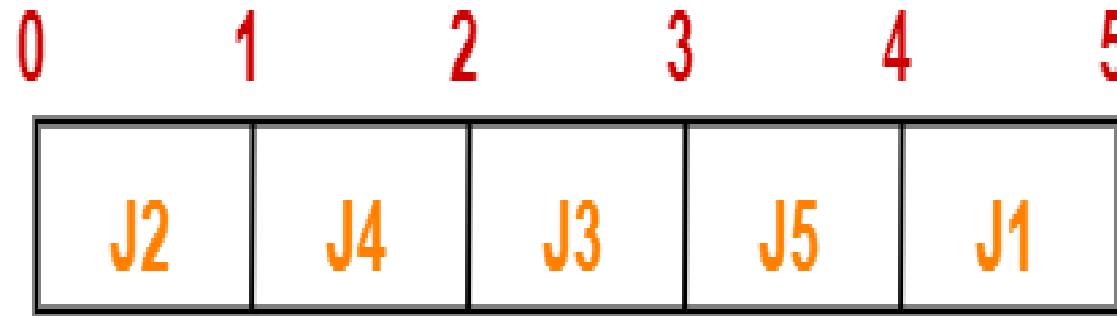


Fig 5: Gant chart for final output

# References

- [1] <https://www.gatevidyalay.com/wp-content/uploads/2018/06/Job-Sequencing-With-Deadlines-Problem-01-Step-02.png>
- [2] <https://www.gatevidyalay.com/wp-content/uploads/2018/06/Job-Sequencing-With-Deadlines-Problem-01-Step-02.png>
- [3] <https://www.gatevidyalay.com/wp-content/uploads/2018/06/Job-Sequencing-With-Deadlines-Problem-01-Step-02.png>
- [4] <https://www.gatevidyalay.com/wp-content/uploads/2018/06/Job-Sequencing-With-Deadlines-Problem-01-Step-02.png>
- [5] <https://www.gatevidyalay.com/wp-content/uploads/2018/06/Job-Sequencing-With-Deadlines-Problem-01-Step-02.png>

## Books:

1. Introduction to Algorithms by Cormen, Leiserson, Rivest, Stein.
2. Fundamentals of Algorithms by Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran



# THANK YOU