**Mathematical Relation Visualizer**

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**Chapter 1**

**1. Overview of Project**

* 1. Problem Definition

The relations and functions are interesting concepts of discrete mathematics. They appears in the form of pairs and shows the association between the elements of sets. They have certain properties. For example a relation can be symmetric, reflexive, transitive or antisymmetric and a function can be one-to-one or onto. These properties can be used to perform different analyses. These properties of a relation cannot be checked quickly when the relation is written in the form of pairs.

* 1. Proposed System

The proposed system is a desktop app. For visualization system shows the digraph of a relation. It checks which property holds for a relation and which do not. If a particular property does not hold for a relation then the system also tells why this property does not hold. These properties can also be visualize through the color of edges of the digraph.

* 1. Motivation

The motivation behind this project is to build a tool for the students of Discrete Mathematics or Introductory Computing Theory. It will help the students for the proper understanding of relations and functions. Using this system students can quickly check the properties of relations and functions.

* 1. Project Scope
* System draws the digraph of finite binary relation and function.
* System tells the properties of finite binary relation and function.
* The inputs and their results can be save in PDF, Word Document and XML formats.
* The XML file can be import to visualize the saved results.

**Chapter 2**

**2. Relations**

* 1. Introduction to Relations

There are many kinds of relationships in the world. We speak of the relationship between the student and a teacher, between people who work for the same employer, and between people who share a common ethnic background.

Similarly, the objects of mathematics may be related in various ways. A set *A* may be said to be related to a set *B* if *A* is a subset of *B*, or if *A* is not a subset of *B*, or if *A* and *B* have at least one element in common. A number *x* may be said to be related to a number *y* if *x* < *y* etc. Relation here is also called binary relation because it is a subset of a Cartesian product of two sets or a set by itself.

Relation defined in this report is called a binary relation, because it is a subset of a Cartesian product of two sets. Relations can be finite or infinite, but here we consider only the finite binary relations.

* 1. Definition of a Relation

A binary relation **[2]** from a set*A* to a set*B* is a subset

*R ⊆ A × B.*

If (*a, b*) *∈ R* we say *a* is relatedto *b* by *R*.  
 *A* is the domainof *R*, and  
 *B* is the codomainof *R*.

Cartesian product of *A* and *B, A* × *B*, consists of all ordered pairs  
whose first element is in *A* and whose second element is in *B*:

*A* × *B* = *(x, y)* | *x* ∈ *A* and *y* ∈ *B*

**Example 2.1.** Let *A* = {0, 1, 2} and *B* = {1, 2, 3}

and let us say that an element *x* in *A* is related to an element *y* in *B* if, and only if, *x* is less than *y*.

In this case:

*A* × *B* = {(0, 1), (0, 2), (0, 3), (1, 1), (1, 2), (1, 3), (2, 1), (2, 2), (2, 3)}

Then *R* = {(0, 1), (0, 2), (0, 3), (1, 2), (1, 3), (2, 3)}

* 1. Types of Binary Relations

There are two types of binary relations:

* + 1. Relation over One Set

If *A* = *B*, *R* is called a binary relation on the set*A*. A relation on a set *A* is a relation from *A* to *A*. It is also called an endorelation or a homogeneous binary relation.

Some important properties of homogeneous binary relation are:

* Reflexive
* Symmetric
* Transitive
* Antisymmetric

**Example 2.3.1:**

Let *A* = {1, 2, 3}, then

*A x A* = {(1, 1), (1, 2), (1, 3), (2, 1), (2, 2), (2, 3), (3, 1), (3, 2), (3, 3)}

And Let *R* = {(1, 3), (2, 1), (2, 2), (2, 3)}

* + 1. Relation over Two Sets

A relation *R* on two different sets *A* and *B* is a binary relation from *A* to *B*. It is also called a heterogeneous binary relation.

Some important properties of heterogeneous binary relation are:

* Functional
* One-to-One or Injective
* Onto or Surjective

**Example 2.3.2:**

Let *A* = {a, b, c} and *B* = {1, 2, 3}, then

*A x B* ={(a, 1), (a, 2), (a, 3), (b, 1), (b, 2), (b, 3), (c, 1), (c, 2), (c, 3)}

And Let *R* = {(a, 1), (a, 2), (c, 3)}

These relations can be easily visualize with the help of digraph. The digraph is discuss in detail in the next chapter.

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