

LDA Classifier For Packet Status Prediction In A Wireless Star Network Topology

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Problem Context

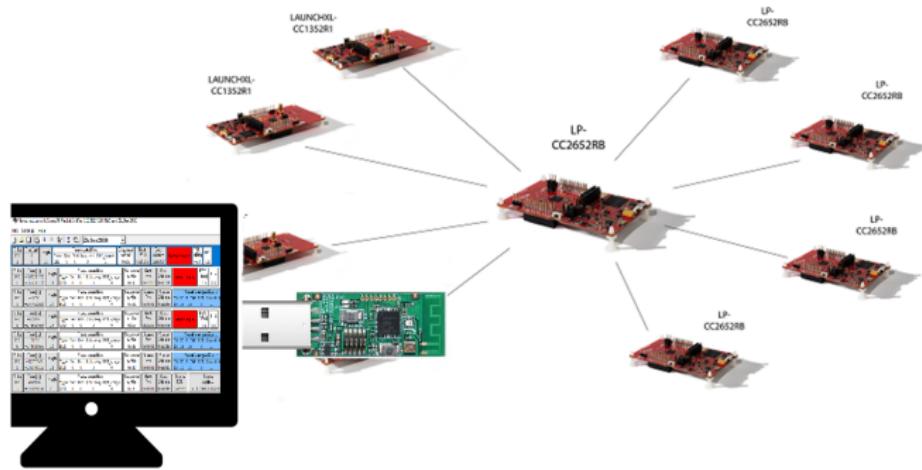
- Packet loss describes lost packets of data not reaching their destination after being transmitted across a network.
- Organizations no longer work from a **fixed address**, or rely on a **wired connection** to keep the lines of communication open.
- Packet loss will generally **reduce the speed or throughput** of a given connection due to **recovery mechanisms** implemented, which involve **re-sending packets altogether**. Sometimes this can result in a **loss or reduction in quality** to applications.
- Packet loss sits in the trio **the major network performance complications: latency, jitter and packet loss**.



Data Collection: Hardware

The first step in the study was to determine **how to collect data on packets across a wireless network using Wireless Protocol IEEE 802.15.4**, in order to analyze what factors influence and how to predict if a packet would be arrive OK or with Error:

- Sensor Node: Texas Instruments CC13x
- Collector Node: Texas Instruments CC26x
- Sniffer: CC2531 USB Dongle



Data Collection: Experimentation

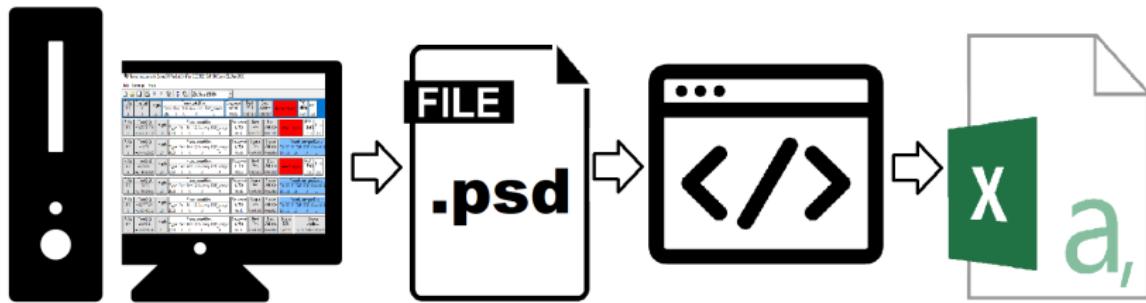
Over the course of three days we performed **7 Controlled-Environment Tests** that each exposed the installed network to different conditions over **1 hour of duration**:

- ① Control Test 1: No interference whatsoever.
- ② Control Test 2: No interference whatsoever.
- ③ Double Network Test: An additional star network apart from tested network.
- ④ Radiofrequencies Test: Microwave, Air Fryer, Blender, Toaster and a Sandwich Maker.
- ⑤ No restriction Test: People in the house living normally around the network.
- ⑥ Wind Test: Two Fans blowing air across the space.
- ⑦ Wireless Test: A SmartTV, 3 cellphones, a game console (PlayStation 4), 2 laptops, all downloading content from wifi network.



