Carnegie Mellon University

Heinz College

INFORMATION SYSTEMS • PUBLIC POLICY • MANAGEMENT

Improving User Engagement using ML

One Touch Reveal, LifeScan

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Agenda

Research Phase: LifeScan goals, Diabetes and User behaviors

Discovery Phase: Data Analysis and Findings

Ideation Phase: Potential Solutions

Implementation Phase: Fleshing out ideas, Aligning on Deliverables

Next Steps: Risks, Mitigations and Plan Ahead

LifeScan, Inc.

Introduction and our support team

LifeScan, Inc.

Leading blood glucose monitoring company in the U.S.

OneTouch® brand products are recommended by more endocrinologists and primary care physicians than any other brand

Globally, more than 10 million people depend on OneTouch® brand products to manage their diabetes

LifeScan, Inc. Team

Neelima

Staff Test Engineer

Manasa

Data Science and Reporting Analyst

Michael

Head, Digital Product Development & Innovation

Research Phase

Diabetes and User behaviors

Diabetes

Diabetes is a metabolism disease resulting in high blood glucose levels due to lack of insulin production or resistance to insulin produced.

It is controllable if patients learn to manage the disease well.

Normal range: 70 - 140 mg/dl for adults

Types - Type 1, **Type 2**, Gestational

Treatment of Diabetes

Tools and skills to live healthy with diabetes.

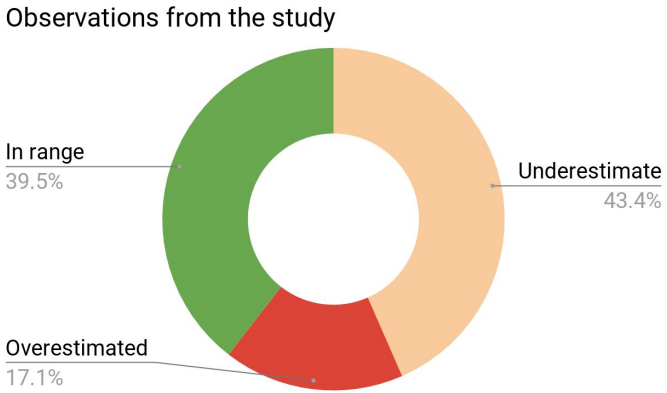
1. **Monitoring Blood Glucose 2-4 times per day**
2. Nutritional Changes
3. Exercise
4. Medications (insulin or pills)

Guessing blood sugars does not work well

In 2005, the British Journal of General Practice published a study entitled, "**Estimation of blood glucose levels by people with diabetes: a cross-sectional study.**" The study took place in one general practice in Oxfordshire, United Kingdom.

The study concluded that the majority of people could not accurately guess, and therefore testing with a glucometer is needed.

CAN ONE TOUCH REVEAL APP BE IMPROVED AS SMBG (Self monitoring blood glucose) TOOL?

