AI Implementations @ TeknoVe

Delivering an ML/AI Strategy, AI for Business Leaders, Udacity

Jorge Thomas, August - 2022

Executive Summary

Purpose of Project

- Thoroughly learn a framework and a methodology to assess AI implementations in real business projects.
- Business automation and creation of value thinking about customers' experience.

Methodology

- Analysis conducted over three (03) weeks
- Five (05) potential use cases underwent thorough assessment for feasibility and impact!
- Incorporated both technical knowledge and user feedback from different professional environments!

Path Forward

- Two (02) use cases identified for implementation
- Needs and requirements to be successful plus evaluation of risk and feasability
- Next steps

I started with five use case ideas

1: Facial Recognition for UX

2: Engine Live Monitoring

3: Demand Prediction for Inventory Optimisation

4: Demand Side Management for Charging with Renewable Electricity

5: Reliability Engineering for Heavy Machinery

I started with five use case ideas*

1: Facial Recognition for UX
-> Easy architecture and reliable data with high impact and momentum

2: Engine Live Monitoring
-> Cumbersome implementation and huge IT requirements. Maybe with more experience.

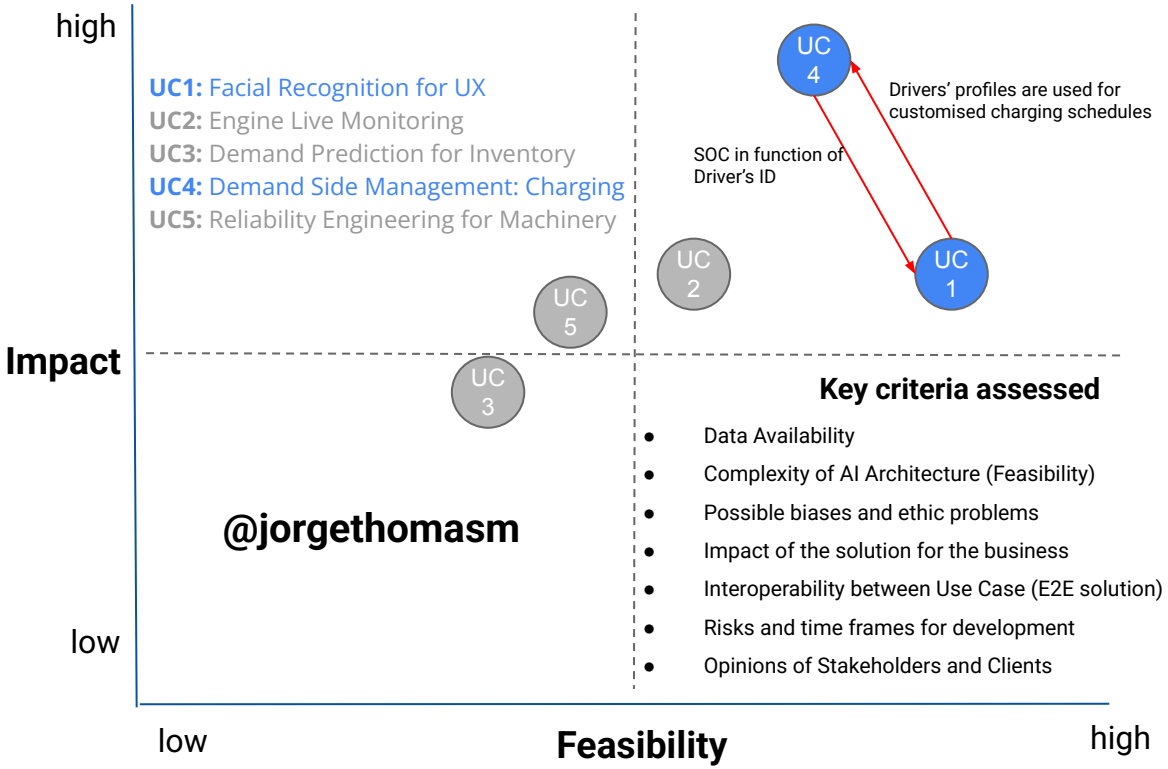
3: Demand Prediction for Inventory Optimisation
-> Study (see attached excel file) determined a low impact and unreliable data.