Data Collection: Building The Dataset

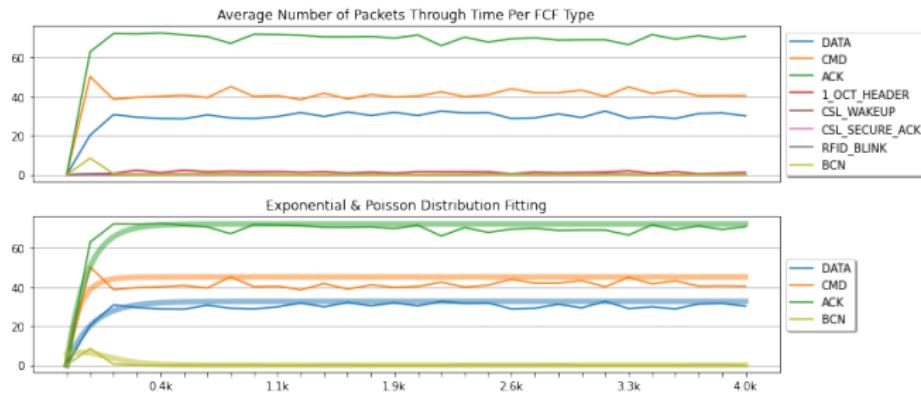
After each experiment, we stored using the Sniffer Software a **.psd file**, which is Texas Instruments' file format for Packet Sniffer Data.



We coded a program that reads the **.psd** files **byte-wise** and converts those 0's and 1's into the **overall packet info dataset with 33k rows and 24 columns**.

Data Analysis: Our First Date

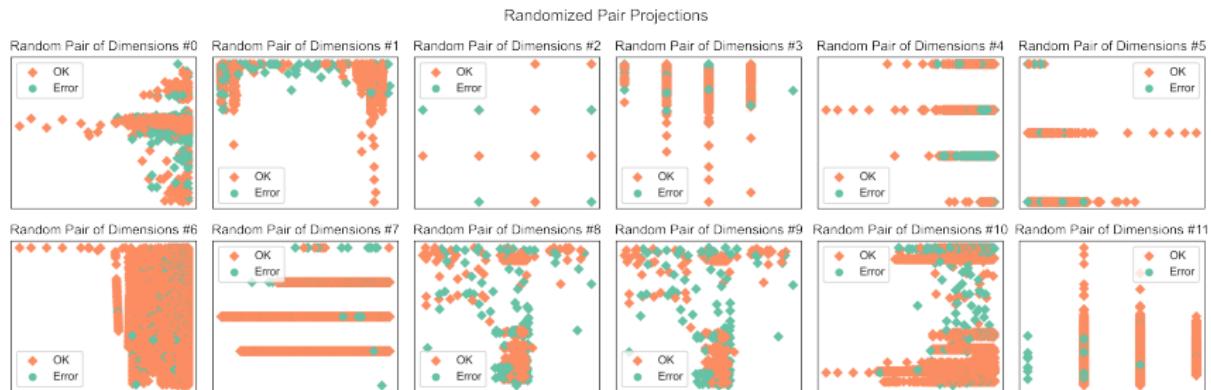
The next step was to get to know our dataset: for this, we performed **parametric distribution fitting**, since the packet arrival behaviour showed **Poisson and Exponential Distributions**.



with $f(x) = 1 - e^{-\frac{1}{120}x}$, $f(x) = 1 - e^{-\frac{1}{75}x}$, $f(x) = 1 - e^{-\frac{1}{150}x}$ and $f(x) = \frac{1.15^x}{x!} e^{-1.15}$

