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First thing I'd like to dedicate my work to the most priceless people in my life that always have been there for me in the bad times before the good times.

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you are the reason that I am happy and healthy. And I want to tell what my father told me your family more than your life.

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To the people behind the see:

I wish you both where here and I hope you are and well.

To my cousins that I have been raised with you are the best friends and the best brotherhood that I have.

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Summary

Acknowledgement..

Summary ....

Figures list..

Abstract..

Introduction 1

Chapter I

Concepts about graphs

1- Introduction:.. 3

2- History on graph theory: 3

3- Graph theory: 3

3-1- Graph: 3

3-2- Graph types:.. 4

4- Vocabulary and notation:.. 5

4-1- Order of graph 5

4-2- Size of graph.. 5

4-3- Neighborhood.. 5

4-4- Degree of a vertex: 6

4-5- Isolated vertex 6

4-6- Clique.. 6

4-7- Circuit 6

4-7-1- Eulerian.. 6

4-7-2- Hamiltonian.. 6

4-8-Path.. 6

4-9- Cycle: 8

5- Subgraphs: 9

5-1- Induced subgraph: 10

5-2- What's the Difference between induced subgraph and ordinary subgraph? 10

6- Graph isomorphism: 11

7- Particular graphs: 11

8- Planar graph: 11

9- Complete Graph: 12

10- Comparability graph: 12

11- Isolated graph: 13

12- Cyclic graph: 13

13- Bipartite graph: 13

14- Tree: 14

15- Conclusion: 14

Chapter II

Project management 15

1-Introduction: 16

1-Definitions 16

1-1- Project: 16

1-1-1-The NOT BEFORE relations 17

1-1-2The NOT LATER relations 17

1-2-Project management 17

2-Critical path method (CPM): 17

2-1-Critical path: 17

2-1-1Critical path algorithm: 17

2-1-2-The forward pass: 17

2-1-3-The backword pass: 17

2-1-4Calculate the critical path: 179

2-1-5-Calculate the float (margin): 179

2-1-6The uses of critical path method: 21

2-1-7-CPM's Pros and cons: 21

2-1-7-1-Advantages of the critical path method: 21

2-1-7-2-Disadvantages of the CPM: 22
3-PERT-Chart (diagram/graph): 22
3-1-PERT-Time 23
3-2-PERT-Cost: 23
3-3-The critical activities in PERT-chart: 23
3-4-The dummy activity: 23
3-5-Principal: 24
3-6-Explaining the task representation: 24
3-7PERT chart algorithm: 24
3-7-1-Identifying all of the project's 24
3-7-2-Identifying 25
3-7-3-Work breakdown structure: 25
3-7-4-Connect project tasks: 25
3-7-5-Estimate project time frame: 25
3-8-PERT's pros and cons: 26
3-8-1-The advantages of PERT: 26
3-8-2-PERT's disadvantages: 26
4-Gantt chart: 27
4-1-History about Gantt: 27
4-2-Definition of Gantt chart: 27
4-3-Gantt chart algorithm: 27
4-3-1-Define the time range: 27
4-3-2-Adding tasks with starting and ending dates: 27
4-3-3-Clarifying dependencies: 28
4-3-4-Pinpoint milestones: 28
4-3-5-Milestones: 28
4-3-6-Modifying work as plans change: 28
4-4-Gantt's pros and cons: 28
4-4-1-The advantages of Gantt-chart: 28

4-4-2-Gantt’s disadvantages: 28

5-The difference between PERT-chart, CPM, and PERT-chart, Gantt-chart: 28

5-1-PERT-chart vs. CPM: 28

5-2-PERT-chart vs. Gantt-chart: 29

Chapter III

Implementation 31

1-Introduction: 32

2-JavaFX 32

3-CSS 32

3-Java 33

3-1-Definition 33

3-2-Java Plug-in: 33

3-3-Java features: 33

4-IntelliJ IDEA: 34

4-1-Definition: 35

4-2-Basic environment: 35

4-3File management system: 35

4-4-File types: 36

4-4-1-Physical files : 36

4-4-2-Logical files: 36

5-LaTex: 37

5-1-Definition 37

5-2-LaTeX versus word: 38

5-2-1-General comparison: 38

5-3-Benefits of LaTex: 40

5-4-LaTeX and publications: 40

5-5-LaTeX and presentations: 40

5-6-LaTeX History: 41

5-7LaTeX files: 42

5-8-Document structure: 42
5-8-1-Compilations: 42
5-9-LaTeX documents types: 43
5-10-Code source: 43
5-11-Result 44
5-12-The most used environments: 44
5-12-1-Case presentation: list: 44
5-12-2-Case presentation: table: 44
6-Scenario 47
7-The representation of a model that solves project management problem: 50
8-Conclusion 50
General conclusion: 52
Bibliography 54

Figures list

Figure -1-: Geographic map: Konigsberges. 3

Figure -2-: Graph example. 4

Figure -3-: Directed graph example. 4

Figure-4-: Undirected graph example 5

Figure -5-: Neighborhod example... 6

Figure-6-: Circuit types example. 7

Figure-7-: Path examples.. 8

Figure -8-: Cycle examples. 9

Figure-9-:Subgraphs examples. 9

Figure-10-: Super graph example. 10

Figure -11-:Graph isomorphism example. 11

Figure -12-: Example of particular graph.. 11

Figure -13-: Planar graph example. 12

Figure-14-: Example of complete graph. 12

Figure -15-: Comparability graph example. 12

Figure-16-: Isolated graph example. 13

Figure-17-: Cyclic graph example. 13

Figure-18-: Bipartite graph example.. 14

Figure-19-: Tree examples. 14

Figure-20-: CPM example.. 20

Figure-21-: Pert example.. 22

Figure-22- dummy activity example... 24

Figure-23-: General task presentation on PERT-chart. 24

Figure-24-: Gantt-chart example. 27

Figure-25 - IntelliJ logo... 35

Figure -26- Hierarchy of Java FileWriter Class. 37

Figure- 27- FileWriter to write data to a File. 37

Figure -28- LaTeX vs word. 39

Figure-29- LaTeX vs word. 39

Figure -30- MikTex official website. 42

Figure -31- TexMaker official website. 42

Figure -32- LaTeX example. 43

Figure -33- LaTeX pdf example. 44

Figure -34- Latex example list... 46

Figure -35- Latex example table. 47

Figure -36- application interface.. 48

Figure -37- creating and writing in Latex file 48

Figure -38- The file created by application. 49

Figure -39- The PDF file created by application. 49

Abstract

We sometimes solve a type of problem serval times, until we arrive at a stable resolution model: there for we repeat the same steps and we notice that it would better to automate the solution.

In the other side, we found that writing a correction to a certain type of exercise can also follow a model and we took advantage of LaTeX text formatting language to design an application that solves an exercise of graph theory (project management) and then write LaTeX instructions that allow to produce the resolution (the correction).

This corrector is a jump from solving problem manually (and thus check the solution many times) to solving the problem automatically.

Keywords: Project management, LaTex, writing , graph theory.

Résumé

Il arrive parfois de résoudre un type de problèmes plusieurs fois, jusqu'à arriver à un modèle de résolution stable ; de ce fait nous refaisons les mêmes étapes et nous remarquons qu'il sera préférable d'automatiser cette résolution . Dans la même optique , nous avons constaté que l'écriture d'un corrigé d'un certain type d'exercice peut suivre aussi un modèle et nous avons tiré avantage du langage de formatage de texte LATEX pour concevoir une application qui permet de résoudre dans un premier temps un exercice de la théorie des graphes (ordonnancement de projet) et de produire par la suite les instructions LATEX qui permettent de produire la résolution (ou le corrigé type) .

Ceci permet de libérer le correcteur de deux taches embêtantes : résoudre le problème manuellement (et donc vérifier la solution plusieurs fois) et se casser la tête pour écrire le code LATEX pour générer le corrigé type .

Mots clés : ordonnancement de projet, LaTex, écriture, théorie des graphes.

Introduction

Introduction

Task automation has become more and more important, according to it growing number it also become more difficult. But to automate a task it must arrive to a resolution algorithm, which has commune characteristics to a model.

We are trying to build an application which helps the teacher to gain a time from repeating the solution steps and also have a tool to product a corrected type.

We are making not for the first time surly, the resolution of a problem in graph theory, in the occurrence of project management.

In this part of the problem, the algorithms are existed, and the solution or the corrected type implicitly followed a model, in other word, to get it in coherent and educative, a teacher does not have to change each time the way to explain the solution!

In the other hand, we are going to use the advantage of programmable aspect of formatting text language LaTeX, to produce the instructions or the code to generate the correction.

This application is able to give us the resolution of other problems in graph theory, or in case of other fields problems which the solution followed an algorithm or a model.

To avoid a long heavy hours (that causes head-aches) to verify the solution and surly for writing the LaTeX code which allows to generate and minimize into few minutes. It must only take the date as input of the problem and lunch the resolution of the code.

From the advantages of using LaTeX is making the user free to text formatting, and cancelling syntax errors of LaTeX code. Since the model created is fixed and prior and also the instructions which produced are verified once and for all.

Chapter I
Concepts about graphs

1- Introduction:

This chapter contains basic concepts and basic definitions in graphs theory, which are a models to represent the relationships between objects (direct graphs) and also symmetric relationships between them (undirected graphs).

The graph has developed upon the time and became an important tool to solve the problems not only in mathematics but in almost every science field, we discuss also some notions for algorithms, and actually almost every single thing about graph can be presented by algorithmic way.

Also, at the end of this chapter we talked about some graph types and classes that make the graph becoming a very strong tool to solve the problem

2- History on graph theory:

It all starts at Königsberg the city of the four lands and the seven bridges, where its people used to entertain themselves by trying to pass around the lands of the city by crossing the bridges just once.

The origins of the graph theory have been known to the world in the 18th century when Leonhard Euler's work on the Königsberg bridges problem around 1730's,by a mathematical vision which gave us the concept of Eulerian graph, which has leaded to the problem has no possibility of happening .[1]

The Königsberg bridges problem as in figure -1-

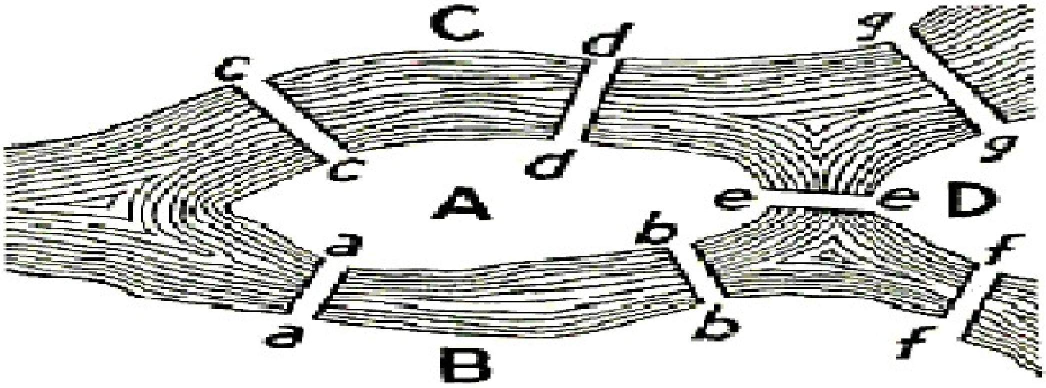


Figure -1-: Geographic map: Königsberg.

3- Graph theory: is a combination of mathematical and computing to study the graphs and interested of its properties (the graphs).

3-1- Graph: geometric case (tool) to analyse a problem by collection of the elements of the problem.

[1] Graph Theory 1736-1936 (NORMAN L.BIGGS, E. KEITH LLOYD, ROBIN J. WILSON).

By presenting these elements by vertices (points/nodes) related by edges (lines).”Figure -2-”

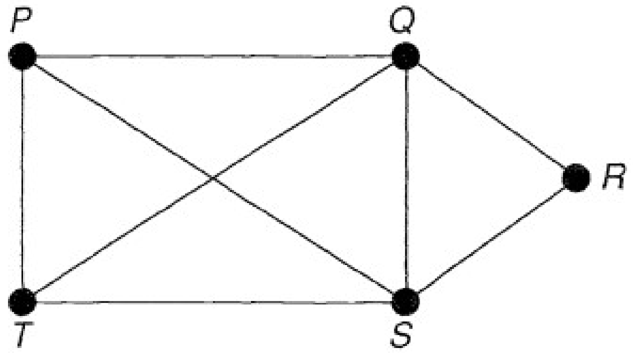


Figure -2-: Graph example.

3-2- Graph types:

There are two types of graph:

- Directed graphs: a directed graph G= (V, H) V a nonempty set of vertices Ni, H a set of directed edges or arcs each edge is an ordered pair of vertices (Vi, Vj) ∈ V , a pair (Vi, Vj) called a directed edge (arc) started at the vertices Vi and finished at the vertices Vj , the edge (arc) is e= (Vi, Vj). Then Vi is the initial vertices of this edge and is adjacent to Vj and Vj is the terminal (or end) vertices of this edge and is adjacent from Vi. The initial and terminal vertices of a loop are the same.

The in-degree of a vertices Vi, denoted: deg (Vi), is the number of edges which terminate at Vi. The out-degree of Vi, denoted deg+ (Vi), is the number of edges with Vi as their initial vertex. Note that a loop at a vertex contributes 1 to both the indegree and the out-degree of the vertices[2]. Figure-3-.

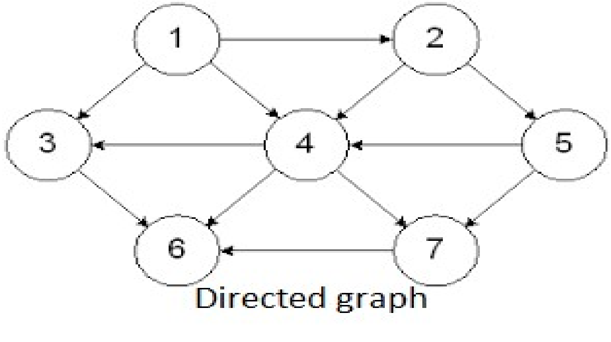


Figure -3-: Directed graph example.

