Decision Tree Modification to Choose Suitable Quest Clearing Sequence in Japanese Role-Playing Game Atelier Iris 3 : Grand Phantasm

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***Abstract*—Games as a source of entertainment entered a stage where it is not just something to kill time. Games has become a hobby with many people approach it in different ways. Casual gamers will play with the flow, while hardcore gamers tend to experience the game to the fullest. But nowadays, games are getting more complex people are getting harder to fully experience it the way we want. So many things to consider to progress. But using discrete mathematics, we can determine how to experience the game at its maximum potential with every approach players choose.**

***Keywords*—JRPG, Quests, Sequence, Tree.**

I. INTRODUCTION

For a long time, games has been one of the primary entertainment sources for people. Its different take from novels, comics, movies, etc gives different experience of entertainment to its players. All the time games come in different forms. Traditional games usually take form as a physical game, involving physical properties and activities. Some games of this kind is Hide-and-Seek, Dampu Bulan, and don't forget sports such as soccer. As time goes on, it is realized that traditional games pose many limitations, mainly in the easeness.

Traditional games was fairly simple, especially in processing states, because people simply can't track the everchanging states in complicated games. Say, we want to play a card game but with its cards can only stay in the game for 7 turns. It will be hard tracking how long each card has been in the game, posing limitation in play. To compensate for this, modern games, with the help of computer was born. With modern games, all the processing is done with an autonomous system and players can solely enjoy the experience from the game. Japanese Role-Playing Game is one of the genres born from it.

For a long time, Japanese Role-Playing Game (abbreviated JRPG) has had a strong fanbase around the world. Its uniqueness in style and gameplay attracts player in a different way to other games. Since its birth, JRPG is known for its emphasis in storyline and narrative. Japanese Role-Playing Game is *not* simply a Role-Playing Game made in Japan. The combination of good storytelling and compelling character immerses the players to a world never seen before.

Atelier Iris 3 : Grand Phantasm is one JRPG from the well-known JRPG franchise in Japan, Atelier Series. Atelier Iris 3 : Grand Phantasm is the 8th game of the official series and the last sequel in the Iris trilogy. The game was developed for Playstation 2 by Gust, currently a division from Koei Tecmo Holdings. It was fully released globally on July 27th 2007. In the game , players take the perspective of a boy doing quests as a *Raider*. Players can choose which quests they want to take and by each quest progress either the world or the character. The process of choosing which quest to take and progressing the game in different manner will be taken from the perspective of Discrete Mathematics, approached with its Decision Tree.

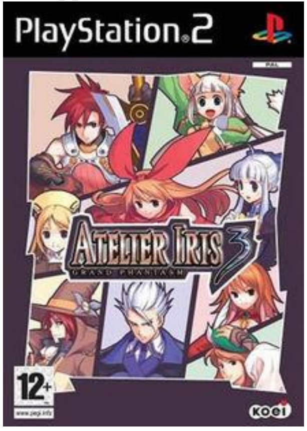


Image 1.1 Atelier Iris 3 : Grand Phantasm Game Cover
(Source: https://en.wikipedia.org/wiki/Atelier_Iris_3:_Grand_Phantasm accessed on December 4th 2019 4:40 PM)

II. BASIC THEORIES

A. Graph

Graph is defined as a tuple of set (V, E) used to represent discrete objects and their relationship with each other. Suppose we have a graph G = (V, E), the set $V = \{v_1, v_2, v_3, \dots, v_n\}$ represents the object in G known as *vertices* whereas the set $E = \{e_1, e_2, e_3, \dots, e_n\}$ represents the relationship of the objects known as edges. Edges can sometimes be represented as e_{xy}, meaning it is an edge connecting x to y. A graph may have zero to any amount of edges, but it *has* to have at least 1 node (another name of vertice) to be called a graph. Following images are few examples of graph.

