FINAL YEAR PROJECT

Text Classification on Diabetes Mellitus Symptom and Treatment Documents Using Support Vector Machine (SVM)

Presentation Video:
https://youtu.be/RvpUL_deGNU

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CHAPTER 1
INTRODUCTION

Introduction

Diabetes Mellitus (DM)

- Metabolic disorder characterised by excessively increased blood glucose levels with numerous subtypes
- Severe and varied symptoms of hyperglycemia include abnormalities in the metabolism of carbohydrates, fats, and proteins
- Early detection and efficient management is required but challenging

Text Classification

- A type of the NLP unstructured text analysis techniques
- A predetermined label or tag will be given to each document in the dataset by the classifier

Support Vector Machine (SVM)

- A type of commonly used machine learning text classifiers that give significant result

Problem Background

The number of people suffered from the disease Diabetes Mellitus (DM) keep increasing

A lot of publishments regarding to diabetes for early diagnosis, treatment, management and prevention

Early diagnosis by identifying the symptoms is significant to ascertain suitable treatments

Previous studies mostly used clinical data and patient medical record in classification using machine learning methods such as Fine Decision Tree and SVM but lack of study focus on the classification for medical journal articles that describing the symptoms and treatments of DM

Difficulty to discover and to classify the important information from numerous documents for better understanding and is time consuming

Potential to develop text classification model for diabetes symptom and treatment documents using SVM method to optimize the diabetes diagnosis and management

Problem Statement

- Overwhelming amount of medical literature and research on DM, which can hinder the efficiency of early detection and the effectiveness of management for diabetes patients and doctors

- Keeping up with the latest research discoveries and therapeutic approaches is getting harder as diabetes becomes more common and more complex

- Lack of research on the application of SVM for text classification on DM symptom and treatment documents

- Text classification model is used to assist in finding crucial symptoms and methods of therapy for DM, enhancing the effectiveness and precision of information retrieval

Research Objectives

Goal

To develop and evaluate a SVM based text classification model for DM symptom and treatment documents

Objectives

(a)To identify the related features that are relevant to Diabetes Mellitus (DM) symptoms and treatments in multiple documents.

(b)To perform text classification for a collection of DM documents dataset using Support Vector Machine (SVM) method.

(c)To evaluate the performance of machine learning model that apply Support Vector Machine (SVM) method through several model evaluation techniques

Research Scope

1. To use a collection of articles from PubMed by National Center for Biotechnology Information (NCBI)

2. The documents in the dataset are chosen by focusing on the symptoms and treatments of DM

3. To use Term Frequency-Inverse Document Frequency (TF-IDF) algorithms to spot the important terms of DM symptoms and treatments

4. To use Support Vector Machine (SVM) algorithms to classify text documents

Research Contribution

First

Contribute to the fields of natural language processing (NLP) and machine learning

Second

Contribute to the information retrieval fields with the enhancement of retrieving process that enable domain stakeholders of DM to efficiently identify and classify the important symptoms and treatments for DM based on the analysis of a large corpus of medical documents

Third

Potentially facilitate the development of more effective interventions for diabetes management.

CHAPTER 2

LITERATURE REVIEW

Diabetes Mellitus (DM)

Four major types of DM:

- Type 1 diabetes (T1DM)
- Type 2 diabetes (T2DM)
- Gestational diabetes mellitus (GDM)
- Other specific types

Misdiagnosis always occur between T1DM and T2DM. Although they share some certain features, but the way of presenting the symptoms is distinct.

- T1DM: Quickly within few weeks
- T2DM: Slowly over a long period of time

Can cause many vital organ fail to function, e.g. retina, kidney, neurological system, heart, blood vessels

Diabetic with T1DM and T2DM always accompanied by the following **common symptoms**:
weight loss, dry or itchy skin, blurred vision, polyuria, excessive thirst, increased hunger, sluggish wound healing, frequent infections and depressive mood

Formed when the body's cells and tissues are **unable to use the insulin produced by the pancreas** or when the **pancreas cannot produce enough insulin**

Two main drug therapies in **treating people with T2DM**:

- Oral
- Injection

Therapies in **treating people with T1DM**:

- Insulin with adjunctive drugs like Metformin and DPP-4 Inhibitors

Certain cases of T1DM and T2DM:

- Combination of multiple drugs
- Insulin for T2DM diabetics

Common treatment:

- Diet monitoring

A disease that involve metabolic disorder distinguished by **hyperglycemia**, a physiologically dysfunctional condition reflected by **excessively increased blood glucose levels**

Text Mining

Interdisciplinary field: Information retrieval, text analysis, information extraction, categorization, clustering, visualisation, data mining, and machine learning.

A data mining approach or process that identifies previously unexplored and insightful information from massive quantities of unstructured text data

Overall process of text mining:

- Problem Identification
- Text pre-processing
- Pattern extraction (Text mining)
- Text post-processing (Evaluation)
- Knowledge usage

Text Classification

- The automated assignment of text documents into predefined groups according to the content of the text itself by using various technologies and algorithms

- One the most prominent technique of text mining and Natural Language Processing (NLP)

- Can be break down into four stages

Stages of Text Classification System

Stage 1 Feature Extraction

Stage 2 Dimension Reduction

Stage 3 Classifier Selection

Stage 4 Evaluation

Text Enrichment

Word2Vec

- One of the word embedding methods
- Uses deep learning ideology to create a distributed representation of words in semantic space where a corresponding vector will be assigned to every term
- To create a distributed representation of the word:
  - Continuous skip-gram or Continuous Bag-of-Words (CBOW)
- To determine words' similarity:
  - Euclidean distance, Cosine Similarity
- **Benefits:**
  - Excellent training effectiveness and rich semantics, which can be utilised for part-of-speech analysis, **synonym search**, and clustering

Feature Extraction

- Convert text into keyword schedule to makes it feasible for supervised learning
- Vectorizing text data is necessary before utilising it as input for a machine learning system since the input must be numerical
- Two main types of feature extraction methods:
  - Weighted word
    - Bag-of-Words (BoW), TF-IDF
  - Word embeddings
    - Word2Vec, GloVe

Weighted Word Technique

TF-IDF

- Emphasises a word's importance in a text in relation to the entire corpus
- Basic concept:
  - a term that frequently appears in a document but infrequently in the whole corpus is more informative than a word that regularly appears in both corpus and document
- Two steps involved in TF-IDF, calculating:
  - Term Frequency (TF)
  - Inverse Document Frequency (IDF)

Summary of Machine Learning Approaches

Approaches	Advantages	Limitations
Support Vector Machine (SVM)	• Efficient in performing non-linear classification. • Low prediction error due to risk minimization concept. • Great option for handling high-dimensional data.	• Limited to small sample. • Selection of different kernels may yield the efficiency of classifier.
Naive Bayes Classifier (NBC)	• Easy and quick to implement.	• Precision might decrease when data size is small. • Correlated attributes will affect the performance.