- Undirected graph: Two vertices Vi, Vj in an undirected graph G are called adjacent (or neighbours) in G if there is an edge e between Vi and Vj.

[2] https ://perso.liris.cnrs.uk/samba-ndojh.ndiaye/files/Graphs-app.pdf

Such an edge e is called incident with the vertices Vi and Vj and e is said to connect Vi and Vj .

The set of all neighbours of a vertice Vi of G = (Vi, Vj), Denoted by N (v). It is called the neighbourhood of v. If A is a subset of Vi, we denote by N (A) the set of all vertices in G that are adjacent to at least one vertices in A.

The degree of a vertex in a undirected graph is the number of edges incident with it, except that a loop at a vertices contributes two to the degree of that vertices. The degree of the vertices v is denoted by deg (v)[3]. Figure-4-

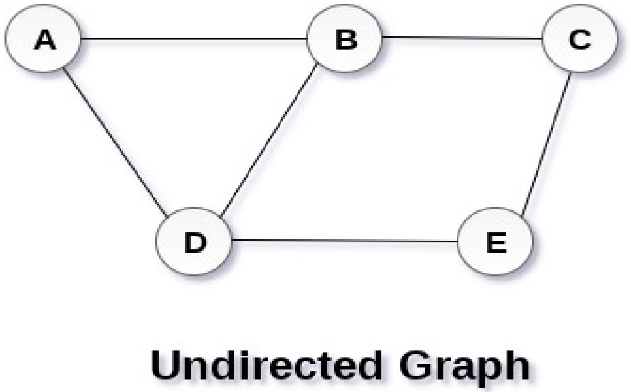


Figure-4-: Undirected graph example

4- Vocabulary and notation:

4-1- Order of a graph: The number n of vertex is called the order of a graph G, it is noted |G|. And also the number of rows and columns of an adjacency matrix of the graph.

4-2- Size of graph: Size of a graph is the number of edges in a graph G, it is noted |G| (which is equal to |A|). And it is also the number of <<1>> divided on 2 in an adjacency matrix of the graph.

4-3- Neighborhood of a Vertex: Let G=(V,E) and v ∈ V .The Neighborhood of v ,Ng(v) is {u ∈ V|u v ∈ E }. (Noted N(v))[4].

[3] https ://perso.liris.cnrs.uk/samba-ndojh.ndiaye/files/Graphs-app.pdf.

[4] Course 441 discrete mathematics Graph by Milos Hauskrecht page 08.

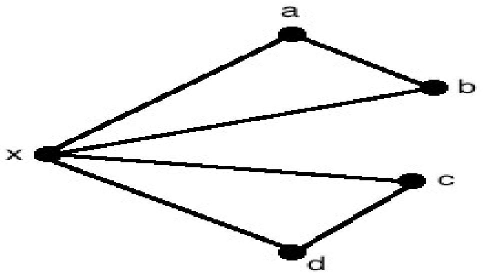


Figure -5-: Neighborhod example.

4-4- Degree of a vertex: the degree of a vertex is by definition the cardinality of N(v), noted by deg(v).

The degree of a vertex equals the number of vertices it is adjacent to, and every one of those adjacent vertices will be in that vertex neighborhood , and so follows that the cardinality of vertex is equal to the degree of that vertex .

For a directed graph, we call an incoming degree of a vertex v, noted by Deg-(v), and for outgoing degree of a vertex v, noted by deg+ (v). The number of edges of which vertex is the successor.

For undirected graph, we call the degree of a vertex v, noted by d(v). The number of edges of which vertex is the end[5]. Figure-4-.

4-5- Isolated vertex: The degree of isolated vertex equals 1.

4-6- Clique: A clique of graph G, is induced subgraph of G that is complete. Cliques are one of the basic concepts of graph theory and are used in many other mathematical problems and constructions on graphs. It's called maximal clique if it does not contain any other clique[6]. Figure-5-

4-7- Circuit: a circuit is a sequence of adjacent nodes (vertexes) starting and ending at the same vertex (node). Circuits never repeat edges. However, they allow repetitions of nodes in the sequence[7].

There are two particular categories of circuits with specific characteristics: (Figure-6-)

4-7-1- Eulerian: this circuit consists of a closed path that visits all edges of a graph exactly once.[8]

4-7-2- Hamiltonian: this circuit is a closed path that visits all nodes of a graph exactly once[9].

[5] Larremendy Valverde Alain Marie-Jeanne, Graph theory introduction page 7.

[6] Alba, Richard The Journal of Mathematical Sociologie(1973).

[7] Robin Wilson Graph theory page 76.

[8] Mathematic learning graphs Chapter 14 page 1.

In Figure -6- We can note that:
The first graph (with the hamiltonian circuit) is a hamiltonian and non-eulerian graph. So, there is no way to create an eulerian circuit with it.
Similarly, the second graph (with the eulerian circuit) consists of an eulerian and non-hamiltonian graph. Thus, there is no possible hamiltonian circuit on it.

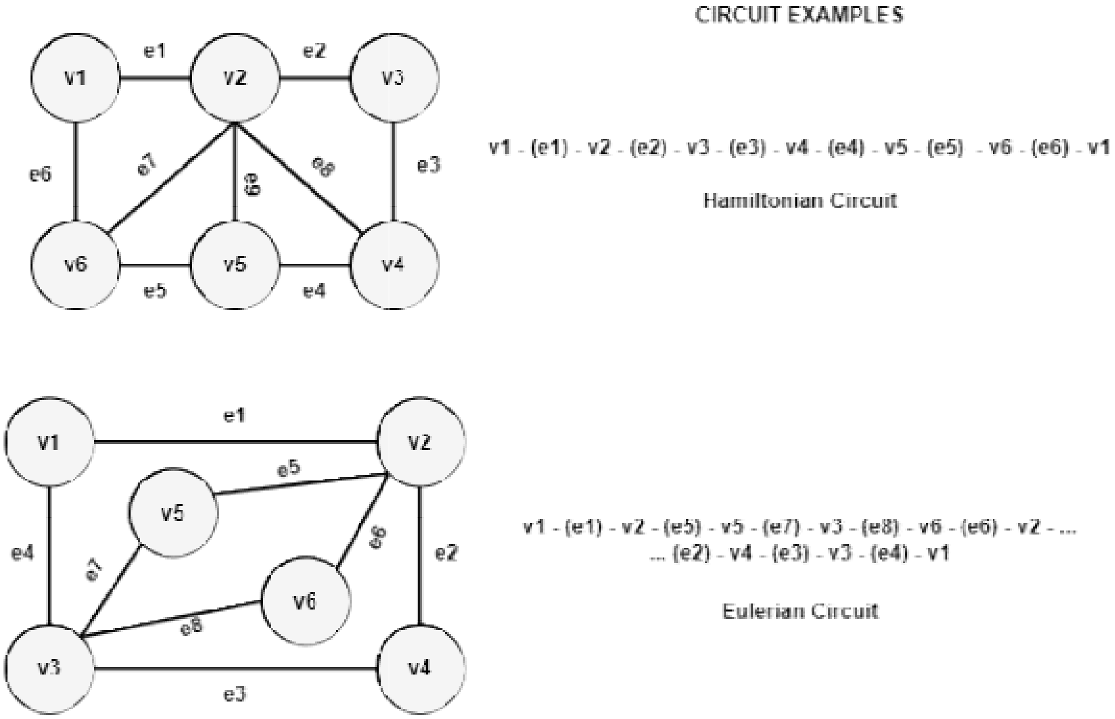

CIRCUIT EXAMPLES
v1
v2
v3
v4
v5
v6
e1
e2
e3
e4
e5
e6
e7
e8
e9
v1 - (e1) - v2 - (e2) - v3 - (e3) - v4 - (e4) - v5 - (e5) - v6 - (e6) - v1
Hamiltonian Circuit
v1
v2
v3
v4
v5
v6
e1
e2
e3
e4
e5
e6
e7
e8
v1 - (e1) - v2 - (e5) - v5 - (e7) - v3 - (e8) - v6 - (e6) - v2 - ...
... (e2) - v4 - (e3) - v3 - (e4) - v1
Eulerian Circuit

Figure-6-: Circuit types example.

4-8- Path: In practical terms, a path is a sequence of non-repeated nodes connected through edges present in a graph. We can understand a path as a graph where the first and the last nodes have a degree one, and the other nodes have a degree two. If the graph contains directed edges, a path is often called dipath. Thus, besides the previously cited properties, a dipath must have all the edges in the same direction[10]. Figure -7-

[9] Mathematic learning Chapter 14 page 3.
[10] https://www.baeldung.com/cs/path-vs-cycle-vs-circuit.

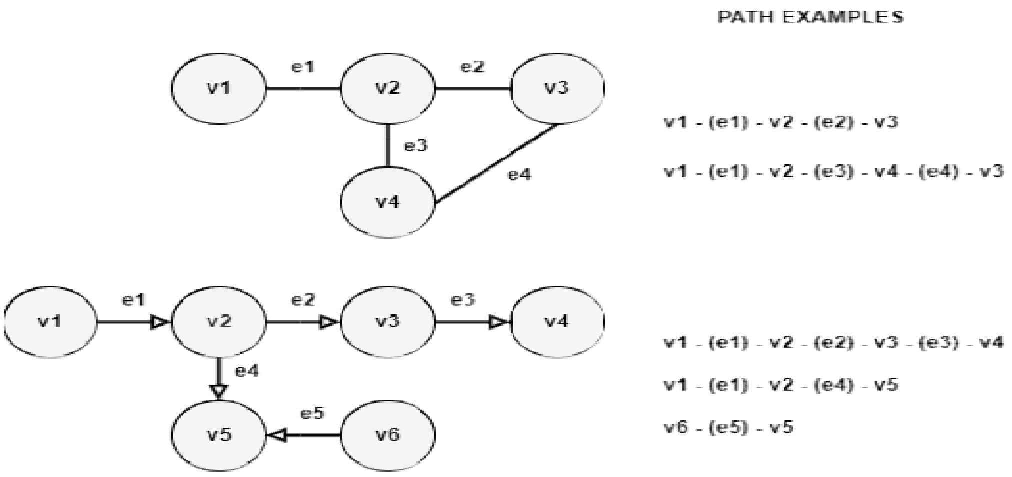

PATH EXAMPLES
v1
e1
v2
e2
v3
e3
v4
e4
v1 - (e1) - v2 - (e2) - v3
v1 - (e1) - v2 - (e3) - v4 - (e4) - v3
v1
e1
v2
e2
v3
e3
v4
e4
v5
e5
v6
v1 - (e1) - v2 - (e2) - v3 - (e3) - v4
v1 - (e1) - v2 - (e4) - v5
v6 - (e5) - v5

Figure-7-: Path examples.

By analyzing the available paths of a graph, we can draw some conclusions:

A graph is, at least, weakly connected when there is an undirected path (disregarding the directions in a directed graph) between any two nodes (vertexes).

If a directed graph provides the opposite oriented path for each available path, the graph is strongly connected.

If there are one or more paths between two nodes (vertexes) in a graph, the distance between these nodes is the length of the shortest path (otherwise, the distance is infinity).

4-9- Cycle: A cycle consists of a sequence of adjacent and distinct nodes in a graph. The only exception is that the first and last nodes of the cycle sequence must be the same node. In this way, we can conclude that every cycle is a circuit, but the contrary is not true. Furthermore, another inferring is that every Hamiltonian circuit is also a cycle. So, we call a graph with cycles of cyclic graphs. Oppositely, we call a graph without cycles of acyclic graphs. Finally, if a connected graph does not have cycles, we call it a tree. Cycle detection is a particular research field in graph theory. There are algorithms to detect cycles for both undirected and directed graphs. There are scenarios where cycles are especially undesired. An example is the use-wait graphs of concurrent systems. In such a case, cycles mean that exists a deadlock problem[11].

Figure -8- presents an example of a cyclic graph, acyclic graph, and tree:

[11] https://www.baeldung.com/cs/path-vs-cycle-vs-circuit.

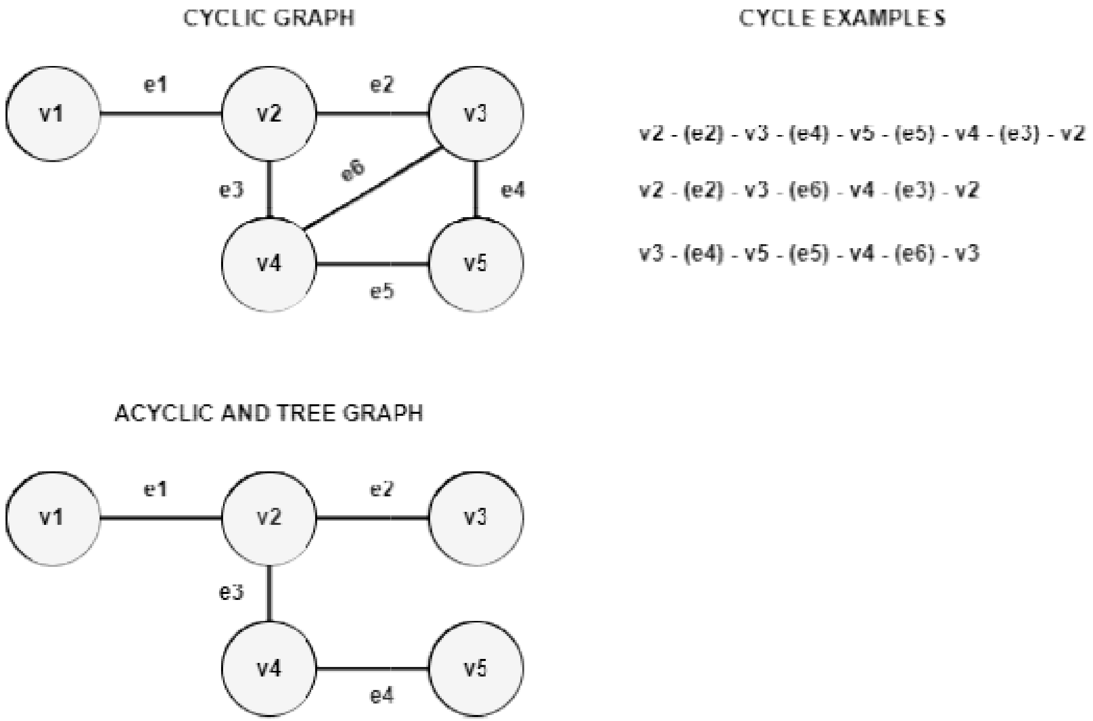

CYCLIC GRAPH
CYCLE EXAMPLES
v1
v2
v3
v4
v5
e1
e2
e3
e4
e5
e6
v2 - (e2) - v3 - (e4) - v5 - (e5) - v4 - (e3) - v2
v2 - (e2) - v3 - (e6) - v4 - (e3) - v2
v3 - (e4) - v5 - (e5) - v4 - (e6) - v3
ACYCLIC AND TREE GRAPH
v1
v2
v3
v4
v5
e1
e2
e3
e4

Figure -8-: Cycle examples.

