# Explaining Clustering using Decision Trees

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# Agenda

REVA UNIVERSITY
Bengaluru, India
Established as per the section 2(f) of the UGC Act, 1956,
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**DARPA** Technical strategy: Address diverse DoD user types

**Explainable AI system development-to-use timeline**

*Notional* — Conceptual System — Prototype System — System V&V — System Acceptance Testing — Operational System — After Action Reviews — Regulatory Reviews

**Explainable AI system users**

**Developers**

**AI Expert**
Design, develop, and debug

**Task SME**
Test and evaluate

- Explanations expose finer details of the system
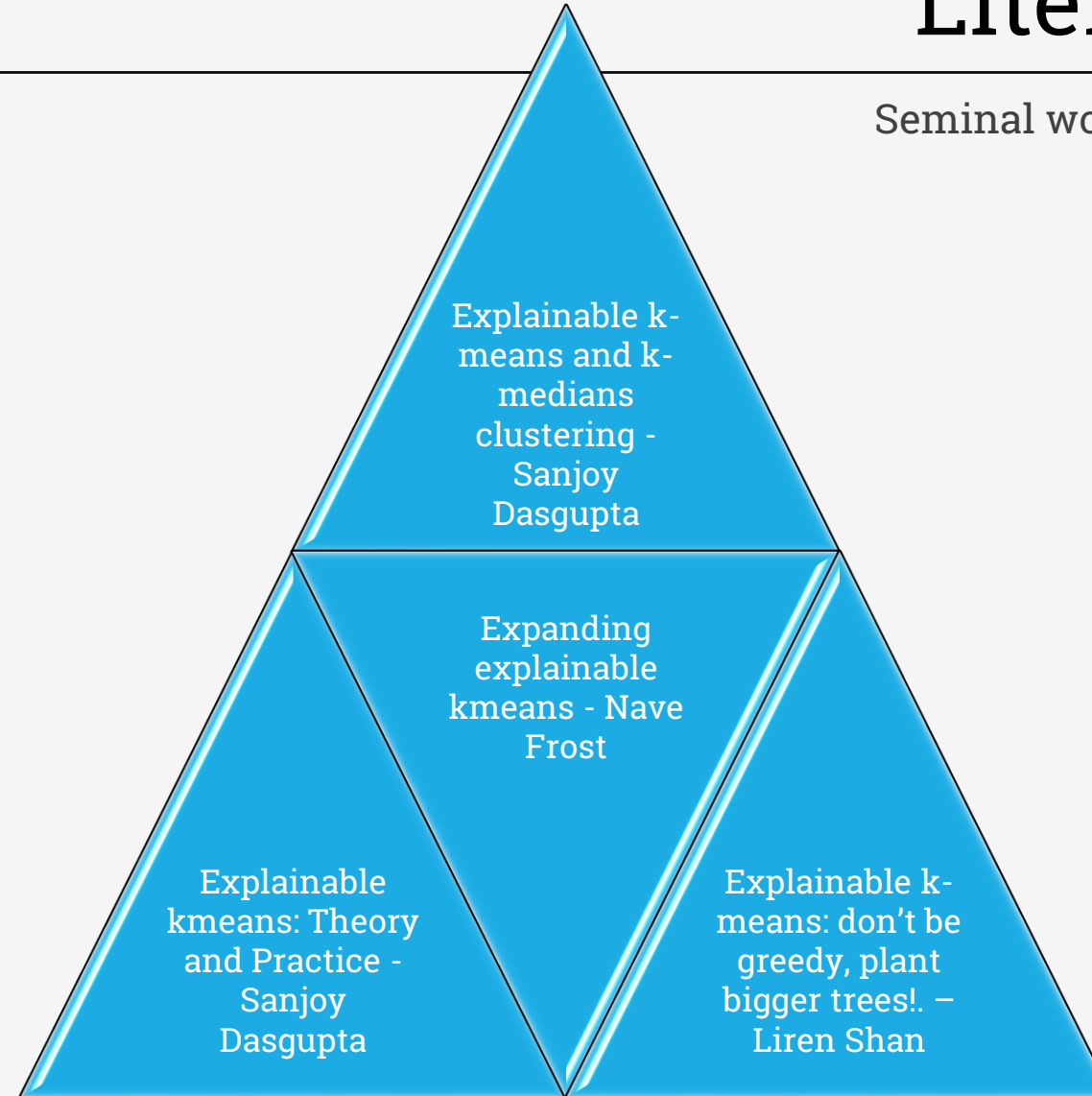- Explanations are used to modify/refine the system

**End Users**
- DoD/Military
- Legal
- Transportation
- Security
- Finance
- Medical

- Explanations aid decision making/recommendations
- Explanations justify actions taken and decisions

**Policymakers/Regulators**

**Commander**

**Policymaker Regulator**

- Decision patterns are defensible
- Decisions meet policy/regulatory requirements

