

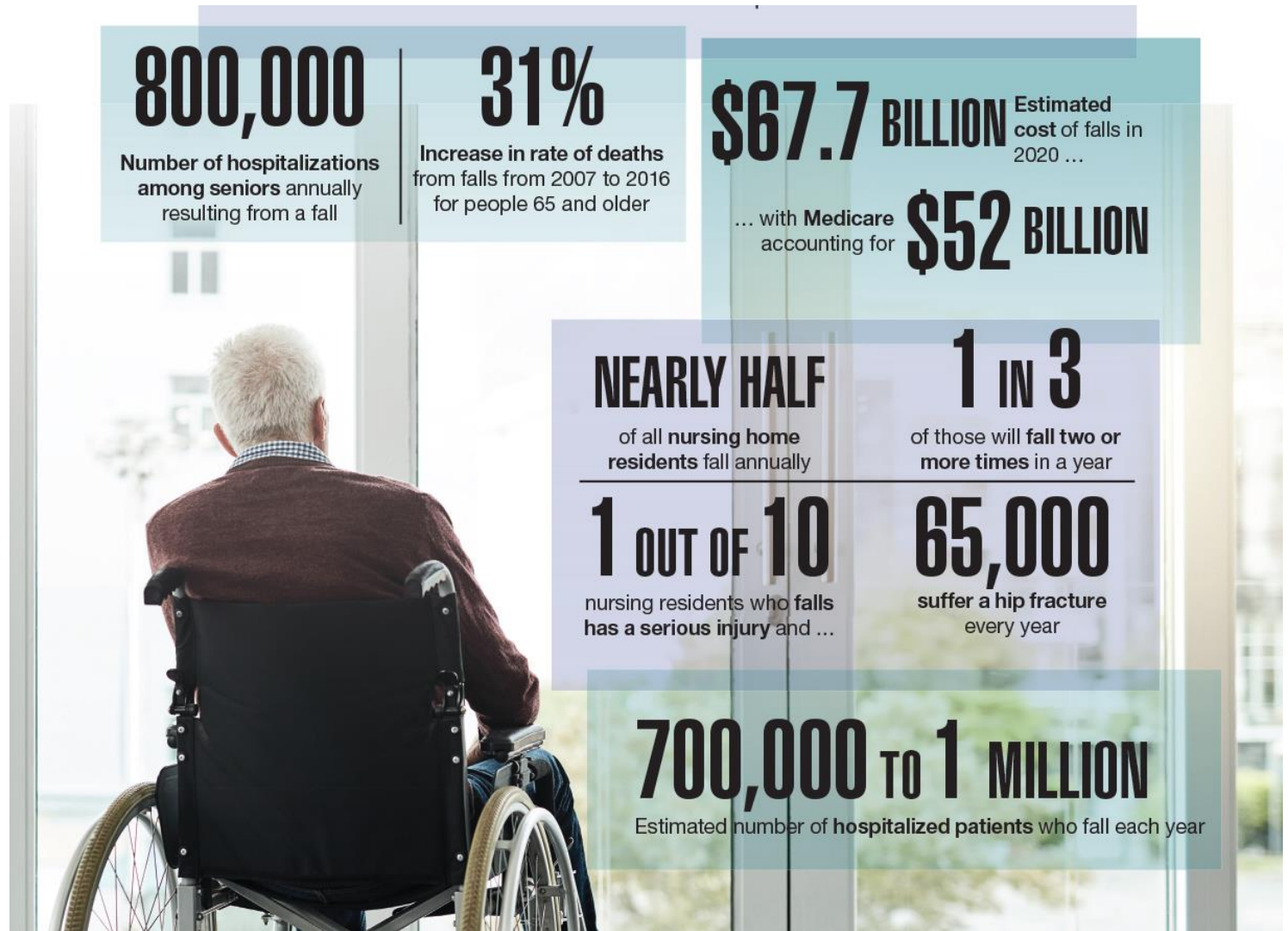
# A CLUSTERING-AIDED APPROACH FOR DIAGNOSIS PREDICTION: A CASE STUDY OF ELDERLY FALL

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# Elderly Fall

- A serious problem in healthcare
- Early prediction and detection is key to prevent elderly fall