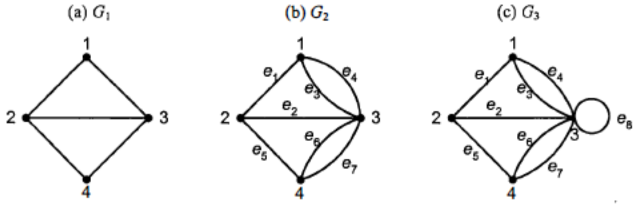


Image 2.1 3 examples of graph (a) simple graph, (b) multigraph, (c) pseudograph (Source : Matematika Diskrit 3rd ed, Rinaldi Munir [1])

Based on the direction of the edges, graph can be classified into 2 categories.

1. Undirected Graph
   A graph with no orientation on its edges. Suppose we have a graph $G = (\{v_1, v_2\}, \{e_{12},\ e_{21}\})$, the edge e_{12} and edge e_{21} are essentially the same two edges, connecting vertices 1 and 2.
2. Directed Graph
   A graph with orientation on its edges. Suppose we have a graph $G = (\{v_1, v_2\}, \{e_{12},\ e_{21}\})$, the edge e_{12} and edge e_{21} represents a different edge. The former represents an edge connecting vertice 1 *to* vertice 2, whereas the latter represents an edge connecting vertice 2 *to* vertice 1.

The following images picture the different of both graphs.

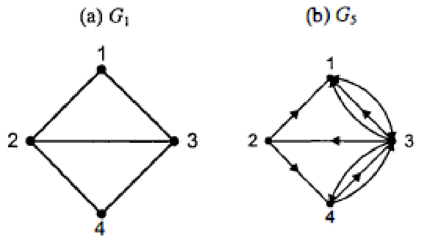


Image 2.2 (a) Undirected Graph, (b) Directed Graph (Source : Matematika Diskrit 3rd ed, Rinaldi Munir [1])

B. Tree

Tree is one of many applications of graph. Tree is defined as a connected undirected-graph with no circuit in it. Below are few examples of tree.

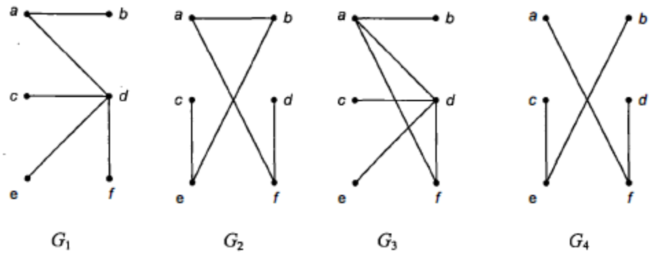


Image 2.3 G_1 and G_2 are trees, G_3 and G_4 are not trees (Source : Matematika Diskrit 3rd ed, Rinaldi Munir [1])

Tree itself has several specific applications.

1. Rooted Tree
   Rooted tree is a tree application with one node acting as the tree's "root" whereas the others act as its branch, connected by edges directing further from the root.
   In building a rooted tree, we need to at least have 3 main components.
   1. Root
      The base of the tree having no predecessor.
   2. Internal Nodes
      Nodes with predecessor and successor.
   3. Leaves
      Nodes with predecessor but no successor.

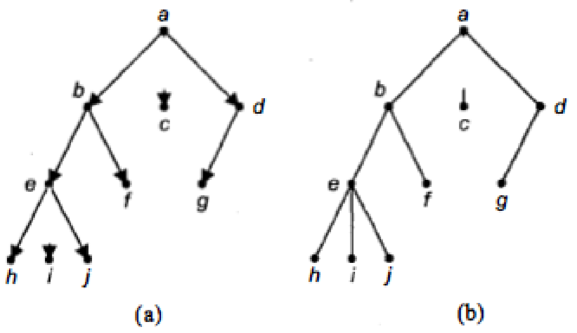


Image 2.4 (a) rooted tree, (b) as a convention, edges' directions can be discarded (Source : Matematika Diskrit 3rd ed, Rinaldi Munir [1])

Several terminologies are made specifically for rooted tree.

a. Parent and Children
   Nodes acting as predecessors are called Parents, while the nodes acting as their successors are called Children. In *Image 2.4* node *e* is the parent of *h*, *i*, and *j*. Whereas *f* and *e* are the children of *b*.
b. Sibling
   Children with the *same* parent are called siblings. In *Image 2.4* node *h*, *i*, and *j* are siblings.
c. Path
   Each node can be reached from the root with a one and only specific route. This route is called path. In *Image 2.4* the path to *j* is *a-b-e-j*
d. Degree
   Degree is a terminology used to indicate how many children a node has. In *Image 2.4* the node *e* has the 3 children thus has the degree 3.
e. Level and Height
   Level indicates how deep a node is from the root. The root is by default given the level 0. Whereas height indicates the deepest level in the rooted tree. In *Image 2.4* node *e* is on level 2, whereas the height of the tree is 3.

