



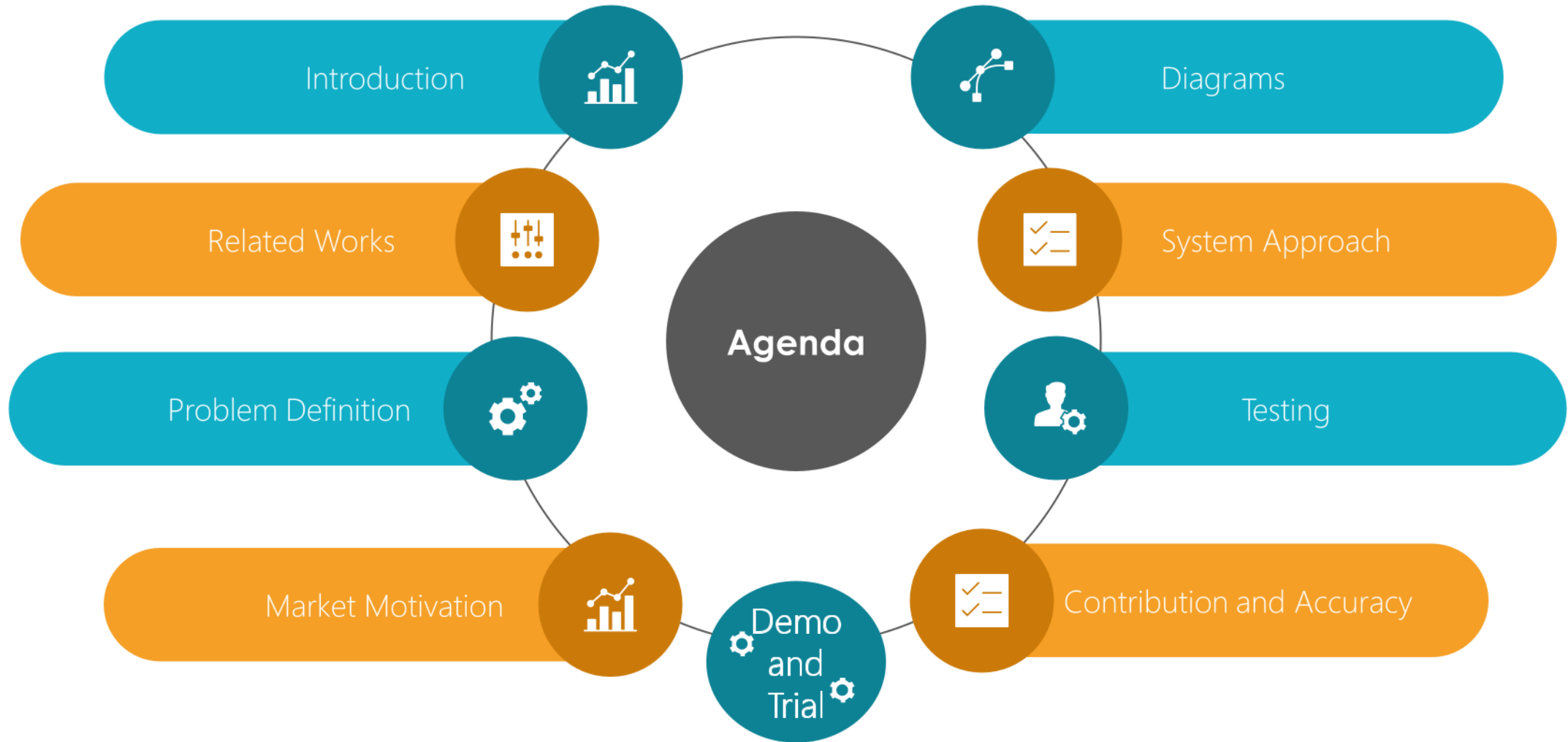
# Automatic Recognition of Suitable Design Pattern

Thesis Presentation  
4/7/2020

By: Clara Kamal  
Farida Mohamed  
Hashem Mohamed  
Veronia Emad

Supervised By:  
Dr. Taraggy Ghanim  
Eng. Nada Ayman

# Thesis Presentation



# Introduction 1/2

## Design Patterns:

- Reusable solutions to commonly occurring software design problems.
- Ready-made templates but not used directly in a machine code.
- First initiated (Gang of Four Collection) in 1994 by four software engineers in their book[1]
- Gang of Four Collection: 3 Categories and 23 DPs

[1] Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides. Design Patterns: Elements of Reusable Object-oriented Software. Addison-Wesley Longman Publishing Co., Inc., Boston, MA, USA, 1995.

# Introduction 2/2

The selection of the suitable DP is one of the most critical & challenging tasks through the software development due to:

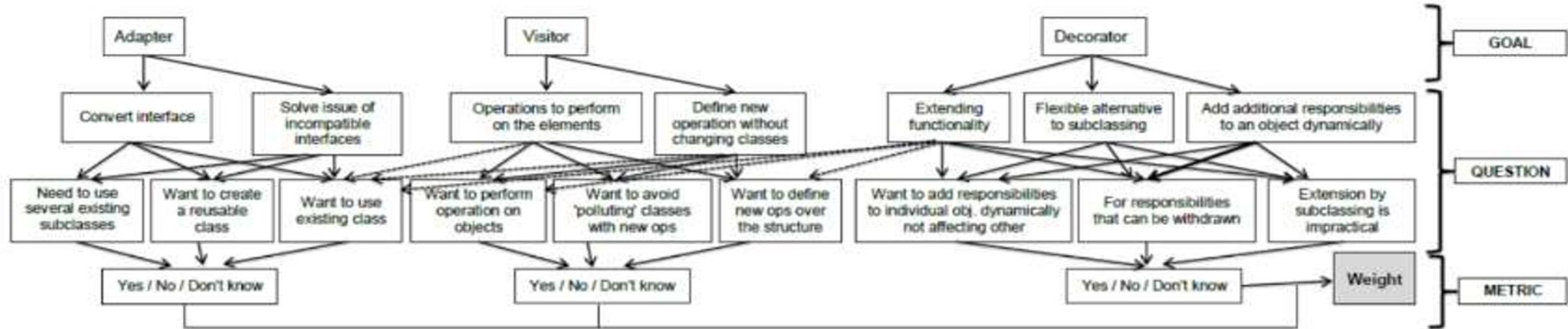
- Their large number (23 DPs)
- The similarities between them (in purposes and actions)
- The negative effect of wrong selections (anti-patterns)