# FALLS AMONG OLDER ADULTS ARE

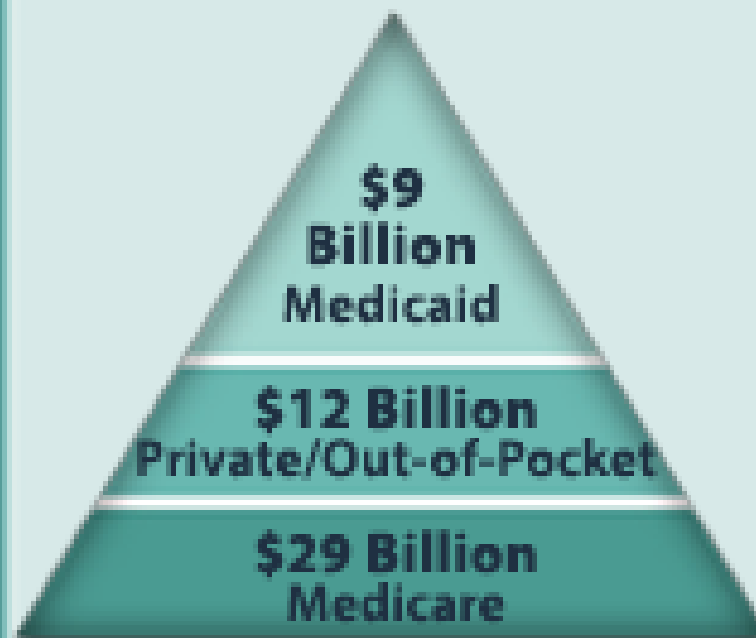
## COMMON



1 in 4  
Older adults (65+)  
falls each year

## COSTLY

**\$50 Billion Annually**



## PREVENTABLE



Clinicians can use  
**STEADI**  
to prevent falls &  
reduce costs



# WHAT CAUSES ELDERLY PEOPLE TO FALL?

## A DECLINE IN PHYSICAL HEALTH.

Many adults become less active as they age, which increases the physiological effects of aging. The lack of light exercise may result in decreased muscle strength, decreased bone quality, loss of balance and coordination, and decreased flexibility.

## IMPAIRED VISION.



Age-related eye diseases can make it difficult, if not impossible, to detect fall hazards, such as steps, and thresholds. Even if a senior is in top physical condition, failing to see obstacles or changes in ground level can lead to a nasty tumble.

## MEDICATIONS.

Side-effects, such as drowsiness, dizziness, and low blood pressure, can all contribute to an accident. Sedatives, anti-depressants, antipsychotics, opioids, and some cardiovascular drugs are the most common culprits.

## CHRONIC DISEASES.



# 4



Health conditions such as Parkinson's disease, Alzheimer's disease, and arthritis cause weakness in the extremities, poor grip strength, balance disorders, and cognitive impairment. Poor physical health increases a person's initial risk of falling and minimizes their ability to respond to and recover from hazards, like tripping or slipping.



# 5

## SURGICAL PROCEDURES.



Hip replacements and other surgeries can leave an elderly person weak, in pain and discomfort, and less mobile than they were before the procedure. This can be temporary while a patient heals or a new and lasting problem.

## ENVIRONMENTAL HAZARDS.



# 6

A big percentage of falls in the elderly population occur in seniors' homes. Environmental factors such as poor lighting, clutter, areas of disrepair, loose carpets, slick floors, and lack of safety equipment can jeopardize a senior's safety in their home.