2. N-Ary Tree
   N-ary tree is an application of rooted tree specifically defining that each internal nodes can only have at most N children. The most often seen of this type of tree is *Binary Tree* which is a 2-ary tree and *Ternary Tree* which is a 3-ary tree.

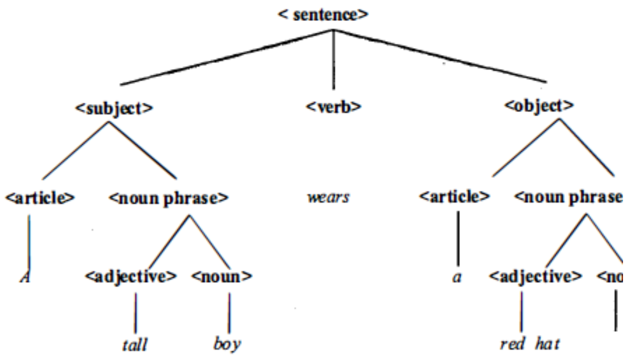


Image 2.5 Parsing Tree, an application of N-Ary Tree (Source : Matematika Diskrit 3rd ed, Rinaldi Munir [1])

An N-ary tree is called a full N-ary tree *if and only if* every internal node in the tree has exactly N children.

3. Decision Tree

Decision tree is another application of rooted tree made to ease decision-making by defining the flow in the decision-making process. The most basic decision tree modifies the rooted as below.

1. Each node represents either a decision or consideration.
2. Each edge represents the outcomes of consideration leading to more nodes (considerations or decisions).

In this case, leaves (nodes with no branches) act as decisions that can be taken whereas root and internal nodes (nodes with branches) act as considerations to be evaluated. Below is an example of a decision tree.

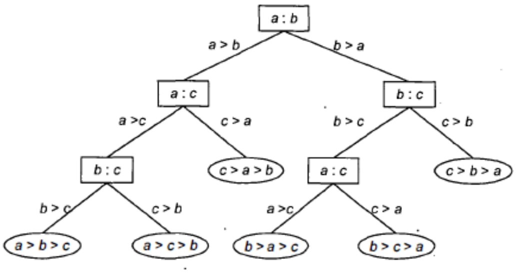


Image 2.6 A decision tree to sort 3 integers a, b, and c (Source : Matematika Diskrit 3rd ed, Rinaldi Munir [1])

C. Atelier Iris 3 : Grand Phantasm

Atelier Iris 3 : Grand Phantasm (will be called Grand Phantasm in next occasions) is a Japanese Role-Playing Game developed by Gust. In Grand Phantasm, players will take the perspective of a young boy named Edge Vanhite. Players will go on an adventure in a group of *raiders* consisting of a female alchemist, Iris Fortner, and a female fighter, Nell Ellis.

The story takes place in a city called Zey Meruze, where by appearance takes a real resemblance of Venice in the way that it the city is crossed by many water channels. Aside from its usual hustle-bustle as a city, there are also portals to other dimensions, called "Alterworlds" here.

Image 2.7 Zey Meruze City, Western Recidences District

Edge, Iris, and Nell work as "raiders" for the Raiders Guild, an organization performing tasks, usually at a price. Usually these tasks involve adventuring to the Alterworlds, but can also be as simple as delivering letters.

The game follows Edge's team in their journey rising through the Guild's raider rank, while at the same time revealing the real story of the game. The real story of the game involves a sealed book which Iris owns that contains enormous power but can only be released by collecting eight gem-like fragments across the Alterworlds. But their endeavor doesn't stop there, because an ancient destruction god, Uroborus, is going to awaken and destroy the world.