5- Subgraphs:

Let’s say that we have a graph G = (V, E). Where V is a set of vertexes (nodes), and E denotes the edges between them, a subgraph of G is any graph G’ = (V’, E’). Such that V’⊂ V and E’ ⊂ E.

In other words, each node in a subgraph is also a node in the supergraph. Further, every edge in the subgraph is an edge in the supergraph[12].

For example the graphs in figure -9- can be listed as a Subgraphs of the graph in figure-10-

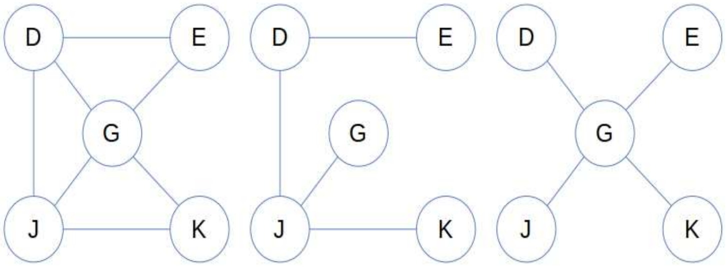


Figure-9-:Subgraphs examples.

[12] https://www.baeldung.com/cs/induced-subgraphs.

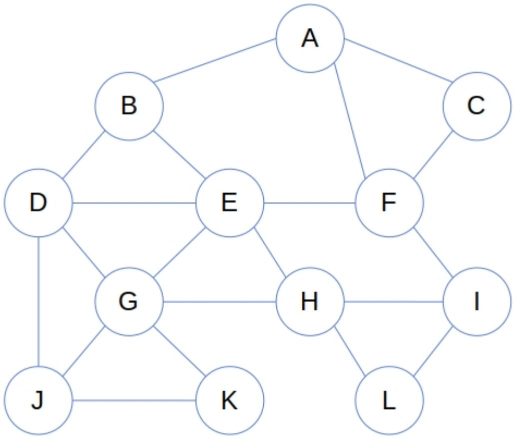


Figure-10-: **Super graph example.**

There is a special case of subgraph called induced subgraph

5-1- Induced subgraph: if S is a subset of G’s vertexes (nodes). Then the subgraph of G induced by S is the graph that has S as its set of vertexes and contains all edges of G that have both endpoints in S. The definition covers both directed and undirected graphs. Also, it covers the weighted and the unweighted ones.

5-2- What’s the Difference between induced subgraph and ordinary subgraph? Their concepts are very similar, the difference is an induced subgraph includes all the edges that have both endpoints in the inducing set S, where as an ordinary subgraph may miss some. So, an induced subgraph keeps both adjacency and non-adjacency of the inducing vertexes, in contrast to an ordinary subgraph preserves only non-adjacency[13].

[13] https://www.baeldung.com/cs/induced-subgraphs.

6- Graph isomorphism:

G= (V, E) , and G'= (V',E') are two graphs , G and G' are isomorphisms only if there is a projection p of V to V' verifying p(E)==E'[14]. Figure -11- .

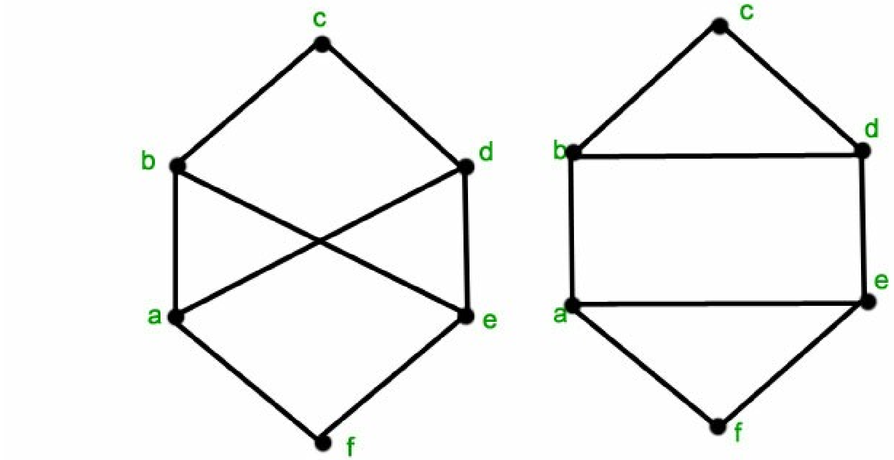


Figure -11-:Graph isomorphism example.

7- Particular graphs:

Symmetric graph: a graph G = (V,E) is symmetric graph if ∀ v,e ∈ V, (v, e) ∈ E ⇒ (e,v) ∈ E.[15]

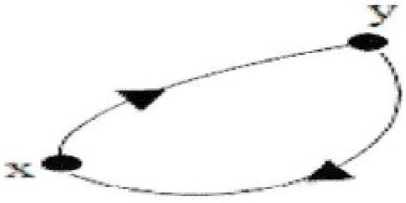


Figure -12-: Example of particular graph.

8- Planar graph:

Planar graph is a graph that can be drawn in a plane such that none of its edges cross each other[16].

[14] Larremendy Valverde Alain Marie-Jeanne, Graph theory introduction page 7.

[15] Larremendy Valverde Alain Marie-Jeanne, Graph theory introduction page 7.

[16] Margaret M. Fleck Planar graphs December 2nd 2011. Page 1,2,3.

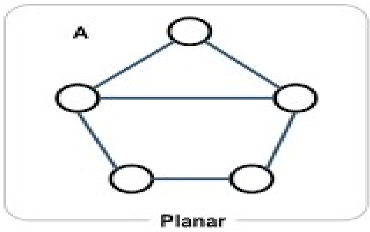


Figure -13-: Planar graph example.

9- Complete Graph:

a graph in which each vertex is connected to every other vertex is called a complete graph. Note that degree of each vertex will be n−1, where n is the order of graph. So we can say that a complete graph of order n is nothing but a (n−1)-regular graph of order n. A complete graph of order n is denoted by Kn[17].

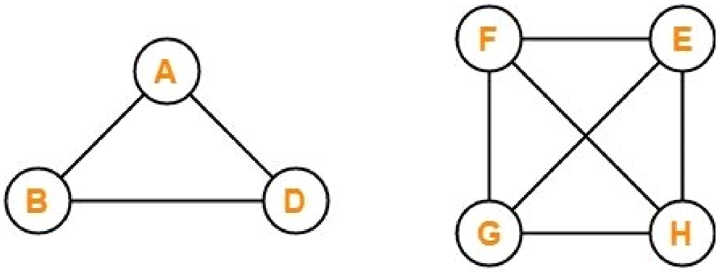


Figure-14-: Example of complete graph.

10- Comparability graph:

A graph is called a comparability graph if its edges can be transitively oriented (i.e., whenever (x, y), (y, z) are directed arcs, so is (x, z).) The complement of a comparability graph is called a co comparability graph. Co triangulated and co interval graphs are defined similarly[18].

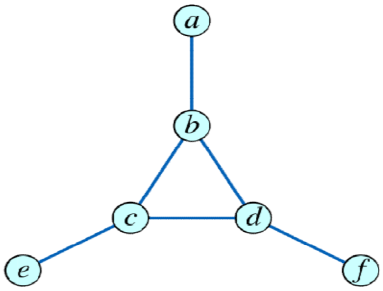


Figure -15-: Comparability graph example.

[17] Jeremy L. Martin complete graphs chapter 06 part 02 page 4,5.

[18] Prof Amit Kumar Algorithmic graph theory chapter 03 page 1,2.

11- Isolated graph:

Isolated graph noted by In. It called also by Null graph. The degree of all its vertexes is zero, all its vertexes are isolated[19]. Figure -16-

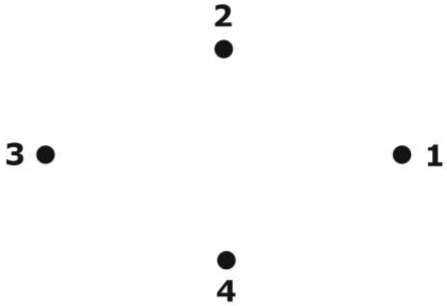


Figure-16-: Isolated graph example.

12- Cyclic graph:

A cyclic graph is a graph containing at least one graph cycle. A graph that is not cyclic is said to be acyclic. A cyclic graph possessing exactly one (undirected, simple) cycle is called a unicyclic graph[20]. Figure -17-

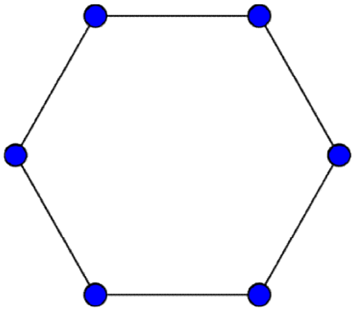


Figure-17-: Cyclic graph example.

13- Bipartite graph:

A bipartite graph also called a bi-graph, is a set of graph vertices, i.e., points where multiple lines meet, decomposed into two disjoint sets, meaning they have no element in common, such that no two graph vertices within the same set are adjacent[21]. Figure -18-

[19] Yair Caroa , Adriana Hansberg Partial Domination - the Isolation Number of a Graph page 6,7.

[20] https://mathworld.wolfram.com/CyclicGraph.html#:~:text=A%20cyclic%20graph%20is%20a,Cyclic%20graphs%20are%20not%20trees.

[21] https://www.educative.io/answers/what-is-a-bipartite-graph.

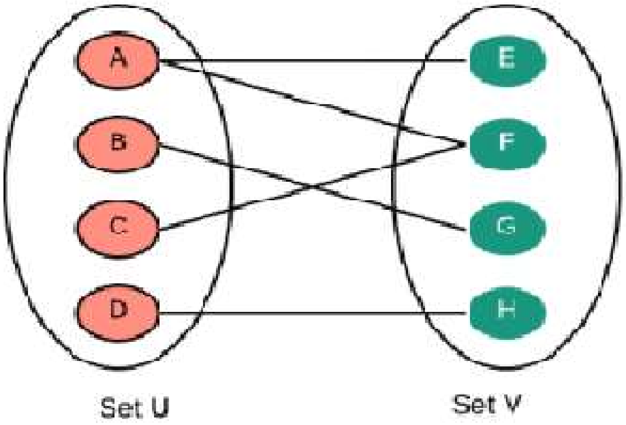


Figure-18-: Bipartite graph example.

14- Tree:

A tree is a mathematical structure that can be viewed as either a graph or as a data structure. In graph theory, a tree is an undirected graph in which any two vertices are connected by exactly one path, or equivalently a connected acyclic undirected graph[22]. Figure -19-

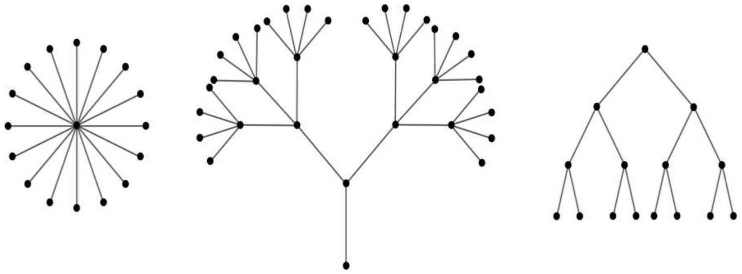


Figure-19-: Tree examples.

15- Conclusion:

At this part of our final dissertation we based on a lot of definitions and concepts about graph theory, then to try to make the concepts as simple as possible and also the progress of our chapters and understand the graph theory by using definitions, types, and some examples.

All this is for giving you a hint for starting the next chapter which gives us a lot of clearness about the algorithms that we used to base on for our study.

[22] https://www.tutorialspoint.com/graph_theory/graph_theory_trees.htm,

Chapter II
Project management

1-Introduction:

The graph theory is the combination of the mathematical and computing that is interested by the graphs and their properties, and explains the algorithms to solve the problems. The theory objects have many uses in almost every single field that is related to graphs and network representation.

That what shows a number of problems in the existence of the paths , the shortest path, and the best path.

We are going to see the project management and its history and project management characteristics.

The presentation of project management done by graphical part and which used in many deferent ways. which we will see in this chapter.

1-Definitions:

1-1- Project: A project is a set of interrelated tasks, or operations that must be performed in a certain order so as to reach some goal. It can be defined also as an individual or collaborative endeavour that is planned to achieve a particular aim[23].

Events (activities or sub-activities) are starting and finishing points of various operations of the project. The operations of the project are interrelated through precedence relations of two types, NOT BEFORE and NOT LATER. One of the traditional graphical forms of project representation is a directed graph, or a network, in which edges (arcs) are identified with project operations (tasks) and verteces (nodes) with events. The graph contains, also, additional edges in order to properly represent the precedence relations between operations. The resulting graph G=(V,E) having vertexes (nodes) set V and edges (arcs) set E.

Let E:

$$E= \{1\ldots n\}$$

Be a given set of events of the project, and ti the (unknown) time at which the event i, $i \in E$.

[23] Mashhood Ishaque, Abbas K. Zaidi, Alexander H. Levis Project Management Using Point Graphs page 12.

1-1-1-The NOT BEFORE relations: denote that certain operation can be started (and/or finished) not before than in a(i,j), the given amount of time unites after other operation has started (and/or finished):

$tj-ti \geq a(i,j), \ (i,j) \in V \subset E \times E$.