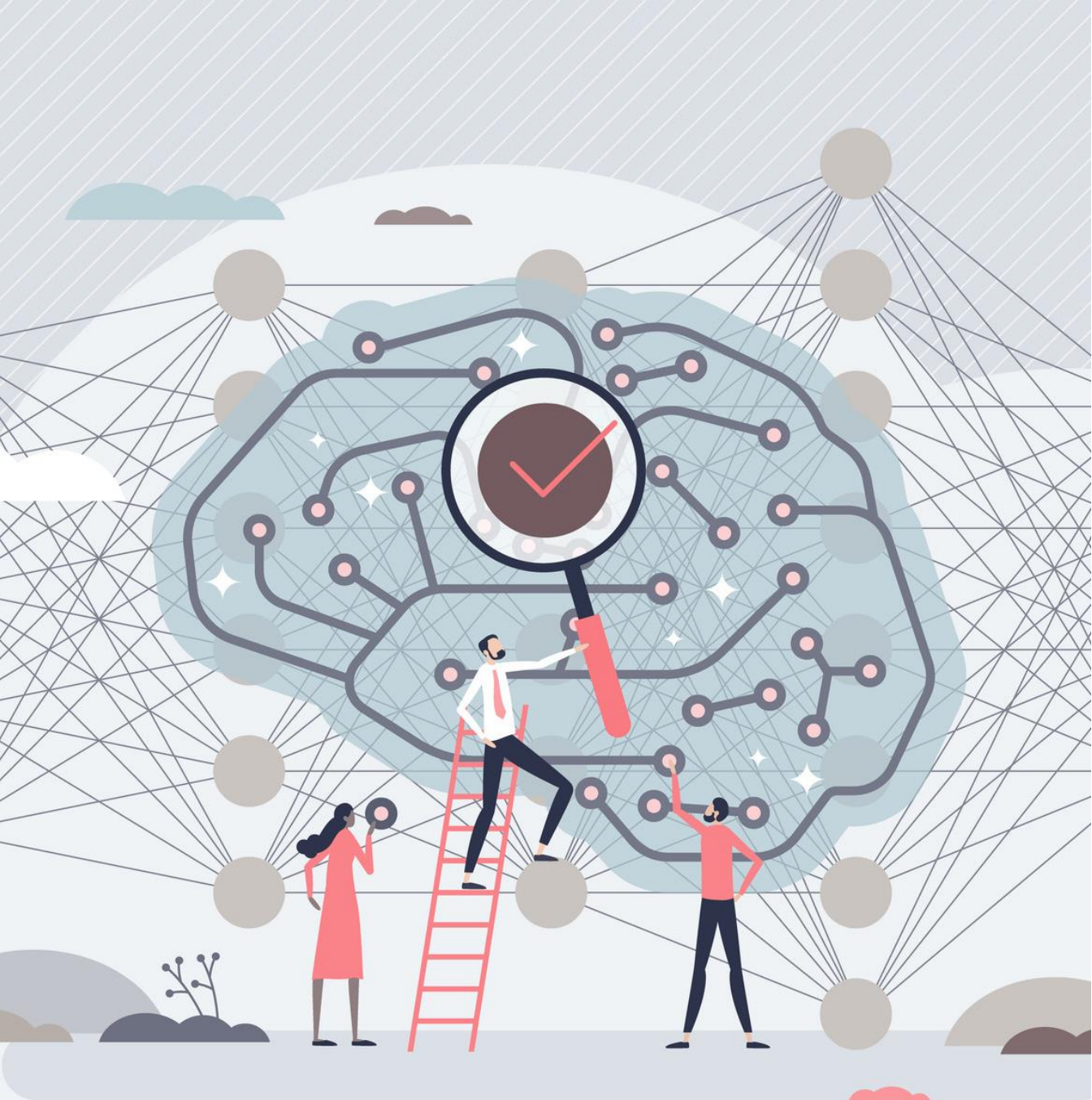
## BEHAVIORAL HAZARDS.



# 7

A person's fall risk is influenced by their unique lifestyle and behaviors. This includes the types of activities they engage in, the level of physical demand these activities require. For example, laundry is a normal daily activity for many people, but it can involve a great deal of exertion for a senior, especially if they transport a heavy laundry basket. Failing to modify behaviors can be a contributing factor for falls in older individuals.





