

# Unbounded Knapsack Problem

(Unlimited == Unbounded)

# Subproblem Graph

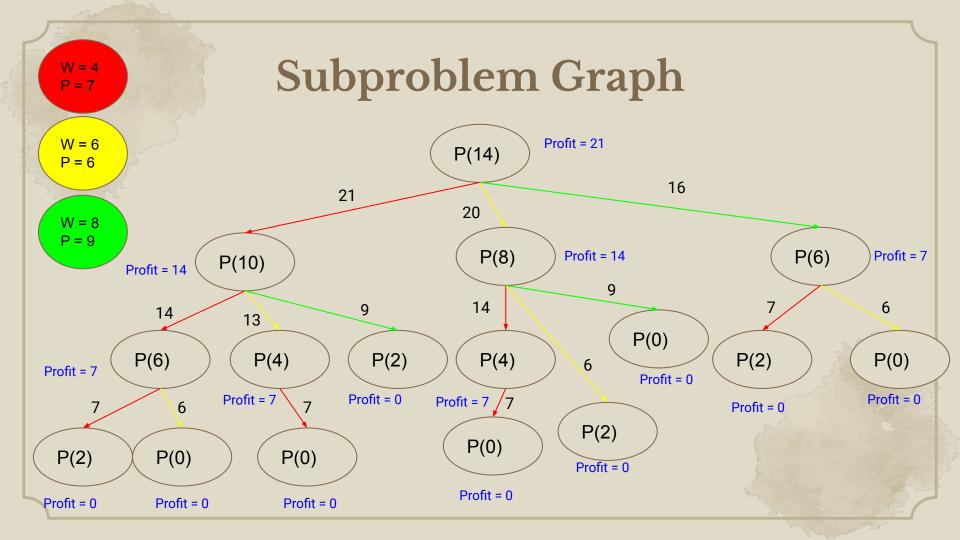
	0	1	2
wi	4	6	8
pi	7	6	9

#### Definitions:

- P(C): Maximum profit at particular C value (Dependent on w[i] and p[i])
- C: Capacity of knapsack (Dependent on w[i])

#### Mechanics:

- 1. When C = 0 or can no longer be reduced by any of the weight, P(C) = 0
- 2. Return to previous state, save the profit of the weight that led to dead end.
- 3. Continue down alternative paths with other weights and repeat (1) and (2)
- 4. Compare the profits and save the higher profit.
- 5. Rinse and repeat 1-5 until function returns back to starting point with max profit



# Dynamic Programming Algorithm

1. Create a new array soln of size C+1. The array indicates the maximum profit we can achieve with a knapsack capacity.

```
soln[i] = max profit with a knapsack of capacity i
```

Aim is to find soln[C]

Initialise the array to zeros

- We iterate over all the elements available for each knapsack capacity between 1 to C and determine if it can be used to achieve a greater profit
- 3. The recurrence relation would be

```
soln[i] = max(soln[i], soln[i-w[j]] + p[j])

if w[j] < i => item j is taken
```

## Dynamic Programming Recurrence Relation

```
soln[i] = max(soln[i], soln[i-w[j]] + p[j])
```

## Implementation in code

```
public static void UnboundedKnapsack (int [] w, int [] p, int C, int n)
   System.out.println("-----
   System.out.println("The problem is P("+n+","+C+") : Unbounded Knapsack");
   long start = System.nanoTime();
   int r, c;
   int soln[] = new int[C+1];
   for(r = 0; r <= C; r++)
       for(c = 0; c < n; c++)
           if(w[c] <= r)
                if(soln[r] < soln[r - w[c]]+ p[c])</pre>
                    soln[r] = soln[r - w[c]] + p[c];
    long end = System.nanoTime();
   long timeElapsed = end - start;
   System.out.println("The solution is "+ soln[C]);
   System.out.println("Execution time in seconds: " + (double)timeElapsed / 1000000000);
```

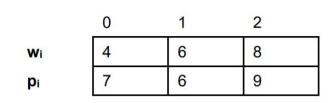
## **Complexity Analysis**

```
public static void UnboundedKnapsack (int [] w, int [] p, int C, int n)
   System.out.println("-----");
   System.out.println("The problem is P("+n+","+C+") : Unbounded Knapsack");
   long start = System.nanoTime();
   int r, c;
   int soln[] = new int[C+1];
   for(r = 0; r <= C; r++)
                                                      O(C+1)
      for(c = 0; c < n; c++)
           if(w[c] <= r)
              if(soln[r] < soln[r - w[c]]+ p[c])
{
    soln[r] = soln[r - w[c]]+ p[c];</pre>
                                                   Constant
   long end = System.nanoTime();
   long timeElapsed = end - start;
   System.out.println("The solution is "+ soln[C]);
   System.out.println("Execution time in seconds: " + (double)timeElapsed / 1000000000);
```

Total time complexity = O(Cn)

Total space complexity = O(C)