**A good explanation incorporates context about the user's knowledge, task, and concept of operations**

Technical | Functional

_Research Hypothesis 1:_

_Less than 50% of features are adequate to explain the cluster assignment_

_Research Hypothesis 2:_

_Less than 5 clusters of kmeans clustering are adequate to explain the variance of dataset_
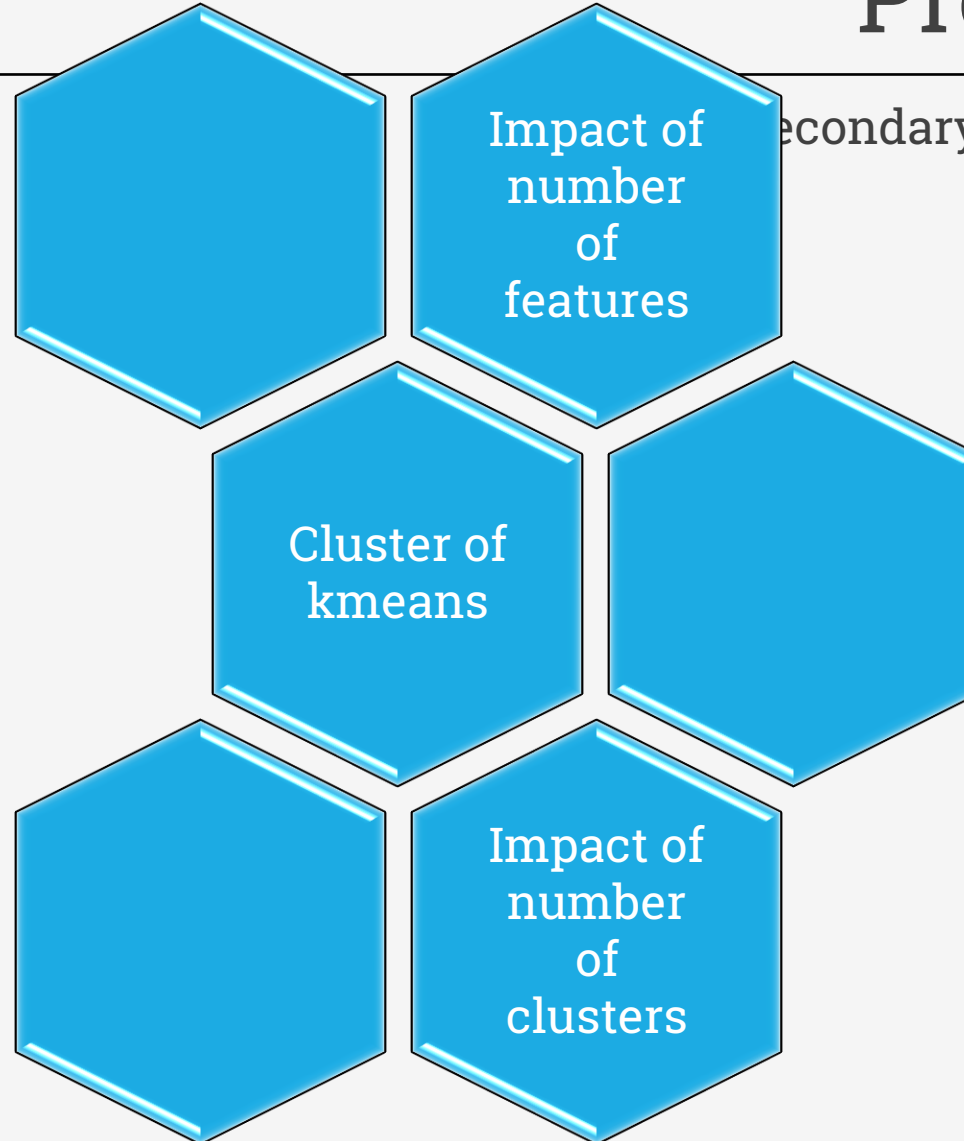
# Project Objectives

Impact of number of features

Cluster of kmeans

Impact of number of clusters

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Exploratory data analysis is to be conducted to understand the diabetes dataset where the features of the dataset are the predictor variables.

Once the data is ready, kmeans model needs to be built and cluster assignment is to be performed. The important step is to build a decision tree classifier with cluster segments as labels.

The so created decision tree classifier will provide explanations where the leaf nodes are the clusters and the non-leaf nodes are the features and their ranges.

The accuracy of the decision tree is the percentage of explainability.

The project methodology is pictorially shown in Figure.

Conceptual Framework | Research Design

**Prepare Diabetes Dataset**

**Clean Diabetes Databset**

**Process Diabetes Dataset**

**Perform Exploratory Data Analysis**

**Build kmeans model**

**Assign cluster assignments**

**Explain kmeans clusters**

**Compute percentage of explainability**

Pima Indians Diabetes Dataset

National Institute of Diabetes and Digestive and Kidney Diseases.