Image 2.8 Grand Phantasm Characters, starting upwards clockwise : Ash, Yula, Edge, Iris, Nell, Alvero (Source: https://tvtropes.org/pmwiki/pmwiki.php/VideoGame/AtelierIris3GrandPhantasm accessed on December 5th 2019 10:00 PM)

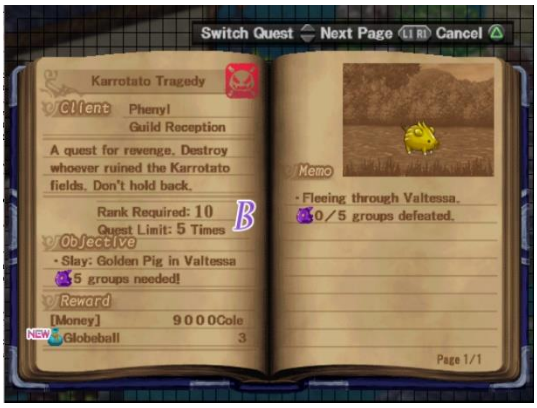
1. Alterworlds

   Alterworld is a certain world accessible only through Alterworld portals spread across Zey Meruze. These worlds are inhabited by monsters and Beastmen, a group of intelligent races resembling animals. There are a total of 5 Alterworlds in the game, each with different monsters and inhabited by different race of Beastmen.

   a. Ancient Forest of Valtessa (No Beastmen)
   b. Ancient Castle of Grimoire (Squawks)
   c. Posporia Battlegrounds (Kumas & Fairies)
   d. Crystal Valley of Dakascus (Pengies)
   e. Grand Gardens of Ishtar (Wonwon)

Image 2.9 Alterworld Posporia Battlegrounds

2. Guild
   Guild is an organization with the ultimate goal to bridge the human world and the Alterworld so both the worlds can live together (without the Beastment and Human fantasy racism). The goal is slowly being achieved by its *raiders*, a selected few people doing errands for both the worlds. Every raider in the guild has his/her own rank which raises as they gain points.
3. Quests
   Quest is how the guild calls the errands and tasks for its raiders to do. Every quest is a request made by people from the 2 worlds, with the minimum requirement defined by rank. By doing quests, raiders can get rewards from the guild (which is a donation from people) and sometimes become more intimate with the Non-Player Characters in the world. Based on its reward, quests are divided into 2 categories.
   1. Main Quests
      Main Quests aid the game's main story progression. Main Quest is indicated by its reward which gives Quest Points, a currency needed for raiders to rank up. For every rank the raiders raise a main-story arc will be revealed.
      The task for these quests vary from delivering letters to defeating a demon lord. Main Quests usually give more dialogs and chances to become closer with NPCs by progressing their own story.
   2. Side Quests
      Side Quests aid the player's progression by giving rewards for players to improve themselves. The rewards are usually Cole (money currency in Zey Meruze), items, or recipes for Alchemy. These quests don't give Quest Points, but sometimes still give a chance to be closer to NPCs.
      The task for these quests are usually brute task such as hunting monsters, searching for materials, or making items. Other main difference from Main Quests is Side Quests tend to be repeatable.



Karrotato Tragedy

Client Phenyl
Guild Reception

A quest for revenge. Destroy whoever ruined the Karrotato fields. Don't hold back.

Rank Required: 10
Quest Limit: 5 Times

Objective
・Slay: Golden Pig in Valtessa
5 groups needed!

Reward

[Money]	9000Cole
NEW Globeball	3

Memo
・Fleeing through Valtessa.
0/5 groups defeated.

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Image 2.10 Side Quest Karrotato Tragedy

III. Determining Quest Clearing Sequence

A. Defining Players

In the following sections, we will try to determine the most suitable quest clearing sequence in the game by modifying the decision tree previously explained. The word "suitable" is used to suit the needs of different types of players. Based on their approach in game completion, we categorize JRPG players (but not limited to) as below.

1. Progressive
   This type of player has the tendency to only focus on the main features of a game, in this case storyline. Progressive players' top priority is to keep progressing through the game, unlocking each main-story arc. Whereas the other features of the game, are not of his attention. This results in their general behavior of doing *main quests* before every other thing.
2. Completionist
   This type of player has the tendency to get and do everything there is in the game. This includes every possible item, recipe, quest, dialog, completing monster bestiary, etc. Completionist players' top priority is to make sure that at the end of the game, they have experienced everything thus truly conquered the game. This results in their general behavior of doing *side quests* before every other thing.