1-1-2The NOT LATER relations: denote that some operation is to be started (or, equally possible, to be finished) not later than the given time b (i,j) before some other operation will start (finish):

$tj-ti \leq b(i,j), \ (i,j) \in V \subset E \times E$ [24].

1-2-Project management: is defined as a discipline that has the goal of initiating, planning, executing, controlling, and closing the work of a team which has the goal of achieving a certain predefined success criteria, by dealing with the resources in every single activity in order to minimize the time and the cost. It has the traditional project management and concurrent engineering approaches that has started in the 1950's and developed with time, it was known by its critical path method (CPM) ("that developed "). The classical project management used to have a certain limitation in terms of the activities type, and the time between them. These time (temporal) relations called "Generalized Precedence relations'' (GPR). Its representation came in two different flavours: activity on arc (AOA), and activity on node (AON). And each representation has its own advantages and disadvantages in the different terms of modelling, visualisations, and computational complexity. In 1990's the project management has converted all the temporal constraints into the analytical representation, then create a new graphical representation[25].

The representation of project management: The project management can be presented by:

2-Critical path method (CPM): This method has been developed in 1950's as method to resolve the issue of the cost's increasing, it is a technique that helps to identify tasks that are necessary for the project completion.

The CPM resolves around discovering the most important tasks in the project timeline, identifying task dependencies, and calculating task duration. And it became popular for planning projects and prioritizing tasks, it helps also to

[24] https://www.simplilearn.com/what-is-a-project-article.

[25] Mashhood Ishaque, Abbas K. Zaidi, Alexander H. Levis Project Management Using Point Graphs page 7.

breakdown complex projects into individual tasks and gain a better understanding of the project’s flexibility[26].

CPM can provide valuable insight on how to plan projects, allocate resources, and schedule tasks. And it is used to improve the future planning by comparing the expectations with the actual progress, and also used to facilitate more effective resource management by prioritize tasks, and giving a better idea of how and where to deploy resources.

2-1-The critical path: is the longest estimated sequence of interdependent tasks that should be completed on time to ensure the project’s finish on due-date[27].

2-1-1Critical path algorithm:

To find critical path should be:

2-1-1-1-Listing the activities: Should be done by work breakdown structure.

2-1-1-2-Identifying dependencies: based on the work breakdown structure, most determine the tasks that are dependent on one another, which should facilitate the identifying of any work that can be done in parallel with other tasks.

2-1-1-3-Creating a network diagram: By turning the work breakdown structure to a network diagram, which is a flowchart displaying the chronology of activities.

2-1-1-4-Estimating the tasks durations: by using these techniques:

2-1-2-**The forward pass:** is used to calculate the earliest start (ES) and the earliest finish (EF) dates by using a previously specified start date. Early start (ES) is the highest early finish (EF) value from immediate predecessors, where EF is ES+ duration. The calculation starts with 0 at the ES on the first activity and proceeds through the schedule.

2-1-3The backward pass: is used to calculate the latest start (LS) and the latest finish (LF) dates, LS is LF- duration, where LF is the lowest LS value

[26] https://www.imse.iastate.edu/files/2015/08/Critical-Path.pdf

[27] https://mymanagementguide.com/basics/critical-path-project-management/

from immediate successors. The calculations start from the last scheduled activity and proceeds backward through the entire schedule.

The early and the late start and finished used to calculate the float (margin)[28].

2-1-4-Calculate the critical path: this step can be done manually by the next steps:

Step 1: writing the start time and the end time next to each activity. The first activity start time is 0, and the end time is the duration of activity. The next activity start time at the end time of the previous activity and the end time is the start time + duration.

Ps: these steps are for all the activities.

Steps 2: The end time of the last activity in the sequence to determine the duration of the entire sequence.

Step 3: The sequence of activities with the longest duration is the critical path[29].

2-1-5-Calculate the float (margin):

2-1-5-1-Float (margin): is the amount of time for which an activity can be deployed without delaying the completion date subsequent tasks (successors) or the entire project. And it is a resource that should be used to cover the project risks on the unexpected issues that may show upon the project duration.

The critical tasks have a zero float, which means that these tasks have fixed dates. The float has two types, which are:

2-1-5-1-1-Total float (total margin): This is the amount of time that an activity can be delayed from the early start date without delaying the project finish date or violating a schedule constraint. Total float = LS - ES – the current task duration or LF – EF - the current task duration.

2-1-5-1-2-Free float (free margin): This refers to how long an activity can be delayed without impacting the following activity. There can only be free float when two or more activities share a common successor. On a network

[28] https://asana.com/resources/critical-path-method.

[29] https://asana.com/resources/critical-path-method.

diagram, this is where activities converge. Free float = ES (next task) - EF (current task) - the current task duration[30].

2-1-5-1-3-The benefits of the float: the float keeps project running on time by monitoring a project's total float allows to see the project is on track, the float allows also to prioritize by identifying activities with free float and this helps to get an idea of which task should be prioritized, and it's a very useful resource to cover the project risks and unexpected issues by knowing how much float allows to choose the most effective way to use it. Also it helps finding the critical path[31].

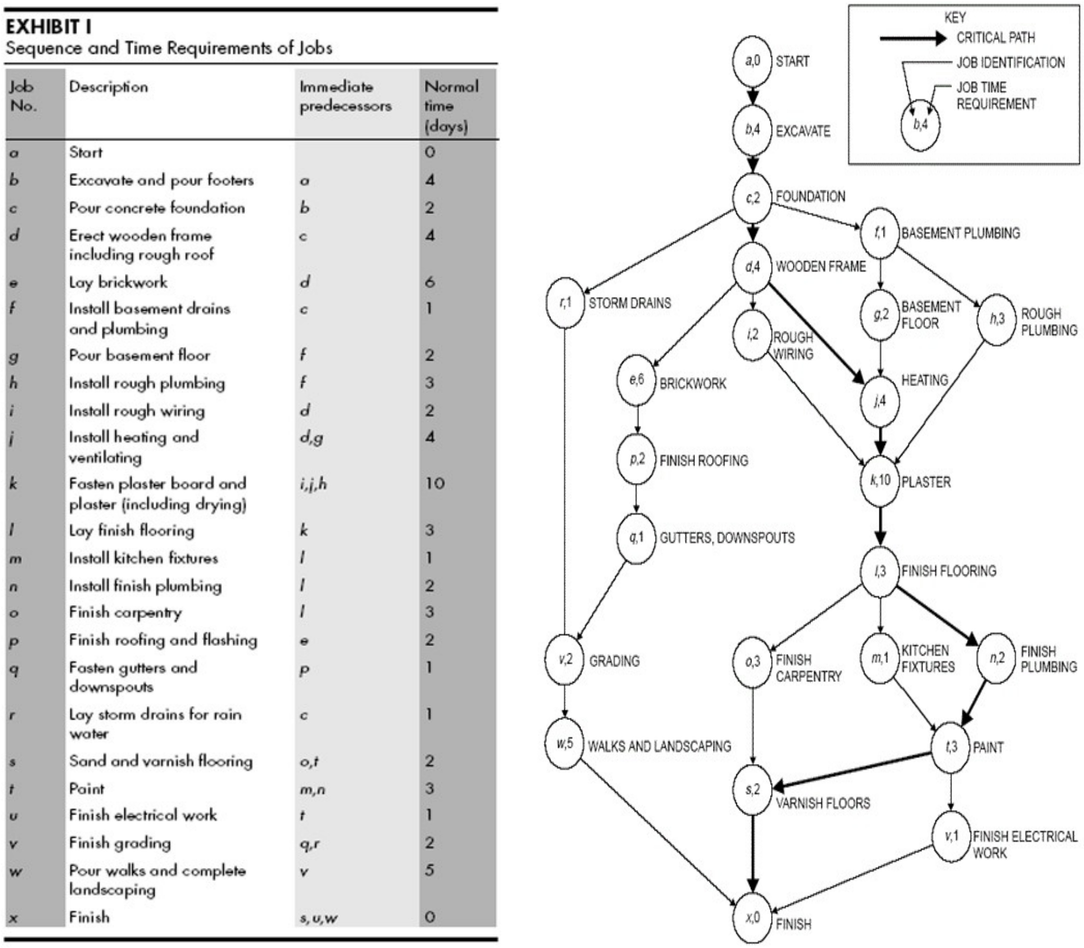


EXHIBIT I
Sequence and Time Requirements of Jobs

Job No.	Description	Immediate predecessors	Normal time (days)
a	Start		0
b	Excavate and pour footers	*a*	4
c	Pour concrete foundation	*b*	2
d	Erect wooden frame including rough roof	*c*	4
e	Lay brickwork	*d*	6
f	Install basement drains and plumbing	*c*	1
g	Pour basement floor	*f*	2
h	Install rough plumbing	*f*	3
i	Install rough wiring	*d*	2
j	Install heating and ventilating	*d,g*	4
k	Fasten plaster board and plaster (including drying)	*i,j,h*	10
l	Lay finish flooring	*k*	3
m	Install kitchen fixtures	*l*	1
n	Install finish plumbing	*l*	2
o	Finish carpentry	*l*	3
p	Finish roofing and flashing	*e*	2
q	Fasten gutters and downspouts	*p*	1
r	Lay storm drains for rain water	*c*	1
s	Sand and varnish flooring	*o,t*	2
t	Paint	*m,n*	3
u	Finish electrical work	*t*	1
v	Finish grading	*q,r*	2
w	Pour walks and complete landscaping	*v*	5
x	Finish	*s,u,w*	0

Figure-20-: CPM example

[30] https://www.deepfriedbrainproject.com/2009/08/total-float-vs-free-float-cpm-network-diagram.html.

[31] https://www.indeed.com/career-advice/career-development/float-project#:~:text=Ensures%20projects%20stay%20on%20schedule,they%20meet%20their%20project%20deadline.

2-1-6-The uses of critical path method: The CPM provides visibility into the project progress, also it allows monitoring the tasks and their finish time and it also used in:

2-1-6-1-Compress schedules: In certain situations the project deadline may be pushed up. In this case there are two techniques might be used to compress the schedules:

2-1-6-2-Fast tracking technique: by finding the critical path the project might have activities performed at the same time. Running parallel process will speed up the overall duration.

2-1-6-3-Crashing technique: This process involves allocating more resources to increase the project's activities.

2-1-6-4-Resolve resource shortages: The CPM does not take resource availability, when there is a resource shortage, there is a technique called resource levelling to solve the issue. This technique aim to resolve resource over allocation issues and it does this by adjusting project start and end dates.

2-1-6-5-Compile data for future use: By comparing the CPM schedule to the actual critical path as the project is on the run time. This data can be used in the future as a reference to get more accurate task duration estimates for future projects[32].

2-1-7-CPM's Pros and cons:

2-1-7-1-Advantages of the critical path method:

1- The CPM helps to figure out if there are parallel running activities.
2- Shows the critical tasks (activities/element) of the project.
3- Gives a practical and disciplined base which helps to reach the project's objective.
4- CPM is effective in new project management.
5- It provides demonstration and dependencies to schedule the individual activities.
6- Shows in a network diagram the activities and their outcomes.
7- Gives a fair and concise procedure of the project documentation.
8- Helps to find out the slack time project.
9- CPM is a clear and explicit approach of communicating project plans, schedules, time and cost performance is developed.

[32] Santiago, Jesse (February 4, 2009). "Critical Path Method" (PDF). Stanford.

10- Helps the optimization by determining the duration of the project[33].

2-1-7-2-Disadvantages of the CPM:

1- In the critical path method it is hard to estimate the completion time of an activity.
2- The critical path is not always clear in CPM.
3- Also the critical path needs to be calculated precisely.
4- In the big projects the CPM becomes more complicated.
5- It does not handle the scheduling of the resource allocation[34].

3-PERT-Chart (diagram/graph):

The PERT graph/network (for Project Evaluation and Review Technique), is directed graph helps us to minimize the project time and cost, and breaking large complex project to sub-activities, by making nodes (vertexes/circles) indicating the beginning and the end of activity which is represented by arcs (edges).

And it is a useful tool to drive project effectiveness and efficiency, and it can be applied in a lot of sectors, construction, military...and education[35].

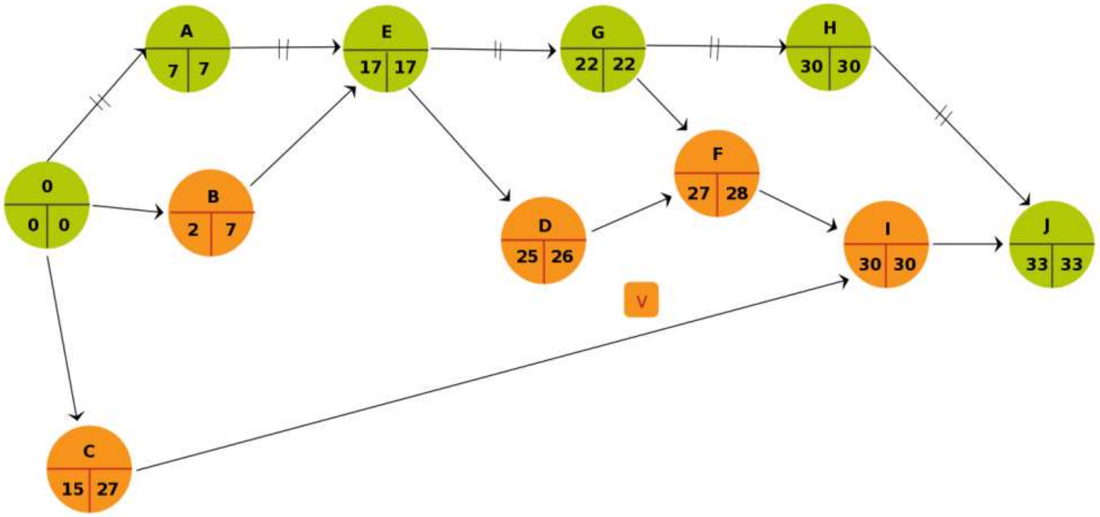


Figure-21-: Pert example

[33] https://www.smartsheet.com/content/critical-path

[34] https://www.smartsheet.com/content/critical-path.