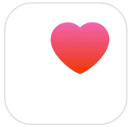


Source: Study from The Diabetes Council

Discovery Phase

Data Analysis and Findings

Overview of Dataset

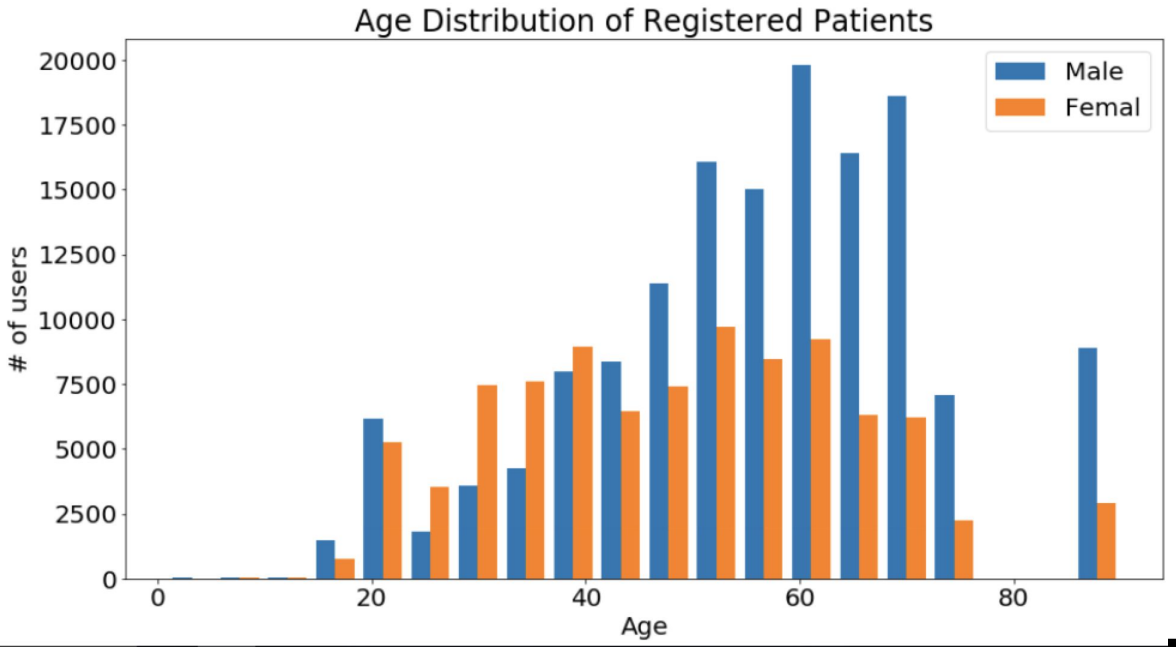


Primary Data Source: OneTouch reveal mobile app

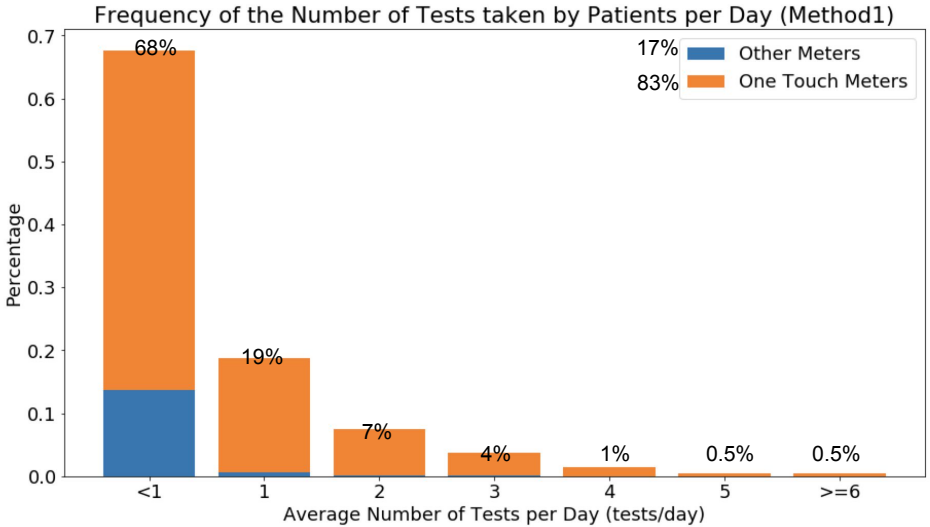
Dataset	Date	Processed Result
BG Logs	2018/01/01-2018/08/31	• 122,213 Users • 20,844,195 bg logs • Around 170 bg logs per user
Food Logs	2018/01/01-2018/08/31	• 12,543 Users • 1,061,394 food logs • Around 84 food logs per user • 1 out of 10 patients who has a reading also has food logs (Approximate)
Users	All Time	• 239,582 Users (Excluding NA and 0)