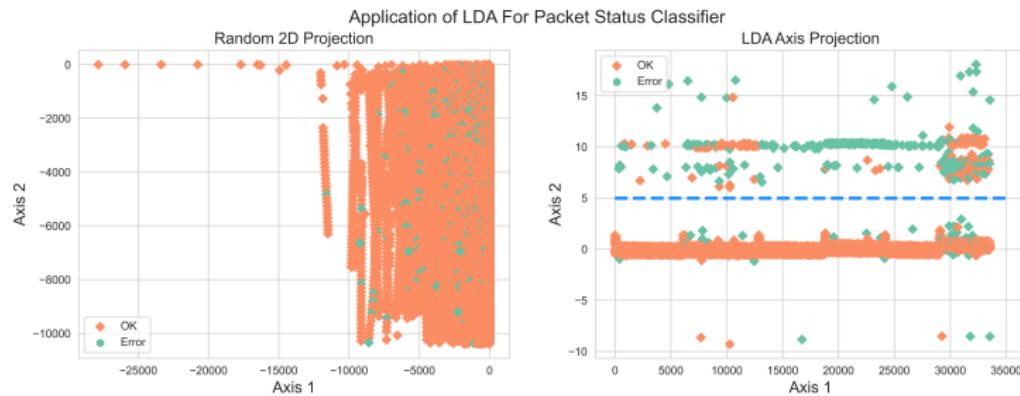
LDA: Projections

LDA seemed as the best option since the dataset had multiple columns, and the pairplot of each of the combinations of features did not show a separable data relationship with the Packet Status column (class):



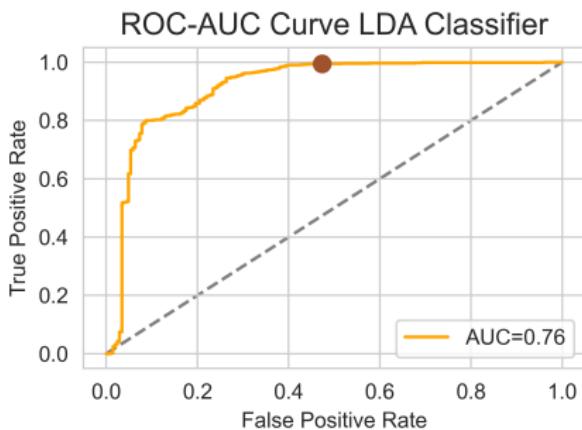
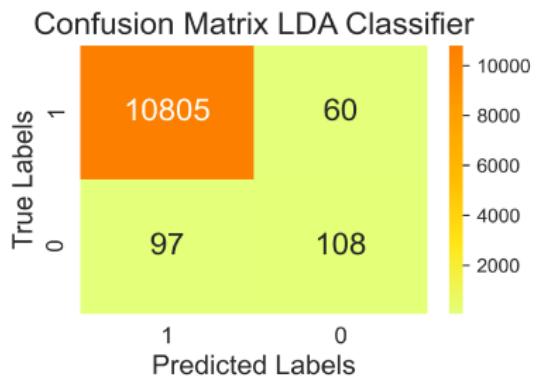
LDA: Results

After performing LDA for dimension reduction into **one eigenvalue**, since we had two classes, the model found an axis from where the classification could be possible:



Performance: Confusion Matrix, ROC-AUC Curve

To evaluate the classifier that was created using Linear Discriminant Analysis, we computed the Confusion Matrix. **The amount of Packets with class 1 (OK) and 0 (Err) was equal**, and thus the matrix shows a **high TPR** and **almost mid-valued FPR**, which became the ROC curve with an **AUC = 0.76**, suggesting the classifier is moderately accurate.



Conclusions

- Hypothesis:
There exists a condition or a set of conditions in a network's environment that, when present, cause packet loss.
- The AUC = 0.76 shows a prominent suggestion that there exists in fact a relationship between the *combination of columns* and the prediction of a packet status, like it was stated in the hypothesis.

Thank you!



References

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