RoboBEER:

A robot made with LEGO components that showed to be not a toy when analysing beer quality parameters based on foamability using computer vision algorithms.

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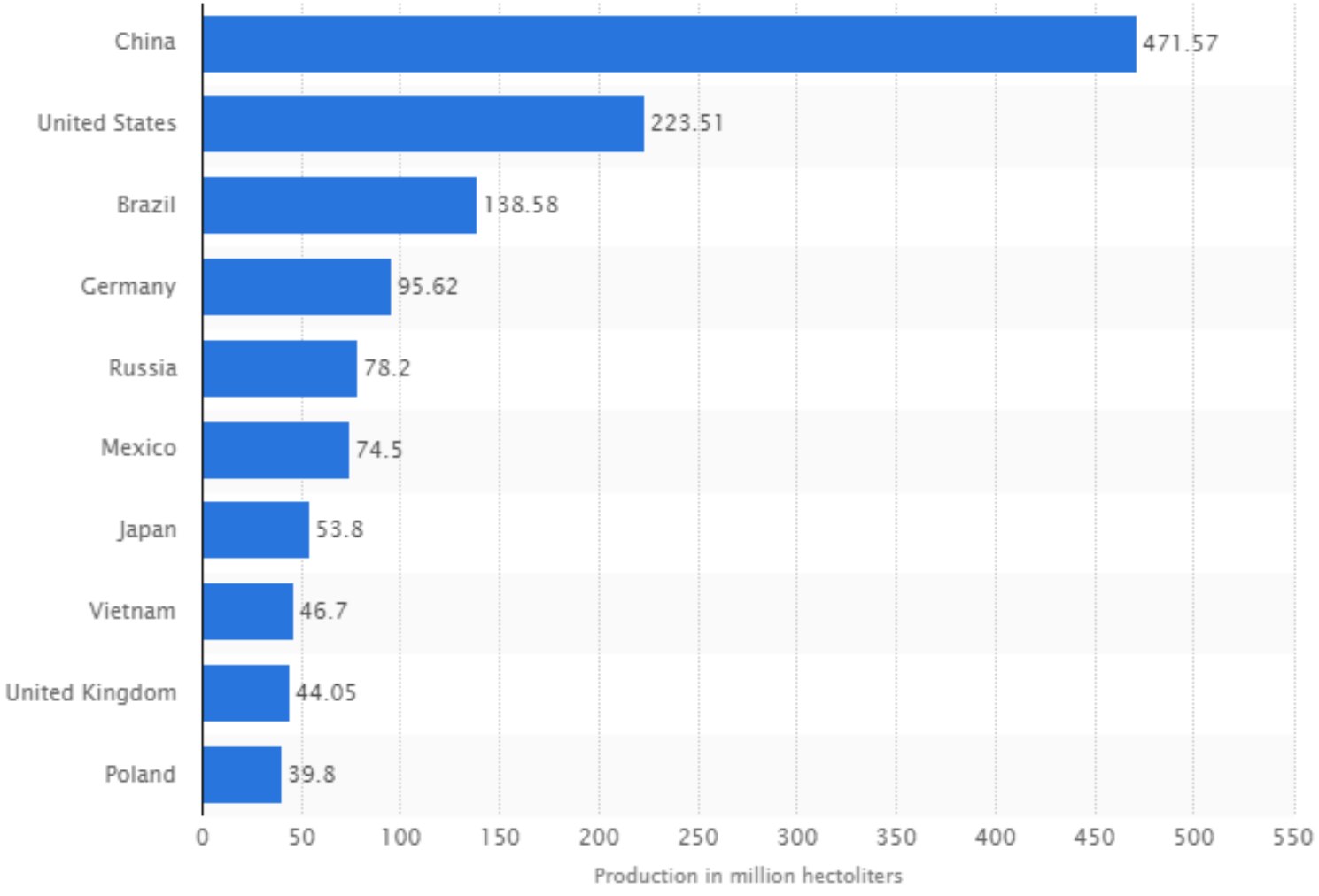
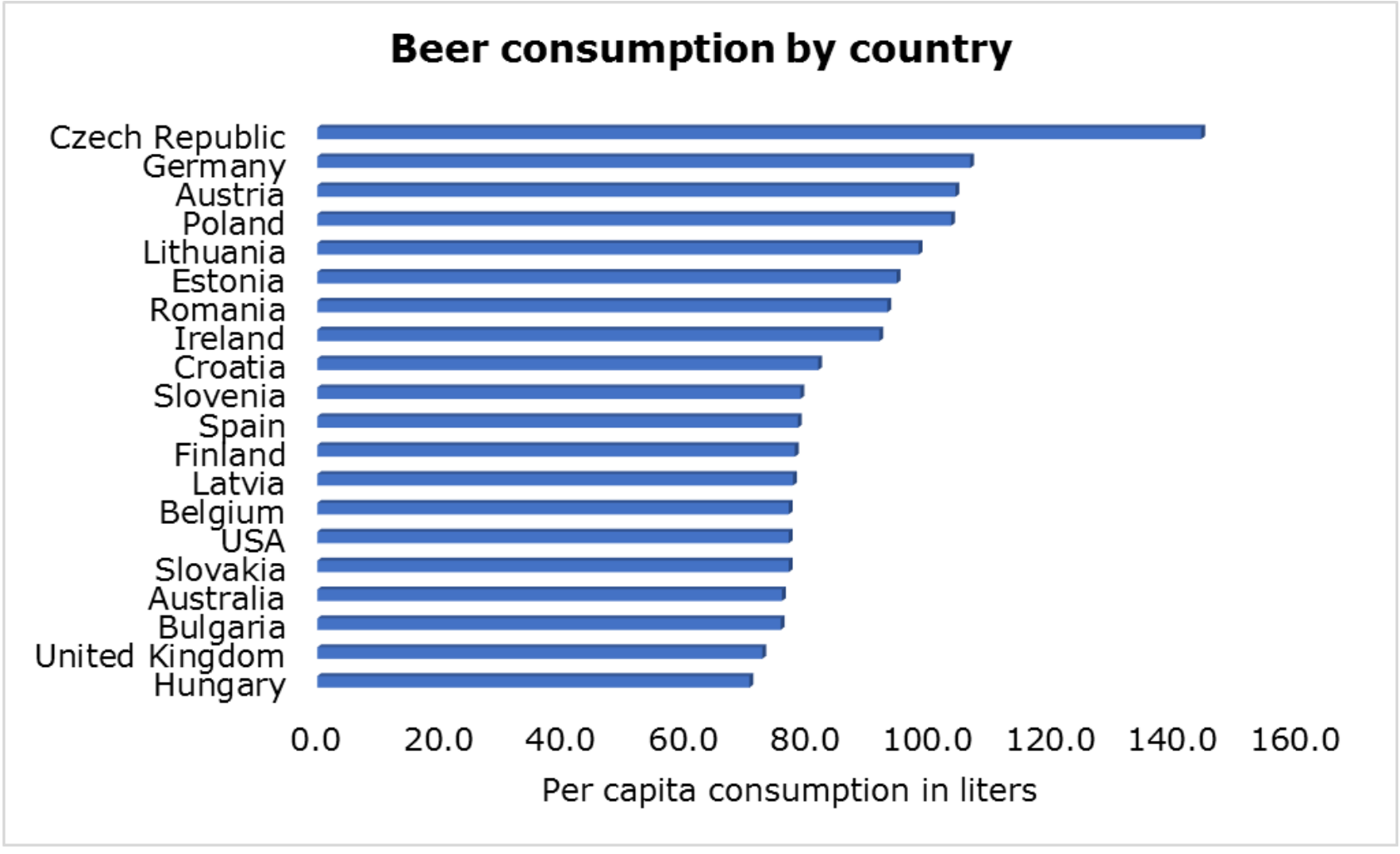
Background