[35] Project management Pert-CPM page 03.

3-1-PERT-Time: Let G a PERT graph (network), G= (V, E). With V a set of vertexes (nodes), and E a set of edges (arcs), for some edges (e’, e’’) ∈ E, let there be given d(e’, e’’), with the lengths of e’ and e’’ are non negative lengths, with the giving of two fixed vertexes s the start and f the finish. The problem is to find the shortest path from s to f (it called “the critical path”). And it determines the shortest time to the graph G is completely finished[36].

3-2-PERT-Cost:

Let P a project with event set E, and operation set V. Only one type of precedence relation, NOT BEFOR is presumed to be imposed by operations in this model. The corresponding PERT is assumed to be acyclic: Associated with each operation (i, j) ∈ V are its “normal” completion time p(i, j), its "crash" completion time q(i,j) and the cost c(i,j) of shortening the operation by one time unit. Denoting by t(i,j) the actual (unknown) duration of the operation (i,j), the latter quantity is to be between q(i,j) and p(i,j), (i,j)∈V, and the cost of the operation (i,j) is

$$\mathbf{c(i,j)(p(i,j)-t(i,j)).}$$

The problem is to find the minimal cost of shortening the project to a given duration T[37].

3-3-**The critical activities in PERT-chart:** an activity called a critical activity in PERT-chart is when the earlier start time and the latest finish time are equal, or its floats are null.

3-4-**The dummy activity:** is an activity added to the project as a placeholder. It has no activity time associated with it. A dummy activity is intended to show a path action in project activity diagram and is employed when logical relationship between two activities cannot be linked by showing the use of arrows linking one activity to another. An activity followed by a dummy activity can only be completed once the activity or activities preceding the dummy activity is completed. It can be either critical or non-critical activity. The representation of a dummy activity by a dashed (doted) line[38].Figure-3-

[36] https://www.masterstudies.com/Masters-Degree/Project-Management/Part-time/.

[37] https://www.masterstudies.com/Masters-Degree/Project-Management/Part-Cost/.

[38] Project management :Pert-CPM page 07.

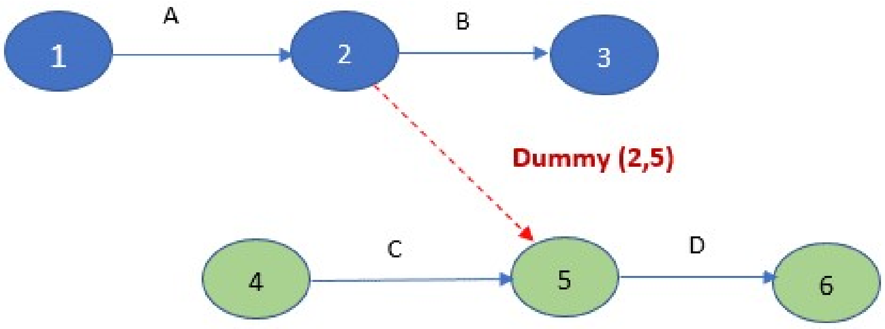


Figure-22- dummy activity example.

3-5-Principal:

How PERT chart works? A PERT chart works by visually representing a project's tasks and the dependencies connected to each one. It also used to create an initial and estimated timeline to study the project before it even starts.

3-6-Explaining the task representation:

A: is the Task (activity), x: is the duration of activity, N and N': the steps numbers, Y: the earliest start, Z: the latest start, Y': the earliest finish (or the earliest start to the next task "if it does excite"), Z': the latest finish (or the latest start to the next task "if it does excite").

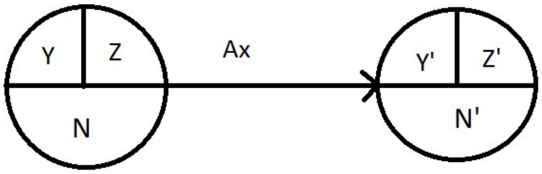


Figure-23-: General task presentation on PERT-chart.

3-7PERT chart algorithm:

3-7-1-Identifying all of the project's tasks (activities): First step is collecting all necessary project information and tasks, by defining all the project's major phases, milestones, and the activities in order to complete the project

3-7-2-Identifying the dependencies of tasks: the dependencies of a task or milestones is to find out if the task or milestones is related on another task to be completed before the actual task can be started. It is sometimes related to a logical relationship and often used in a work breakdown structure. By creating dependencies of a task can be helpful to track the work, and ensure the task's finishing point, and establish clear communication.

In PERT diagram, the dependencies are observed by connecting and numbering tasks, while it is not relating to other methods like work breakdown structure, and it shows a high-level visualization of tasks and the work needed to complete them.

3-7-3-Work breakdown structure: a tool to organize the project by hierarchy.

3-7-4-Connect project tasks: once the dependencies have been created, the connection between the project tasks one to another. It consists of edges (arcs/arrows), which represent tasks, and nodes, which represent events or milestones.

3-7-5-Estimate project time frame: estimating overall project timeframe using the critical path method and PERT formula. The critical path is the longest sequence of tasks that must be finished to complete the project successfully. By finding the longest path that will take the most time to finish in order to estimate the shortest overall project duration. Time estimating can be calculating based on the following:

3-7-5-1-Optimistic time: Is a concept used in PERT. It represents the shortest estimated time period within which a task is likely to be completed, and is used in project planning. In other words it is the minimum amount of time needed to accomplish a task. It means that if everything goes well then there is more chance of completing the activity within this time.

3-7-5-2-Pessimistic time: The maximum amount of time needed to accomplish a task. In other words it is the longest time that the activity would take to complete. It is the worst time estimate, because the activity can face unexpected problems.

3-7-5-3-Most likely time: the best estimate of how long it will likely take to accomplish a task.

3-7-5-4-PERT formula: it is used to calculate the expected duration of a task and completion time using:

(O + (4 × M) + P) ÷ 6

This can be measured by minutes, hours, days (any time unite), or even weeks. With:

O: optimistic time.

P: pessimistic time

M: most likely time.

3-7-5-5-Manage task progress: It can be done by closing dependencies and mitigating issues along the way until all tasks are completed. The PERT diagram should be update throughout the project as changes occur. This could be paired with a change control process, which helps map and communicate project changes[39].

3-8-PERT's pros and cons:

3-8-1-The advantages of PERT:

1- The graphical representation of the project helps to easily understand the relationships among the activities.
2- Handling the project from tactical level planning and operational level control.
3- PERT is an effective tool in planning single project activities in any type.
4- Helps to analyse the activities and showing the likely time and budget of the project's completion.
5- Helps the management in identifying the essential elements to complete the project.
6- PERT make well organised for the representation of large amount data.

3-8-2-PERT's disadvantages:

1- Its maintenance is expensive and complex.
2- In the case of huge number of tasks (hundreds or thousands) the PERT becomes difficult to study.

[39] https://www.fool.com/the-ascent/small-business/project-management/articles/pert-chart/.

3- It also cannot handle situations in which two project share available resources[40].

4-Gantt chart:

4-1-History about Gantt: was developed by Henry Gantt around 1910 - 1915 the bar chart was created around 1810-1820, Gantt had changed it from a vertical bar chart to horizontal bar chart[41].

4-2-Definition of Gantt chart: It became a useful tool in production and project management (scheduling). It is a popular device because its simplicity and clear graphical display for simple scheduling problems. The Gantt chart can be defined by a horizontal bar chart used to illustrate the timeline of project and tasks, which gives a visual overview of project schedule, upcoming milestones, and overall project timeline.

Each horizontal bar in the chart represent a task and the length of each bar represent the amount of time that task (activity) will take[42].

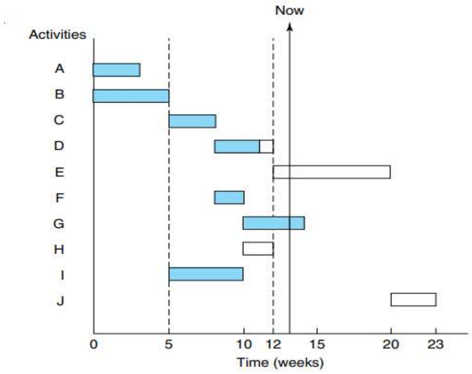


Figure-24-: Gantt-chart example.

4-3-Gantt chart algorithm: To have a well done Gantt chart:

4-3-1-Define the time range: The Gantt chart should represent a project with a known start and end dates.

4-3-2-Adding tasks with starting and ending dates: Each individual task must have a specified beginning and end date, for an easy visualization on bar chart

[40] https://smallbusiness.chron.com/pros-cons-pert-charts-42359.html

[41] Graphical Project Planning Techniques: An Overview of Gantt, PERT, and CPM Charts Prepared for groups in ECE480.

[42] https://www.apm.org.uk/resources/find-a-resource/gantt-chart/

4-3-3-Clarifying dependencies: In the project some tasks cannot be started until other tasks are completed. To keep the project's running smoothly, it's a simple to visualize dependencies between tasks in Gantt chart.

4-3-4-Pinpoint milestones: Unlike most tasks in Gantt chart the milestones are fixed point in time.

4-3-5-Milestones: A project milestones mark specific point along a project timeline. They are checkpoints that identify when activities or groups of activities have been completed or the start of an activity.

4-3-6-Modifying work as plans change: Plans will inevitably change, which is why Gantt chart is adapted to changes[43].

4-4-Gantt's pros and cons:

4-4-1-The advantages of Gantt-chart:

1- Gantt simplifies the complex projects.
2- Establishes initial project schedule that helps to know who is going to do what, when, and how much time the project takes to finish.
3- Gantt makes it easy to understand timeline and brings clarity of dates.
4- Give a clear view to the project and its tasks (project activities).

4-4-2-Gantt's disadvantages:

1- The size of bar chart does not necessarily indicate amount of work done in project.
2- Gantt charts and projects need to be updated on regular basis.

5-The difference between PERT-chart, CPM, and PERT-chart, Gantt-chart:

In the tables below there are the differences:

5-1-PERT-chart vs. CPM:

Critical path method (CPM)	PERT-char
1-CPM manages predictable project activities. 2-CPM focuses on time-	1-PERT manages uncertain project activities. 2-PERT focuses on

[43] https://asana.com/resources/gantt-chart-basics

cost-trade offs.	meeting or minimizing project duration.
3-CPM a deterministic model.	3-PERT is a probabilistic model.
4-CPM has only one estimate for the activities	4-PERT has three estimates for each activity

5-2-PERT-chart vs. Gantt-chart:

PERT-chart	Gantt-chart
1- PERT charts are flowcharts by taking different layouts depending on the project.	1- Gantt-charts are a traditional bar-charts approach.
2- PERT charts allow simple layout customization which is better for high-level project needs.	2- Gantt charts are more structurally organized.
3- PERT charts can be used before the project begins	3- Gantt charts are more popular for mapping out project tasks throughout the project lifecycle
4- PERT charts Plot activities without timescale	4- Gantt-charts plot activities with timescale.

6-Conclusion:

The comprehension of the project management, in this context, we presented all through the chapter theoretical analyse of the project management which allows us to complete the project in the shortest time with the minimized coast, also we are going to see the classes and the application, and calculating the float (margin) to find the critical path.

The work done in this chapter the aspect presentation which allows theoretical that also allows describing the used ways in the practical part (chapter 3).

Chapter III
Implementation

1-Introduction:

Simple examples by using Java compiler that makes programming possible, to have a more comfort models, the using of an integrated development environment (IDE) is proffered. In our project we are using IntelliJ IDEA.

The reason behind choosing IntelliJ is that it is not based only in Java, IntelliJ support other programming languages (Python, C++, HTML... etc). It understands all the modern IDE characteristics.

In the other hand, the LaTeX editor allows to get a high quality documents without a lot of knowledge of typography or layouts.

The LaTeX language is so famous and easy to use in the scientific fields, and also allows us to get a solution in well done PDF form.

In this part of our study we are going to create a comfort model as a solution in project management.

2-JavaFX:

JavaFX is a software development platform from Oracle to facilitate desktop and rich web applications (RIA) that can be accessed from deferent gadgets. JavaFX originally created by Sun Microsystems, comprises of JavaFX script and JavaFX mobile.

The scripting language is expected to facilitate the using of Java Swing UI (user interface) library to make rich UIs, which will run anywhere the Java standard edition is upheld. JavaFX empowers the creation of GUIs in declarative language design that characterizes interface components from Java's Swing interface toolkit alongside an assortment of show impacts including movement (animation), vector graphics, audio tracks and video, all running in a Java virtual machine (JVM)[44].

3-CSS:

Cascading Style Sheets (CSS) a stylesheet language used to portray the presentation of a document written in HTML or XML (including XML dialects such as SVG, MathML or XHTML). CSS depicts how elements should be rendered on screen, on paper, in speech, or on other media. CSS is among the

[44] https://www.theserverside.com/definition/JavaFX.

center dialects of the open web and is normalized across Web browsers according to W3C particulars. Already, the advancement of various parts of CSS specification was done synchronously, which permitted the forming of the most recent suggestions[45].

3-Java:

3-1-Definition:

Java is a general-purpose, class based, object-oriented programming language, computing platform released in 1995 by Sun Microsystem developed by James Gosling. This language is created for having lesser implementation dependencies and used also in application development. Nowadays is widely used to run devices, including mobile devices, gaming consoles, medical devices and many others.

Java is provided by a tool called JDK (Java Development Kit) which is the core component of Java Environment and supplies all the tools, executables, and binaries required to compile, debug, and execute a Java Program[46].

3-2-Java Plug-in:

Java Plug-in is a software product Sun released it 11 April 1998, which works as a scaffold between a browser and external JRE, by “telling” (the browser takes an order from the developer) the browser to use the external JRE by putting special HTML on web a web page. Once all this happened, the browser can run Java applet and JavaBeans parts that approach to all features (within the limits of Java's security model) of this external JRE[47].

3-3-Java features:

Object oriented: Java is an object-oriented programming language. Everything in Java is an object. Object-oriented means we organize our software as a combination of different types of objects that incorporate both data and behavior.

