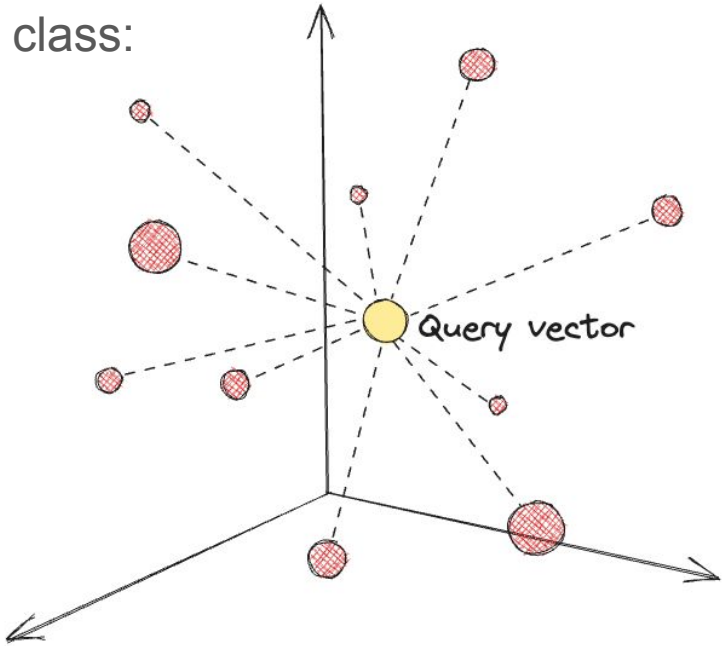
K-NN and A-NN

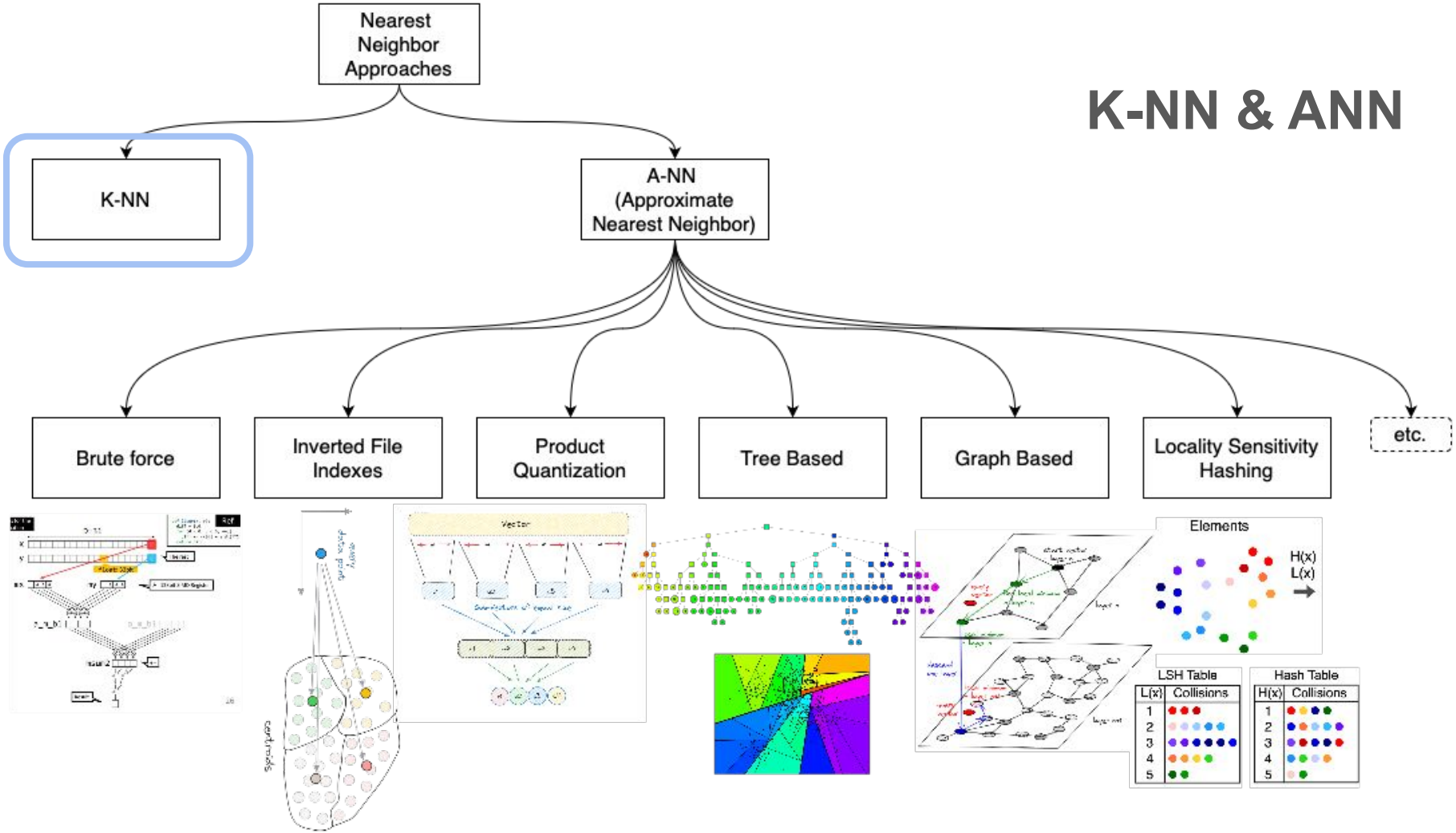
Characteristics, strengths and weaknesses