# Related Work

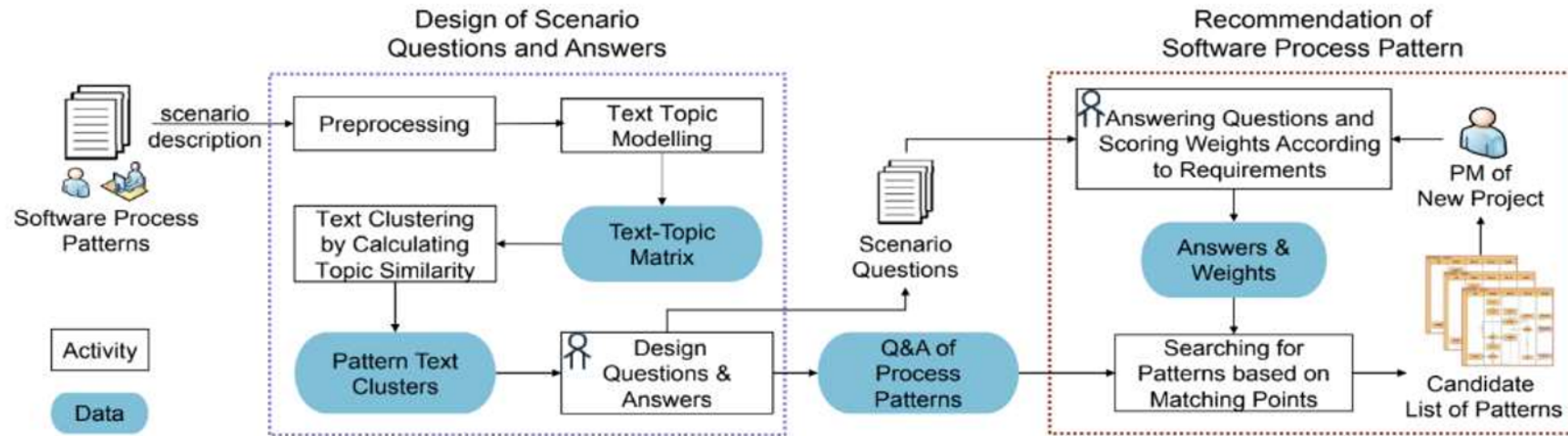


# (1) Recommendation System for Design Patterns in Software Development(DPR)[2]



- Based on Goal-Question-Metric(GQM) approach
- Applied on 3 DPs
- Presents a **prototype** that provides a questionnaire to select that suitable DP then uses this result to perform a secondary-level recommendation.
- 50% correct recognition rate

# (2) A GQM-based Approach for Software Process Patterns Recommendation[3]



- Algorithms: LDA, K-means, TFIDF, Euclidian distance, GQM
- Applied on Software Process Patterns
- Based on a set of generated questions, their answers states the suitable software pattern.
- Precision= 57%

(3) Automatic Recommendation of Software Design Patterns:  
Text Retrieval Approach[4] and Topic Modelling for Automatic  
Selection of Software Design Patterns[5]

- 2 different papers
- Main Approach: NLP
- Applied on 14 DPs
- Takes the design problem description in natural language the select the most suitable DP for this problem.
- Precision= 72%

[4] Abeer Hamdy and Mohamed Elsayed. Automatic recommendation of software design patterns: Text retrieval approach. JSW, 13(4):260–268, 2018.

[5] Mohamed Elsayed Abeer Hamdy. Topic modelling for automatic selection of software design patterns. JSW, 13:260–268, 2018.



# Problem Definition

The proposed approach will help software engineers to find the suitable design pattern for a specific problem scenario to avoid:

- Anti-patterns problem
- Complicated Code
- Confusion of beginner software engineers during selection

# Market Motivation 1/3



A survey was conducted at the beginning to get some experts' opinions from different companies .