Goal: The goal of this dataset is to predict occurrence of diabetes diagnostically based on the measures in the dataset.

Features: Pregnancies, Glucose, Insulin, Age, Blood Pressure, Skin Thickness, BMI, Diabetes Pedigree Function

```
#Experiment Variables

num_of_clusters = [2,3,4,5,6,7,8,9]
dia_tree_criteria = ["gini", "entropy"]
topN = [1, 2, 3, 4, 5, 6, 7, 8]
depth = [2,3,4,5,6,7,8,9]
num_leaf = [4,5,6,7,8,9,10,11,12]
```

1. **Dataset Preparation** – Download the dataset and load it into Dataframe
2. **Perform Data Wrangling** – Do cleanup of nulls and perform EDA
3. **Model Building** – Use scikit-learn to build the kmeans model. The fit method activates the unsupervised learning algorithm to find patterns and form clusters
4. **Build Decision tree surrogate model -** decision tree classifier implemented in sci-kit learn is an optimized version of the CART algorithm
5. **Explain kmeans cluster assignment**
6. **Compute percentage of explainability**

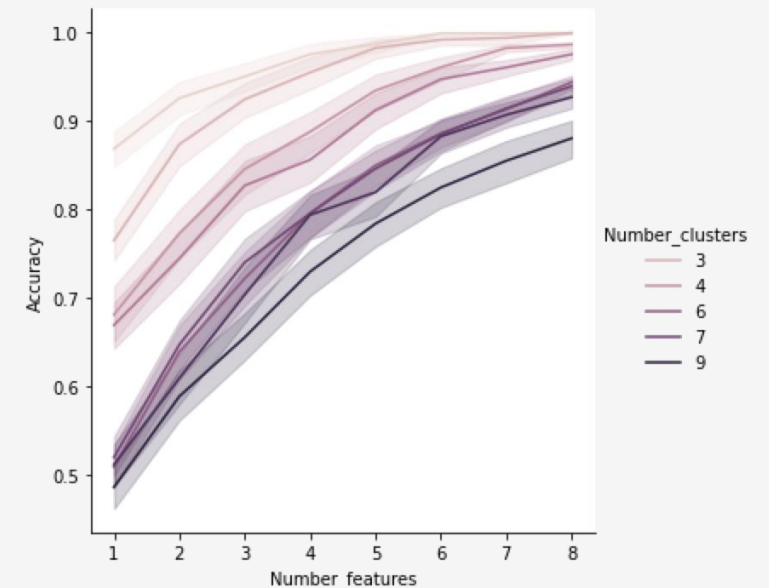**Experiments: Accuracy plots by varying number of features, clusters and type of tree**
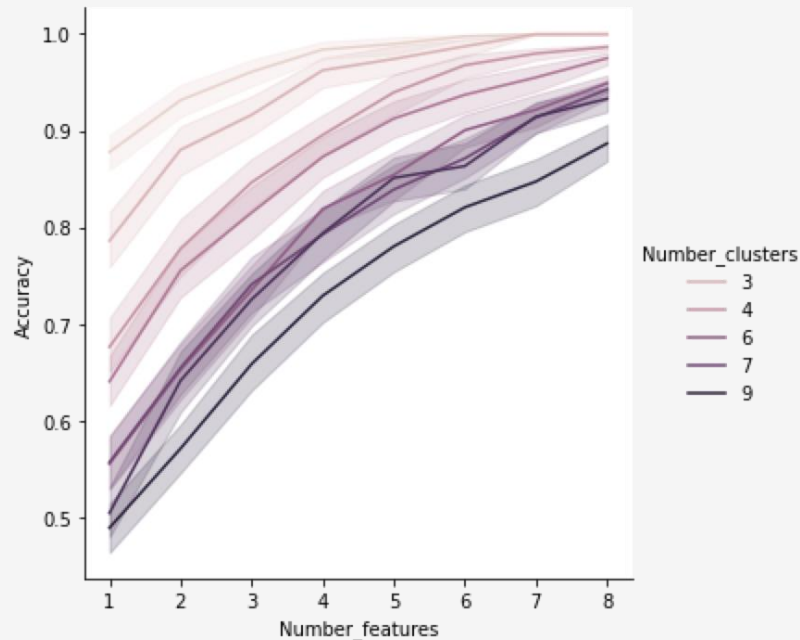


Less than 5 cluster == Good percentage of explainability

50% of features (4) === Good percentage of explainability

## Accepted Research hypothesis

❖ Less than 50% of features are adequate to explain the cluster assignment
❖ Less than 5 clusters of kmeans clustering is adequate to explain the variance of dataset

The graphs that were plotted enabled to arrive the acceptance of the research hypothesis by empirically displaying the truthfulness of the two hypotheses.

## Future Scope

Research the effect of number of leaves and depth of decision tree on the percentage of explainability can be explored.

Application of this in recommender systems and other real world practical use cases can be explored

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