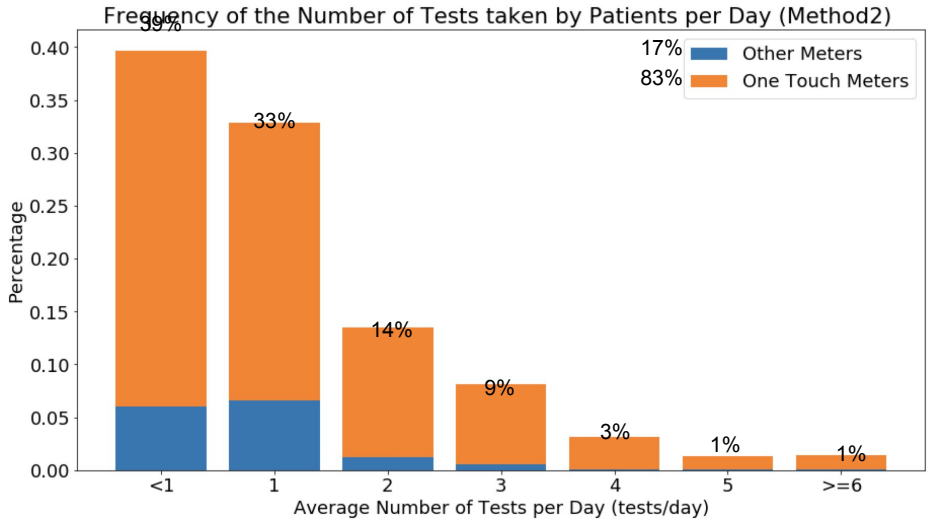
Patients Profile - Age & Gender

Gender	Number of Patients	
F	92,570	39%
M	147,012	61%
Total	239,582	100%



Patients Profile - Number of Tests Taken by Patients

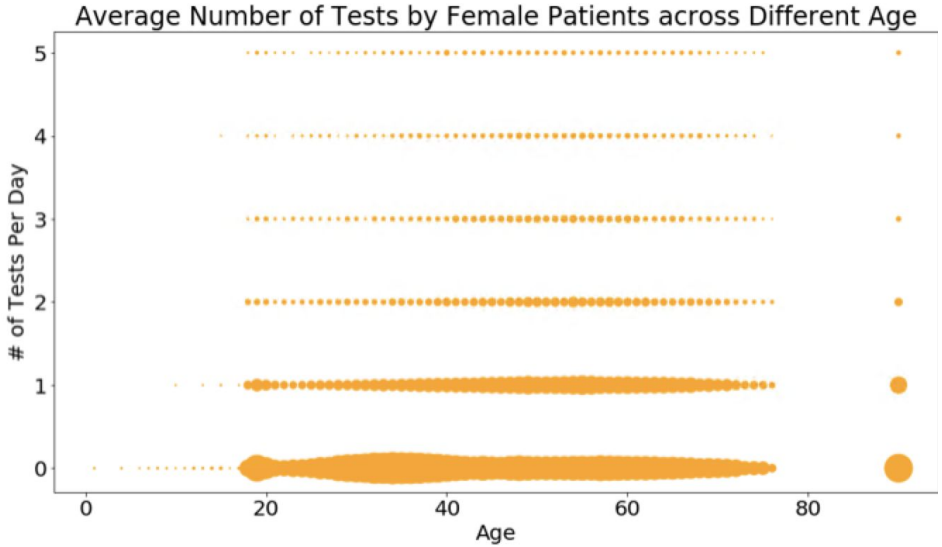


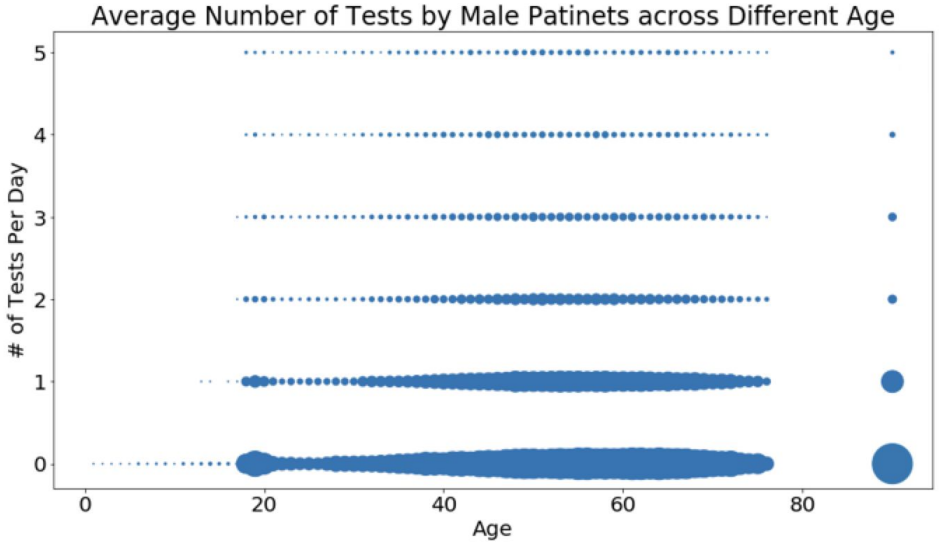


- Method 1 Calculation:
  Total Tests / days elapsed between
  (Aug 31st - 1st day of taking test)