# Market Motivation 2/3

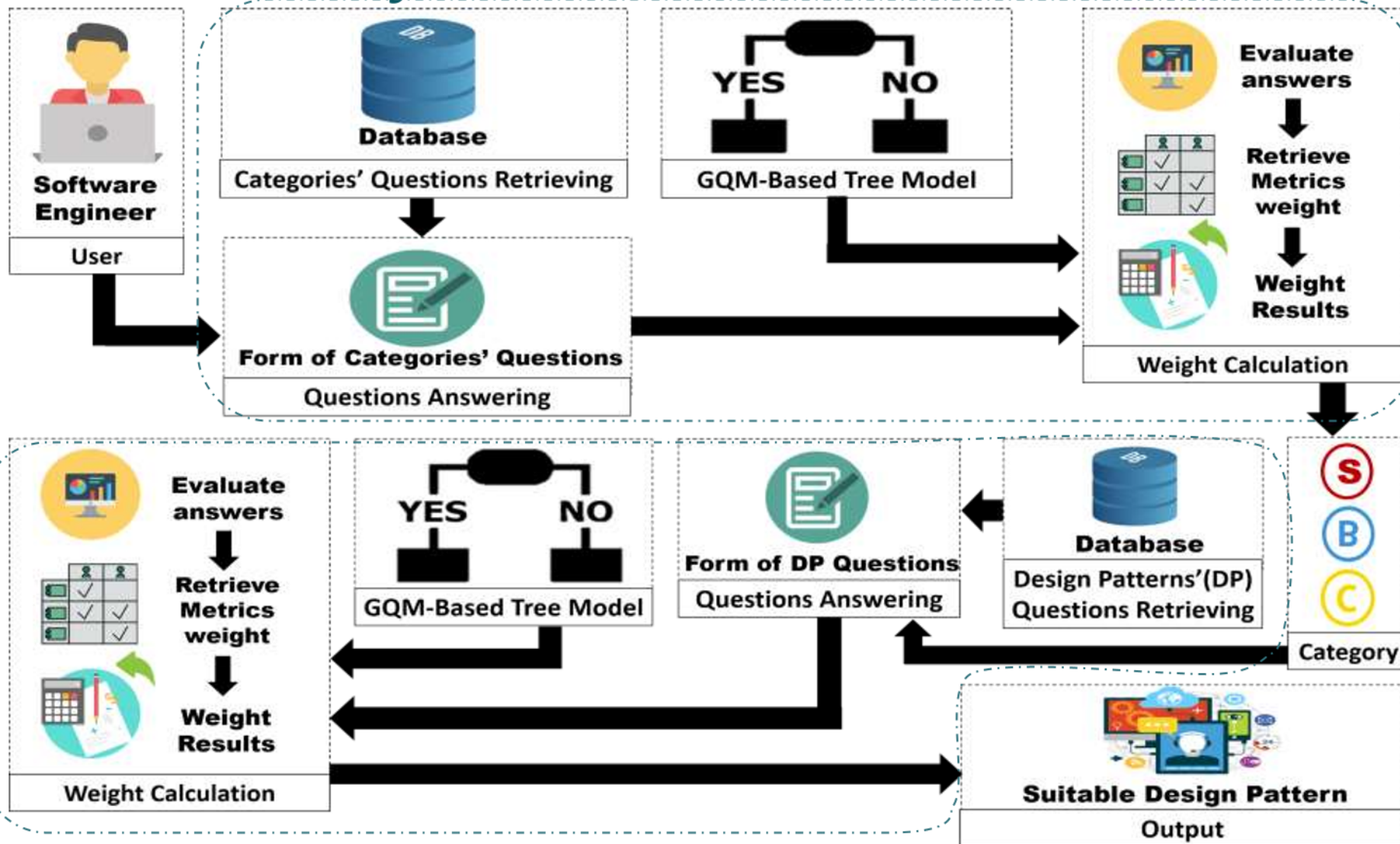
Survey Question	Yes Percentage	No Percentage
Have you faced a problem before while choosing the suitable design pattern for your system?	72.7%	27.3%
Have you ever discovered after writing your code that you used the wrong design pattern?	63.3%	36.4%
Do you prefer automatic or manual selection of software design patterns?	54.5%	45.5%
If there is a system that helps in selecting the suitable design patterns, will you use this system?	100%	0%
Will you have the interest to sponsor our system?	63.3%	36.4%

# Market Motivation 3/3

- Through the current pandemic situation, the system would help in the following situations:
  - No offices -> No assistance from others if SWE is confused during the selection of DPs → **Our system works as an assisting tool for them at home.**
  - No face-to-face SWEs meetings-> hard communication between team members -> complicated non-understandable codes → **Our system provides accurate selection for better code quality with less complications.**



# System Overview



Category Recognition Phase

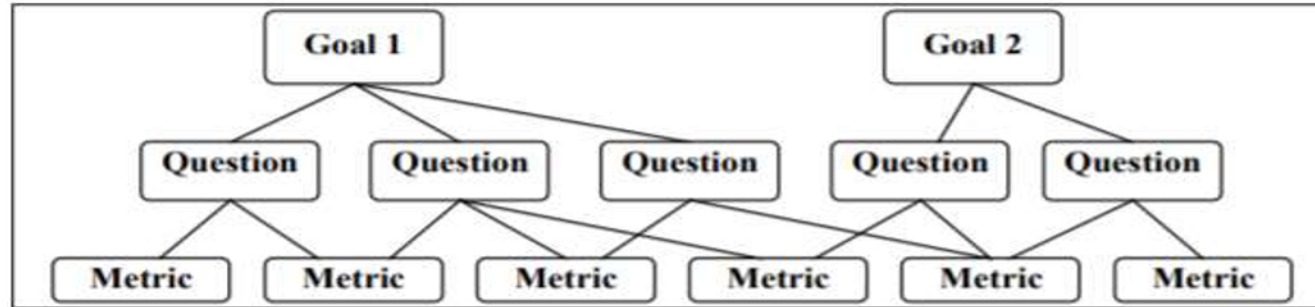
DP Recognition Phase

# System Approach 1/5

- Our approach is based on a **GQM-Based Tree Model**:
  - **Decision tree** to fully analyze the possible consequences of an answer that finally leads to the decision which is the "Suitable Design Pattern " in our case.
  - **GQM** to support our system with a weighted balanced score.
- Concerned with 11 Design Patterns
- Starts by selecting the Design Pattern category

# System Approach 2/5

## What is the Goal-Question-Metric?



- The GQM approach has been proposed by Basili<sup>[6]</sup> in 1994 and supported by NASA.
- It is a technique to identify meaningful metrics for the measurement process.
- It's based on defining a set of **questions** to achieve specific **goals** and identify **metrics** to every question's answers.

# System Approach 3/5

## Questions Designing Phase:

1. Extract them from the definitions and the most common problems that each category/DP solves.
2. Two answers for each question: 'Yes' or 'No'
3. For each Category/DP:  
Total weight of the 'Yes' answers = 100  
Total weight of the 'No' answers = 50
4. 'Yes' weight = depends on the importance of the question  
'No' weight = half of its corresponding 'Yes' value



# System Approach 4/5

- The GQM-Based Tree Model represents 2 phases:
  - 12 levels of Categories Questions
  - 24 levels of DPs Questions
- Two possible answers for each question: 'yes' and 'no'.
- Each answer has an assigned weight.
- Each category/DP is represented by a score that collects its total weight.
- After each answer, weights are added to the categories'/DP scores.