Summary of Machine Learning Approaches

Approaches	Advantages	Limitations
K-Nearest Neighbor (KNN)	• Simple to run. • Effective with big training datasets and robust to noisy data.	• Slow in handling large data. • Sensitive to unnecessary factors. • High demand in memory.
Decision Tree	• Data normalization is not necessary. • Support high dimension data.	• The continuous fields are tough to forecast. • Unstable due to its dependency on dataset type.
Random Forest	• High accuracy	• Time consuming and large memory space needed. • Overfitting may occur if noise exist.

Summary of Related Work

Text Classification

- Several studies about text classification were conducted to compare different types of machine learning algorithms
- Datasets: Journal articles, Research paper, News articles, Movie Reviews and SMS messages

Evaluations

- SVM is used almostly in all the studies
- By comparing with other machine learning algorithms, SVM model always shows better performance

- (Rasheed et al., 2018):
  - Accuracy: **SVM-68.73%**, Decision Tree-62.37%, KNN-55.41%
- (Chowdhury and Schoen, 2020):
  - Accuracy: **SVM-88%**, Naive Bayes-86%, KNN-83%

Discussion

Clinical dataset (Pima Indian) and eye fundus numerical images dataset were commonly used among the researchers to classify whether the patients are diabetic or non-diabetic and to discover the cause of the diabetes.

Numerous publications pertinent to the most thoroughly studied diseases are readily available. These unstructured data have become the potential sources that can provide beneficial information to the medical experts in their diagnosis.

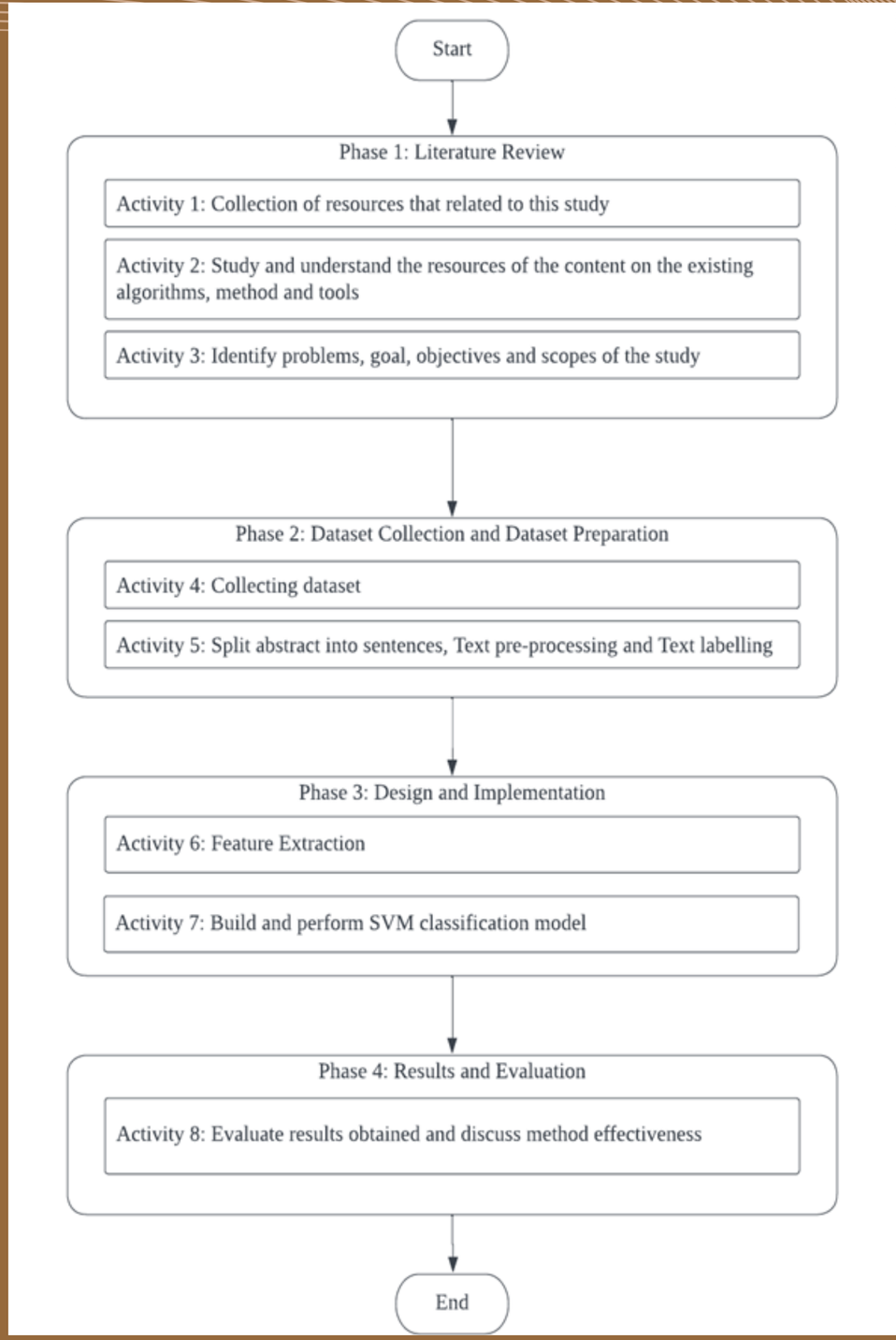
There is lack of studies that occupy thoughts with the narrative documents of DM by classifying their symptoms for different types of DM and its treatment.

SVM is able to perform well in text classification.

It is potential to conduct research studies on text classification for DM symptom and treatment documents using SVM algorithms