Vector Space Classification

- Documents as points in a vector-space
- Contiguity hypothesis
- Vector based classification methods from this class:
  - Rocchio
  - SVM
  - **K-NN**
  - **A-NN**

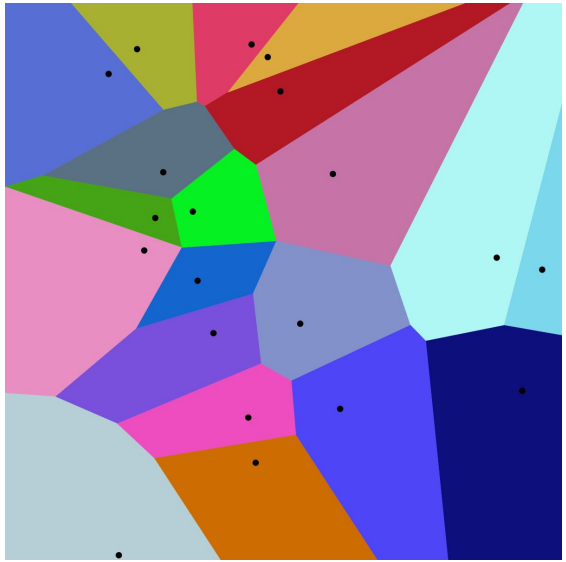


K-NN & ANN


Nearest Neighbor Approaches
K-NN
A-NN (Approximate Nearest Neighbor)
Brute force
Inverted File Indexes
Product Quantization
Tree Based
Graph Based
Locality Sensitivity Hashing
etc.
Vector
Elements
H(x)
L(x)
LSH Table
L(x)
Collisions
Hash Table
H(x)
Collisions

K-NN

- Documents as points in the vector space
- Measure the distance to each document
- Finding the K nearest
- Assigning a class



Voronoi

K-NN & ANN

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  - K-NN
  - A-NN (Approximate Nearest Neighbor)
    - Brute force
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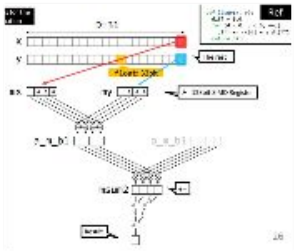
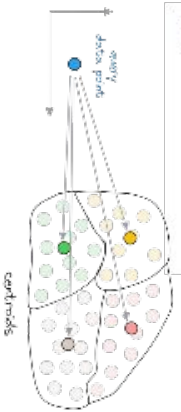
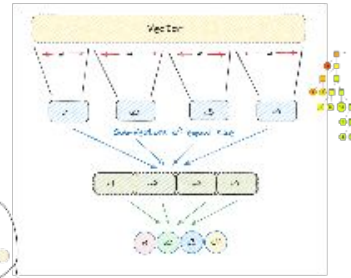
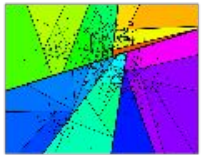
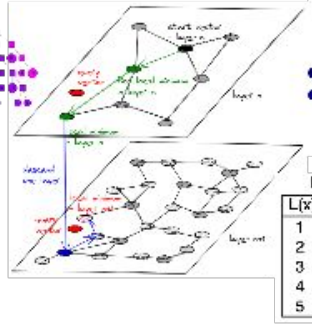
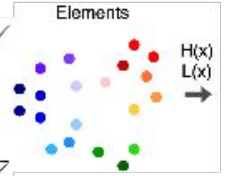