# System Approach 5/5

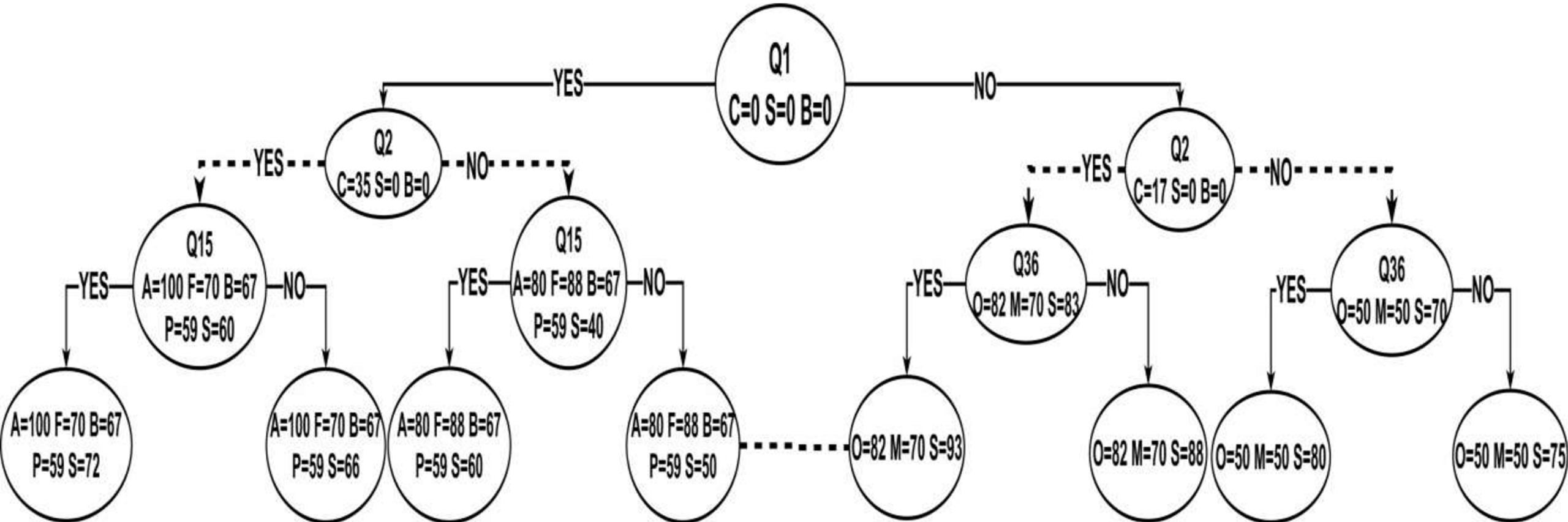
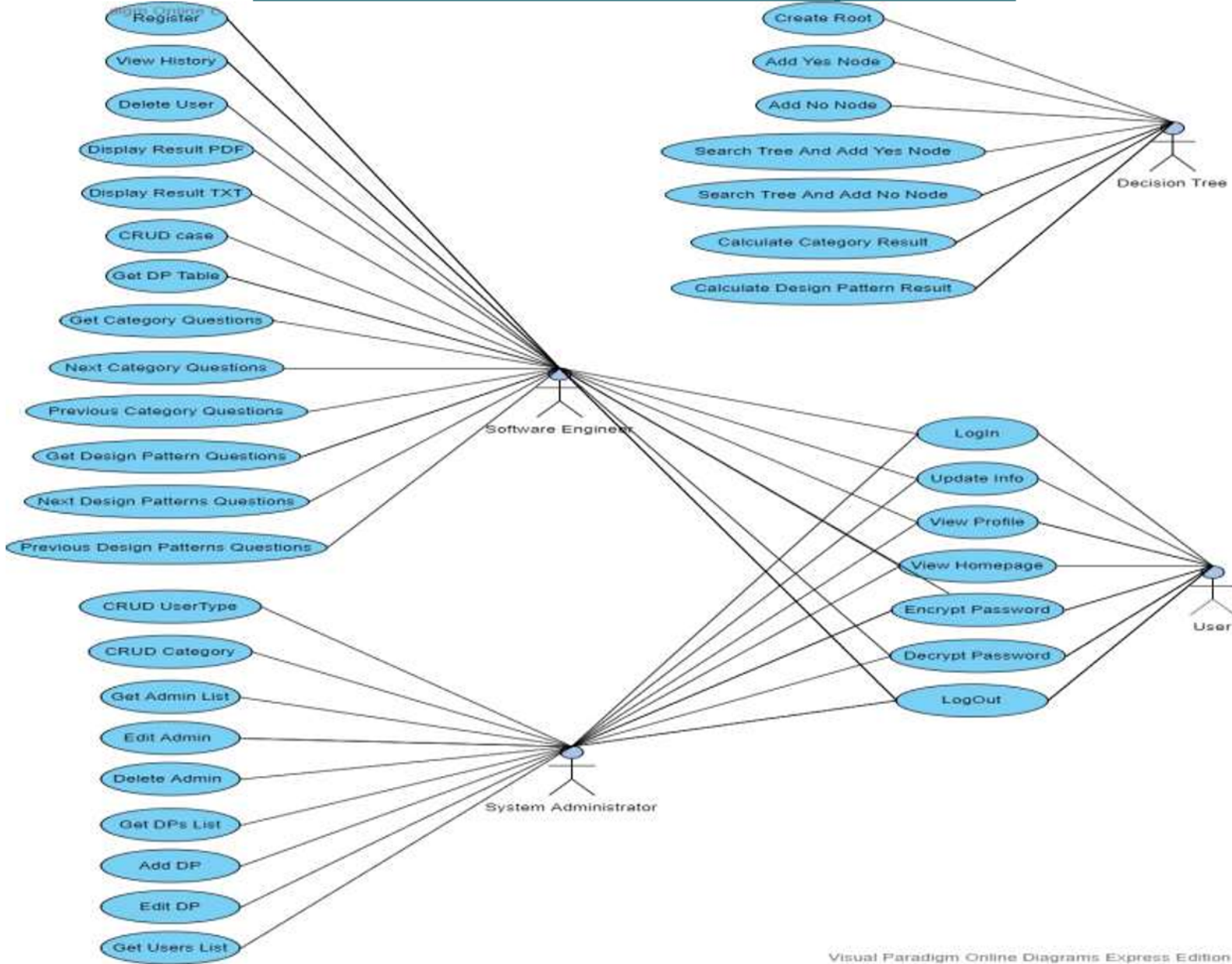