CHAPTER 3
RESEARCH METHODOLOGIES

Research Workflow

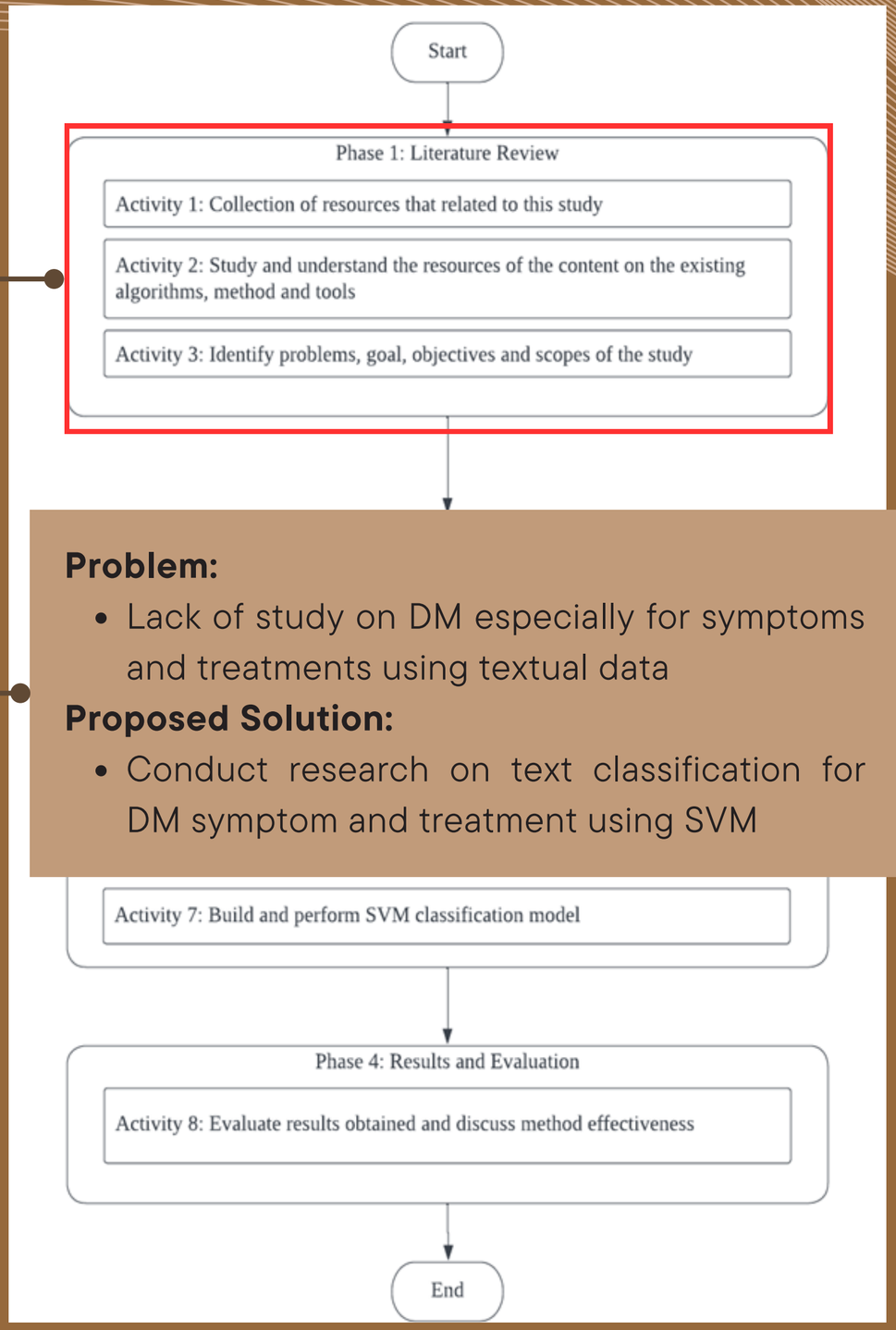


Research Workflow

Phase 1

- The problem background, past studies and related work are discussed.
- Have more understanding regarding to the definition and existing knowledge of DM, text classification and SVM.
- Previous studies: text classification using several types of machine learning methods
  - To find out how previous researchers did to conduct their research

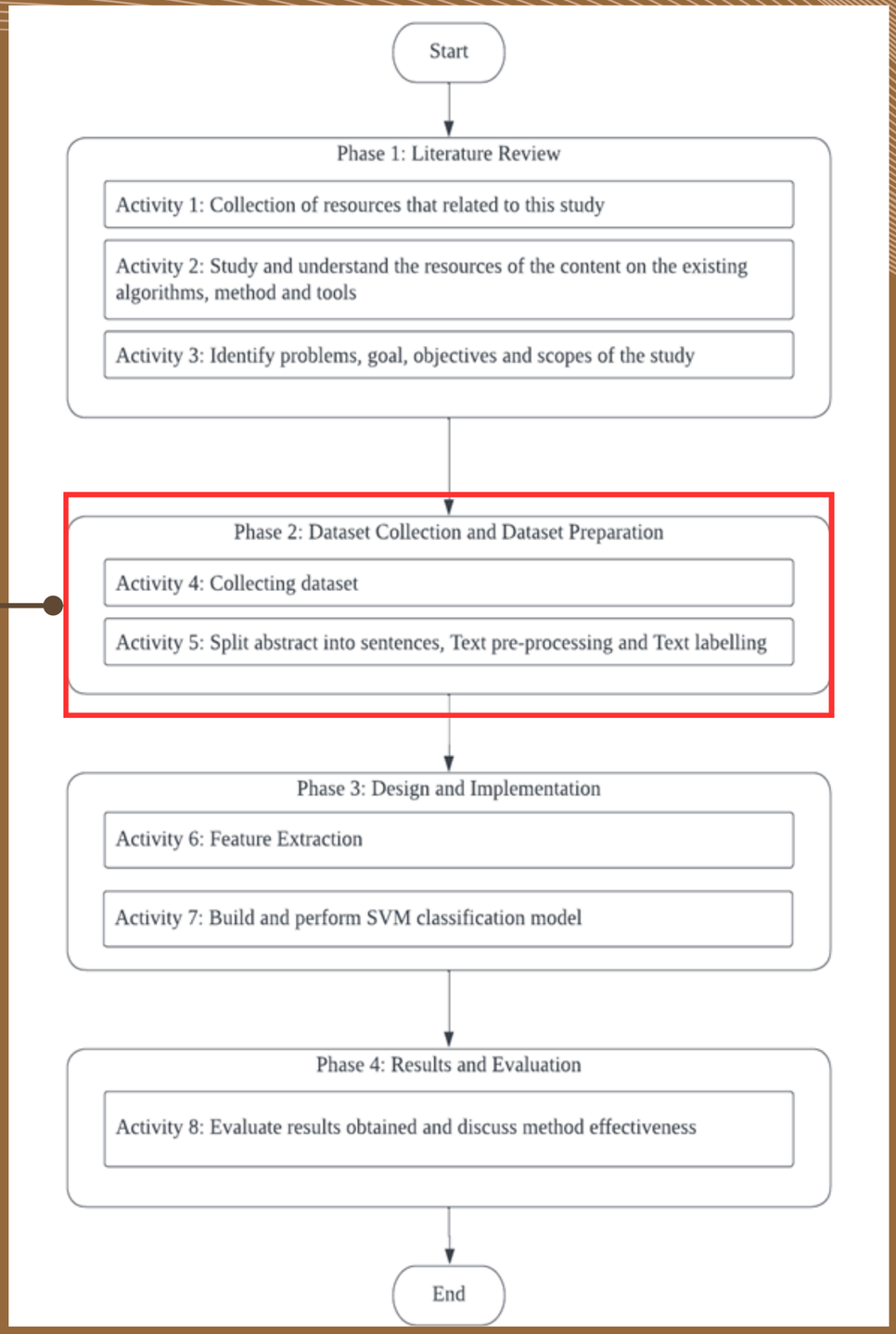
To comprehend the underlying issue or potential future work



Research Workflow

Phase 2

- Data collection:
  - **Source: PubMed website**
    - mainly accesses MEDLINE database of references and abstract on topics related to life science and biomedical.
    - allow user to look for articles using various criteria
  - The **search key term, range of year** and **size of dataset** is set to fetch the relevant journal articles.
  - Saved as csv file for better readability and easier processing