4: Demand Side Management for Charging with Renewable Electricity
-> Huge potential and impact for TeknoVe's image and diversification. Very Feasible.

5: Reliability Engineering for Heavy Machinery
-> Really hard to get parameters to model digital twins of the machinery. These are all from third parties.

*** Details in Analysis (4A) and Feedback (6A)**

I assessed **feasibility** vs. **impact** for all cases



Transforming our business using ML/AI with these top two use cases

Facial Recognition for UX

TeknoVe has long been exploring different ways to **personalize a rider's experience**. With the advent of **facial recognition**, the company has been exploring potential uses of the technology both inside and outside the car. One thought is to tie **keyless ignition** and auto-unlock to facial recognition.

There is even **potential to control** heating, lighting, and entertainment based on emotional queues.

…The added feature will further TeknoVe's "image" as a cutting edge technology company first and an automobile manufacturer second.

Demand Side Management for Charging with Renewable Electricity

TeknoVe considers sustainability core to their mission.
Much of the electricity used to power the company's cars is produced through **burning fossil fuels**. In many locations, more renewable forms of electricity are available at off-peak hours.

The corporate responsibility organization has suggested launching a **new charging product** that uses **predictive and optimization models** to charge vehicles only at select times where the electric grid has lower demand, a process known as demand response.

The company knows it can build the product!

By executing on these two projects I believe we can start transforming the image of our business by implementing cutting edge AI and become a Data-Driven company in today's new knowledge economy.

Facial Recognition for UX - Deep Dive

Process Today

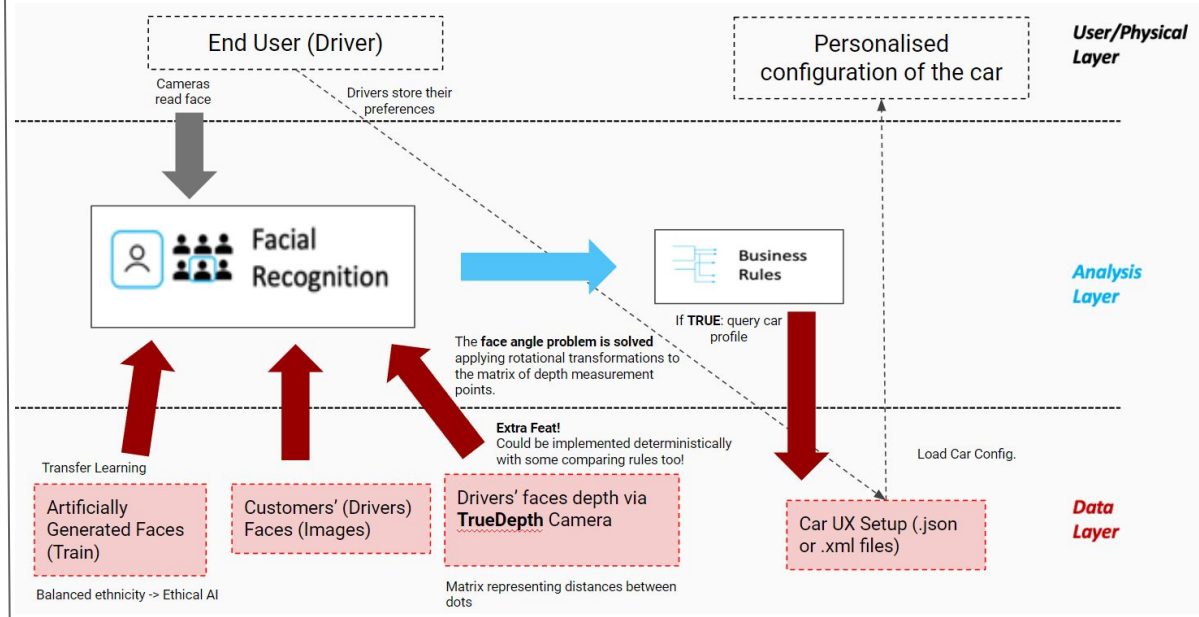
- The same for a century
- UX is adjusted manually
- Lack of flexibility
- Car keys are still around

Process Tomorrow

- Cars turn into PCs with wheels
- UX profile automatic loaded
- More flexibility
- No more keys!
- Cars will be safer!