B. Generalizing Quests

According to the explanation above, there should be at minimum two approaches in how players do their quests in sequence. The consideration is mainly from the quest type; main quest or side quest. An additional information is available, that is every quest happening on the same place (be it alterworlds or town) is done simultaneously. So for example we have 3 quests in a Posporia Battlegrounds, all of them can be done together. For this paper, we will be using 13 quests, categorized by place and type as below.

Table 3.1 Quests vailable to be done (Alterworlds name are shorten, QP is Quest Points)

No	Quest Name	Type	Place	Reward
1	New Type Sweets	Side	Town	Strange Slab x 4
				Bucket Cookie x 1
2	New Menu Pudding!?	Side	Town	Crunchy Fruit x 1
				Holy Emblem x 7
3	Prince of The Sea	Side	Town	Merdoll x 1
				Thunder Rod x 3
4	Magical Amulet	Side	Ishtar	Glitter Thread x 10
				Dragon Bone x 8
5	The Holy Knight	Side	Ishtar	9000 Cole
				Formal Fabric x 5
6	Memory Calls	Side	Ishtar	Elixir x 1
				Crown Plate x 1
7	Karrotato Tragedy	Side	Valtessa	9000 Cole
				Globeball x 3
8	Lost, I'll Find	Main	Valtessa	150 QP
				???? x 1
9	Subcontract, Again	Main	Posporia	150 QP
				Chain of Gleipnir
10	BattleField Nurse	Main	Posporia	100 QP
				Fragment of Aion x 2
11	Pamela's Death	Main	Grimoire	150 QP
				Glasses x 1
12	Left Behind	Main	Ishtar	150 QP
				Ladies Clothes x 1
13	Sword of Dakascus	Main	Dakascus	300 QP
				Heaven's Book x 1

The quests available above will again be generalized by the places as below.

1. Town
   - 3 Side Quests
2. Ishtar
   - 3 Side Quests
   - 1 Main Quest (150 QP total)
3. Valtessa
   - 1 Side Quest
   - 1 Main Quest (150 QP total)
4. Posporia
   - 2 Main Quests (250 QP total)
5. Grimoire
   - 1 Main Quest (150 QP total)
6. Dakascus
   - 1 Main Quest (300 QP total)

The generalization above will serve as our main consideration in building the decision tree.

C. Modifying Decision Tree

Decision tree from Section 2.B.3 will be modified as below.

1. Each node either represents a pool of place to choose (oval) *or* a chosen place (rectangle).
2. The edges will represent consideration of current pool in a certain manner.
3. Tree starts at the top with a root node representing a pool of all places we can choose (in this case alterworlds and town).
4. From the top, we will consider the place with best connection to our rule, which depends on the approach. The place will then be a new node on the left, whereas the remaining pool of place will be on the right.
5. The derivation continues for the last pool of place until it contains no more place.
6. The chosen places traversed from above will be the most suitable sequence for clearing the set of quests.

Below is an example if our pool of place are Town, Posporia, and Ishtar.

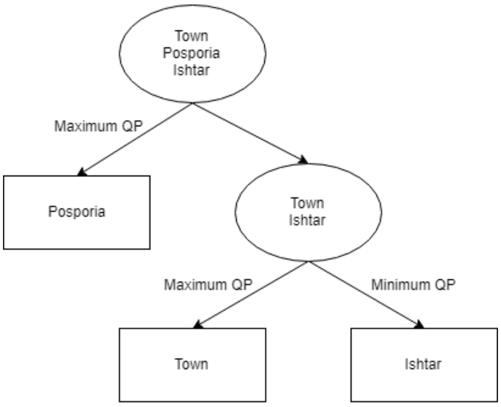

Figure 3.1 Quest Decision Tree Example with 3 Places

In above example Town, Posporia, and Ishtar are the three places available in the pool of places. The rule was made simple : places with maximum Quest Points are priority. So here we eliminated the places with maximum Quest Points first, leaving the rest and start eliminating until the pool is empty. The conclusion, the suitable route for the current approach is Posporia → Town → Ishtar.