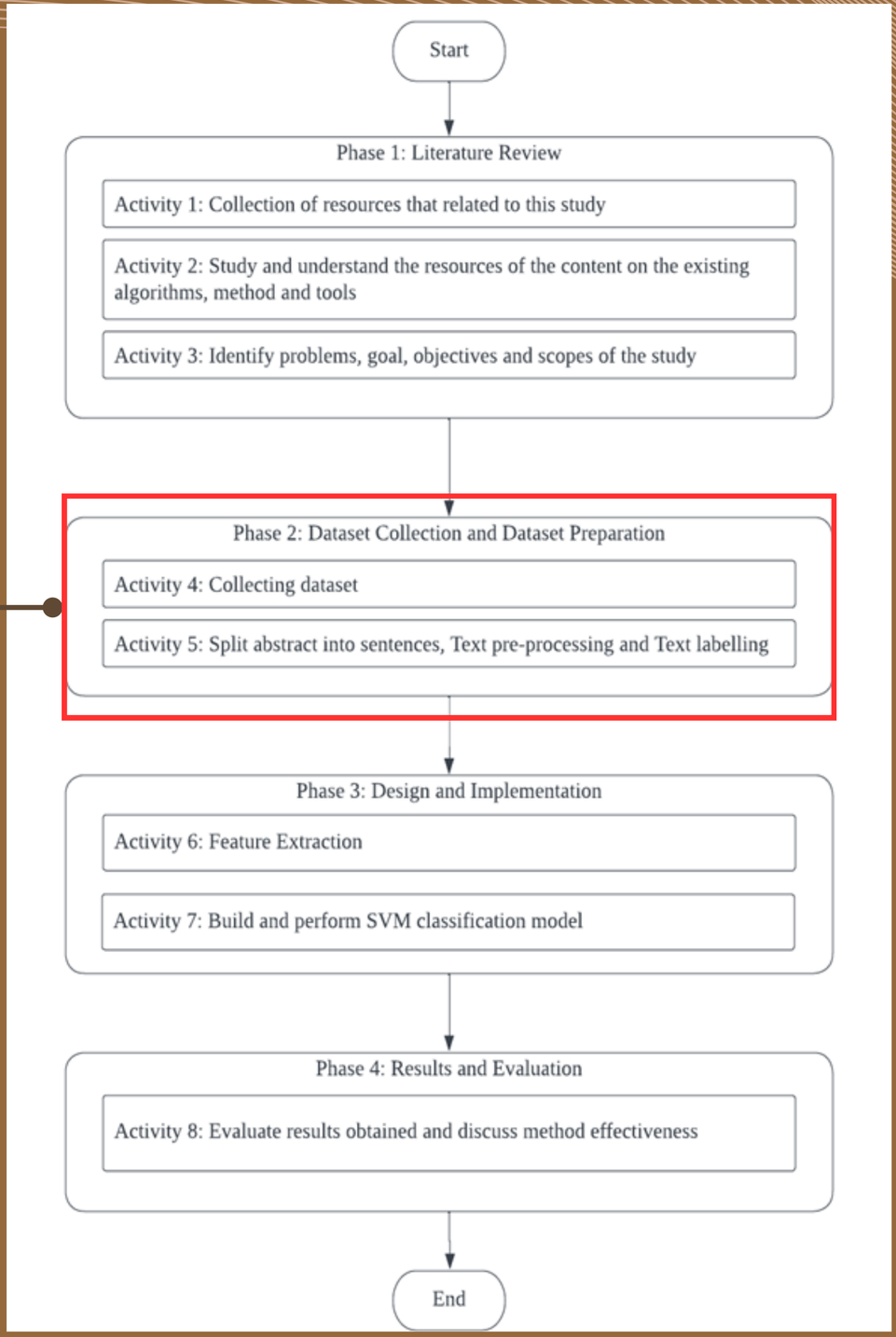


Research Workflow

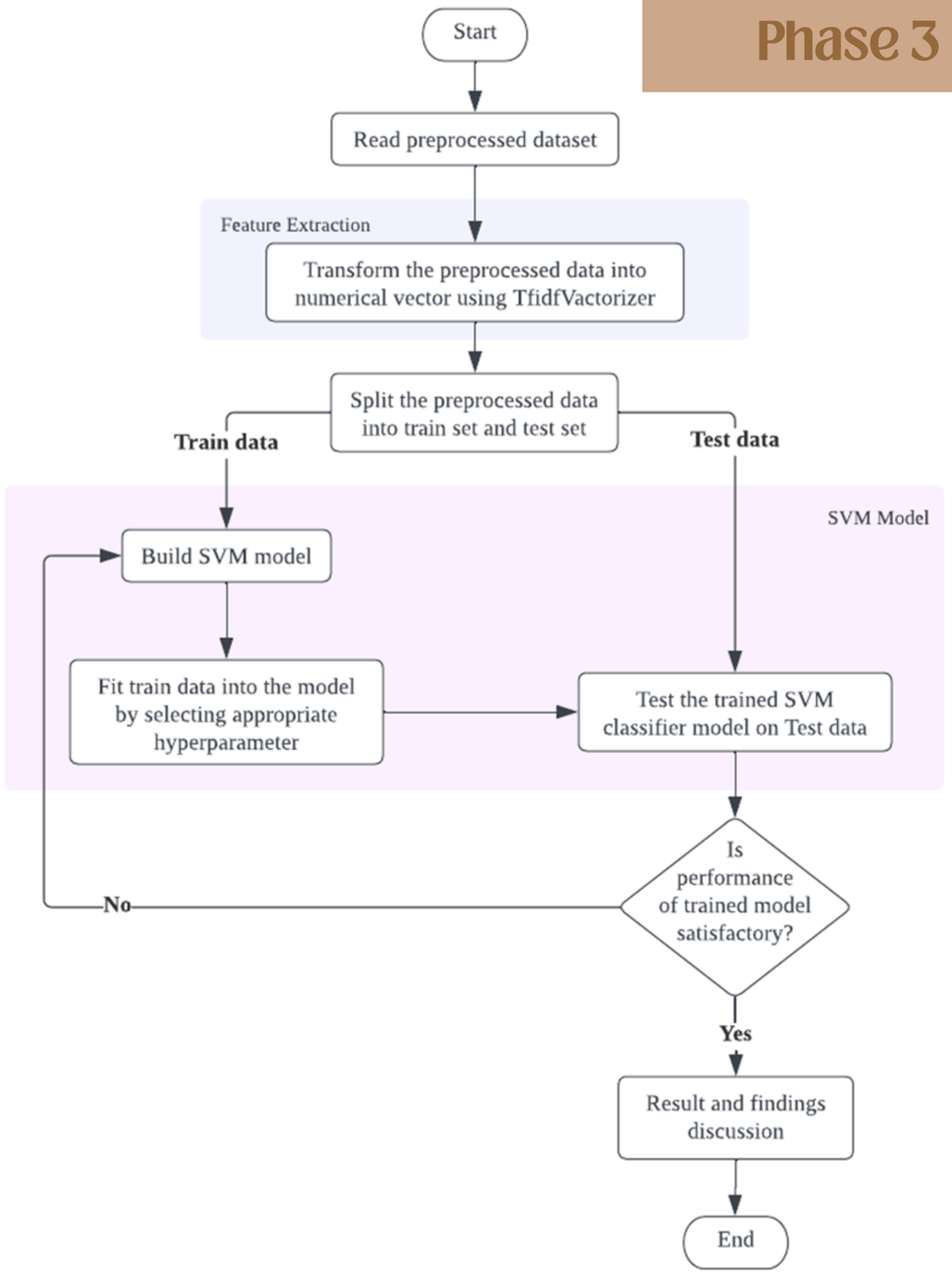
Phase 2

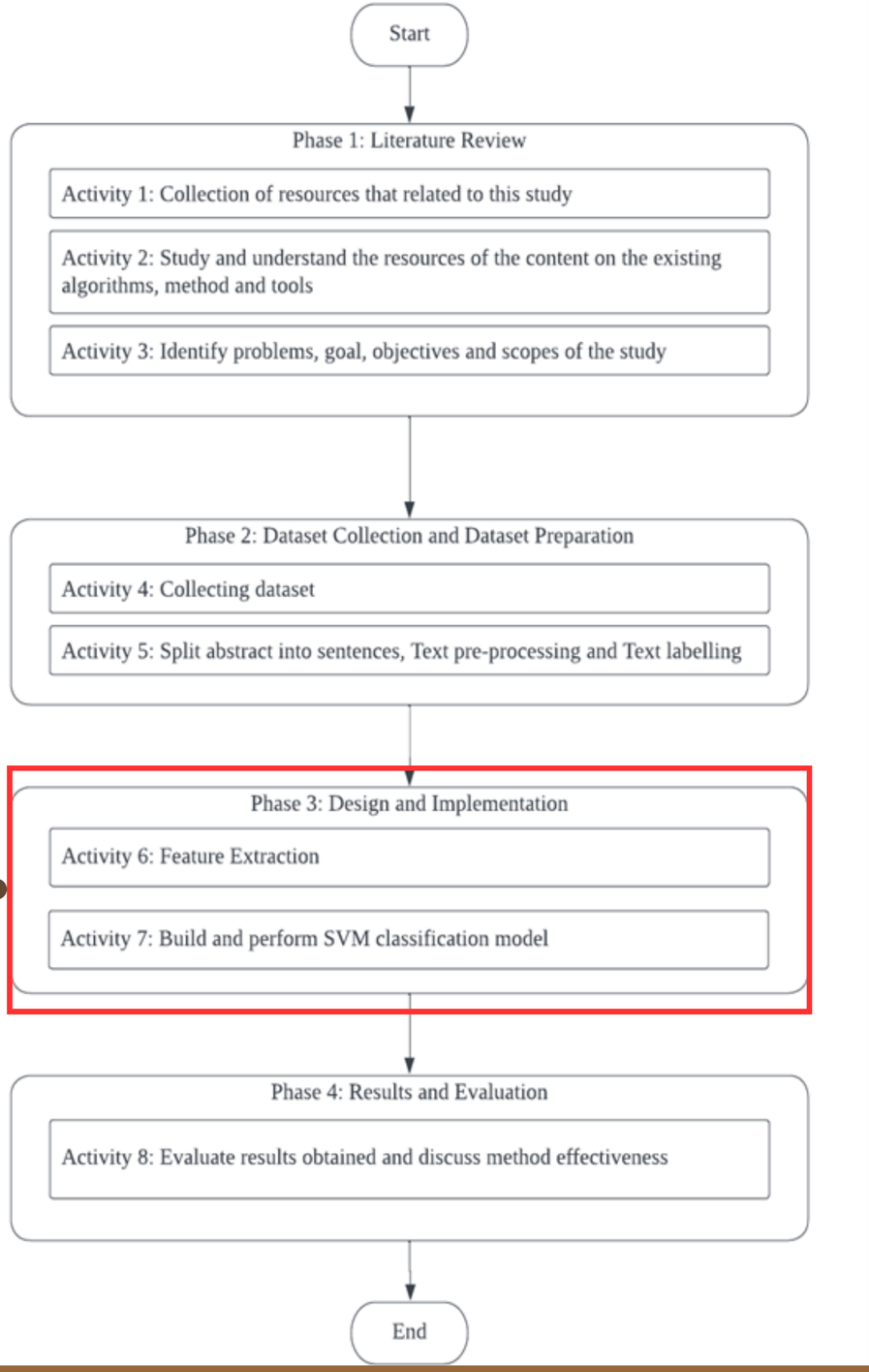
- Dataset Preparation:
  - Split abstract into sentences
  - Text Pre-processing
  - Text Labelling

- Exploratory Data Analysis
  - Wordcloud



Phase 3


Start
Read preprocessed dataset
Feature Extraction
Transform the preprocessed data into numerical vector using TfidfVactorizer
Split the preprocessed data into train set and test set
Train data
Test data
SVM Model
Build SVM model
Fit train data into the model by selecting appropriate hyperparameter
Test the trained SVM classifier model on Test data
Is performance of trained model satisfactory?
No
Yes
Result and findings discussion
End

