# Greeting

- Good morning, dear members of the examination committee (and dear audience).
- My name is Martin Beneš.
- Welcome to my bachelor thesis defense.

# Assignment

- Study the PIR sensors and recognition/classification.
- Design the theoretical system, using the PIR sensor data, scanning the situation, possibly the count of people.
  - Predefined fuzzy logic system
  - Artificial learning system
- Implement the described algorithm.
  - Verify its functionality on real situation.
- Sum up the result.

# Design

- Hardware
  - Sensor device (B+B Sensors:PIR STD, NodeMCU)
    - ESP8266 (WiFi), mDNS, HTTP
  - Classification server (software implemented)
- Software
  - Sensor device (C++/Arduino)
    - Sensing, homogenous segmentation
  - Monitor
    - Python3 = easy prototyping
      - NumPy, SciPy, scikit
      - MatPlotLib, PySerial
    - Presentation, (fusion)

# Feature extraction

- CWT = edge function
- Segment borders (extremes), segmentation
- Artefacts
  - Merging the segments using fuzzy system
- Features
  - Mean
  - Variance
  - Scale of interpolated line
  - Length of artefact

# Classifier

- Based on linear regression
  - Multiple classifiers, each determining one attribute
    - Distance
    - Orientation
    - Side
    - ...
- Spacial model of sensed area = matrix of fuzzy values
  - Formula for the index value from the classifier outputs
    - Index has unique vector of coefficients for each classifier
  - Indices do not separate the space homogenously

## Training

- Manual labelling
  - Reference of synchronized video frame
- Rather inaccurate
- Definitely a room for improvement

## Postprocessing

- **Localization** = cluster analysis
  - K-means **vs.** Partitioning around medoids
- **Counting the people** = minimal within-cluster sum of squares

# Implementation

- **Sensor device**
  - Sensor = PIR STD (*B+B Sensors*)
  - MCU = NodeMCU
    - ESP8266 = WiFi
    - mDNS and HTTP
    - Programmed in C++/Arduino
- **Classification server**
  - Monitor (software) = Python
    - Number of libraries = easy prototyping
      - NumPy, SciPy, scikit
      - MatPlotLib
      - PySerial
  - Linux/Bash used as well

# Results

- Posterior probability (percentage) of partial classifiers
- Evaluation:
  - How many positive samples were classified positive?
- Possible improvements to the future
  - Change the labelling method
  - Usage of multiple sensors
    - Fusion described theoretically, but not implemented