Modeling Performance with CGMs Using Device Specifications

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Dexcom® CONTINUOUS GLUCOSE MONITORING

Background & Introduction

For patients struggling with diabetes, Continuous Glucose Monitors (CGMs) provide them with regular updates on their glucose levels. This critical information is sent via Bluetooth from the CGM to the patient's smart device.

Some devices may not communicate well with the CGMs: messages may be lost in transmission or only received after a long delay.

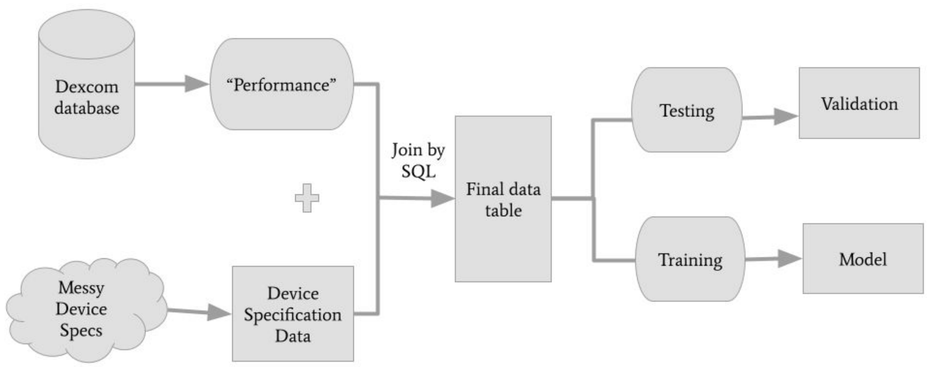
Dexcom must test smart devices with their CGMs and reject devices with insufficient communication performance, as well as rejecting all untested devices.

Dexcom wants to use **device specifications** to **predict** whether smart devices will have **sufficiently high performance** with their CGMs.

Data Pre-Processing

Our data processing involved the following steps, as outlined in the flowchart:

1. Web-scrape and clean device specifications data from GSMArena
2. Extract device performance data from Dexcom's internal database
3. Join the two datasets into a final data table for modeling and prediction
4. Split the data into two groups: training (for modelling) and testing (for measuring model performance)



Feature selection:
There are many device specifications available but not all of them are useful for predicting device performance with CGMs. To avoid overfitting and for efficiency, we only kept the important features which we expect to relate to device communication.

Important device specifications are shown below:

Platform	Memory	Comms	Battery	Tests
• OS • Chipset • CPU • GPU	• Internal	• WLAN • Bluetooth • NFC • Radio	• Type	• Battery Life

Methods

To understand how device specifications relate to performance, we created one regression model for each performance measure.

Performance Measures:
- Packet Capture Rate: proportion of messages sent from CGM that are received by device (range 0-1)
- Long Gaps per Day: count of great delays in message reception per day (a great delay is a delay of more than 60 min)

A good performing device would have packet capture rate ≥ 0.9 and long gaps per day ≤ 0.5.

Techniques:
- Beta regression: Appropriate to model the packet capture rate because it is strictly in the range of 0 to 1.
- Linear regression: Appropriate for modelling long gaps per day since it can be any positive value.

Analysis & Results

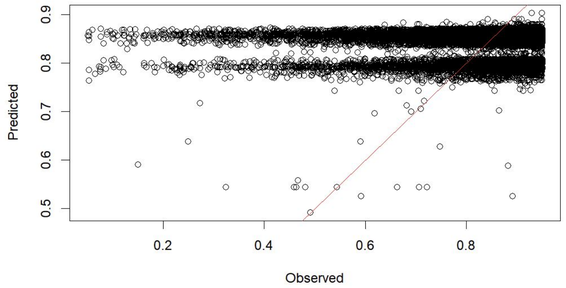
Packet Capture Rate (PCR)

Confounding variables include OS version, app version, hardware version, and battery optimization.

After controlling all the confounding variables, important device specifications to predict packet capture rate include WLAN, battery type, GPU, chipset type, and minimal CPU speed.

Lower Packet Capture Rate (Bad)	Higher Packet Capture Rate (Good)
• WLAN Wi-Fi 802.11 • Battery type Li-Po (vs. Li-Ion) • Chipset = new Kirin	• GPU = newPowerVR • Higher minimum CPU speed

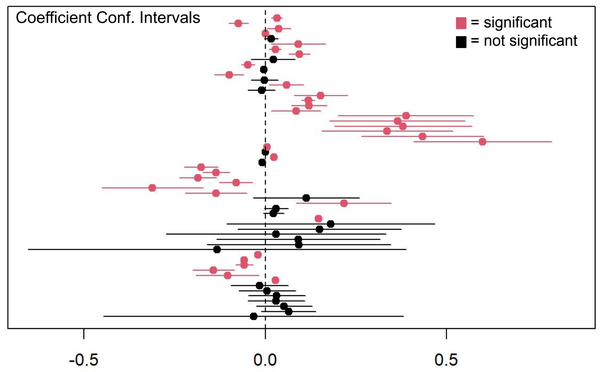
PCR Prediction vs. PCR Observation



We see that predicted PCR tends to be higher than observed values. Prediction accuracy remains lower than ideal, likely due to roughness of the specification data.

Long Gaps Per Day

Of 59 predictors used in the linear regression, 36 were statistically significant based on 95% confidence intervals.



More Long Gaps per Day (Bad)	Less Long Gaps per Day (Good)
• No radio capability • NFC capability • Chipset = Exynos • GPU = Adreno • Higher RAM • Larger chipset size	• Higher bluetooth version • aptX HD (Bluetooth codec) • GPU = Mali • Lower battery capacity

Above are the device specifications which had significant coefficients.

Notably, we see device performance distinguished by presence of certain features, and by the companies designing/manufacturing certain parts of the device.

Conclusions

Overall, we find that **certain device specifications** are **significantly correlated** with **performance** in communication with CGMs.

Though our findings are limited by various imperfections in the device specification data, these findings provide a proof-of-concept for the use of (licensed, clean & structured) device specifications in the prediction of smart device performance.
This has the capability to either better guide Dexcom in selecting new devices worth testing, or ultimately remove the necessity of lab-testing new smart devices entirely. Either would have great implications in cost-savings and better serving patients.