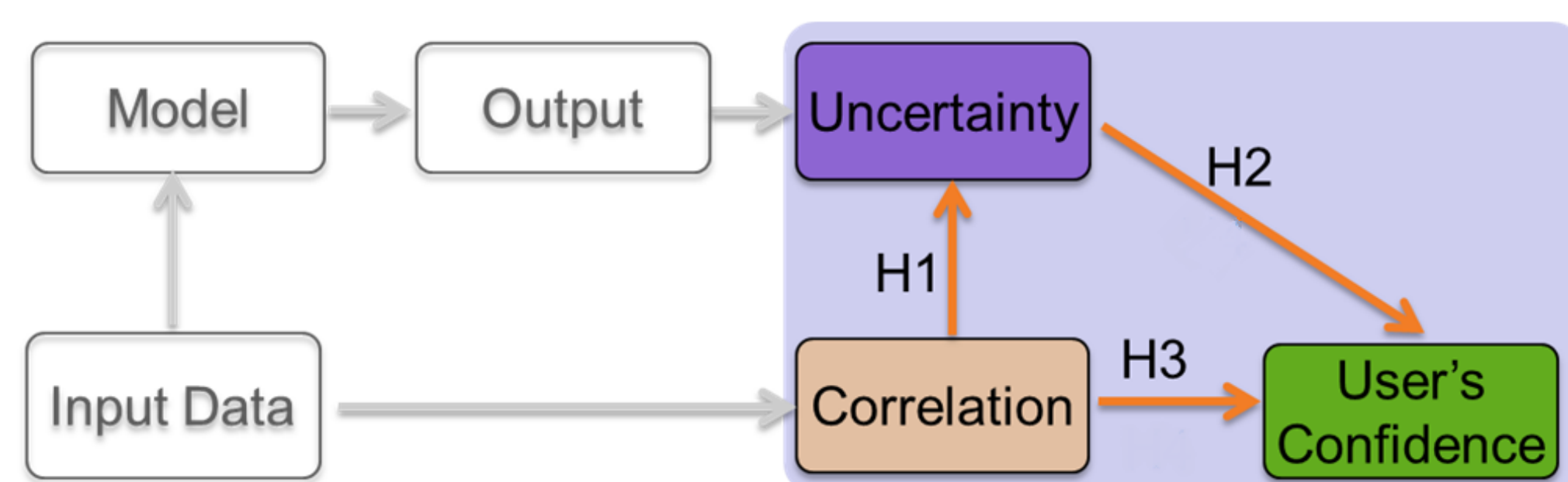


## The Problem

The aim of the study is to investigate effects of uncertainty and correlation on **user's confidence** in machine learning (ML) based **decision making** in order to develop effective user interface in ML-based intelligent systems.

## Opportunities

The ML-based data analysis is widely used in decision making in various intelligent system. Investigating on this topic could help develop more effective user interface for ML-based intelligent systems



## Hypotheses

- H1** Correlation positively affects the understanding of model output uncertainty
- H2** Uncertainty is the most important factor for user's decision and confidence in ML-based decision making
- H3** When correlation is provided and uncertainty is not, users are less confident in model output and in their decision