# Risk Factors can be measured in Machine Learning algorithms

- These risk factors can be measured in Electronic Health Records
- Machine learning can identify and predict elderly with high risk of falls
- Type of Machine Learning: Classification
- Goal: Identify patients with high risk of fall



# Constructing Risk Factors

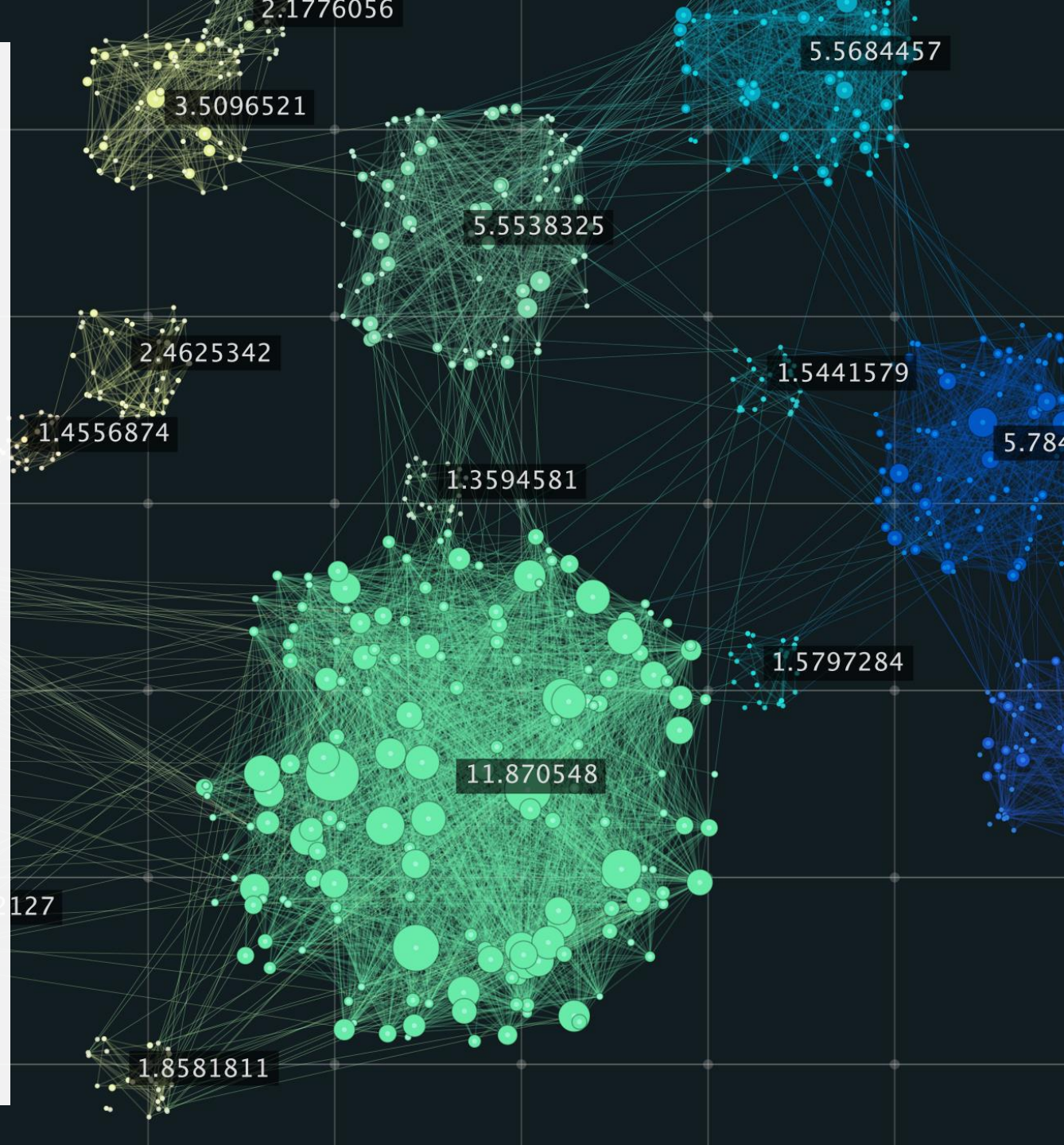
- A total of 24 Risk factors are vectorized
- Sex
- Race
- Diagnoses: Common Hypertension, Gait and Balance, Vertigo, Vision, Dizziness, Dementia, Depression, Alzheimer's, Parkinson's, Dystonia, Lack of Coordination, Cardiovascular disease, Hypotension, Macular Degeneration, Hearing Loss, Presbyopia, Diabetic Retinopathy, Alcohol Disorders.
- Medications: Antidepressants, Antidiabetic, Anti-Inflammatory, Cardiovascular Medications





# Applying Clustering Algorithms

- Before applying Machine Learning algorithm, a patient pre-clustering can discover a high-risk group of patients
- The unsupervised Clustering Algorithms can Improve Machine Learning prediction performances.