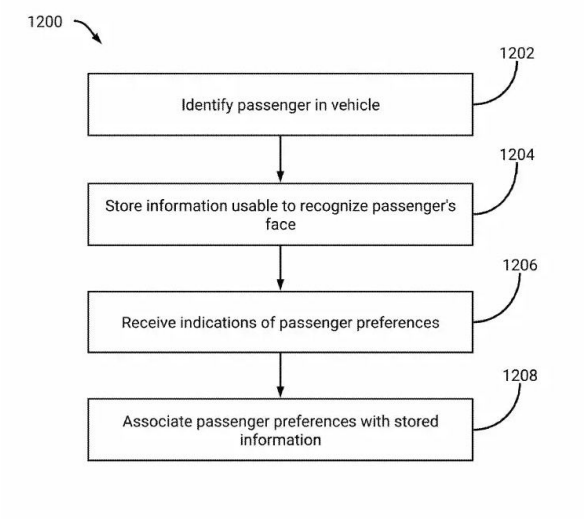
The impact of Facial Recognition for UX will be huge thanks to current advancement in training data for faces!

Example Architecture



Facial Recognition for UX - Deep Dive

In 2021, the **competition** filed a patent with similar purposes:
https://www.notateslaapp.com/software-updates/upcoming-features/id/500/tesla-to-use-face-recognition-to-offer-new-driver-and-passenger-profiles



Our first step will be to examine this patent with detail!

The use of new Artificial Faces will give us an edge:

Figure 1. We render training images of faces with unprecedented realism and diversity. The first example above is shown along with 3D geometry and accompanying labels for machine learning.

Reference:
Wood et al."Fake it till you make it: face analysis in the wild using synthetic data alone", Microsoft (2021)
https://arxiv.org/pdf/2109.15102.pdf

Demand Side Management for Charging with Renewable Electricity - Deep Dive

Process Today

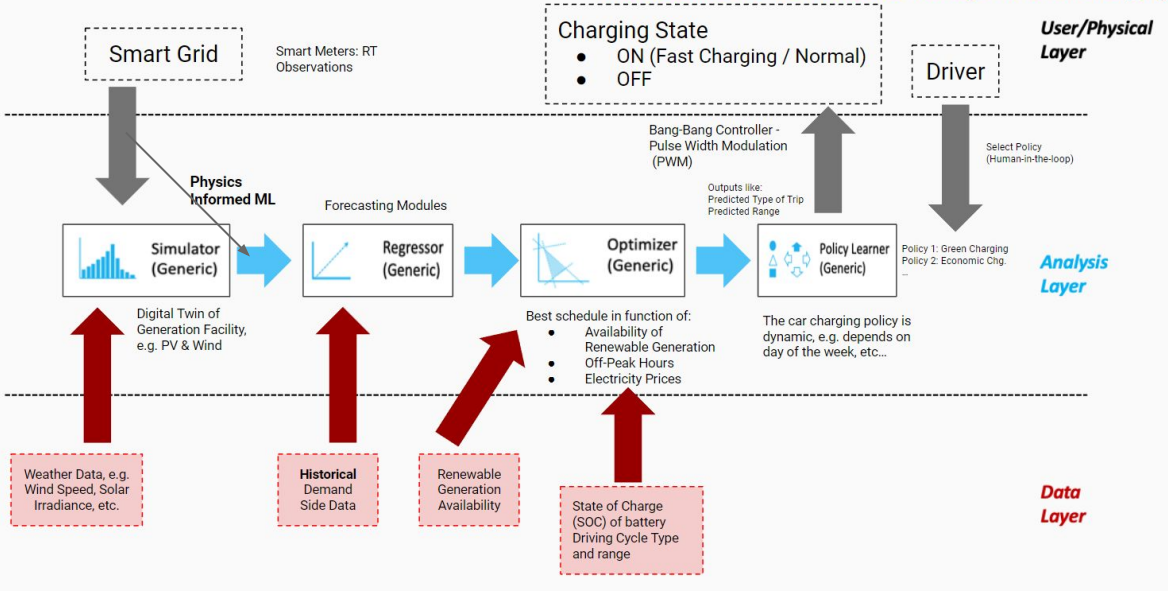
- Cars are off-grid
- No data collected
- Energy management is all about driving styles
- No more alternatives to reduce CO2 emissions