[45] https://developer.mozilla.org/en-US/docs/Web/CSS#:~:text=Cascading%20Style%20Sheets%20(CSS)%20is,speech%2C%20or%20on%20other%20media.

[46] Petter Andersen Busterud’s Master thesis “Investigating Different Concurrency Mechanisms in Java “ page 15.

[47] https://www.infoworld.com/article/2076434/plug-into-java-with-java-plug-in.html#:~:text=What%20is%20Java%20Plug%2Din,tags%20on%20a%20Web%20page.

Platform independent: Java is platform independent because it is different from other languages like C, C++, etc. which are compiled into platform specific machines while Java is a write once, run anywhere language. A platform is the hardware or software environment in which a program runs.

Simple: Java is very easy to learn, and its syntax is simple.

Secure: Java is best known for its security. With Java, we can develop virus-free systems. Java is secured because:

- No explicit pointer
- Java Programs run inside a virtual machine sandbox

Portable: Java is portable because it facilitates you to carry the Java bytecode to any platform. It doesn't require any implementation.

High performance: Java is faster than other traditional interpreted programming languages because Java bytecode is "close" to native code. It is still a little bit slower than a compiled language (e.g., C++). Java is an interpreted language that is why it is slower than compiled languages, e.g., C, C++, etc.

Distributed: Java is distributed because it facilitates users to create distributed applications in Java. RMI and EJB are used for creating distributed applications. This feature of Java makes us able to access files by calling the methods from any machine on the internet..

Dynamic: Java is a dynamic language. It supports the dynamic loading of classes. It means classes are loaded on demand. It also supports functions from its native languages, i.e., C and C++. [48]

4-IntelliJ IDEA:

The programming has a lot of uses could be used to give examples with Java compiler, but in order to use it more comfort have to use integrated development environment IDE, as Eclipse ,NetBeans , IntelliJ IDEA.

In our project we are using IntelliJ.

[48] https://www.techno-science.net/definition/5346.html.

4-1-Definition:

IntelliJ is a Java-based integrated development environment (IDE) for JVM languages designed to maximize developer productivity. The term also refers to the IDE’s fundamental application platform framework, released in open source by Sun in June 2009 licensed under the open-source apache license. IntelliJ does not support only Java it also support many other programming languages, as Python, C, C++, XML ... etc. IntelliJ understands all the modern IDE features (multiple language support, code editor, code convertor, cross-platform support, batch code analyzer, interfaces graphically editor... etc).

IntelliJ is available on Windows, Lunix, macOS. And it is already developed by Java[49].

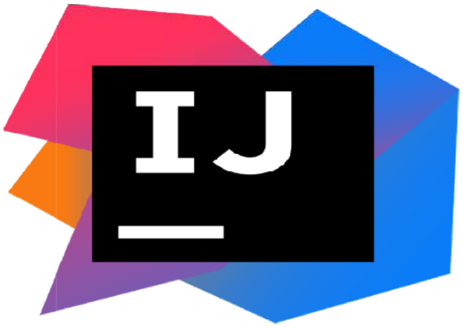


Figure-2 - IntelliJ logo.

4-2-Basic environment:

The basic environment includes these general functions:

1- Configure and manage the user’s graphical interface.
2- Support the multiple languages.
3- The import/ Export function from and to other IDE.
4- Manage and access to data base, web server, shared resources[50].

4-3File management system:

File system (Filesystem) or File Management System (FMS) is a data structure allows saving and arranging the files data that are in what is called secondary memory (Hard disk drives, Optical discs, Floppy disks ... etc).

[49] https://www.jetbrains.com/help/idea/discover-intellij-idea.html.

[50] https://www.jetbrains.com/help/idea/discover-intellij-idea.html

Any FMS gives permission to manage, recover and share the data between many computer programs. It also gives an abstract view of the files for their location by an access path[51].

4-4-File types:

4-4-1-Physical files :

Contain the genuine information (data) that is put away on the system and a description of how data is to be presented to or received from a program. They contain just a single record configuration, and one or more members. Records in database files can be remotely or program-described.

A physical file can have a keyed grouping access way. This means that data is introduced to a program in a sequence based on one or more key fields in the file[52].

4-4-2-Logical files:

Do not contain data. They contain a description of records found in one or more physical files. A logical file s a view or portrayal of at least one physical files. Logical files that contain more than one format are alluded to as multi-format logical files[53].

4-5-How to create a file in java:

Java language facilitates the creation of a file by using pre-defined classes and packages. There are many ways to create a file. But in all java versions Java FileWriter class is used to write character-oriented data to a file. It is character-oriented class which is utilized for file handling in java[54].

Dissimilar to FileOutputStream class, it does not need to convert string into byte array because it provides method to write string directly.

Java FileWriter class inherits from OutputStreamWriter class which in turn inherits from the Writer class.

The constructors of this class expect that the default character encoding and the default byte-support size are adequate. To be specified, construct an OutputStreamWriter on a FileOutputStream.

[51] https://www.techno-science.net/definition/File-system.

[52] https://www.ibm.com/docs/en/i/7.2?topic=files-physical-logical

[53] https://www.ibm.com/docs/en/i/7.2?topic=files-physical-logical

[54] https://www.javatpoint.com/java-filewriter-class.

FileWriter is meant for writing streams of characters. For writing streams of raw bytes, consider using a FileOutputStream.

FileWriter creates the output file if it is not present already[55].

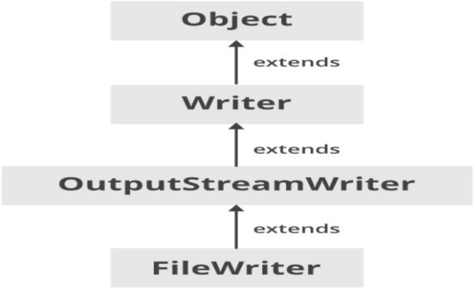
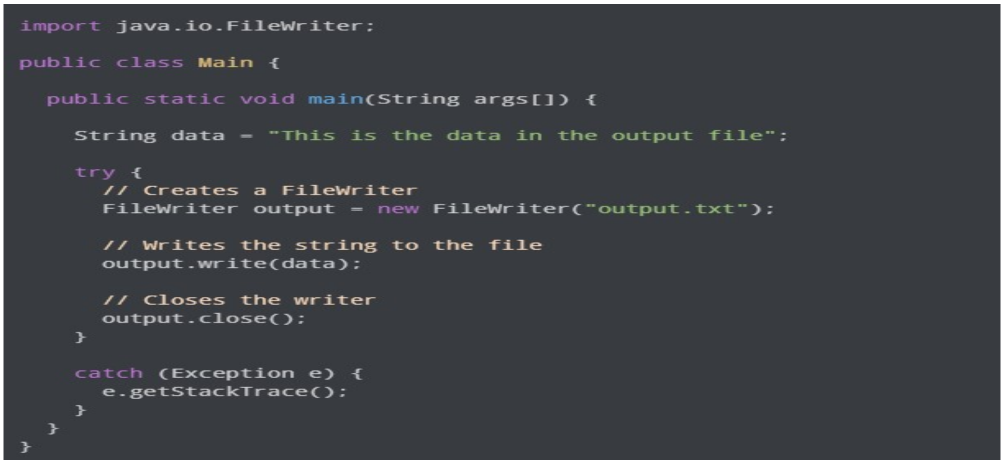


Figure - 26- Hierarchy of Java FileWriter Class.



```
import java.io.FileWriter;

public class Main {

  public static void main(String args[]) {

    String data = "This is the data in the output file";

    try {
      // Creates a FileWriter
      FileWriter output = new FileWriter("output.txt");

      // Writes the string to the file
      output.write(data);

      // Closes the writer
      output.close();
    }

    catch (Exception e) {
      e.getStackTrace();
    }
  }
}
```

Figure- 27- FileWriter to write data to a File.

5-LaTex:

5-1-Definition:

LaTex is language created to separate the contain of forms during the creation of a documents or publication. More explicitly, the author gives the instructions in notepad and manages his text with special commands of LaTeX[56].

LaTex can also be defined as software used for typesetting technical documents.

[55] https://www.geeksforgeeks.org/filewriter-class-in-java/

[56] Laleluolilo, writing a high quality document with LaTeX 29/11/2012.

5-2-LaTeX versus word:

We are going to compare between Microsoft word and LaTeX by a general comparison of their characteristics. Then advantages for using LaTeX .

5-2-1-General comparison:

For some work or study at some point you might need to use a tool for writing, especially if it is a long writing document or report which is also need a long time the layout in the MS Word is a bit hard work.

The user must manage every time the form in working software like MS Word which causes a lot of time wasting.

The changes became quickly a hard job (a headache), every single time selecting, changing even in small details.

The time spent in MS Word reduction almost 50% from the time of managing a long document (if the user is an amateur user).

The more using of the MS Word in sciences (natural or social) the more difficult it became in using effort(the harder it gets), as in the figure below.[57]

[57] https://www.researchgate.net/post/Why_LaTex_is_better_choice_than_Microsoft_Word#:~:text=Latex%20is%20mainly%20a%20format,store%20it%20in%20Latex%20format.

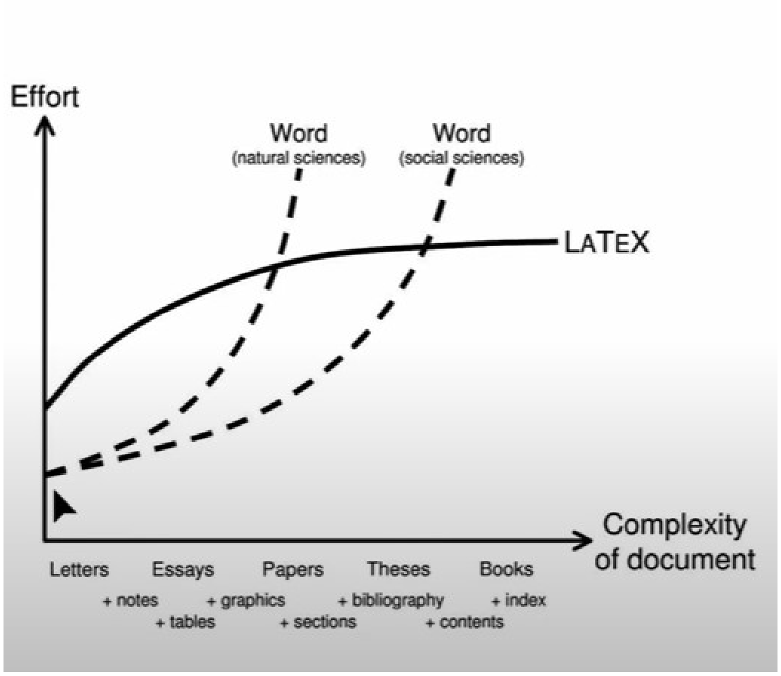
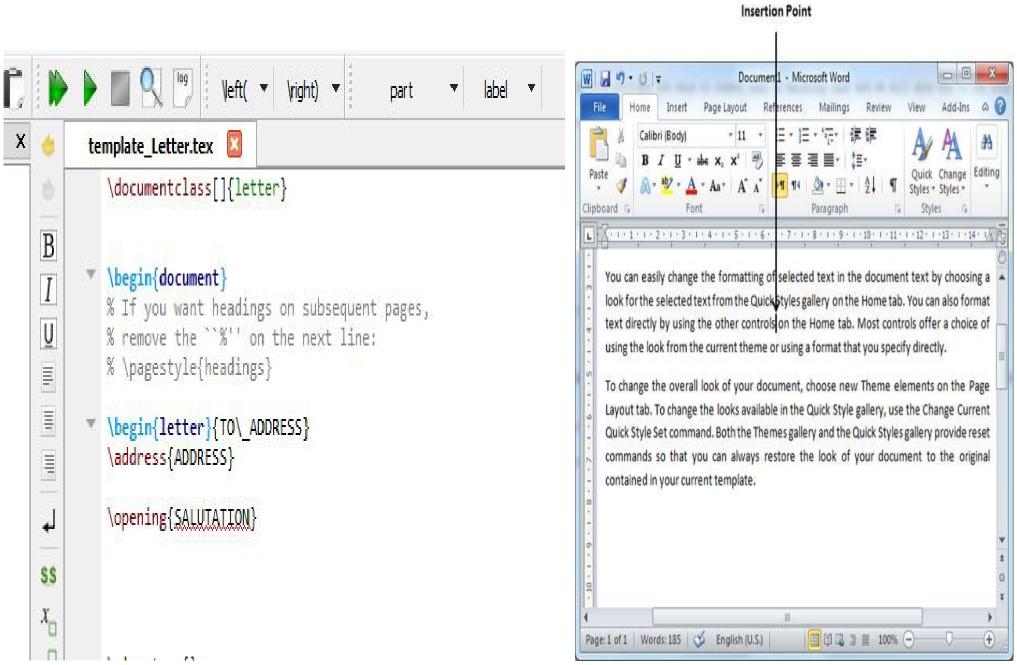


Figure -28- LaTeX vs word.

In the other hand LaTeX is not a management of a document as MS Word or any software of WYSIWYG (WhatYouSeeIsWhatYouGet).The next figure LaTeX(on the left) Word(on the write).



template_Letter.tex

```
\documentclass[]{letter}


\begin{document}
% If you want headings on subsequent pages,
% remove the ``%'' on the next line:
% \pagestyle{headings}

\begin{letter}{TO\_ADDRESS}
\address{ADDRESS}

\opening{SALUTATION}
```

You can easily change the formatting of selected text in the document text by choosing a look for the selected text from the Quick Styles gallery on the Home tab. You can also format text directly by using the other controls on the Home tab. Most controls offer a choice of using the look from the current theme or using a format that you specify directly.

To change the overall look of your document, choose new Theme elements on the Page Layout tab. To change the looks available in the Quick Style gallery, use the Change Current Quick Style Set command. Both the Themes gallery and the Quick Styles gallery provide reset commands so that you can always restore the look of your document to the original contained in your current template.

Figure-29- LaTeX vs word.

LaTeX does not use anything like the MS Word. In LaTeX you must select the type of what are you writing (documents, article, letter... etc).

LaTeX is a free typesetting system that allows you to focus on content without bothering about the layout: the software takes care of the actual typesetting, structuring and page formatting, producing documents of astonishing elegance.