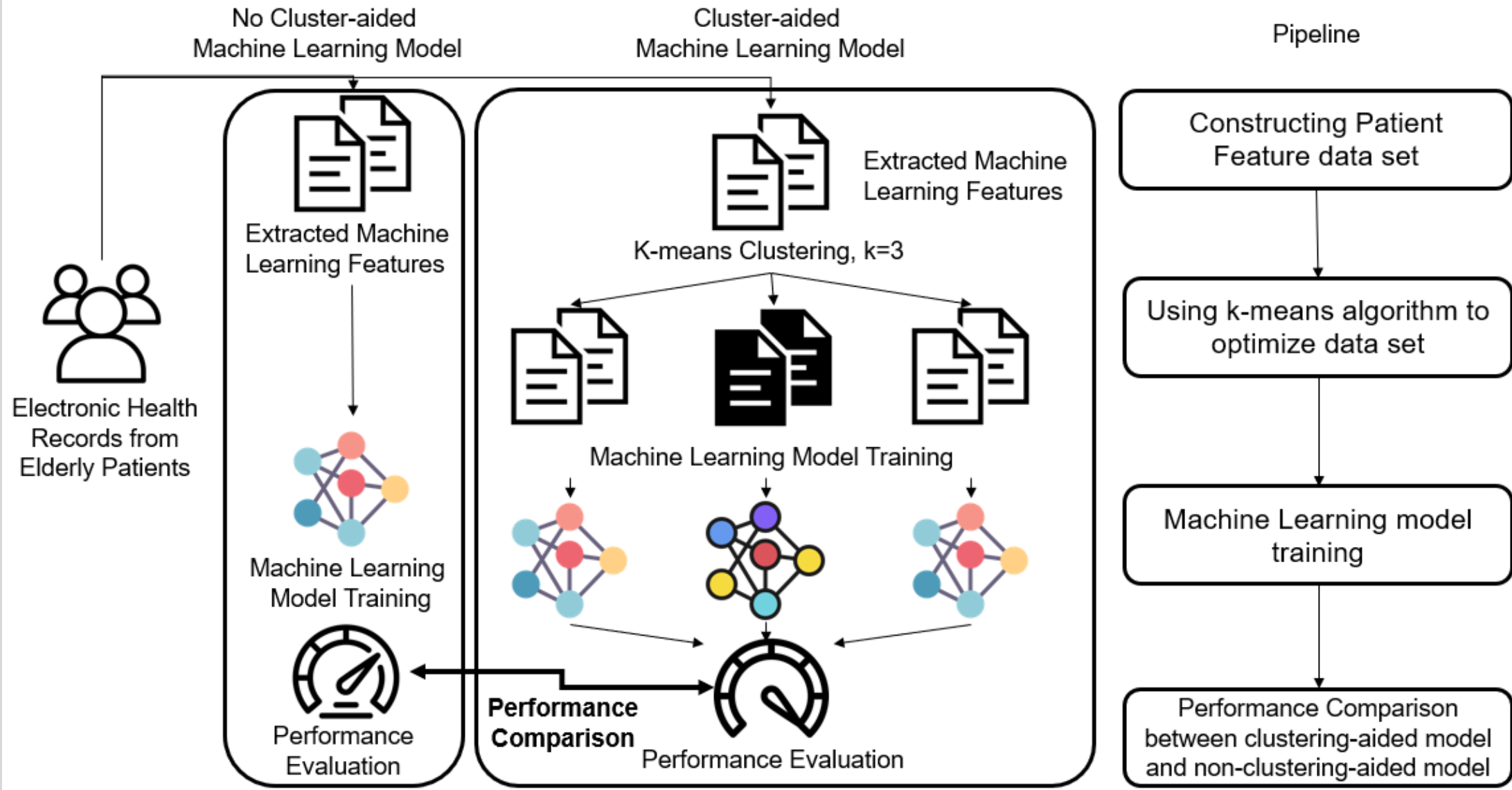




# High Risk of falls

- Unsupervised clustering algorithm clustered high risk of fall patents

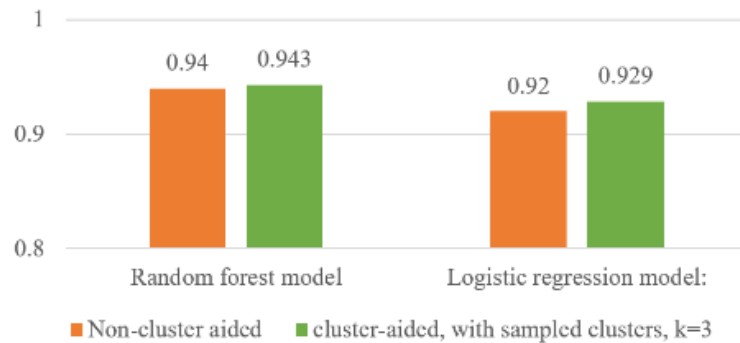
	Baseline Non-Clustered Count	Cluster 1, %	Cluster 2, %	Cluster 3, %
<b>Total # of Patients</b>	384,680	169,993	18,942	197,545
<b># of Fall Patients</b>	48,235	15,171	12,127	20,937
<b>% of Fall Patients</b>	12.5%	8.9%	64.0%	10.6%
<b>Median Age (Years)</b>	74.3	73.6	76.2	74.8
<b>Length of stay (Days)</b>	3.4	2.3	28.1	1.9
<b>Male</b>	177873	100.0%	41.9%	0%
<b>Female</b>	208552	0.0%	58.1%	100%
<b>White</b>	318397	82.6%	80.1%	82.4%
<b>Black</b>	37598	8.8%	17.3%	9.8%
<b>Asian</b>	4015	1.0%	0.6%	1.1%
<b>Other</b>	8318	2.2%	1.6%	2.1%
<b>Unknown</b>	16352	5.3%	0.4%	3.7%
<b>Hypertension</b>	198058	49.9%	94.1%	48.3%
<b>Gait and Balance</b>	40071	8.1%	56.3%	7.9%
<b>Vertigo</b>	9637	1.5%	12.5%	2.4%