D. Quest Decision Usage Tree to Determine Quest Clearing Sequence

In this section, we will start using our Quest Decision Tree (will be abbreviated as QDT) to determine the best quest clearing sequence for the set of quests in section B. We will make 2 QDTs facilitating two approach from Section A; Progressive and Completionist. Let us define the rules for both approach first.

1. Progressive Rules
   i. Places with the most total QP will be cleared first.
   ii. If there are two places with the same total QP, the place with more side quests will be cleared first.
   iii. If the number of side quests from Point (ii) is the same, any place will suffice
   iv. Quests in Town are preferable to Quests in Alterworlds
2. Completionist Rules
   i. Places with 0 QP will be cleared first.
   ii. Places with the most side quests will be cleared first.
   iii. If there are two places with the same number of side quests, the place with less total QP will be cleared first.

iv. If the total QP from Point (iii) is the same, any place will suffice

v. Quests in Town are preferable to Quests in Alterworld.

Next, we will start our derivation on the two approaches with each rule in mind.

1. Quest Sequence for Progressive Approach

   i. Pool of Places : Town, Ishtar, Valtessa, Posporia, Grimoire, Dakascus
   Dakascus as the place with maximum QP (300 QP) is chosen.
   Result → Dakascus

   ii. Pool of Places : Town, Ishtar, Valtessa, Posporia, Grimoire
   Posporia as the place with maximum QP (250 QP) is chosen.
   Result → Posporia

   iii. Pool of Places : Town, Ishtar, Valtessa, Grimoire
   There are 3 places with the same QP: Ishtar, Valtessa, Grimoire (150 QP). Currently Ishtar is the place with the most side quests (3 side quests). So *Ishtar* is chosen.
   Result → Ishtar

   iv. Pool of Places : Town, Valtessa, Grimoire
   There are 2 places with the same QP: Valtessa, Grimoire (150 QP). Currently Valtessa is the place with the most side quest (1 side quest). So *Valtessa* is chosen.
   Result → Valtessa

   v. Pool of Places : Town, Grimoire
   Grimoire as the place with maximum QP (150 QP) is chosen. *Town* as the remaining place is chosen next.
   Result → Grimoire → Town

   The derivation above will result in following QDT.

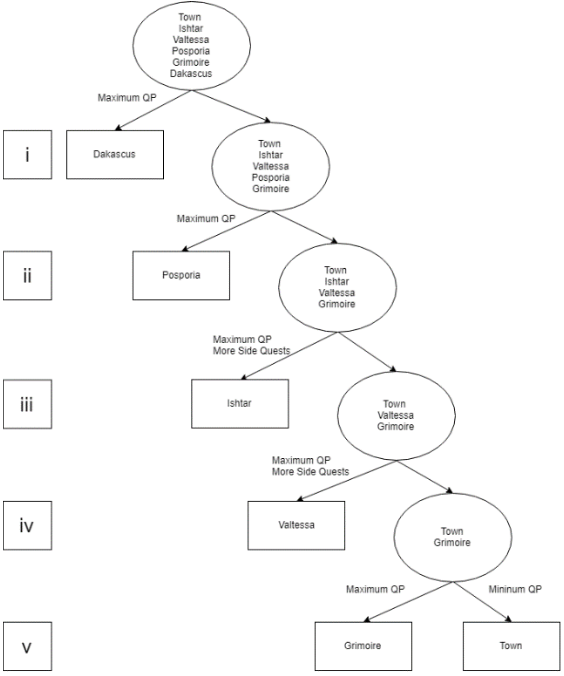

Figure 3.2 Quest Decision Tree for Progressive Approach

   Traversing the QDT from above will result in the sequence:
   Dakascus → Posporia → Ishtar → Valtessa → Grimoire → Town,
   which is the *best suitable route* for the progressive approach.