LaTex is preferred to MS Word in: science documentations, portability, lightness, security are just a few of them (not to mention that LaTeX is free)[58].

5-3-Benefits of LaTex:

Beautifully typeset output: LaTeX is designed by mathematicians for producing beautifully typeset mathematics. Not only are the equations and mathematical symbols beautifully rendered, but LaTeX also does an exceptional job at handling visual components such as fonts, spacing, and line breaks.

Structured files: LaTeX has the author specify various elements of the document, such as title, authors, chapter and section headings, environments for theorems and proofs, appendices, and the bibliography.

Management of internal references: LaTeX elegantly handles numbering and internal referencing within a document.

Management of Citations: As with internal references, LaTeX handles citations elegantly. If you use BibTeX, which is compatible with most reference management software, it is also easy to change bibliographic styles[59].

5-4-LaTeX and publications:

1- Backward compatibility.
2- PDF creations.
3- LaTeX document can be read in all OSs.
4- The layout changes are much easier then WYSIWYG[60].

5-5-LaTeX and presentations:

LaTeX is not only software for writing reports and documents it is also a useful tool in creating a presentations in high quality.

[58] https://nitens.org/w/latex/.

[59] https://marktomforde.com/academic/miscellaneous/images/LaTeX-benefits.html.

[60] Laleluolilo, writing a high quality document with LaTeX 29/11/2012.

5-6-LaTeX History:

LaTeX is a free software package created in 1985 by the American computer scientist Leslie Lamport as an addition to the TeX typesetting system[61].

5-7-Abstract:

LaTeX is a typeset language and a free (software). It allows to get a high quality document without a strong knowledge of layouts managements.

LaTeX focuses on the contain of the document and the other thing are managed automatically by LaTeX. It does not need to pages numbering, summary creation, or figure numbering.

LaTex creates a PDF document that can be opened in all OSs.

LaTeX is preferred in mathematics equations, and references[62].

5-8LaTeX Installation:

In order to install LaTeX there are two types of software need to be installed well.

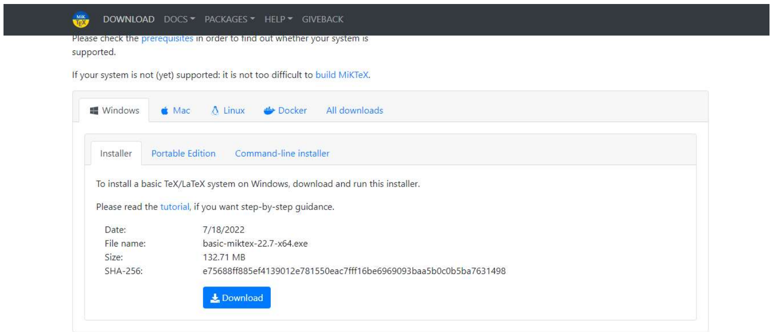
5-8-1-**LaTeX distribution:** is a software contains all LaTeX components, and it is the tool that transfers the typed code to the LaTeX editor in PDF document.

5-8-2-**LaTeX editor:** is software that allows typing the text and it makes a deferent colour for the deferent code typed.

There is a lot of LaTeX distribution but we are using MikTex as LaTex distribution and TexMaker as LaTeX editor. they can be downloaded as an installer (exe file) or installed (Zip file).

[61] https://www.britannica.com/technology/LaTeX-computer-programming-language.

[62] [62] Laleluolilo, writing a high quality document with LaTeX 29/11/2012 .



Please check the prerequisites in order to find out whether your system is supported.

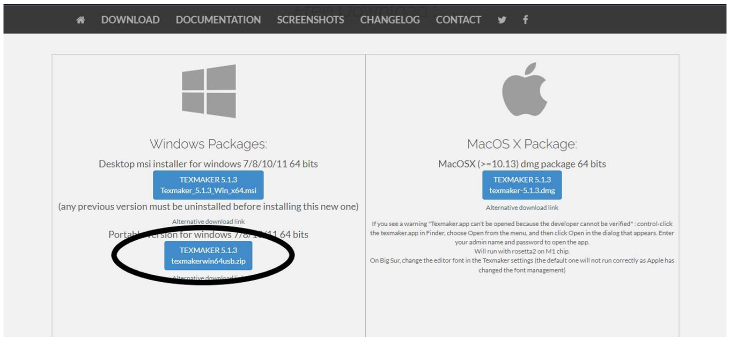
If your system is not (yet) supported: it is not too difficult to build MiKTeX.

To install a basic TeX/LaTeX system on Windows, download and run this installer.

Please read the tutorial, if you want step-by-step guidance.

Date:	7/18/2022
File name:	basic-miktex-22.7-x64.exe
Size:	132.71 MB
SHA-256:	e75688ff885ef4139012e781550eac7fff16be6969093baa5b0c0b5ba7631498

Figure -30- MikTex official website.



Windows Packages:

Desktop msi installer for windows 7/8/10/11 64 bits

(any previous version must be uninstalled before installing this new one)

Portable version for windows 7/8/10/11 64 bits

MacOS X Package:

MacOSX (>=10.13) dmg package 64 bits

If you see a warning "Texmaker.app can't be opened because the developer cannot be verified" : control-click the texmaker.app in Finder, choose Open from the menu, and then click Open in the dialog that appears. Enter your admin name and password to open the app.
Will run with rosetta2 on M1 chip.
On Big Sur, change the editor font in the Texmaker settings (the default one will not run correctly as Apple has changed the font management)

Figure -31- TexMaker official website.

5-10LaTeX files:

LaTeX is a programming language that manages many file types which are:

.tex: these files contain all the typed commands.

.i,e: source files.

.dvi: the result of the typed commands.

.psou.pdf: these files are created after the conversion of the .dvi files.

.bib and .bbl: these files serve bibliography management.

5-8-Document structure:

5-8-1-Compilations:

First of all save your file source in “File.tex” form.

Menu “Tools” then “Quick build” (in MekTex can be done also by pressining F1): for Dvi creation.

Menu “Tools” then Dvi -> PDF (in MekTex can be done also by pressining F4): for PDF creation.

5-9-LaTeX documents types:

Report: small document (1, 2, or 3 pages).

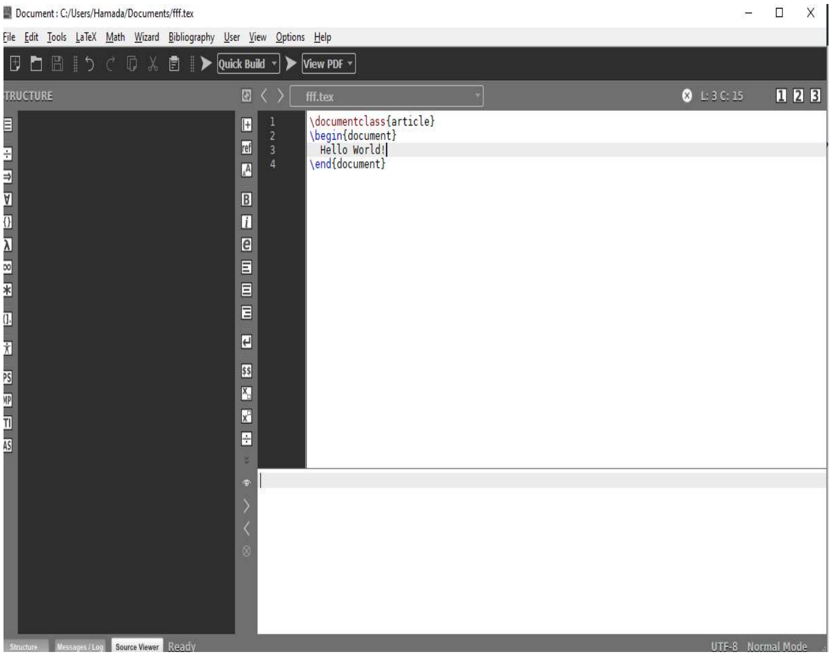
Article: small rapport or article.

Book: long document (Book, Thesis...).

Letter: write a letter.

The choice of the document type is giving also special characteristics as title, size ... etc.

5-10-Code source:

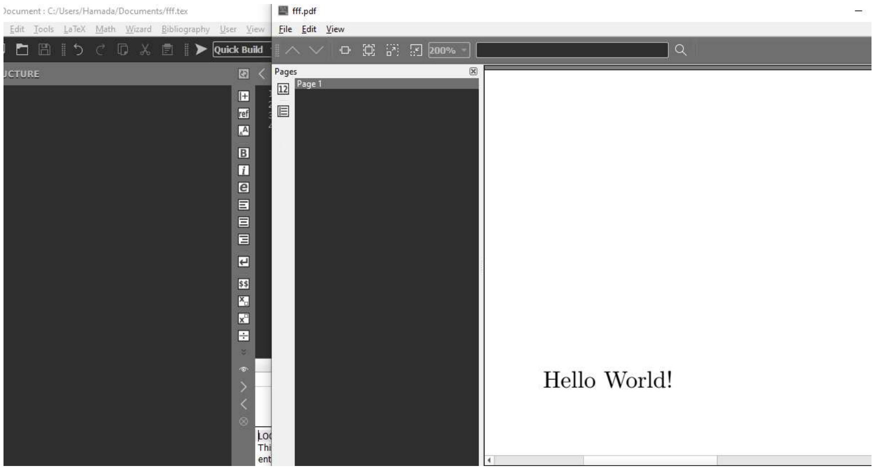


Document : C:/Users/Hamada/Documents/fff.tex

```
\documentclass{article}
\begin{document}
  Hello World!
\end{document}
```

Figure -32- LaTeX example.

5-11-Result:


Document : C:/Users/Hamada/Documents/fff.tex
Edit Tools LaTeX Math Wizard Bibliography User View
Quick Build
UCTURE
fff.pdf
File Edit View
200%
Pages
Page 1

Hello World!

Figure -33- LaTeX pdf example.

5-12-The most used environments:

The most used environments in LaTeX that allows to manage the document are

The lists.

The tables.

These environments are always starts by begin{ environments } and finish with end{ environments}.

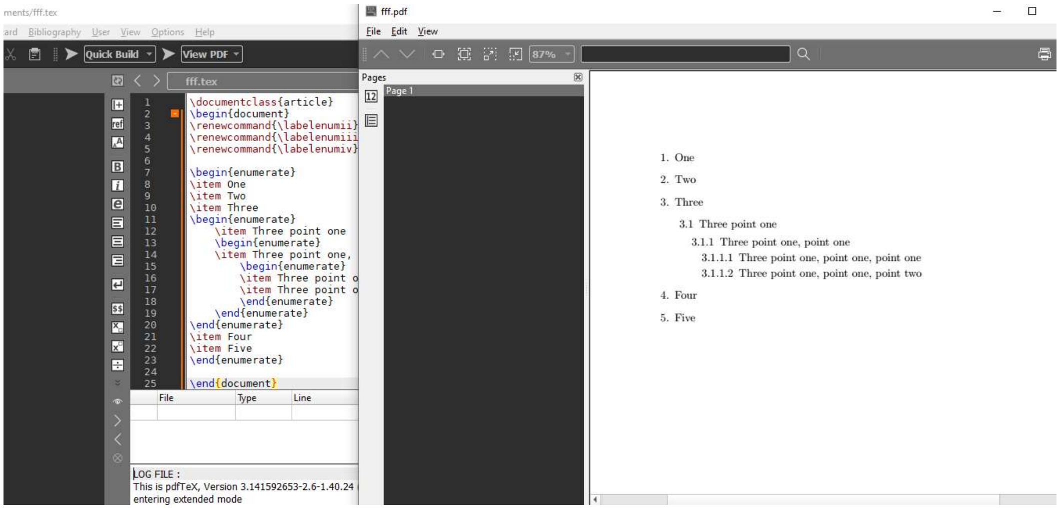
5-12-1-Case presentation: list:

The Lists are declared in environment with begin and end like the next example:

```
\documentclass{article}

\begin{document}

\renewcommand{\labelenumii}{\arabic{enumi}.\arabic{enumii}}

\renewcommand{\labelenumiii}{\arabic{enumi}.\arabic{enumii}.\arabic{enumiii}}

\renewcommand{\labelenumiv}{\arabic{enumi}.\arabic{enumii}.\arabic{enumiii}.\arabic{enumiv}}
```

```
\begin{enumerate}
\item One
\item Two
\item Three
\begin{enumerate}
    \item Three point one
    \begin{enumerate}
    \item Three point one, point one
        \begin{enumerate}
        \item Three point one, point one, point one
        \item Three point one, point one, point two
        \end{enumerate}
    \end{enumerate}
\end{enumerate}
\item Four
\item Five
\end{enumerate}
\end{document}
```

Case presentation: Overview:



```
\documentclass{article}
\begin{document}
\renewcommand{\labelenumii}
\renewcommand{\labelenumiii
\renewcommand{\labelenumiv}

\begin{enumerate}
\item One
\item Two
\item Three
\begin{enumerate}
    \item Three point one
    \begin{enumerate}
    \item Three point one,
        \begin{enumerate}
        \item Three point o
        \item Three point o
        \end{enumerate}
    \end{enumerate}
\end{enumerate}
\item Four
\item Five
\end{enumerate}

\end{document}
```

```
LOG FILE :
This is pdfTeX, Version 3.141592653-2.6-1.40.24
entering extended mode
```

1. One
2. Two
3. Three
    3.1 Three point one
        3.1.1 Three point one, point one
            3.1.1.1 Three point one, point one, point one
            3.1.1.2 Three point one, point one, point two
4. Four
5. Five

Figure -34- Latex example list.