Fig: GQM-Based Tree Model

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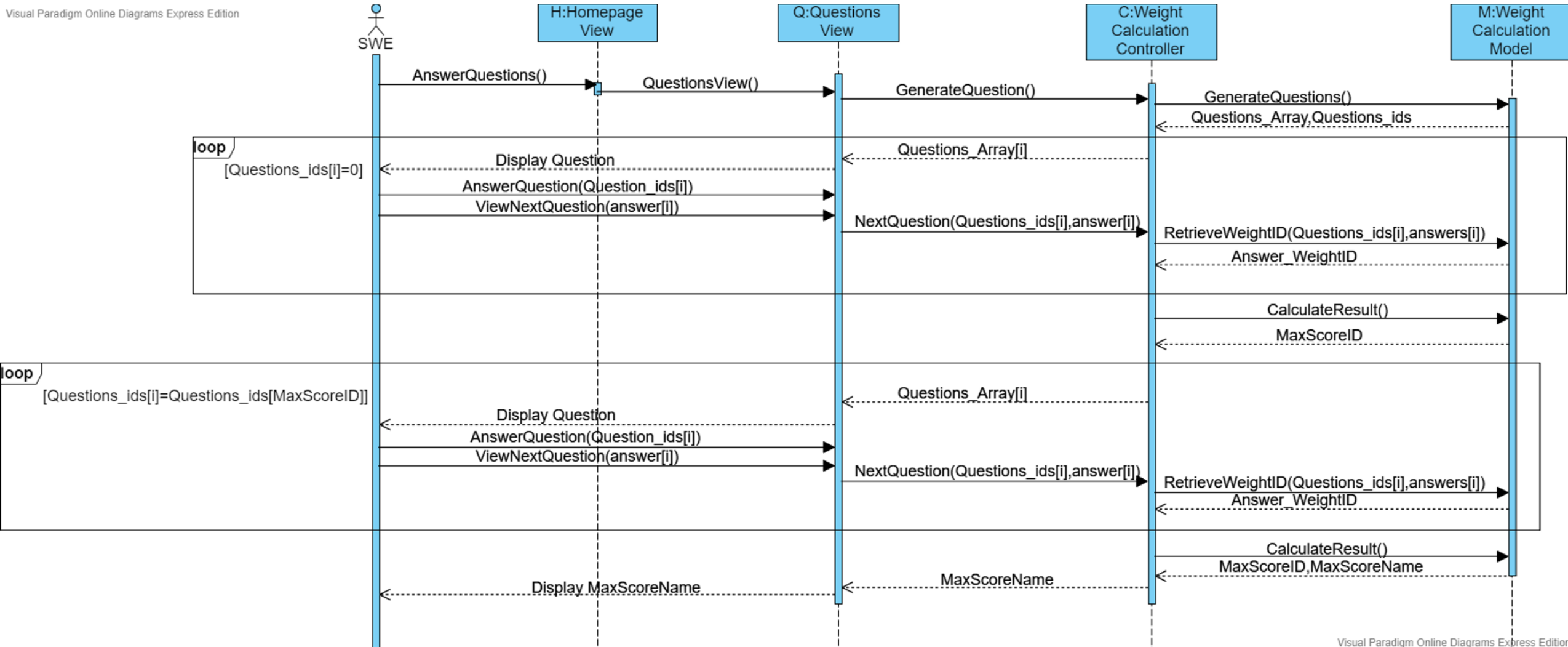
# Use Case Diagram



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## Sequence Diagram

Visual Paradigm Online Diagrams Express Edition



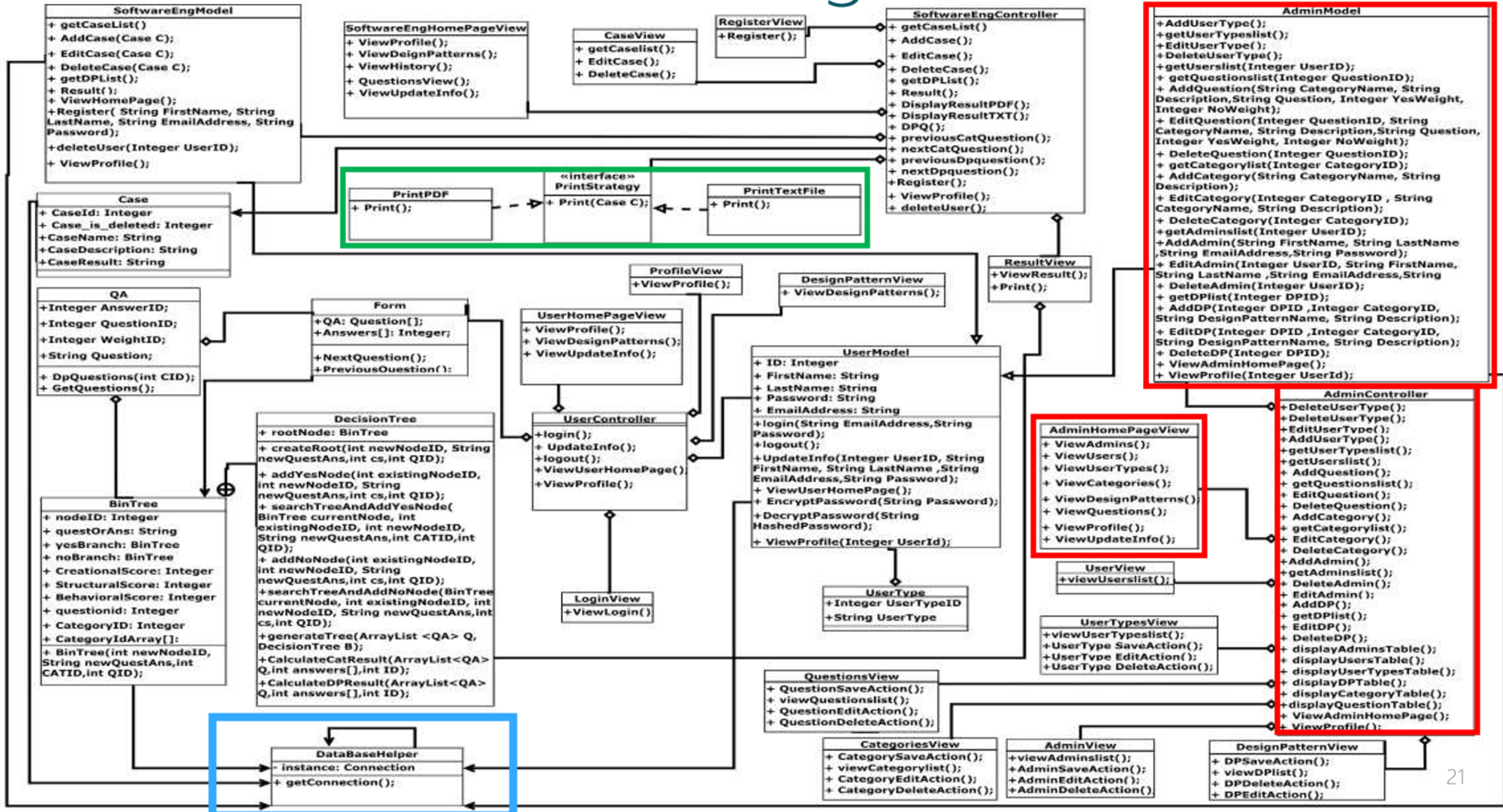
Visual Paradigm Online Diagrams Express Edition