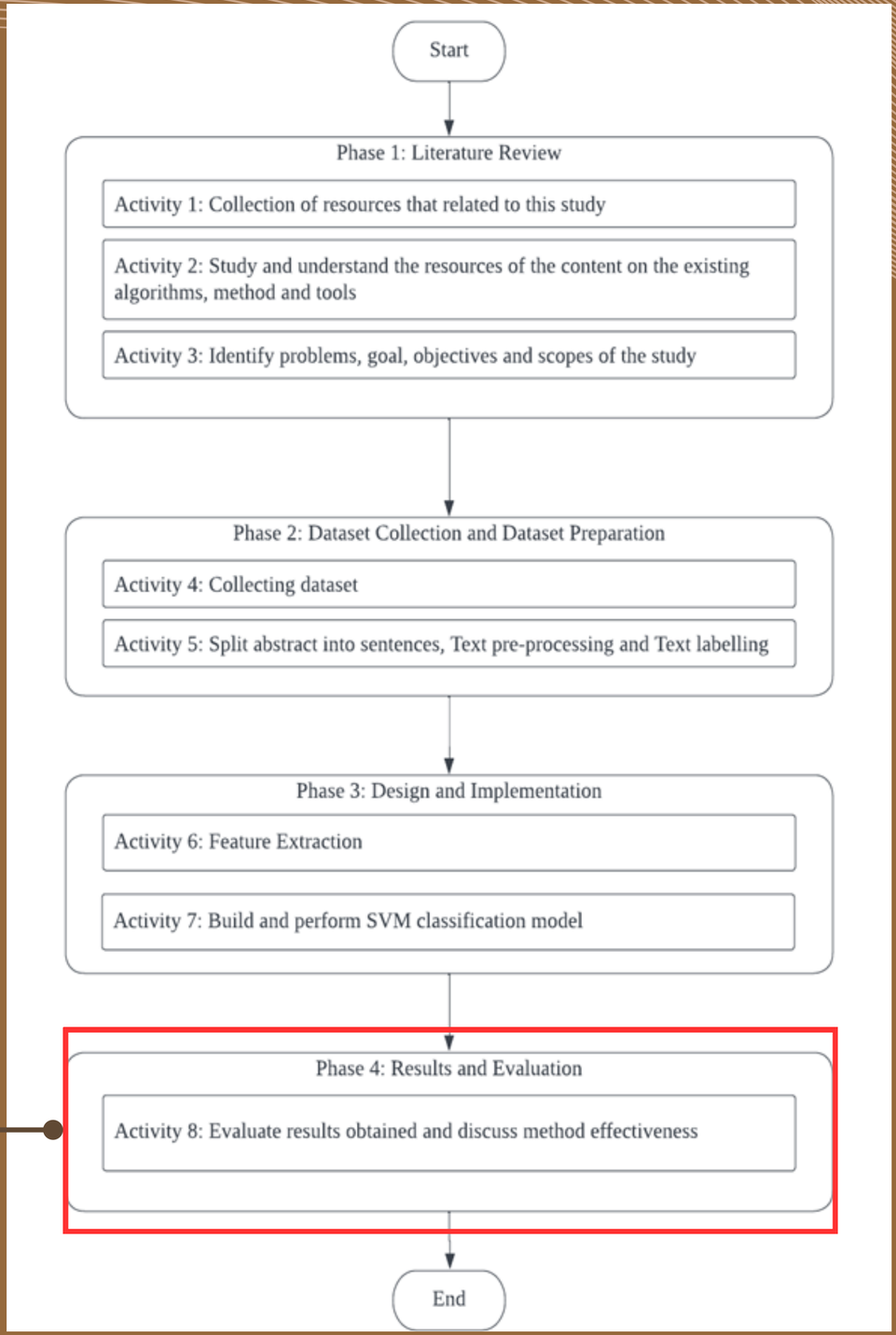

Start
Phase 1: Literature Review
Activity 1: Collection of resources that related to this study
Activity 2: Study and understand the resources of the content on the existing algorithms, method and tools
Activity 3: Identify problems, goal, objectives and scopes of the study
Phase 2: Dataset Collection and Dataset Preparation
Activity 4: Collecting dataset
Activity 5: Split abstract into sentences, Text pre-processing and Text labelling
Phase 3: Design and Implementation
Activity 6: Feature Extraction
Activity 7: Build and perform SVM classification model
Phase 4: Results and Evaluation
Activity 8: Evaluate results obtained and discuss method effectiveness
End

Research Workflow

Phase 4

- **Results evaluation and analysis** by comparing the performance when:
  - different kernel of SVM is used
  - different train test split ratio is used

- **Performance measurement:**
  - Confusion matrix
    - True Positive (TP)
    - True Negative (TN)
    - False Positive (FP)
    - False Negative (FN)
  - Metrics:
    - Accuracy
    - Precision
    - Recall



CHAPTER 4
RESEARCH DESIGN AND IMPLEMENTATION

Dataset Collection and Data Preparation

Stage 1

Extract data from PubMed website

Stage 2

Split abstracts into sentences

Stage 3

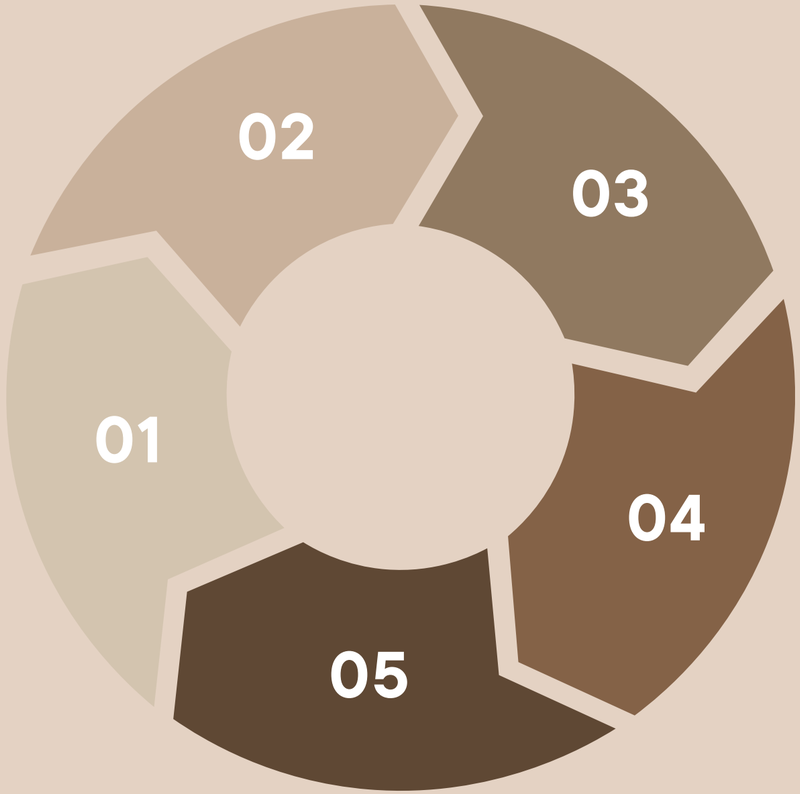
Text Pre-processing

Stage 4

Text Labelling

Stage 5

Exploratory Data Analysis



STAGE 1

Extract Data

- Dataset scrapped from PubMed website
- The search terms are defined as "Type 1 Diabetes Mellitus”, “Type 2 Diabetes Mellitus”, “Symptom” and “Treatment.
- The range of years is set from 2020 to 2023.
- The number of journal articles selected is 300.
- Collected data are saved as csv file.