# Results using Dynamic Programming



```
0 1 2
w<sub>i</sub> 5 6 8
p<sub>i</sub> 7 6 9
```

```
Enter the value of C: 14

Enter the value of n: 3

Enter the value(s) of weights:

6

8

Enter the value(s) of profits:

7

6

9

------
The problem is P(3,14) : Unbounded Knapsack
The solution is 16

Execution time in seconds: 3.1E-6
```

# The End Q&A

# This Is a Map

## Venus

Venus is the second planet from the Sun

## Mercury

Mercury is the smallest planet

## **■** Earth

Earth is the only planet with life



## Literature Review



## Theory 01

Mercury is the closest planet to the Sun and the smallest of them all



## Theory 02

Despite being red, Mars is actually a cold place full of iron oxide dust

# Secondary Objectives

## Mercury

Mercury is the closest planet to the Sun

#### Saturn

Saturn is a gas giant and has several rings

#### Venus

Venus has a beautiful name and is the second planet

## Earth

Earth is the third planet from the Sun

#### Mars

Despite being red, Mars is actually a cold place

## Jupiter

Jupiter is a gas giant and the biggest one

# Awesome Words

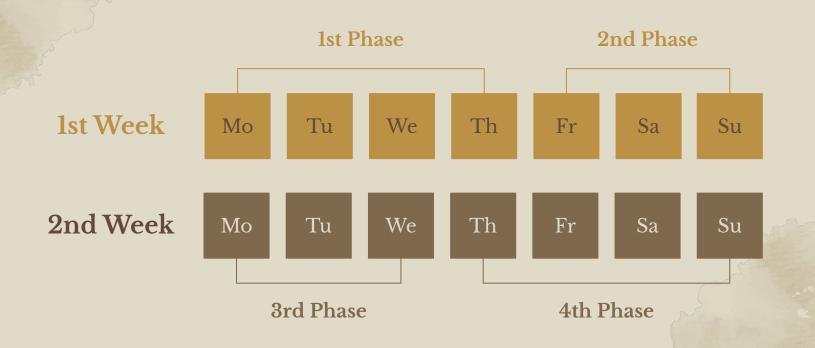
## Your Work

You can replace the image on the screen with your own work. Just delete this one, add yours and center it properly



už predtým, keď na ňom pristál pri navrate z minane. Tu žil v skromnom domčeku, nie oveľa priestrannejšom Jahko opustil". moci matky horko-tažko dosiahol, že ho Augustus menež letná vilka, ako jednoduchý občan. Občas sa prechámoci noval svojim legátom na Rode, čo malo odovodňovať Mul to pre sa reda noval spiritomnost v Rime a zakryt jeho hanbu. Od tych teral bysto, bystr dzal po gymnáziu bez liktora a bez služobníka a udržiaval jeho nežil už len ako jednoduchý občan, ale aj ako bo styky s jednoduchými Grékmi ako so seberovnými. čias itvo vinník; skrýval sa na vidleku vo vnútrozemí a jazlivý vinník; skrýval sa na vidleku vo vnútrozemí a j Jedného dňa ráno, keď zadeľoval práce, povedal len jązavy hybal sa stretnutiu s mužmi, ktori sa plavili okolo ost tak mimochodom, že by chcel navštíviť všetkých chorých Germain. nypai a často ho navštevovali, pretože ani jeden uradnik v mestečku. Ti, čo boli v jeho blizkosti, tomu rozumeli Philosophia South St. Oktob Day William St. a case, a lebo iným poslaním nenastipil služby inakšie a vydali príkaz priniesť všetkých chorých do nesse also nanonti, ani sa len nesto vincii bez toho, ze by sa nezastavil na Rode verejnej kolonády a tam ich roztriediť podľa chorôb. pristupili aj iné dôvody, ktoré ho ešte väčšmi Zarazilo ho to neočakávané divadlo a dlho bol na rozpakoch, čo robiť. Nakoniec však obišiel všetkých chorých vali. Keď totiž prišiel na Samos a navštivil i nevlastného syna Gaia, ktorý bol správcom a každému sa ospravedlnil za to, čo sa stalo, aj keď boli neviasuleno mu Gaius velmi odcudzil, a to hlavne videl, že sa mu Gaius velmi odcudzil, a to hlavne v medzi nimi Iudia nizkeho postavenia a jemu úplne nevidel, ze sa mu crarus venni oucuozu, a to hlavne z hou svojho sprievodcu a vychovávatela Marca Lon. známi. Svoju tribúnsku moc použil, ako sa zdalo, len hou svojno spravove a vychovavateta Marca Loh. ktorý ho pred ním očiernil. Okrem toho upadol do pov jednom prípade — o druhých sa aspoň nehovorí. Často ktory no prec mai oniektorých centúrioch, ktorých sám dozrenia, že poslal po niektorých centúrioch, ktorých sám navštevoval školy a posluchárne učencov. Pri jednej tadozrenia, ze posici po dovolenke vracali naspät do tábora, povýšil a ktorí sa po dovolenke vracali naspät do tábora, kej návšteve strhla sa raz medzi antisofistami prudka povysu a ktori sa po tavonema vracau naspar do tábora, viacerým osobám záhadné odkazy, ktoré, ako sa zdalo, hádka; Tiberius sa do nej zamiešal a tu ho ktosi naviacerym osobom zamono odancy, kore, ako sa zdalo mali každého z nich pripravit na prevrat. Keď mu Aupadol a vyčítal mu, že nadrža druhej strane. Tiberius li tropini gost, la ... oc . Hoth to este style to These my sa nenápadne vytratil, o chvíľu sa znovu zjavil so služobnikmi a hlásateľom, dal vyvolať človeka, ktorý ho urazil, pred svoj tribunál a dal ho uväzniť. nu katostalne pozovující nivaktu obsiali žávostalne pozovující nivaktu z htebo: Potom sa dozvedel, že jeho manželka Iulia bola pre 143 al a leshoral say themy, Valaday lendald fide 142 with the day of a leady of call, the my spella cance being the call to the cal muniter duese where the A Picture Is Worth a Thousand Words