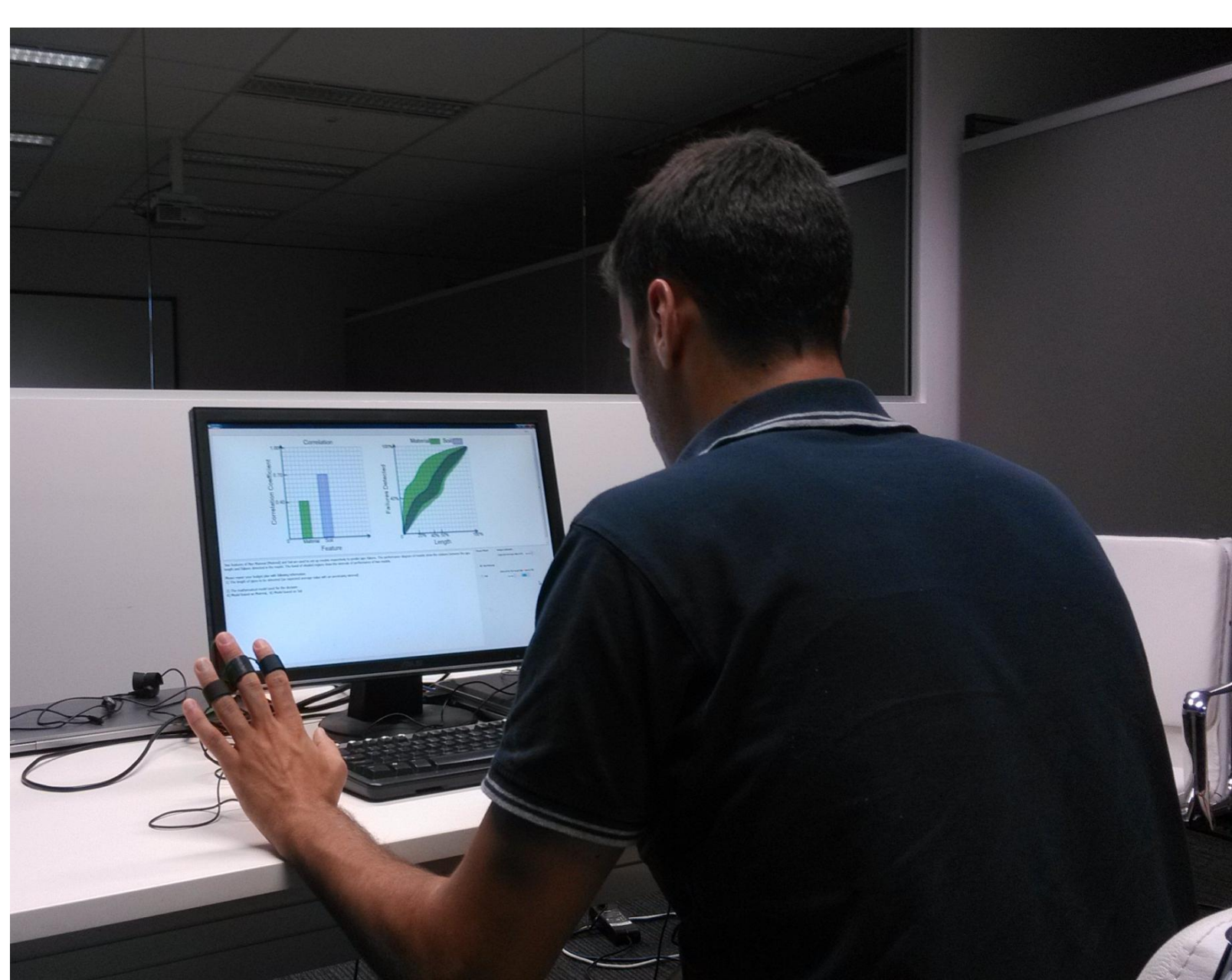


Figure 1 Experiment setup

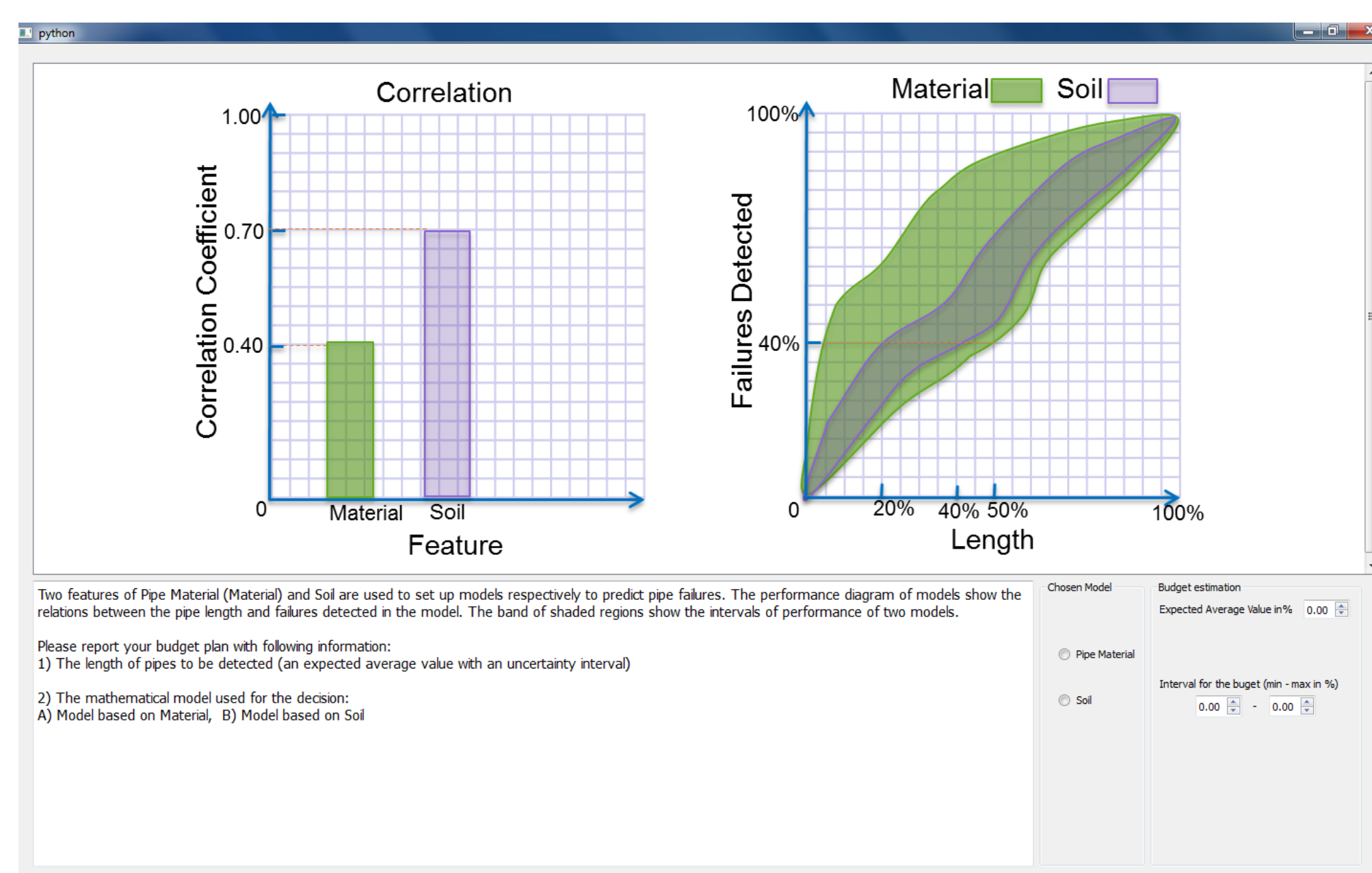


Figure 2 Visualization of correlation and uncertainty in the experiment

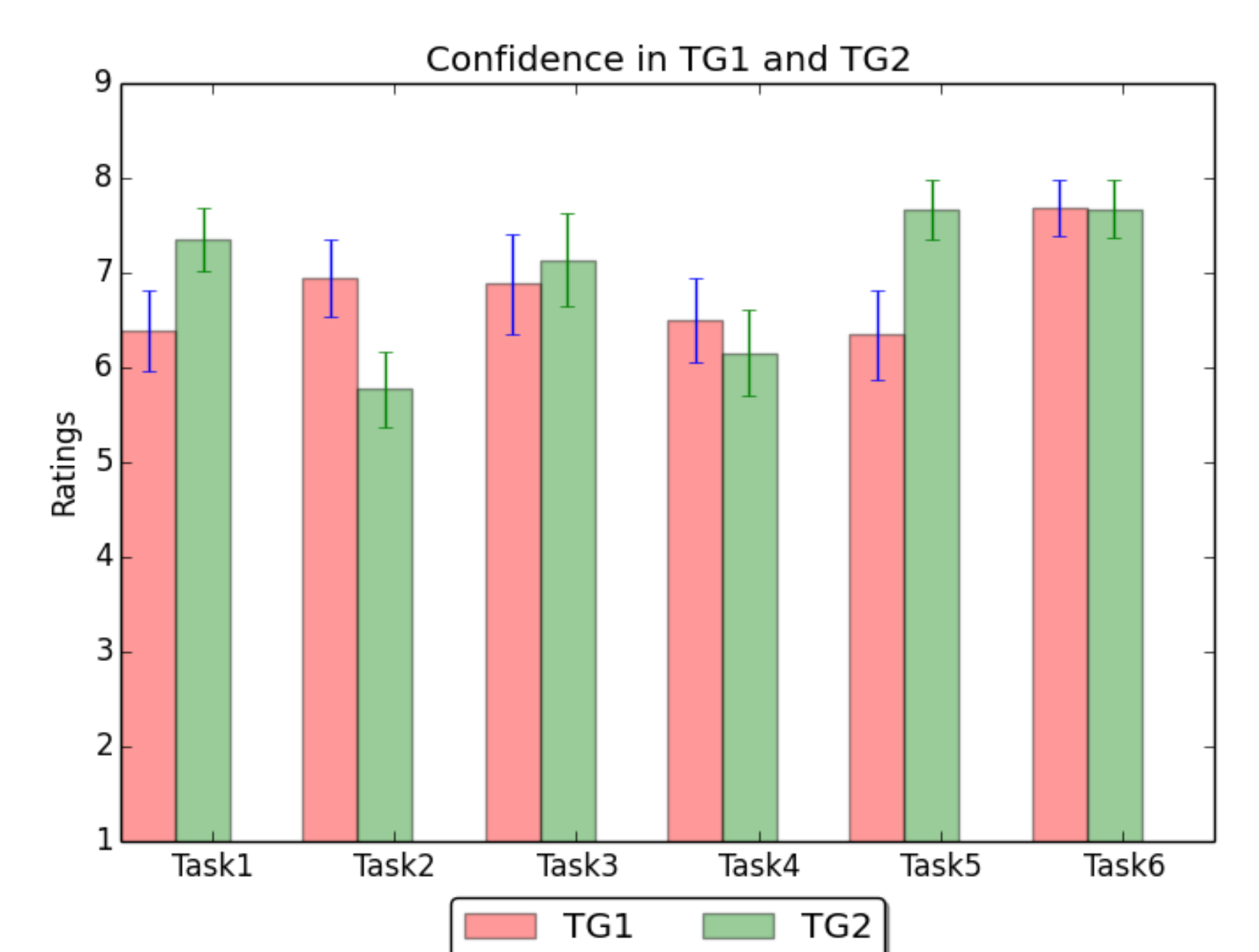


Figure 3 Subjective ratings of confidence in the experiment

## Experiment

### Case Study and Data

Using **water pipe failure prediction** as a case study. Simulated data used for the experiment include:

- 1) failure prediction models
- 2) feature of pipes
- 3) uncertainty of prediction
- 4) correlation

### Tasks

Tasks were divided into two groups (TG) based on uncertainty values and ranges (overlapping and non-overlapping) of two models in each task. Participants were asked to **make a budget plan** based provided models.

To cover every combination of available information

**24 Tasks were designed**

**26 participants** ML researchers, non-ML researchers and general staff were recruited, 9 of whom were female, for the sake of gender equality

### Data Collection

- Physiological signals of GSR, BVP
- Behavioral signals of mouse movement
- Subjective ratings of confidence results