- Method 2 Calculation:
  Total Tests / days elapsed between
  (Last day of taking test - 1st day of taking test)

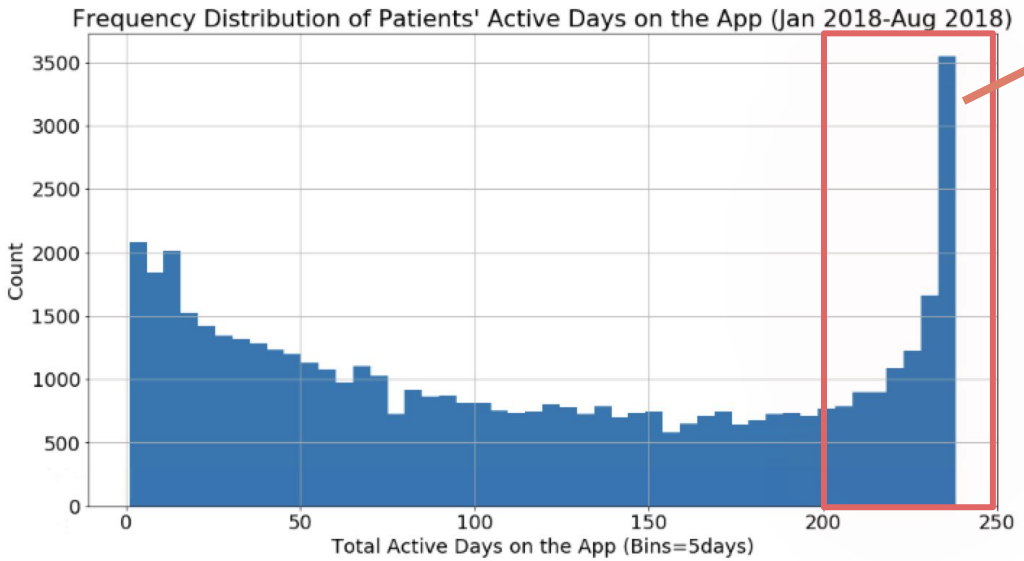
Patients Profile - Gender vs Age vs Number of Tests per Day





- # of Tests Per day uses Method 2 Calculation
- Heavy concentration in the middle age group
- Patients between 40-70 years old take readings more frequently