## Schedule



# 1,927

Big numbers catch your audience's attention

# Table

	Test 1	Test 2	Test 3	Test 4
Indicator 1	<b>V</b>	<b>V</b>	<b>V</b>	<b>V</b>
Indicator 2	*	*	<b>V</b>	*
Indicator 3	*	<b>V</b>	<b>V</b>	*
Indicator 4	<b>V</b>	*	*	V

## Timeline

## Mercury

Mercury is the closest planet to the Sun



#### Mars

Mars is actually a very cold place

1927

#### Venus

Venus is the second planet from the Sun

2027

A Picture Always Reinforces the Concept

Images reveal large amounts of data, so remember: Use an image instead of a long text



## **Important Percentages**

33.5%

Mercury is the closest planet to the Sun

26.7%

Despite being red, Mars is a cold place

18.2%

Saturn is the ringed one and a gas giant

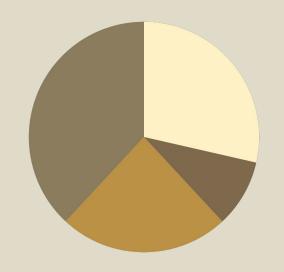
## Methodology

## Research

Venus has a beautiful name, but it's terribly hot

## Data Study

Despite being red, Mars is actually a cold place



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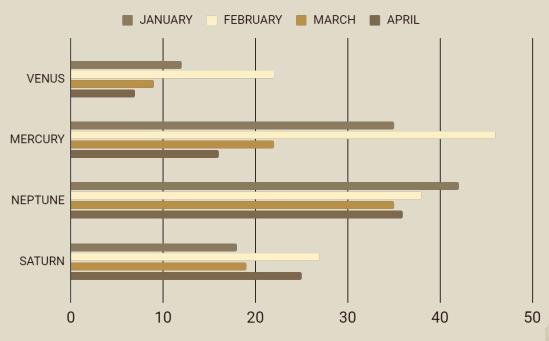
## **Analysis**

Jupiter is the biggest planet in the Solar System

## Comparison

Saturn is the ringed one and a gas giant

# Results Analysis



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## **Conclusions**

## **Conclusion A**

Here you can talk about the conclusions





## **Conclusion C**

Here you can talk about the conclusions

## **Conclusion B**

Here you can talk about the conclusions





## **Conclusion D**

Here you can talk about the conclusions









Do you have any questions? youremail@freepik.com +91 620 421 838 yourcompany.com

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## **Alternative Resources**

#### **Vectors**

- Hand drawn international literacy day
- International literacy day with stack of books
- International literacy day draw

#### **Photos**

- Bunch of old books
- Pile of books on blue background
- Smoke over antique notebook and ink pen

## Resources

#### **Vectors**

- Glasses with books for literacy day
- International literacy day with lots of books
- International literacy day celebration

#### **Photos**

- Glasses on old books in library
- Old books on library table
- Ink pen on opened old notebook

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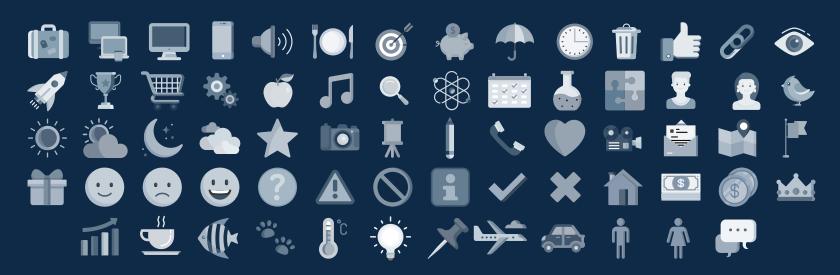




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