Process Tomorrow

- Cars are part of the IoT
- Data are collected and improved (cleaned, transformed)
- Different Energy Policies to charge the car will result in higher flexibility
- New product will diversify TeknoVe's offer

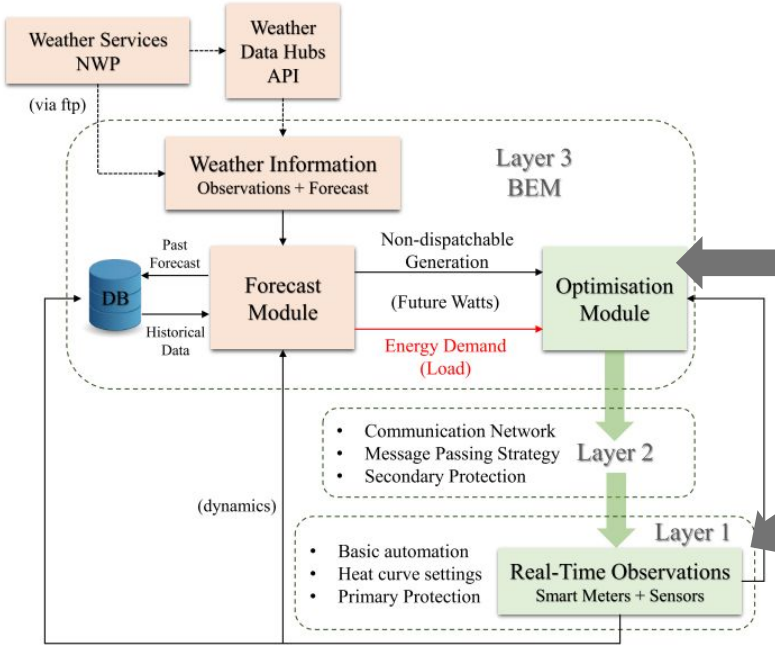
The impact of this UC will be essential to keep going in this business thanks to diversification and the climate awareness of TeknoVe!

Example Architecture



Demand Side Management for Charging with Renewable Electricity - Deep Dive

Given my years of experience in the area of Energy Informatics, **I will be the Product Owner** of this Use Case.
Here, I present a data strategy from the control engineering point of view of an Energy Manager:



We can adapt the code that I developed in R and C# to get the forecast module ready ASAP!

MPC (Model predictive control)

Hardware Layer: New Charger and Vehicle

Reference:
Thomas, J. "Prediction of Heat Demand for Building Energy Managers: An IoT and Control Perspective", Fraunhofer IOSB (2020)