# Thesis Presentation Class Diagram

■ Strategy

■ MVC  
■ Singleton



# Dataset

- Extracted from:
  - Academic books
  - Online resources
- Consists of:
  - A dictionary is created based on DPs definitions for questions designing
  - Case Studies for experiments
- Total number of extracted case studies=92

# Dataset Samples

TABLE XXXII: Singleton Design Pattern

<i>Function</i>	To enclose a global resource.
<i>Intent</i>	Make sure the only one instance is created for a class with a global access point to it.
<i>Objective</i>	Prevent creating multiple instances for a specific class.
<i>Disadvantage</i>	* Singleton client code is difficult to be unit tested, Needs a specialized treatment in the case of multi-threading to prevent the creation of many singleton objects. * May cover bad code designs, Breaks the rule of "Single Responsibility" principle.
<i>When to use</i>	Creating a single instance that can be accessed by all clients, Providing a harsh control on global variables.
<i>Category</i>	Creational

Fig: Sample of a Dictionary Table

## Case study Sample:

Consider a graphics designer add an image to the canvas in Photoshop. Then, he adds a border to it. Then, a bevel effect and finally, sets its transparency to 50%. Now, he wants to apply the same design to another 20 images.

Result: "Prototype"

# Experiments



Each category passes through multiple iterations in order to achieve the most accurate recognitions.

# Creational Category Experiments

## Weight Iterations

Iteration	Questions Weights (Yes Answer)											
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
1	45	30	25	45	30	45	35	20	55	45	60	40
2	30	45	25	45	30	45	35	20	55	45	60	40
3	45	35	20	50	30	45	35	20	55	45	60	40
4	35	45	20	45	35	45	35	20	55	45	60	40

**Blue** for Abstract Factory, **yellow** for Factory Method, **green** for Builder, **red** for prototype and **grey** for singleton.

- Total applied case studies=12
- 1/12 was wrongly recognized in iterations 1-4
- Iterations were applied on the abstract factory and factory
- Result:
  - Solution: Rephrase Q2
  - First iteration is the most accurate



# Structural Category Experiments

## Weight Iterations

- Total applied case studies=27
- 1/27 was wrongly recognized in iterations 1-6
- Iterations were applied on the flyweight and facade
- Result:
  - Solution: Switching Priorities of Flyweight questions
  - Last iteration is the most accurate

Iteration	Questions Weights (Yes Answer)					
	Q1	Q2	Q3	Q4	Q5	Q6
<b>1</b>	60	40	55	45	65	35
<b>2</b>	60	40	55	45	<b>60</b>	<b>40</b>
<b>3</b>	60	40	55	45	<b>55</b>	<b>45</b>
<b>4</b>	60	40	55	45	<b>50</b>	<b>50</b>
<b>5</b>	60	40	55	45	<b>45</b>	<b>55</b>
<b>6</b>	60	40	55	45	<b>40</b>	<b>60</b>
<b>7</b>	60	40	55	45	<b>35</b>	<b>65</b>

**Blue** for Façade, **yellow** for Composite and **green** for Flyweight design pattern.

# Behavioral Category Experiments

## Weight Iterations

		Questions Weights (Yes Answer)				
Iteration	Q1	Q2	Q3	Q4	Q5	Q6
1	65	35	50	45	50	50

**Blue** for Observer, **yellow** for Memento and **green** for Strategy design pattern.

- Total applied case studies=43
- None of the case studies were wrongly recognized
- The first iteration is the most accurate

# Contribution & Accuracy

## Contribution:

- Proposing a detailed analysis on the similarities and the differences between the most popular design patterns.
- Recommend both the suitable design pattern category then the design pattern.
- Designing an innovative set of yes-no questions that leads to the suitable design pattern.
- Proposing an empirical study to evaluate the weights of the designed questions' answers.
- Implementing a GQM score calculation process
- Building a database of all the available case studies of the 11 design patterns.