2. Quest Sequence for Completionist Approach

   i. Pool of Places : Town, Ishtar, Valtessa, Posporia, Grimoire, Dakascus
   Town as the place with 0 QP is chosen.
   Result → Town

   ii. Pool of Places : Ishtar, Valtessa, Posporia, Grimoire, Dakascus
   Ishtar as the place with the maximum side quests (3 side quests) is chosen.
   Result → Ishtar

   iii. Pool of Places : Valtessa, Posporia, Grimoire, Dakascus
   Valtessa as the place with the maximum side quests (1 side quest) is chosen.
   Result → Valtessa

   iv. Pool of Places : Posporia, Grimoire, Dakascus
   There are 3 places with the same number of side quests : Posporia, Grimoire, Dakascus. Currently Grimoire is the place with least QP (150 QP). So *Grimoire* is chosen.
   Result → Grimoire

   v. Pool of Places : Posporia, Dakascus
   There are 2 places with the same number of side quests : Posporia, Dakascus. Currently Posporia is the place with least QP (150 QP). So *Grimoire* is chosen. *Dakascus* as the remaining place is chosen next.
   Result → Posporia → Dakascus

   The derivation above will result in following QDT.

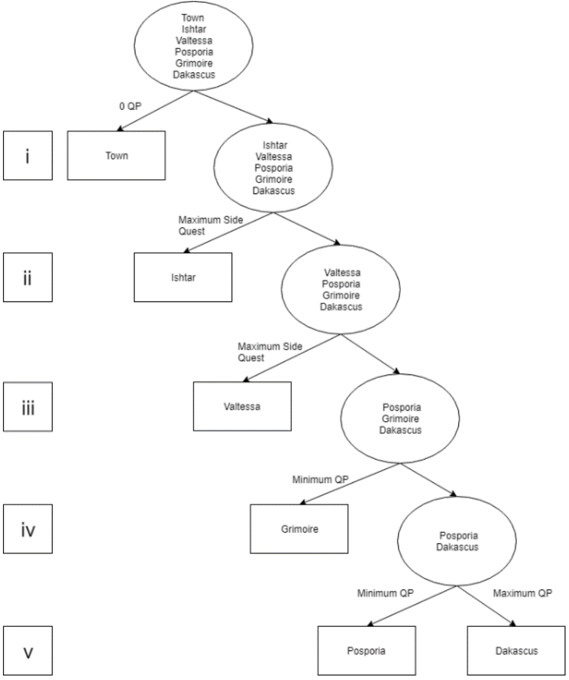

Figure 3.3 Quest Decision Tree for Completionist Approach

Traversing the QDT from above will result in the sequence:
Town → Ishtar → Valtessa → Grimoire → Posporia → Dakascus,
which is the *best suitable route* for the completionist approach.

Concluding both derivation, we learned that for each approach, derivated a different quest clearing sequence.

a. *Dakascus → Posporia → Ishtar → Valtessa → Grimoire → Town* for Progressive Approach
b. *Town → Ishtar → Valtessa → Grimoire → Posporia → Dakascus* for Completionist Approach

Both of them supports the needs and preferences of player in completing the game. With more approach and rules to be defined, there will be a huge number of sequence for player to choose. Each of them with its own suitability which players can fit to their playstyle.

IV. Conclusion

Tree as one of graph's many applications provides great potential in usage. Its versatility allows it to be modified in such a way to deal with various problems we have. This paper is one proof of it, that with enough effort we can use tree to solve a unique -yet wide problem. With confidence I can say that the sky is our limit and imagination is our wings.

V. Acknowledgment

In this section I would like to express my gratitude to Mr. Rinaldi Munir, our Discrete Mathematics lecturer. No other than his imaginative way of teaching and passion to explore induces my creativity to start this paper. I would also like to express my gratitude to my friends for supporting my paper. And lastly, I would like to express my apologies for any mistakes I did in this paper. I highly hope this paper can be publicly read and induce more of people's creativity, in order to make more useful applications of discrete mathematics.

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[1] R. Munir, Matematika Diskrit, 3rd ed. Bandung: Penerbit INFORMATIKA Bandung, 2010.

Pernyataan

Dengan ini saya menyatakan bahwa makalah yang saya tulis ini adalah tulisan saya sendiri, bukan saduran, atau terjemahan dari makalah orang lain, dan bukan plagiasi.

Bandung, 5 Desember 2019

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