Risks/Mitigations

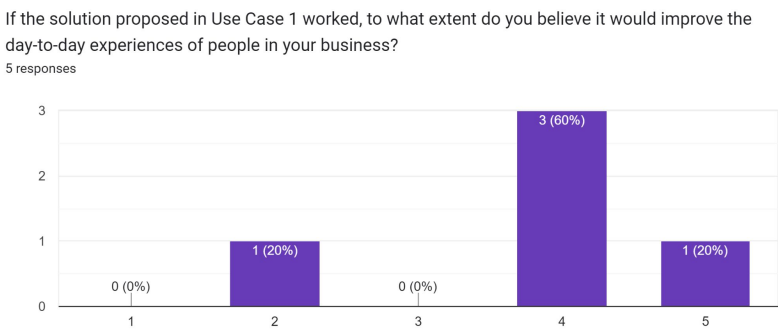
	UC: Facial Recognition for UX	UC: E-Charging with Renewables
Accuracy	**Concern**: Problem with face angle. **Plan**: Use matrix transformations to “rotate” the face before the input of the NN.	**Concerns**: Model drifting due to: aging, different drivers, etc. **Plan**: link with the Facial Recognition UX algorithm for driving cycle recognition. (**Use Case Sinergy!**) Heavy weights on latest data, e.g.: exponential smoothing strategy.
Underfitting/Overfitting	**Concern**: get an optimal Bias / Variance trade-off. **Plan**: with millions of faces, try different Face Recognition algorithms and with hyperparameter optimisation achieve an optimal trade-off.	**Concerns**: Overfitted regression to produce the time series forecasts. **Plan**: get the right cross-validation strategy that involve the inherent daily seasonality of the problem.
Ethical Concerns	**Concern**: car won’t start for clients from an ethnic minority. **Plan**: generate artificial faces with rich and balanced diversity of ethnicity for training the algorithms.	**Concerns**: Target this new product to premium vehicles only. **Plan**: Design a transferable solution for future vehicles in the lower tier.

– Feedback Thus Far: Facial Recognition for UX

"The use case maximises comfort, minimising hassle. For example, **forgotten car keys**." - Retired Lawyer (Facial Recognitions for UX)

"Today, **it's a no brainer** to implement this technology in cars." - Supply Chain Analyst (Facial Recognitions for UX)

"This **facilitates sharing** the car with other members of the family..." - Chemical Engineer (Facial Recognitions for UX)



Proposed Next Steps

- **Start with Facial Recognition for UX** use case to gain momentum!
- Search for patents to study.
- Establish the IT, human capital and cloud service requirements.

Proposed Timeline

Month 1 to 6

- Secure Hardware Supply Chain for both UCs
- Hire human capital and missing human resources!
- Start training existing algorithms for the Faces for UX

Month 6 to 9

- Data Engineering up and running (Hardware, sensors, protocols)
- Hyperparameters optimisation and tweaking

Month 9 to 12

- Prototype car model with new face features.

– Feedback Thus Far
Smart EV Charger

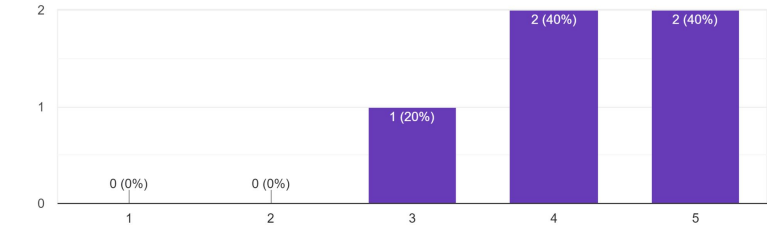
"Having a **new product** in stock will diversify the company's offer. Today doing something for climate change is mandatory."
- Supply Chain Analyst

"**Li-Ion batteries are expensive** to produce, extending their life span and using more renewable energy to charge the vehicle will contribute with the planet" - Chemical Engineer

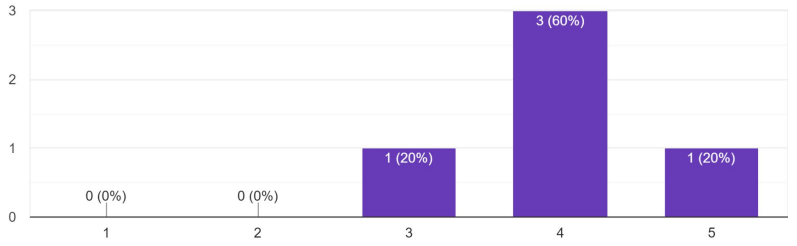
"The potential to **consume more of renewable energy** whenever possible." - Research Associate