<b>Vision</b>	35351	7.1%	38.6%	8.0%
<b>Dizziness</b>	46171	8.5%	55.3%	10.7%
<b>Dementia</b>	17530	3.2%	20.0%	4.2%
<b>Depression</b>	14020	1.9%	24.3%	3.1%
<b>Alzheimer's Disease</b>	8978	1.5%	8.3%	2.5%
<b>Parkinson's Disease</b>	6919	2.1%	5.7%	1.1%
<b>Dystonia</b>	2155	0.4%	3.2%	0.5%
<b>Lack of Coordination</b>	4675	0.9%	7.9%	0.8%
<b>Cardiovascular Disease</b>	46316	12.5%	40.8%	8.7%
<b>Hypotension</b>	34802	7.7%	49.6%	6.2%
<b>Macular Degeneration</b>	21662	4.1%	18.0%	5.7%
<b>Hearing Loss</b>	33753	8.2%	32.3%	6.9%
<b>Presbyopia</b>	24019	5.0%	20.2%	5.9%
<b>Diabetic Retinopathy</b>	6102	1.3%	9.2%	1.1%
<b>Alcohol Disorders</b>	8137	2.7%	8.2%	1.0%
<b>Antidepressants</b>	71991	13.1%	70.2%	18.4%
<b>Antidiabetic</b>	72415	19.0%	63.9%	14.2%
<b>Anti-Inflammatory</b>	91834	20.6%	68.6%	22.2%
<b>Med Cardiovascular</b>	18046	7.5%	18.6%	0.9%