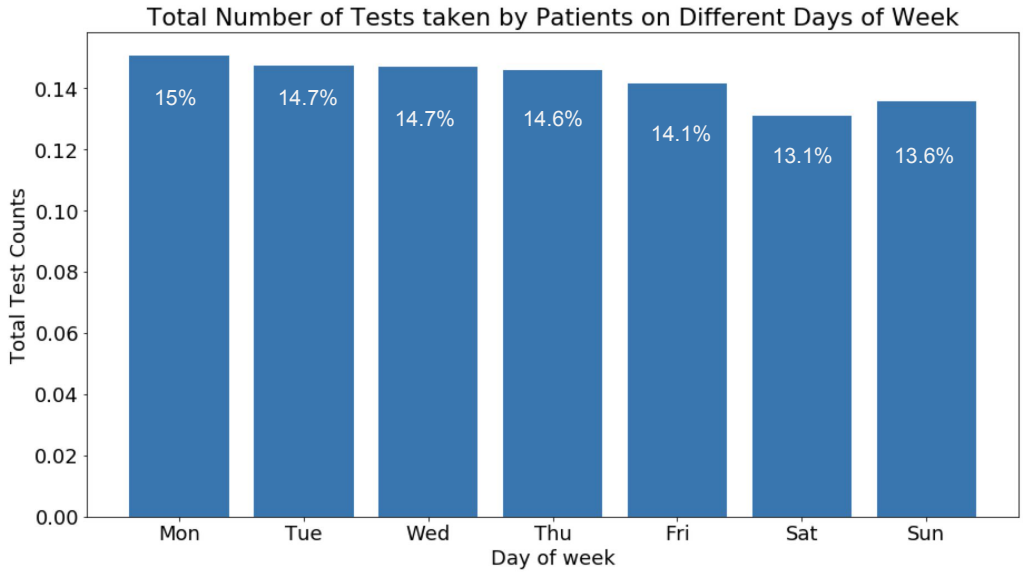
Patients Profile: Patient Active Days Distribution



21% of very engaging users

- **Dataset:** Limited to the patients who had their first test reading on Jan 1st - Jan 10th
- **Definition of "Active":** Have taken >= 1 test on that day
- **Interpretation of graph:** Count drops as total active days increase while total active days <=200

Patients Profile: Total Test Counts v.s Day of Week



- **Graph Interpretation:**

  Number of tests taken on weekends are slightly less than number of tests taken on weekends, but not significant (Aggregate Level).

Key Takeaways

1. **User Engagement** - Patients taking tests **>3 times a day remain minor (<5%)**
2. **Age Group** - Patients between **40 to 70 years old** take more tests per day
3. **Pareto Rule** - Around 21 % of the patients taken tests on 80% of the days
4. **User Behavior** - Number of tests depends on lifestyles and stress levels

Ideation Phase

Potential Solutions

Increasing User Engagement

01	**Improve userflows & UI of the app**	• Make the existing design of the *patterns tab on the app* more intuitive for the users • Involve changing the design, and userflows of the app
02	**Build a comprehensive pattern engine**	• Add new rules to the existing pattern tabs on the app basis diabetes clinician research • Add **finer and relevant** details to the existing patterns.
03	**Provide actionable insights**	• Use **Machine learning for personalized** blood glucose, exercise, and food pattern recognition • Provide **timely updates/notifications**

Implementation Phase

Deliverables

Solution 1 : ML Preview

ML Task 1: Identify Individual User's Usual Test Time During the Day

Purpose: Send reminding notification to user around usual test time ⟹ Improved User Engagement

Possible Tools & ML Techniques: R + Python + K-Means Clustering

ML Task 2: Construct Individual Level Daily Blood Glucose Model

Purpose: Help users to understand the bg characteristics + predictive suggestions ⟹ ML-based Features