"Having a **new product** in stock will diversify the company's offer. Today **doing something for climate change is mandatory.**" - Supply Chain Analyst (Intelligent EV Charger)

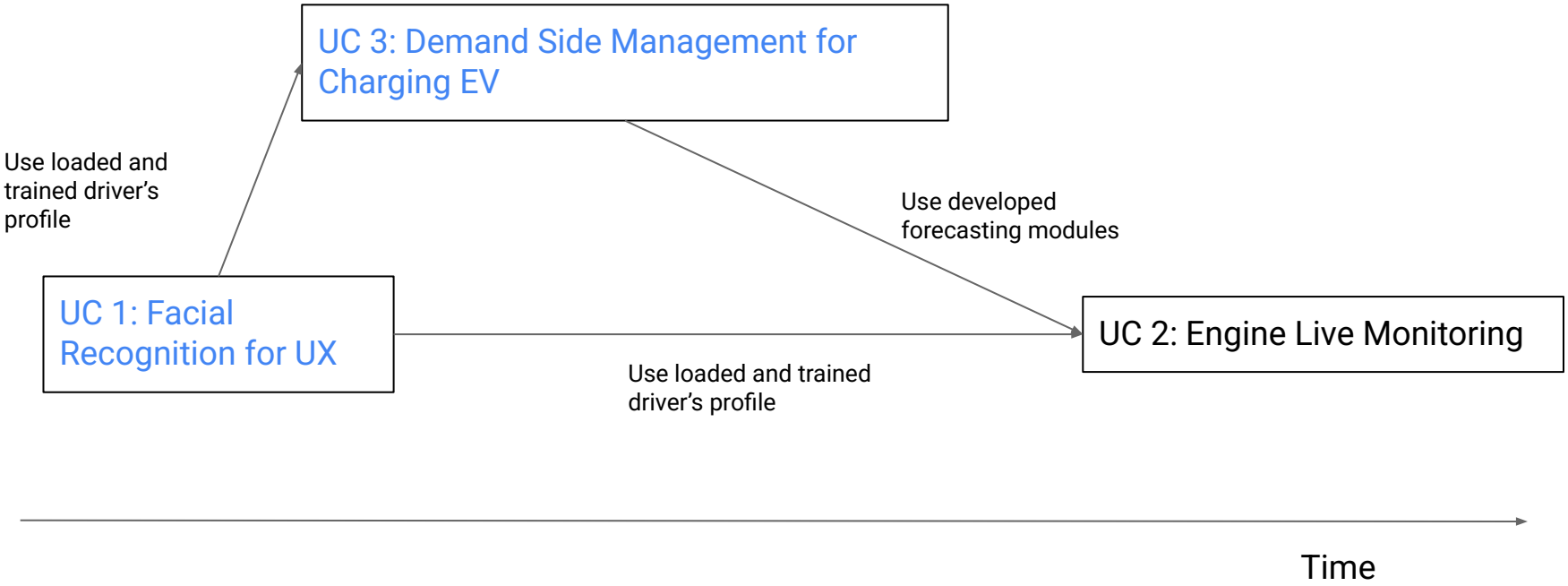
If the solution proposed in Use Case 3 worked, to what extent do you believe it would create business value (e.g., increase revenue or reduce costs) for people in your business?
5 responses



If the solution proposed in Use Case 3 worked, to what extent do you believe it would improve the day-to-day experiences of people in your business?
5 responses



AI Roadmap


UC 3: Demand Side Management for Charging EV
Use loaded and trained driver's profile
Use developed forecasting modules
UC 1: Facial Recognition for UX
UC 2: Engine Live Monitoring
Use loaded and trained driver's profile
Time