Using LLM Embeddings with Similarity Search for Botnet TLS Certificate Detection

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PROBLEM

- Botnets commonly use TLS to connect with C&C servers.
- Features of TLS certificates could indicate being used by botnet activity.
- Can LLM embeddings of certificates be used for botnet detection?

TLS Fields

TLS Certificate used by AsyncRAT C&C

TLS Certificate used by a Benign Website

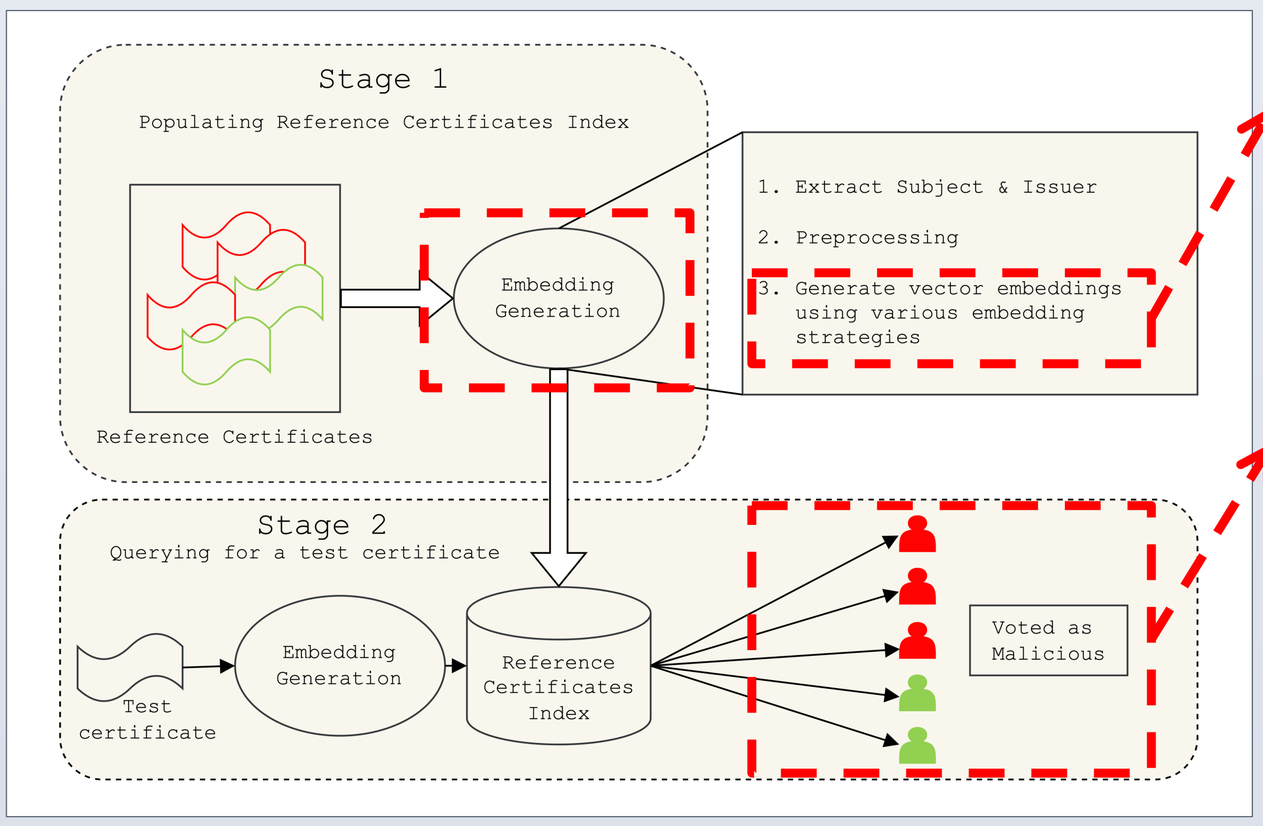
Name	Country	Organization	Organization Unit	Location	State	Email
192.236.160.249	mn	xxxyz	zaaaab	sttuvwww	noopqrrrrs	ccdde@192.236.160.249
www.agl.com.au	AU	AGL Energy Limited	NA	Docklands	Victoria	NA

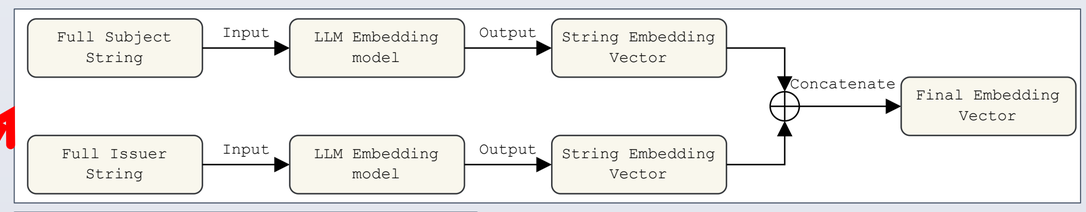
OUR CONTRIBUTION

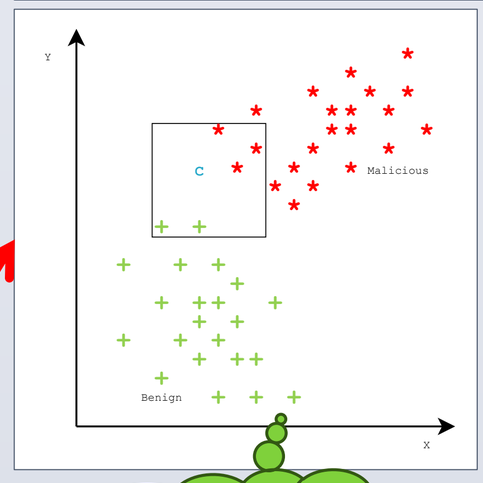
Ablation Study: Rigorous comparison of multiple proprietary and open-source LLM embedding models and selecting the best parameters and strategies.

Real World Validation: Model was evaluated over 150,000 real world certificates collected from Jan – May 2024 from Rapid7's Sonar data

RESEARCH METHODOLOGY







Majority Vote

- Lightweight and scalable
- Uses kNN and majority voting for decision making.

RESULTS

Ablation Study

Conducted ablation study to select the embedding strategy, k, and embedding model

k: 1, **5**, 10, 15, 20

Distance Metric: **COSINE**, EUCLIDEAN, Dot product, MANHATTAN

Embedding Model: **OpenAI**, BERT, Cohere, VoyageAI, Titan, Titan 2, **Character- BERT**

100-fold reduction in human effort

Real World Evaluation

- Our model flagged 13 malicious certificates out of 150,000 where 1 was confirmed malicious by VirusTotal.
- A random selection of 1,300 certs found none.

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