Algorithms – Best Fit
Lesson Plan: Class 08 / ALG / 07

Overall goal of the lesson	Students learn about the Best Fit algorithm. It is used in computer science, by a computer to find memory spaces for running various programs e.g. Microsoft word or games e.g. Pinball.
Prior Knowledge Required	None

Goal:	Introduce students to the Best Fit algorithm.
Description:	In this lesson, examples of Indian Railways seat allotment, and food storage in different containers are discussed to introduce the concept of Best Fit algorithm.
Material Required:	1. One copy of worksheet per student 2. Pen/Pencil, eraser. 3. Lesson Presentation
Procedure Summary :	1. Go through the presentation. 2. Discuss the various cases of seat allotment in Indian Railways. E.g. Senior Citizens, Single Lady Passengers. 3. Discuss the best possible storage of the given fruits in the given containers. 4. Make sure every student is following the slides. 5. Provide the worksheets, once presentation is done. 6. Let the students solve them and help them with answers.
Procedure Details:	**Slide 1:** Title Slide **Slide 2:** Ask students if they know how the ticketing system of Indian Railways allots seats/berths to different kinds of passengers. E.g. Single ladies, families, senior citizens. Discuss with them that one can give berth preference e.g. lower/upper berth while seat booking. But when the ticket is booked, sometimes they will not get their preferred berth. Ask them why it is so? Ask if they have ever stored food in boxes/containers? How did they find the best way to store all the food or maximum amount of food without wasting? **Slide 3:** Consider a train ticket booking of a family of four. Usually for a family all the berths should be in the same coach or even in the same compartment. The ticket booking website is aware of this necessity and tries to allocate berths accordingly. Special preferences like lower berth, upper berth are also considered by the website. A figure of a compartment (Image 1) and a seat map of a coach (Image 2) is given in the slide. **Slide 4:** In this slide we will discuss how the train ticketing system (website) allocates 4 berths for this family of four. It checks through the seat map of a preferred class (sleeper/3AC/2AC/1AC) of tickets. If it finds 4 seats in a single compartment, it will allocate those seats and tickets will be booked.

	In case the website doesn't find 4 seats in the same compartment, it looks for 4 seats in the same coach and allocates them. When the website allocates the seats in the same coach but different compartments, it tries to keep the seats as close as possible. E.g. 2 berths in one compartment and the other 2 berths in the next compartment. Images are given in the slides to better highlight the above allocation procedure by the website. **Slide 5:** In this slide we will consider a ticket booking for the same family of four but with an additional preference of at least 2 lower berths. The website will first look through the seat map to find 2 lower berths. Next if 2 more berths are available in the same compartment it will allocate all 4 in the same compartment. Else it will find the nearest available berths to the allocated lower berths in the same coach or another coach. In case the website is unable to find any lower berths it will allocate 4 berths as mentioned in the previous slide. **Slide 6:** If the passenger is a single male above the age of 21 years. In that case, how does the website allocate his berth? The website will usually allocate the first available upper berth after scanning through the seat map. It usually does not allocate lower berths to male passengers above 21 and travelling alone. The lower berths are usually allocated to senior citizens and women. **Slide 7:** What if a woman is travelling alone? How does the website allocate a berth for a woman travelling alone? The website will always allocate a berth in a compartment with either other single woman or families with women. In case no such compartment is available at the time of booking, a berth is allocated in an empty compartment. During tatkal booking the empty compartment is allocated to other single woman or families travelling with women. Additionally, the website will most often allocate lower or middle berths to women travelling alone. If only upper berths are available, the website will allocate an upper berth provided the compartment has other single woman or families traveling with women. **Slide 8:** As a last example of ticketing system, consider a couple of senior citizens booking tickets. How would the website allocate them berths? A large number of lower berths are reserved for senior citizens. The website would search through the seat map for the available lower berths and allocate the first available lower berths. Only when there are no lower berths available, middle or upper berth seats are allocated to senior citizens. **Slide 9:** In this slide we will introduce another example that employs methods of best fit. Storing fruits in storage containers. Consider two types of containers. Container X and Container Y. The images of these containers are given in the slide. We have 5 containers of each type, making it a total of 10 containers.

These containers are used to store cut pieces of 3 different fruits – Banana, Apple, and Mango. Each type of container (X and Y) has a fixed capacity of storing the fruits.

- Containers X, can hold 2 bananas/1 & a half apple/1 mango.
- Containers Y can hold 2 & a half banana/2 apples/one & a half mango.

If there are 11 bananas, 3 & a half apples, and 3 & a half mangoes. What is the best possible way to store the cut fruits in the given 10 containers?

In the next few slides we will discuss the best possible way to store these fruits.

Slide 10:
We start with the bananas first.
Since container X can store 2 bananas and container Y can store 2 and a half bananas. We will use 3 containers of type X and store 6 bananas (3 containers x 2 bananas = 6 bananas).
Similarly, we will use 2 containers of type Y, and store 5 bananas (2 containers x 2.5 bananas = 5 bananas).
So we were able to store a total of 11 bananas using 3 containers of type X and 2 containers of type Y.

Slide 11:
Now we are left with 2 containers of type X and 3 containers of type Y. Let us start storing the apples now.
Container X can store 1 & a half apples, whereas container Y can store up to 2 apples. Considering we have 3 & a half apples, we can use 1 container of type X to store 1 & a half apples (1 container x 1.5 apples = 1.5 apples).
Next we can use 1 container of type Y to store the remaining 2 apples
(1 container x 2 apples = 2 apples).
Thus we stored 3 & a half apples successfully using 1 container of type X and one container of type Y.

Slide 12:
Finally, we are left with 1 container of type X and 2 containers of type Y. Let us start storing the mangoes.
Container X can store 1 mango and container Y can store 1 & a half mangoes. We can use 1 container of type X to store 1 mango (1 container x 1 mango = 1 mango).
Next, we can use 1 container of type Y to store 1 & a half mangoes (1 container x 1.5 mangoes = 1.5 mangoes).
We have store 2 & a half mangoes only. We still have 1 mango left.

Slide 13:
Now we are still left with 1 mango and 1 container of Y.
Container Y can store 1 & a half mangoes, but we have only 1 mango. We will store this mango in container Y because no other containers are left.
But notice that the container Y can store more than 1 mango, there is unused space (or storage space is wasted).
We were able to store all the fruits but some space is wasted.
Ask if the students can come up with better arrangement/storing of the fruits in 10 containers? Can they find a better arrangement so as to avoid any wastage of space like above?
Tell the students that courier/packages are stored in delivery trucks using such best fit methods trying to reduce the wastage of space. Big containers transported by ships are also stored similarly.
Slide 14:

	This slide contains the lesson summary – the examples we discussed in the presentation and its importance in a computational thinking class. Computers use such allotment/storage methods to find the suitable memory space for different programs. E.g. MS Paint or Microsoft Word or games - Minesweeper. Usually, different programs require different amount of memory. It is quite similar to the case where container X could fit 2 bananas whereas container Y could fit more – 2 & a half bananas. It is the job of the computer to find the best memory space for a program by using best fit method. A big program - MS Word is given large memory and a small program – Minesweeper is given small memory. Best fit method is used to avoid wastage of memory when allotting memory to a program. **Slide 15:** Thank you. Get on with worksheets