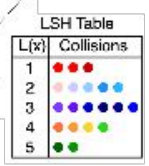


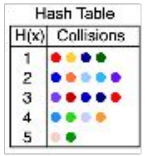












Approximate Nearest Neighbor

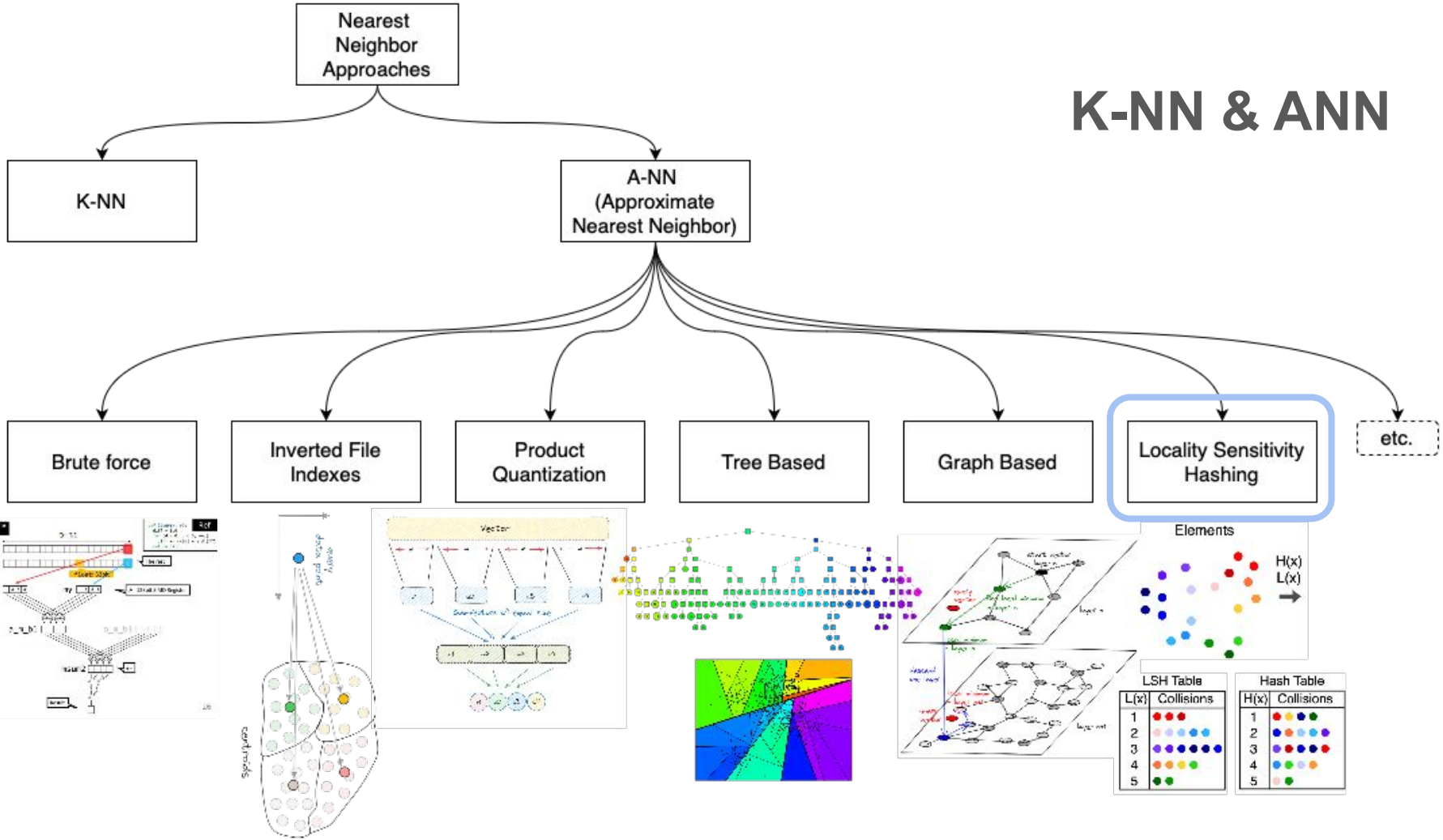
Speeding up KNN with approximation

- Multiple techniques for approximation
- ANN sacrifices accuracy for speed
- Efficient for large-scale similarity search

Idea:

Reduce the number of vectors/documents you have to compare your new document with.