Precision	Recall	Accuracy	F-score
98.1%	97.56%	97.56%	97.56%

# Demo



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# User Trial

Eng. Ahmed Wasfy  
Senior Software Engineer at TD, Canda





# Publications

- Acceptance of a conference paper in International Conference Proceedings Series by ACM (ICSIE 2020) entitled "GQM-based Tree Model for Automatic Recommendation of Design Pattern Category"
- Working on a journal paper (IEEE access) entitled "Design Pattern Recommendation System Using Goal-Question-Metric Based Tree-like Model"

# Thesis Presentation

# Paper Acceptance Email

Notification of Acceptance of ICSIE 2020-E057



icsieconf

to me, farida1602793, hashem1600638, veronia1606845, nada.ayman, taraggy.ghanim

Tue, Feb 18, 12:07 PM



Dear Clara Kamal, Farida Mohamed, Hashem Mohamed, Veronia Emad, Nada Shorim and Taraggy Ghanim,

Thank you for your waiting.

After reviewing, the reviewer recommend that your paper can be included and published into the following journal. **International Journal of Machine Learning and Computing (IJMLC), which will be indexed by** Scopus (since 2017), Inspec (IET), Google Scholar, Crossref, ProQuest, Electronic Journals Library. **Web:** <http://www.ijmlc.org/>

But if you don't want to publish the paper in the journal, you can choose include and publish your paper into ICSIE 2020 conference proceeding by International Conference Proceedings Series by ACM (ACM (978-1-4503-7721-8). Which will be indexed by **Ei Compendex** and **Scopus**.

For more information, pelase refer to the attached notification of acceptance.

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*Thanks & Best Regards*

Conference Secretary: Ms. Teri Zhang

E-mail: [icsieconf@163.com](mailto:icsieconf@163.com)

Web: <http://www.icsie.org/>

2020 9th International Conference on Software and Information Engineering

**ICSIE 2020**



**Thank You**

# Appendix



# Thesis Presentation

## Email Response 1/2

An Email from the author of the most similar system that uses GQM about the weights assigning:



**Francis Palma**

to clara1608421@miuegypt.edu.eg ▾

Jan 16, 2020, 2:42 PM



Hi Clara

Sorry for coming back late, as far as I remember, the weights were subjective and might vary with engineers' expertise and experience. Perhaps, we did not mention this in the paper. However, you can rely on any weighting scheme, as we stated it as "flexible".

--

Regards,

Francis Palma, Ph.D.

Universitetslektor/Assistant Professor/Senior Lecturer

Department of Computer Science and Media Technology

Faculty of Technology, Linnaeus University

Phone: 0480497198 or +46480497198

Email: [francis.palma@lnu.se](mailto:francis.palma@lnu.se)

Web: [francis-palma.net](http://francis-palma.net)

LinkedIn: [linkedin.com/in/francis-palma](https://www.linkedin.com/in/francis-palma)

LNU page: [lnu.se/en/staff/francis.palma/](http://lnu.se/en/staff/francis.palma/)



# Email Response 2/2

**Francis Palma**

Jan 22, 2020, 11:43 AM



to clara1608421@miuegypt.edu.eg ▾

Hi

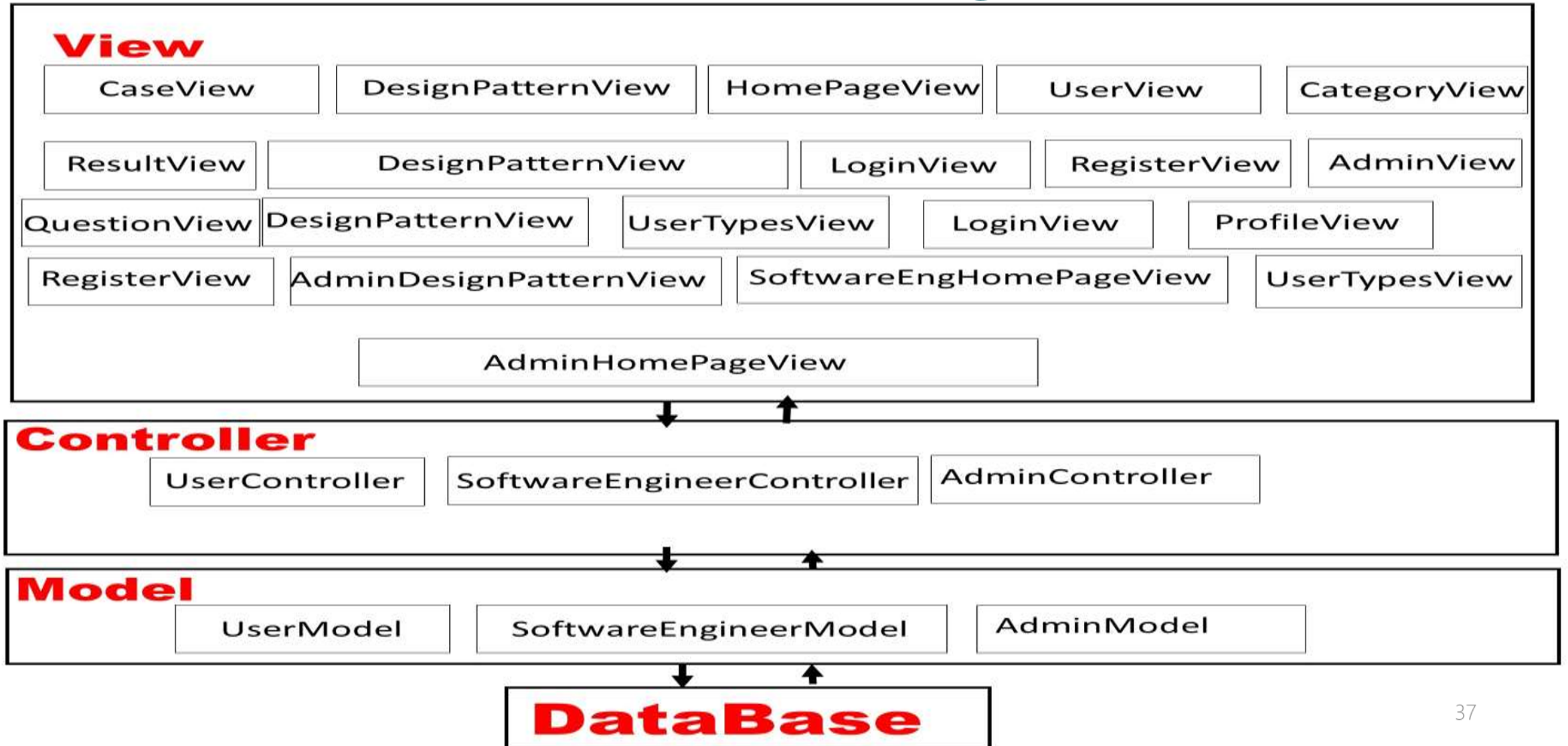
Surely you can apply any weighting scheme, however, we did not want to substitute the “No” values because the total weight might get negative and there would be a large polarity between the “Yes” and “No” total weights. Actually, this was one of the very first work on recommending design patterns to the developers, we could go further..., unfortunately, we did not follow up our work after 2012.