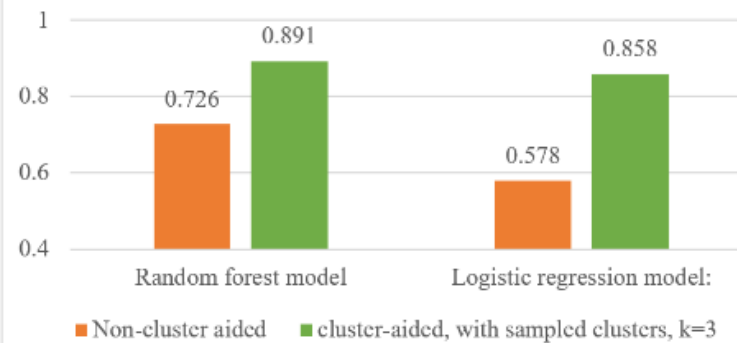


# Machine Learning Algorithm Performances

### Accuracy of Random forest and Logistic Regression models



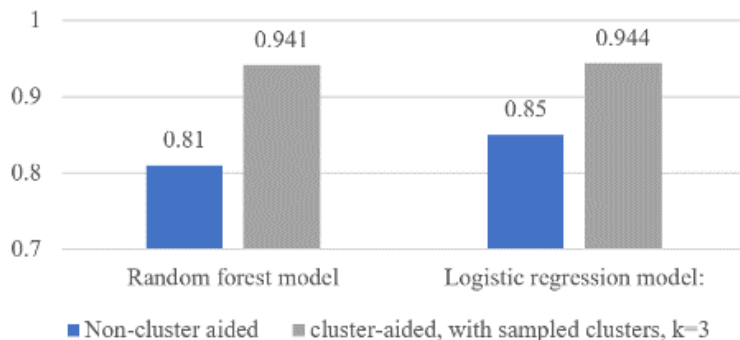
### F1 score of Random forest and Logistic Regression models



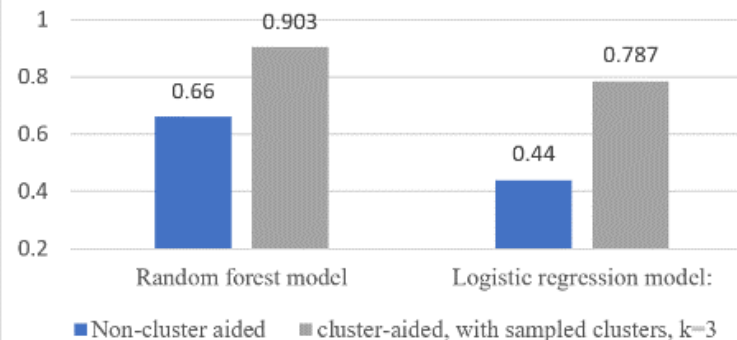
### AUROC of Random forest and Logistic Regression models



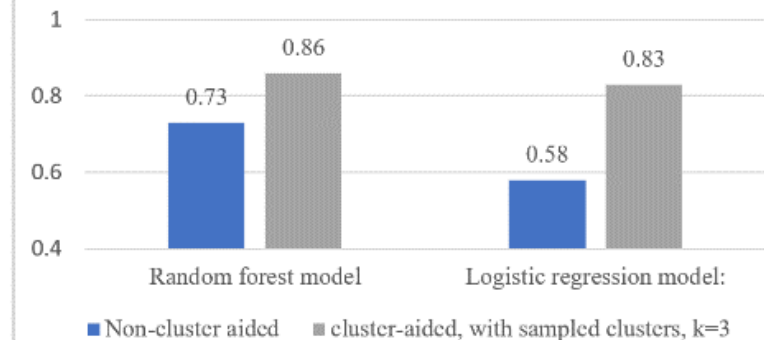
### Precision: Performance for predicting fall category patients



### Recall: Performance for predicting fall category patients



### F1-score: Performance for predicting fall category patients



# Discussion

- Risk factors could be used for decision-making model development.
- Machine Learning model successfully predicted a fall event.
- With pre-defined clusters, we can achieve a higher prediction performance in clustered high-risk group



# Conclusion

- Building a patient set in machine learning can lead to accurate fall diagnosis prediction.
- Our experiment combined unsupervised and supervised learning
- We demonstrated the significance of patient clustering.
- Specifically, we demonstrated that a clustering algorithm could identify patients who shared similar characteristics from clinical or demographic perspectives.
- The clustering resulted in a high-quality data set and supported the machine learning prediction of diagnosis.
- Thus, our approach provided more accurate predictions than non-clustering predictions.
- In a broader context, we believe that this study can be considered along with comparable machine learning healthcare problems.