Possible Tools & ML Techniques: R + Python + Periodic Modeling

Solution 2 : Gamification

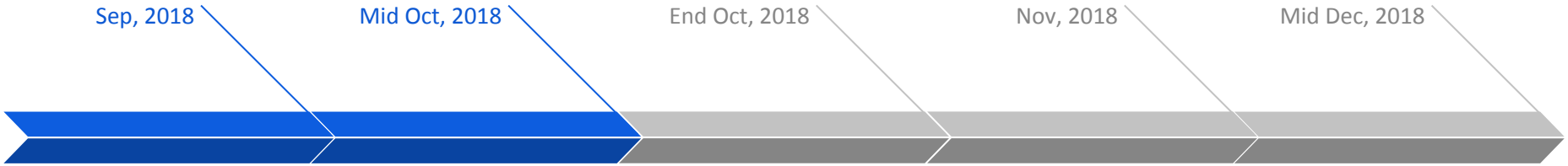
A critical tool to keep users engaged and continuing to use the product

	Business & User Perspective	Implementation
Strategy	Age demographics (40-70 yrs)	Character selection
	Unlocking creative rewards	Smart reminders
	Inside out approach	Empower notification engine

Next Steps

Plan Ahead, Risks, and Mitigations

Plan Ahead



Research & Discovery

Understanding patients, diabetes disease and user habits

Scoping

Dovetailed business needs with user needs

Rudimentary modelling

Design & experiment machine learning techniques and models to best serve objectives

Algorithm refining

Iteratively improving the algorithm to get the optimal accuracy with unseen data

Final deliverables

Smooth transitioning to the team at Lifescan

Risks	Mitigations
Need to evaluate bias vs variance tradeoff	Decision at the time of modeling
Ineffectiveness to capture noise in the data	Noise cancellation techniques
Not capturing seasonality effect	Model can be improved by removing it later
Notification engine not catering to individuals	Notifications based on the user's engagement
Too many notifications might irk the users	Put threshold on the number of notifications

QUESTIONS

Appendix

User Pain Point - Sync issues

While most users are really happy with the way OTR is helping them track BG levels, some have expressed anger in trying to connect with app. Our concern is if syncing issues persist, the user might not be able to log the BG reading despite of the intent generated through a timely notification.

NEGATIVE REVIEWS -

Christine Higgins, says (September 8, 2018)
"App disconnected my meter and won't let me pair it, ***keeps crashing."***

Ashly Brown, says (October 9, 2018)
*"Had the app for over a week now. Everytime I've attempted to pair my meter the app stops responding and shuts down! Haven't got to use it because it "****not responding everytime!"***

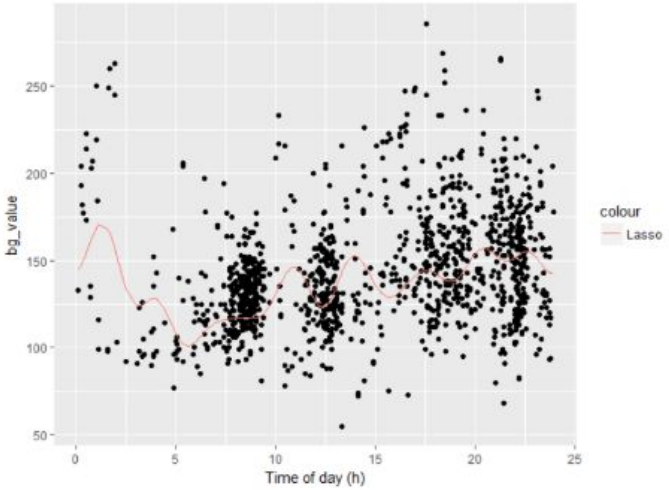
ML Preview

Building individual user level daily blood glucose model

Inspiration: capture periodic trend of blood glucose reading

Purpose: build model with user's historic reading data, to predict e.g:

-
- For specific time period, I would like to know if my reading tends to rise or drop
- If I exercise for x amount of time, what would be my likely bg reading
- ……..



ML technique envisioned:

Step 1: building time-based model

- 1-dimensional Fourier Transformation (Basis Expansion) + cross validate linear regression + regularization (1 dimensional: time and blood glucose value)

Step 2: building upon the time-based model

- Multidimensional Fourier Transformation (incorporate other factors such as nutrition intake, insulin intake, exercise etc.)

Tools: R, Python...