Regards,

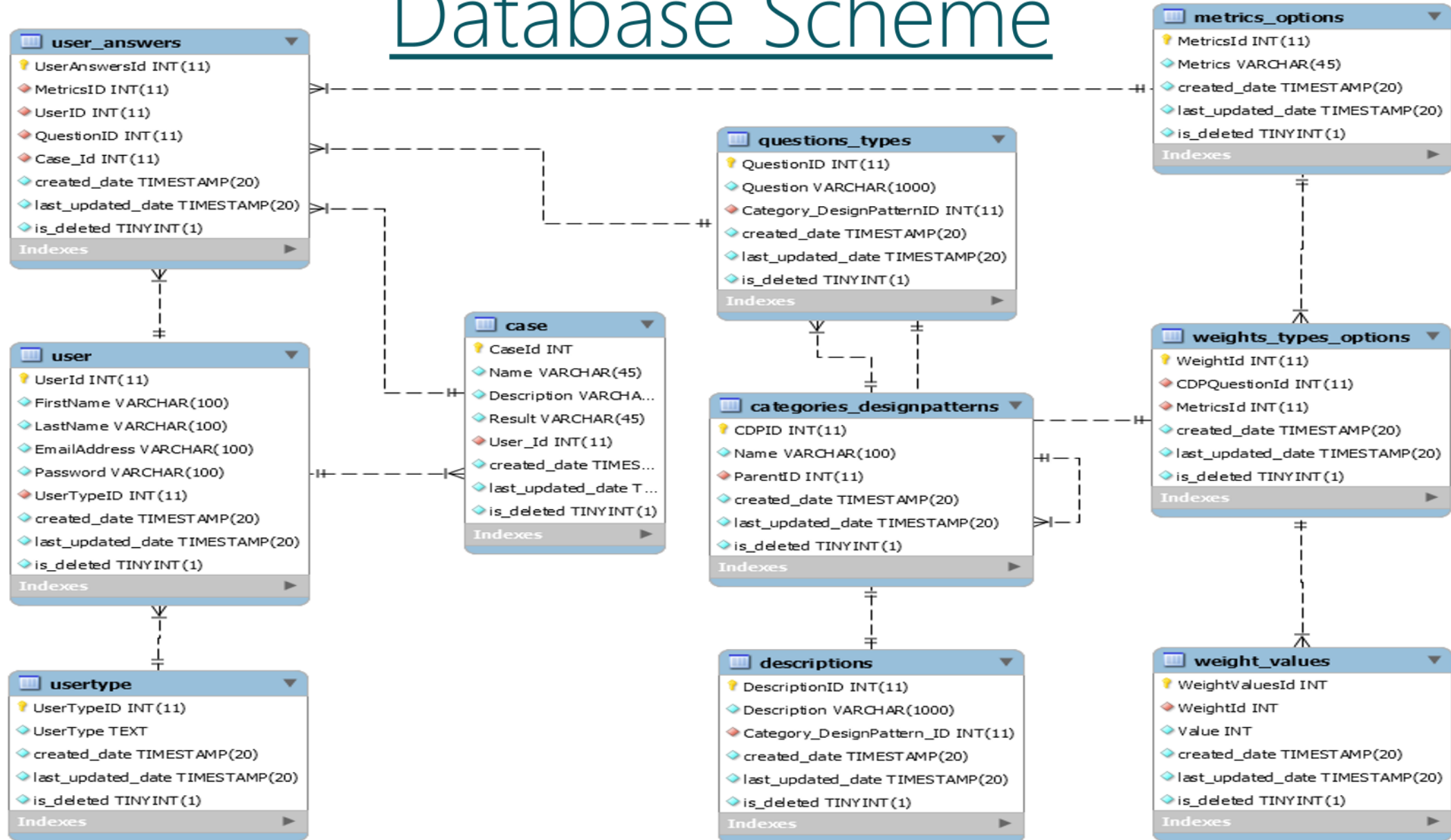
Francis



# Architecture Diagram



# Database Scheme



# Design Patterns Applied

## MVC:

- Applied on the whole structure of the system
- Aim: ➤ Presentation, Data and Functionality separation.
  - Flexibility for modifications.
  - Code reusability.

## Singleton:

- Applied on the database instance generation class.
- Aim: One Instance per execution.

## Strategy:

- PDF files generation in different formats.

# Paper Reviews 1/2

We got the acceptance from both 2 reviewers.

---

## Strengths

- The literature review presents a wide collection of related systems.
- The authors present experimental results on their proposed system.

## Reviewer 1 Comment

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This paper introduces an automatic approach that supports the suitable selection of the design patterns categories. The paper is well written and structure.

## Reviewer 2 Comment



# Thesis Presentation

## Paper Reviews 2/2

### Both Reviewers Evaluations:

Evaluation:					
	Poor	Fair	Good	Very Good	Outstanding
Originality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Innovation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
technical merit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
applicability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Presentation and English	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Match to Conference Topic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Recommendation to Editors					
	Strongly Reject	Reject	Marginally Accept	Accept	Strong Accept
Recommendation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Evaluation:					
	Poor	Fair	Good	Very Good	Outstanding
Originality	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Innovation	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
technical merit	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
applicability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
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Recommendation to Editors					
	Strongly Reject	Reject	Marginally Accept	Accept	Strong Accept
Recommendation	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>