5-12-2-**Case presentationt : table:**

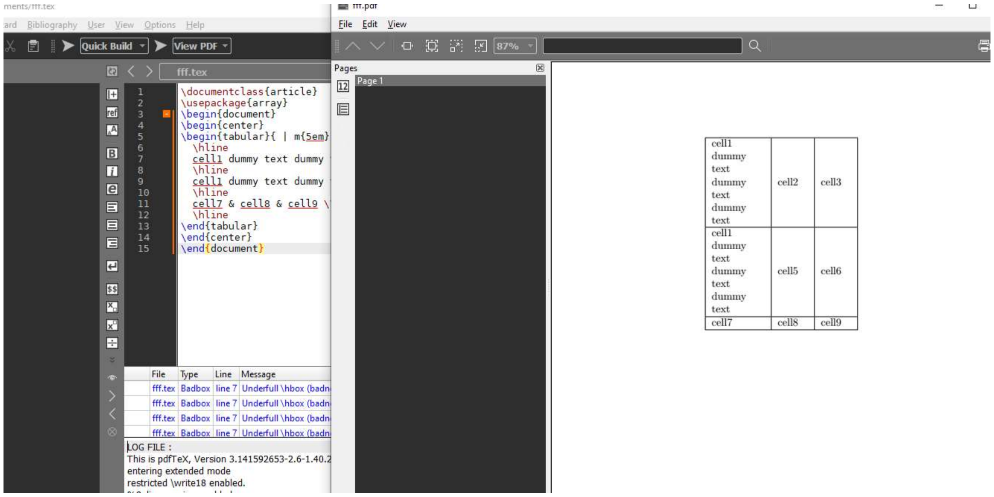
Environment Table

```
\documentclass{article}
\usepackage{array}
\begin{document}
\begin{center}
\begin{tabular}{ | m{5em} | m{1cm}| m{1cm} | }
  \hline
  cell1 dummy text dummy text dummy text& cell2 & cell3 \\
  \hline
  cell1 dummy text dummy text dummy text & cell5 & cell6 \\
  \hline
  cell7 & cell8 & cell9 \\
  \hline
\end{tabular}
```

\end{center}

\end{document}

Case presentation : Overview:



```
\documentclass{article}
\usepackage{array}
\begin{document}
\begin{center}
\begin{tabular}{ | m{5em}
  \hline
  cell1 dummy text dummy
  \hline
  cell1 dummy text dummy
  \hline
  cell7 & cell8 & cell9 \
  \hline
\end{tabular}
\end{center}
\end{document}
```

```
File     Type    Line    Message
fff.tex  Badbox  line 7  Underfull \hbox (badn
fff.tex  Badbox  line 7  Underfull \hbox (badn
fff.tex  Badbox  line 7  Underfull \hbox (badn
fff.tex  Badbox  line 7  Underfull \hbox (badn
LOG FILE :
This is pdfTeX, Version 3.141592653-2.6-1.40.2
entering extended mode
restricted \write18 enabled.
```

cell1 dummy text dummy text dummy text	cell2	cell3
cell1 dummy text dummy text dummy text	cell5	cell6
cell7	cell8	cell9

Figure -35- Latex example table.

6-Scenario:

Our study is about finding and producing a comfort model to solve project management problems, at the end this concept in our project we have created a new project for an IDE of Java that is IntelliJ, this programming could do simple examples with Java compiler, surly with LaTeX editor which will create our solution in PDF form.

In contrast, in order to arrive to our target we have:

Done redaction of project management algorithms in the editor IntelliJ in Java.

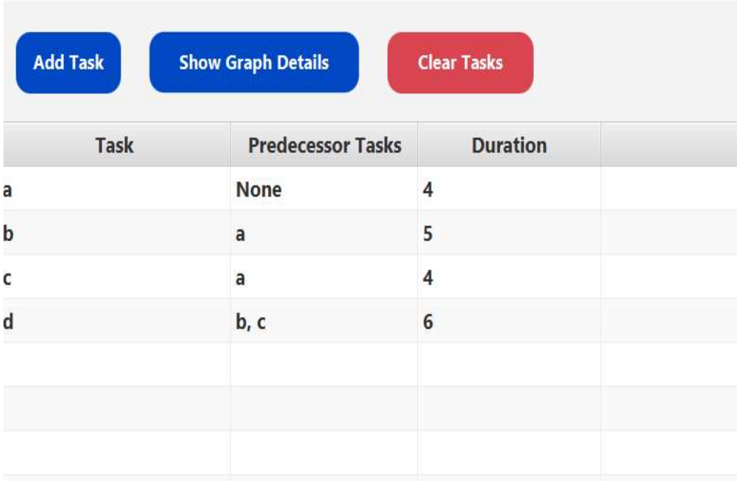
Programming the algorithms to be dynamics in order to find solution for project management problems.

Inserted the instructions of LaTeX in the Java code for compile between Java and LaTeX.

Insinuated the instructions in LaTeX in order to create a text and display the solution in PDF form.

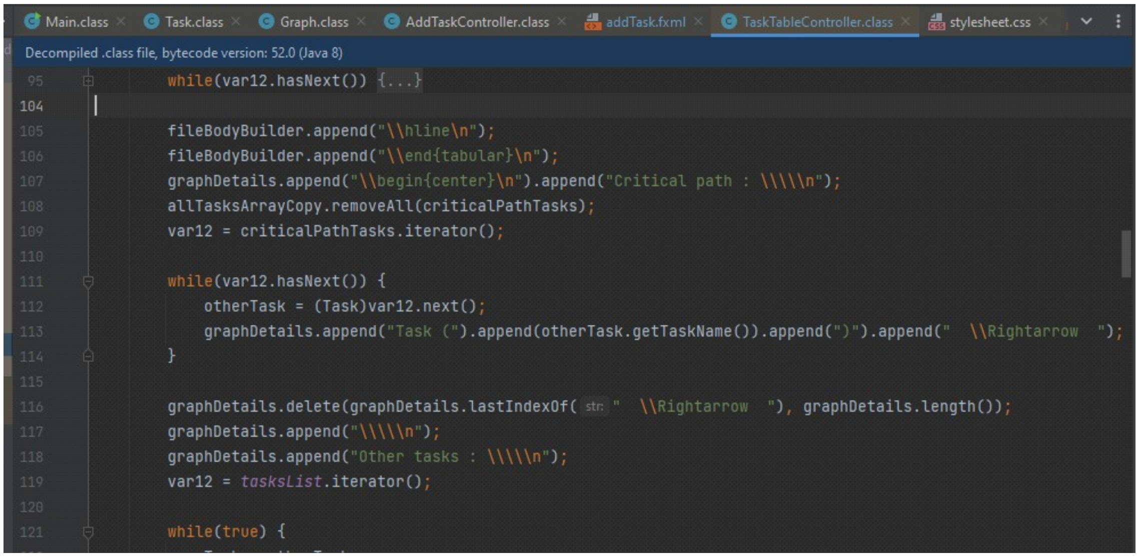
7-The representation of a model that solves project management problem:

The next figure in view in IntelliJ represents the interface of our application and the tasks and their information::



Task	Predecessor Tasks	Duration
a	None	4
b	a	5
c	a	4
d	b, c	6

Figure -36- application interface.

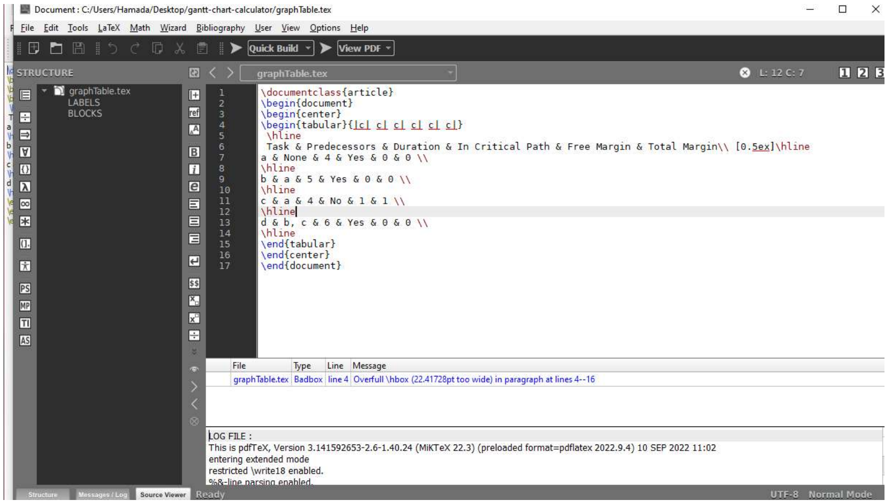


Decompiled .class file, bytecode version: 52.0 (Java 8)

```java
        while(var12.hasNext()) {...}

        fileBodyBuilder.append("\\hline\n");
        fileBodyBuilder.append("\\end{tabular}\n");
        graphDetails.append("\\begin{center}\n").append("Critical path : \\\\\n");
        allTasksArrayCopy.removeAll(criticalPathTasks);
        var12 = criticalPathTasks.iterator();

        while(var12.hasNext()) {
            otherTask = (Task)var12.next();
            graphDetails.append("Task (").append(otherTask.getTaskName()).append(")").append("  \\Rightarrow  ");
        }

        graphDetails.delete(graphDetails.lastIndexOf( str: "  \\Rightarrow  "), graphDetails.length());
        graphDetails.append("\\\\\n");
        graphDetails.append("Other tasks : \\\\\n");
        var12 = tasksList.iterator();

        while(true) {
```

Figure-37- creating and writing in Latex file.

The next figure is how the application creates the LaTeX file and writes the instructions on it:


Document : C:/Users/Hamada/Desktop/gantt-chart-calculator/graphTable.tex
File Edit Tools LaTeX Math Wizard Bibliography User View Options Help
Quick Build
View PDF
STRUCTURE
graphTable.tex
LABELS
BLOCKS
graphTable.tex
L: 12 C: 7
Structure
Messages / Log
Source Viewer
Ready
UTF-8 Normal Mode

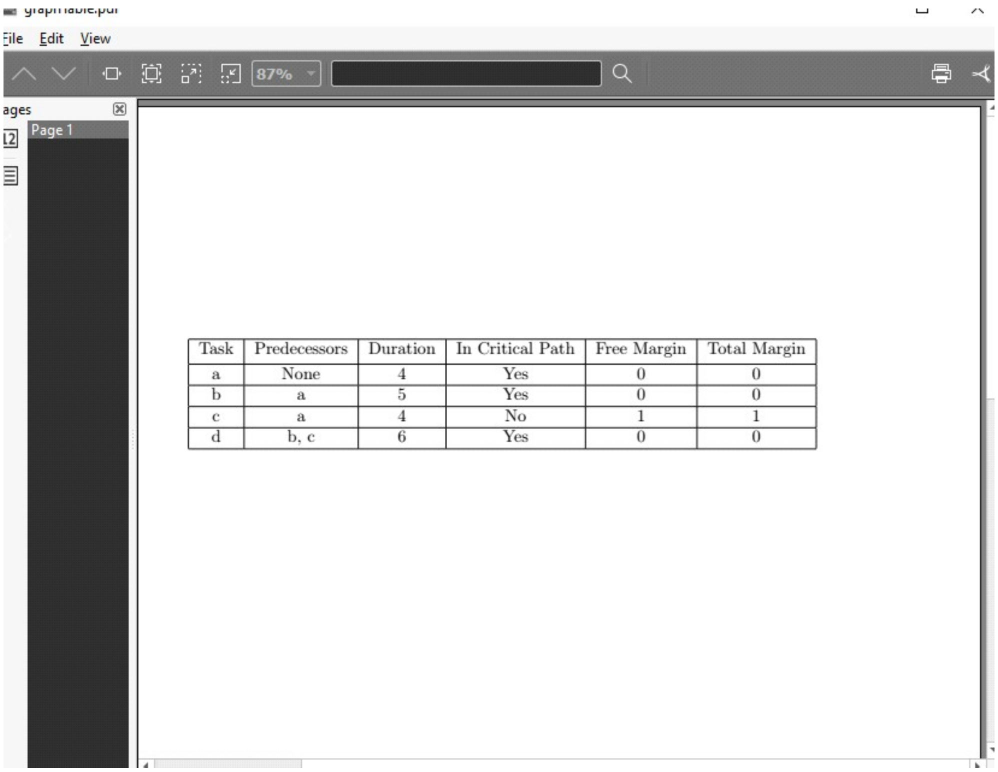
```
\documentclass{article}
\begin{document}
\begin{center}
\begin{tabular}{|c| c| c| c| c| c|}
 \hline
 Task & Predecessors & Duration & In Critical Path & Free Margin & Total Margin\\ [0.5ex]\hline
a & None & 4 & Yes & 0 & 0 \\
\hline
b & a & 5 & Yes & 0 & 0 \\
\hline
c & a & 4 & No & 1 & 1 \\
\hline
d & b, c & 6 & Yes & 0 & 0 \\
\hline
\end{tabular}
\end{center}
\end{document}
```

File	Type	Line	Message
graphTable.tex	Badbox	line 4	Overfull \hbox (22.41728pt too wide) in paragraph at lines 4--16

```
LOG FILE :
This is pdfTeX, Version 3.141592653-2.6-1.40.24 (MiKTeX 22.3) (preloaded format=pdflatex 2022.9.4) 10 SEP 2022 11:02
entering extended mode
restricted \write18 enabled.
%&-line parsing enabled.
```

Figure -38- The file created by application.

The next figure shows the PDF solution:



Task	Predecessors	Duration	In Critical Path	Free Margin	Total Margin
a	None	4	Yes	0	0
b	a	5	Yes	0	0
c	a	4	No	1	1
d	b, c	6	Yes	0	0

Figure -39- The PDF file created by application.

8-Conclusion:

LaTeX is software of editing that allows getting a professional quality of documentations. This language is so famous and known in the superior studies and in the most fields of science. In this part we have created a java application that solves the project management problems.

To get the solution in well done PDF form we have used the file management system in Java that allows us to relate between Java and LaTeX.

General conclusion

General conclusion:

We had fixed target from the start and we put a high measures.

We have made the application real which has the setting of directed graphs, which means that we have solved the manually solution problem and made our automatic solver that gives us the solution in PDF form.

This also facilitates the teacher corrector task or to the student to verify the initial solution.

So the interest in our work was clear, it was solve the manual correction of exercises and made it in automatic way that shows the solution in high quality document using the LaTeX but without even using the LaTeX instructions.

Perspective:

We had the chance to create the three type of presentation in the applications which are the PERT-Chart, Gantt-Chart, and CPM but it shows the difficulty in drawing by Latex.

We also could add a noting system that shows every write answer its points.

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