STAGE 1

Pmid	Title	Abstract
37277527	The geneti	['Diabetes is one of the most common phenotypes of Wolfram syndrome owing to the presence of the variants of the WFS
37264885	[Not Availa	['Maturity-onset diabetes of the young (MODY) is a group of hereditary monogenetic forms of diabetes. MODY accounts fo
37264478	Higher Î² c	['Diabetes is a metabolic disorder of glucose homeostasis in which Î² cell destruction occurs silently and is detected mainly
37259043	Validation	[StringElement('Disordered eating behaviours (DEBs) in patients with type 1 diabetes mellitus (T1DM) are associated with ar
37258468	SGLT2i in F	['Sodium-glucose cotransporter inhibitors (SGLT2i) play an increasingly important role in type 2 diabetes mellitus (T2DM) du
37257909	Navigating	the Seas of Glycemic Control: The Role of Continuous Glucose Monitoring in Type 1 Diabetes Mellitus.
37241059	Benefit or	['Purpose: Dapagliflozin has been used extensively in patients with type 2 diabetes mellitus (T2DM). However, due to
37187225	Determina	[StringElement('To determine the correlation between %TIR and HbA1c in pregnant women with type 1 diabetes mellitus (D
37161897	The Possib	['This minireview discusses the very important biomedical problem of treating type 2 diabetes mellitus (T2D). T2D accounts
37133646	Use of Flas	[StringElement('Estimation of laboratory-derived glycated hemoglobin (HbA1c) cannot be individually used to monitor clinic
37131168	Understan	[StringElement("With the increasing prevalence of pre-existing type 1 and type 2 diabetes in pregnancy and their associated
37121117	The associ	[StringElement('Low baroreflex sensitivity is an indicator of early cardiovascular autonomic neuropathy. We explored the a
37120620	Identificat	['Latent autoimmune diabetes in adults (LADA) has clinical and metabolic features of type 1 and type 2 diabetes. LADA does
37116019	A Case of A	[StringElement("Autoimmune polyendocrine syndrome (APS) type II (Schmidt's syndrome) is defined by the coexistence of a
37101033	[Clinical pr	['In 1989 the St. Vincent Declaration aimed to achieve comparable pregnancy outcomes in women with diabetes and those
37101030	[Diagnosis	['This guideline summarizes diagnosis of type\xa01\xa0diabetes, including accompanying autoimmune disorders, insulin the
37062046	Budget Im	[StringElement("To estimate the budget impact of the potential coverage of FreeStyle Libre Flash Continuous Glucose Moni
37046364	Use of insu	['The use of continuous subcutaneous insulin infusion (CSII) via insulin pumps is today considered standard of care for type
37043824	Evaluation	[StringElement('To evaluate the performance of a real-time continuous glucose monitor (CGM) in individuals with diabetes
37012937	A Pediatric	["The most well-known cause of hyperglycemia is diabetes mellitus,\xa0a condition that affects the body's ability to either
36945977	Low handg	[StringElement('This study aims to reveal the prevalence of low handgrip strength in older patients with type 2 diabetes who
36920867	Novel Onc	[StringElement('Basal Insulin Fc (BIF; insulin efsitora alfa; LY3209590), a fusion protein combining a novel single-chain insulin
36920833	Self-Monitoring of Blood Glucose in Patients With Non-Insulin-Dependent Diabetes Mellitus.	
36916961	Adipose-de	['The worldwide increase in the prevalence of diabetes mellitus (DM) has raised the demand for new therapeutic strategies

STAGE 2

Split Abstracts into Sentences

- Natural Language Toolkit (NLTK) library is imported and package ‘punkt’ is downloaded to perform sentence tokenizing using sent_tokenize function.
- Split sentences are saved in another csv file.

STAGE 2

sentences
['Diabetes is one of the most common phenotypes of Wolfram syndrome owing to the presence of the variants of the WFS1 gene and is often misdiagnosed as other type
We aimed to explore the prevalence of WFS1-related diabetes (WFS1-DM) and its clinical characteristics in a Chinese population with early-onset type 2 diabetes (EOD).
We sequenced all exons of the WFS1 gene in 690 patients with EOD (age at diagnosis\u2009â‰¤\u200940\xa0years) for rare variants.
Pathogenicity was defined according to the standards and guidelines of the American College of Medical Genetics and Genomics.
We identified 33 rare variants predicted to be deleterious in 39 patients.
The fasting [1.57(1.06-2.22) ng/ml] and postprandial C-peptide levels [2.8(1.75-4.46) ng/ml] of the patients with such WFS1 variations were lower than those of the patier
Six (0.9%) patients carried pathogenic or likely pathogenic variants; they met the diagnostic criteria for WFS1-DM according to the latest guidelines, but typical phenotypes
They were diagnosed at an earlier age and usually presented with an absence of obesity, impaired beta cell function, and the need for insulin treatment.
WFS1-DM is usually mistakenly diagnosed as type 2 diabetes, and genetic testing is helpful for individualized treatment.']
['Maturity-onset diabetes of the young (MODY) is a group of hereditary monogenetic forms of diabetes.
MODY accounts for 1-3% of all persons with diabetes but is often undiagnosed or misdiagnosed as type 1 diabetes, type 2 diabetes, or gestational diabetes.
Diagnosing MODY is essential, as the most optimal treatment both during and outside of pregnancy depends on the MODY type.
This review focuses on the outcome and treatment of the three most common types of MODY during pregnancy.']
['Diabetes is a metabolic disorder of glucose homeostasis in which Î² cell destruction occurs silently and is detected mainly when symptoms appear.
In the last few years, it has emerged a great interest in developing markers capable of detecting pancreatic Î² cell death focused on improving early diagnosis and getting a
But other types of diabetes would also benefit from early detection of Î² cell death.
Differentially methylated circulating DNA is being studied as minimally invasive biomarker of cell death.
We aimed to explore whether the unmethylated/methylated ratio of the insulin and amylin genes might be a good biomarker of Î² cell death in different types of diabetes.
A lower index â^†Ct indicates a higher rate of Î²-cell death.
Plasma samples from subjects without diabetes, pregnant women, pregnant with gestational diabetes\xa0(GDM), type 1 diabetes and type 2 diabetes were analyzed.
A qPCR reaction with specific primers for both methylated and unmethylated fragments of insulin and amylin genes were carried out.
Pregnant women, GDM and non- GDM, showed a higher Î²-cell death for both markers (â^†INS\u2009=\u20093.8\u2009Â±\u20092.1 and â^†Amylin\u2009=\u20098.5\u2
The insulin methylation index was associated with the newborn birth weight (r\u2009=\u20090.46; p\u2009=\u20090.033) and with insulin resistance (r\u2009=\u2009-0.

STAGE 3

Text Pre-processing

- Drop empty rows
- Convert case to lowercase
- Removal of punctuations
- Removal of digit values
- Tokenization
- Removal of stopwords
- Stemming
- Lemmatization