K-NN & ANN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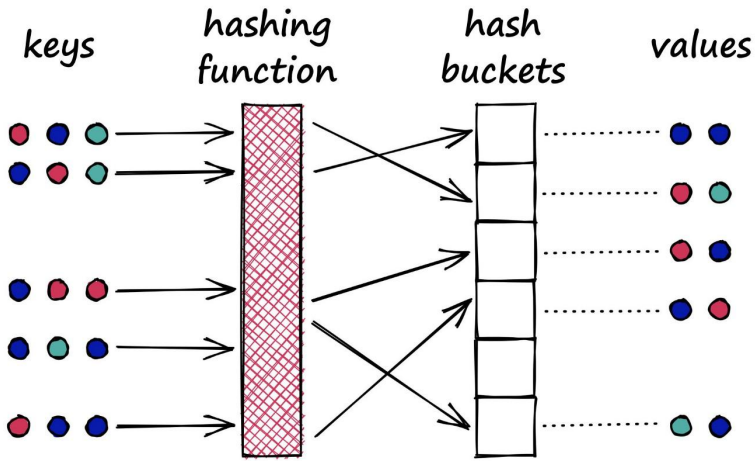
Locality-Sensitive Hashing

Pre-processing:

- All the documents in the collection are hashed into buckets.

Classification:

- Do the same with new document *d*.
- Only calculate the distance to the documents which are in the same buckets as *d* hashed to.



https://www.pinecone.io/learn/series/faiss/locality-sensitive-hashing/

Strength and weaknesses

K-NN

- Simple and easy to understand
- Interpretable (based on real observed data points)
- Accurate, but costly
- Do not scale

When precision is important

A-NN

- Often more complex and less interpretable
- Less accurate
- Scalable
- Adjust approximation method to your need
- Pros and cons with each approximation method

When efficiency is important

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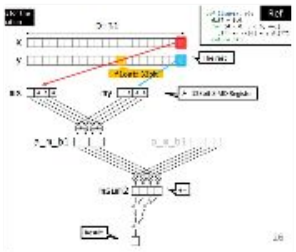

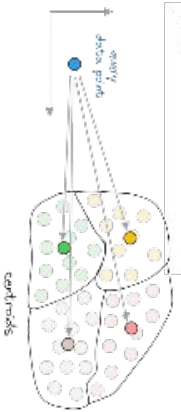

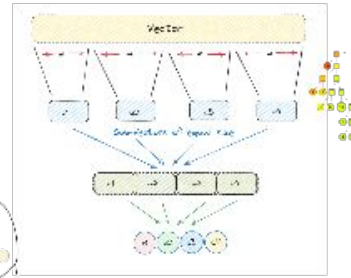

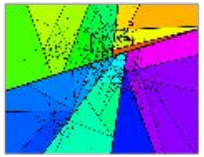

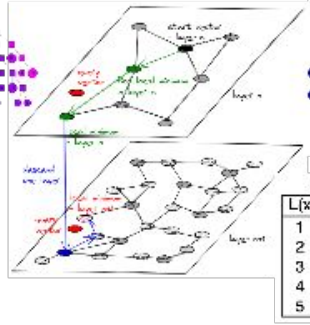

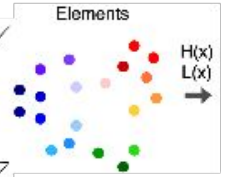

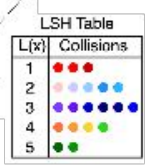

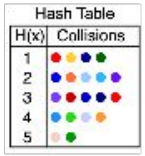

Sources

- https://www.elastic.co/blog/ann-vs-knn
- https://towardsdatascience.com/comprehensive-guide-to-approximate-nearest-neighbors-algorithms-8b94f057d6b6
- https://thedataquarry.com/posts/vector-db-3/
- Lecture slides on ANN and KNN