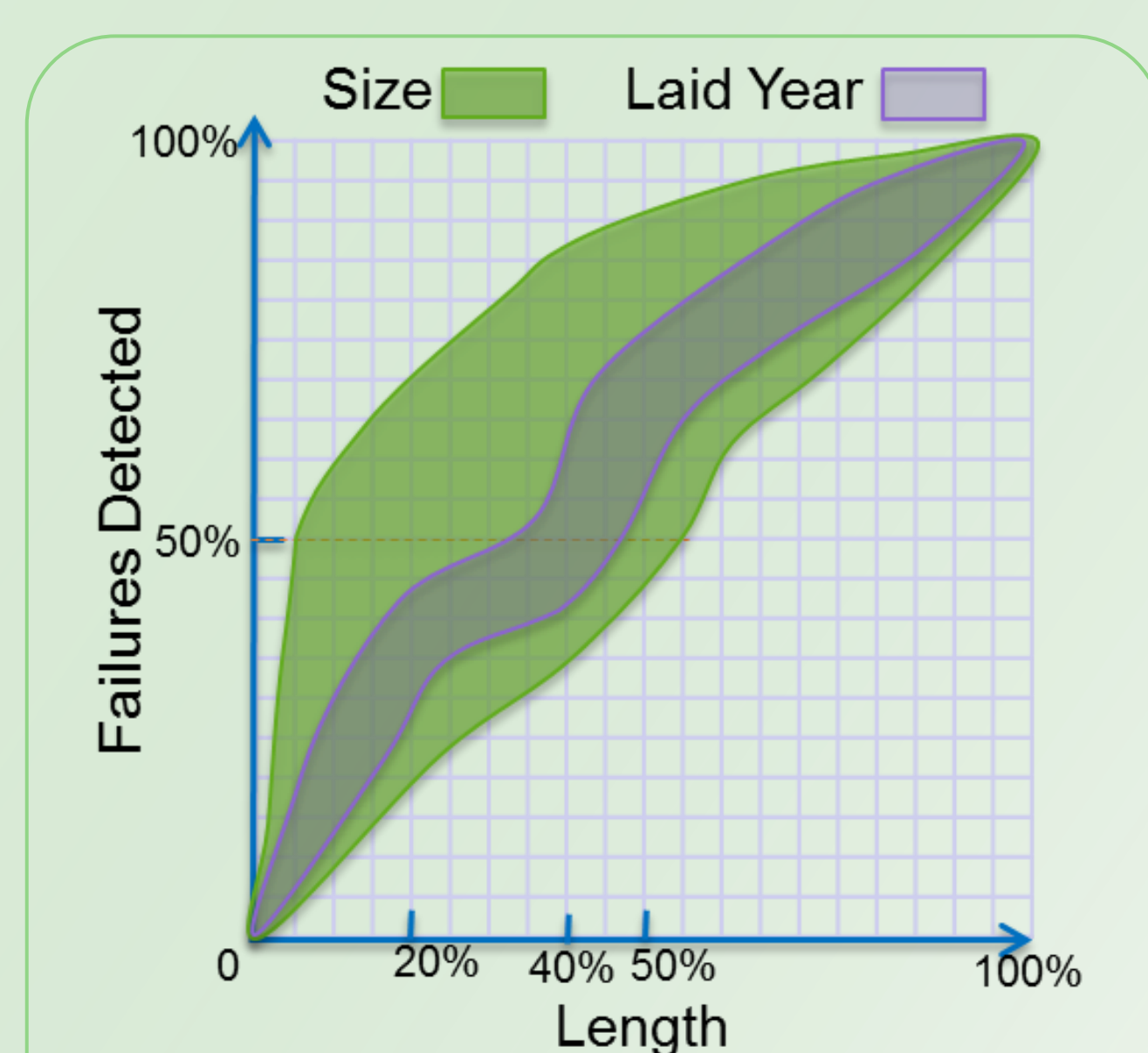


Figure 4 models used in TG1

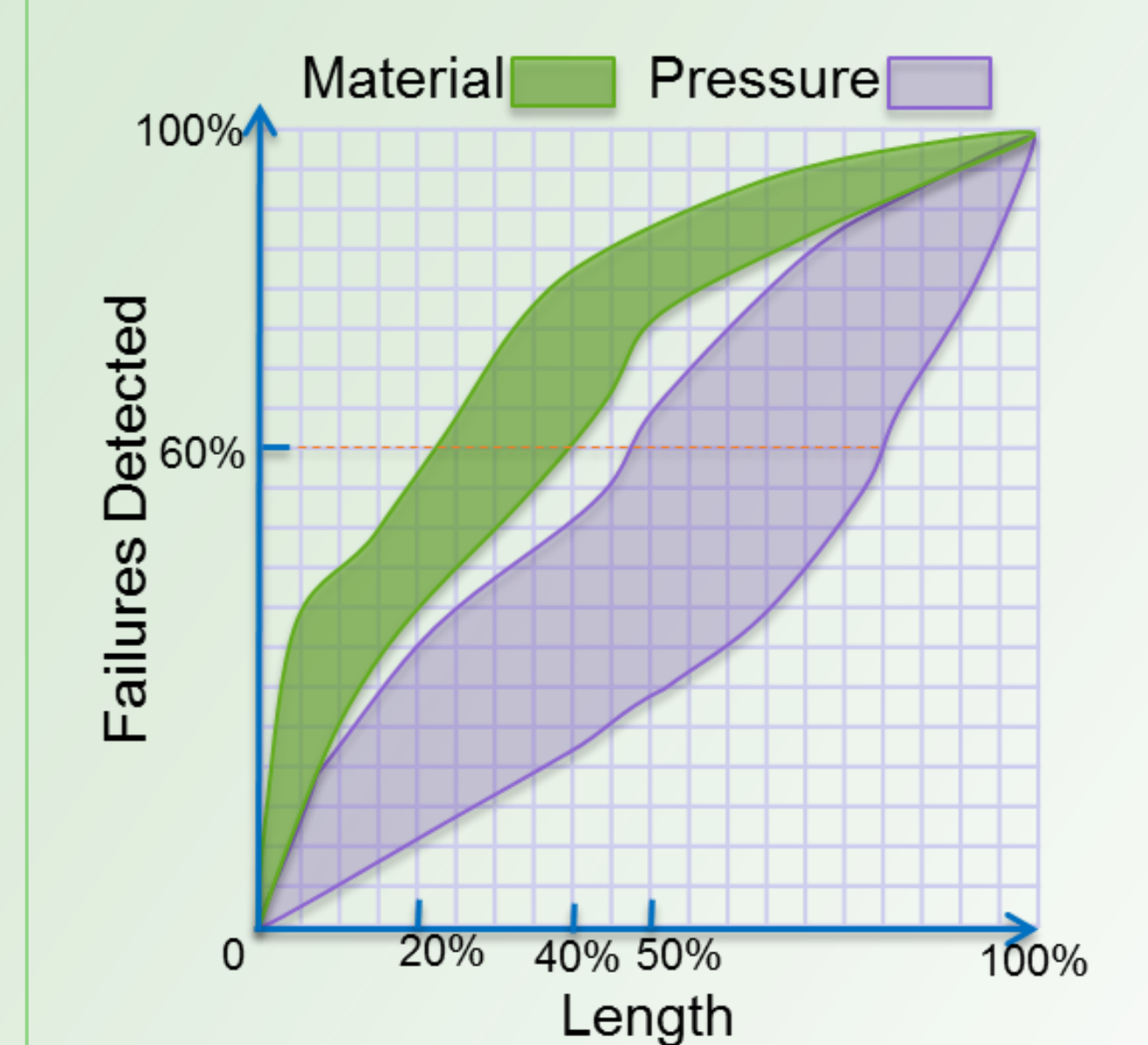


Figure 5 models used in TG2

## Statistical Results

- Uncertainty did not help users to be more confident in decision making not as expected
- Revealing of correlations between features and target values could help users be more confident in decision making
- However, depending on the congruent pattern between performances and correlation, correlation and uncertainty may be leading criteria during machine learning based decision process

## Confidence Indexing

- GSR indexing is more robust for feature extraction and provide significant results to predict users' confidence
- BVP indexing needs an additional step for feature extraction (outlier detection) but provides better accuracy

## Conclusion

This work investigated the effect of uncertainty and correlation on user's confidence in ML-based decision making. The proposed work can be used in confidence-aware user interface design in ML-based intelligent systems. Although significant results were found to use physiological signals to index confidence in decision making, there is still room for improvement

## Future leads

- Combination of GSR and BVP features for multimodal classification
- Improvement in signal reconstruction and feature extraction : interpolation based on mouse movements