STAGE 3

sentences
diabet one common phenotyp wolfram syndrom owe presenc variant wf gene often misdiagnos type diabet
aim explor preval wfsrelat diabet wfsdm clinic characterist chine popul earlyonset type diabet eod
sequenc exon wf gene patient eod age diagnosisuâ‰¤uxayear rare variant
pathogen defin accord standard guidelin american colleg medic genet genom
identifi rare variant predict deleteri patient
fast ngml postprandi cpeptid level ngml patient wf variat lower patient without wf variat respect ngml
six patient carri pathogen like pathogen variant met diagnost criterion wfsdm accord latest guidelin typic phenotyp wolfram syndrom seldom observ
diagnos earlier age usual present absenc obes impair beta cell function need insulin treatment
wfsdm usual mistakenli diagnos type diabet genet test help individu treatment
maturityonset diabet young modi group hereditari monogenet form diabet
modi account person diabet often undiagnos misdiagnos type diabet type diabet gestat diabet
diagnos modi essenti optim treatment outsid pregnanc depend modi type
review focus outcom treatment three common type modi pregnanc
diabet metabol disord glucos homeostasi Î² cell destruct occur silent detect mainli symptom appear
last year emerg great interest develop marker capabl detect pancreat Î² cell death focus improv earli diagnosi get better treatment respons mainli type diabet
type diabet would also benefit earli detect Î² cell death
differenti methyl circul dna studi minim invas biomark cell death
aim explor whether unmethylatedmethyl ratio insulin amylin gene might good biomark Î² cell death differ type diabet
lower index â^†ct indic higher rate Î²cell death
plasma sampl subject without diabet pregnant woman pregnant gestat diabetesxagdm type diabet type diabet analyz
qpcr reaction specif primer methyl unmethyl fragment insulin amylin gene carri
pregnant woman gdm non gdm show higher Î²cell death marker â^†insuuuÂ±u â^†amylinuuuÂ±u wherea td present lower rate â^†insuuuÂ±u â^†amylinuuuÂ±u compar healthi subject
insulin methyl index associ newborn birth weight ruu puu insulin resist ruu puu gdm group
higher rate Î²cell death observ pregnant woman independ metabol statu

STAGE 4

Text Labelling

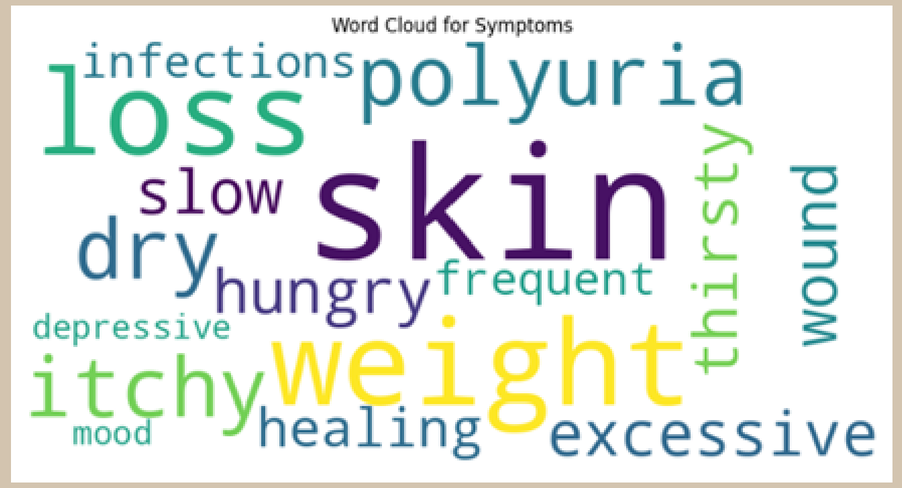
- Define Symptom and Treatment keywords for T1DM and T2DM:
  - Symptom: weight loss, polyuria, dry skin, itchy skin, excessive hungry, thirsty, blurred vision, slow wound healing, frequent infections, and depressive mood
  - Treatment: oral drug, injectable drug, insulin, and diet monitoring
- Pretrained Word2Vec: Identify synonyms of each keyword
- The sentence will be labelled as ‘1’ if the symptoms or treatments keyword exist in the sentence; else, it will be marked as '0'

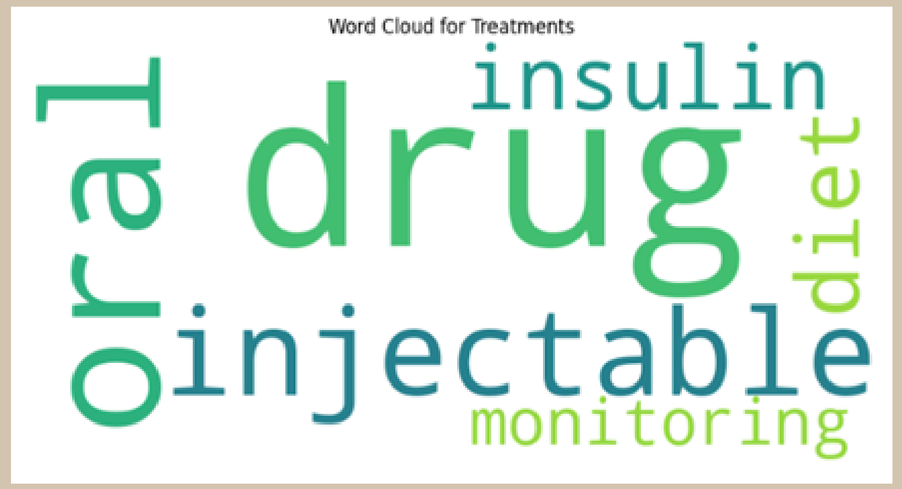
STAGE 4

sentences	weight loss	polyuria	dry skin	itchy skin	excessive hungry	thirsty	blurred vision	fatigue	slow wound healing	frequent infections	depressive mood	oral drug	injectable drug	insulin	diet monitoring
diabet one cc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
aim explor pr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
sequenc exor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pathogen def	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
identifi rare v	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
fast ngml pos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
six patient ca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
diagnos earli	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
wfsdm usual	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
maturityonse	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
modi accoun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
diagnos modi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
review focus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
diabet metab	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
last year eme	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
type diabet w	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
differenti me	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
aim explor w	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
lower index i	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
plasma samp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
qpcr reaction	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
pregnant wor	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
insulin methy	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
higher rate Ï²	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

STAGE 5

Exploratory Data Analysis





CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

Research Outcomes

Objective 1:

To identify the related features that are relevant to Diabetes Mellitus (DM) symptoms and treatment in multiple documents.

- **The textual data of DM documents was successfully scrapped from PubMed websites by using specific search terms.**
- **Each of the extracted abstracts from multiple documents were split into a set of single sentences and cleaned using text pre-processing techniques.**
- **The cleaned dataset is then labelled using the defined keywords and their similar words that obtained from the pretrained Word2Vec model.**

Achievements

Complete Data Preparation:

300 journal articles that related to DM symptoms and treatments were collected from PubMed websites.

The abstracts in the dataset were split into sentences and the cleaned dataset is obtained after text cleaning.

The sentences in cleaned dataset were labelled according to the matching of synonyms of predefined keywords for T1DM and T2DM symptoms and their treatments with the words in the sentences based on their similarity.

Future Works

In PSM II:

Identify the solutions for labelling the symptoms and treatments more precisely since the tokenization method separate the words, which cause certain words that are not actually the symptoms and treatments will also be labelled.

Develop text classification model for the collection of split and labelled sentences of Diabetes Mellitus (DM) that involves T1DM and T2DM symptoms and treatments using Support Vector Machine (SVM).

Evaluate the performance of the trained model with SVM algorithms to identify Diabetes Mellitus (DM) symptoms and treatments.

THANK YOU

End For PSM1