Top producing countries



(Euromonitor-International 2015, Euromonitor-International 2016, Statista 2015)

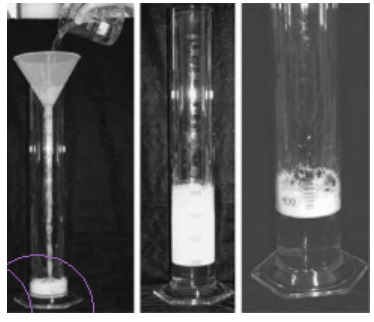
Background



(Euromonitor 2017)

Problem / Application

- Beer quality defined by:
  - Foamability
  - Foam stability
  - Foam texture (bubble size)
  - Colour
  - Alcohol content
  - Flavours and taste
  - Aromas
  - Mouthfeel
- Current methods to assess foam:
  - Time-consuming
  - Measure one or two parameters
  - Manual pouring



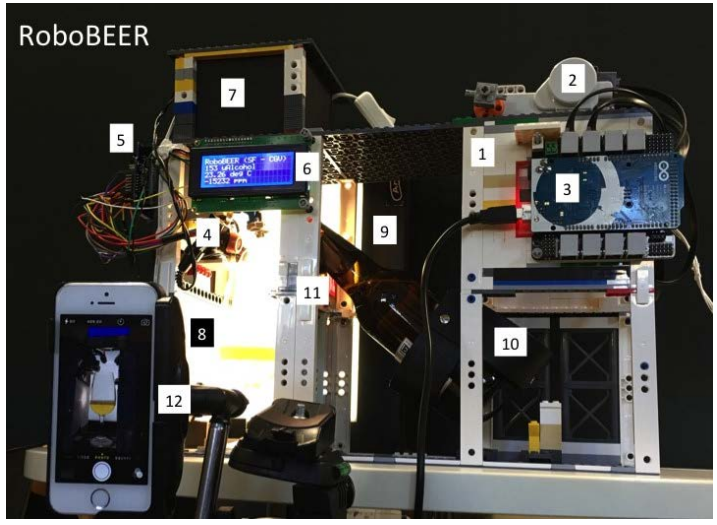
(Bamforth 2011, Cooper et al. 2002, Ferreira et al. 2005)

Importance

- Uniformity in measurement conditions
- Beer quality assessment:
  - Colour and foam-related parameters
  - Sealability
  - Prediction of intensity levels of sensory descriptors
  - Classification per type of fermentation

Approach used to solve the problem

- Robotic pourer prototype:
  - Lego® blocks
  - Lego® Servo motors
  - Open source sensors (temperature, alcohol and CO_2)
  - Arduino® boards
  - iPhone 5S

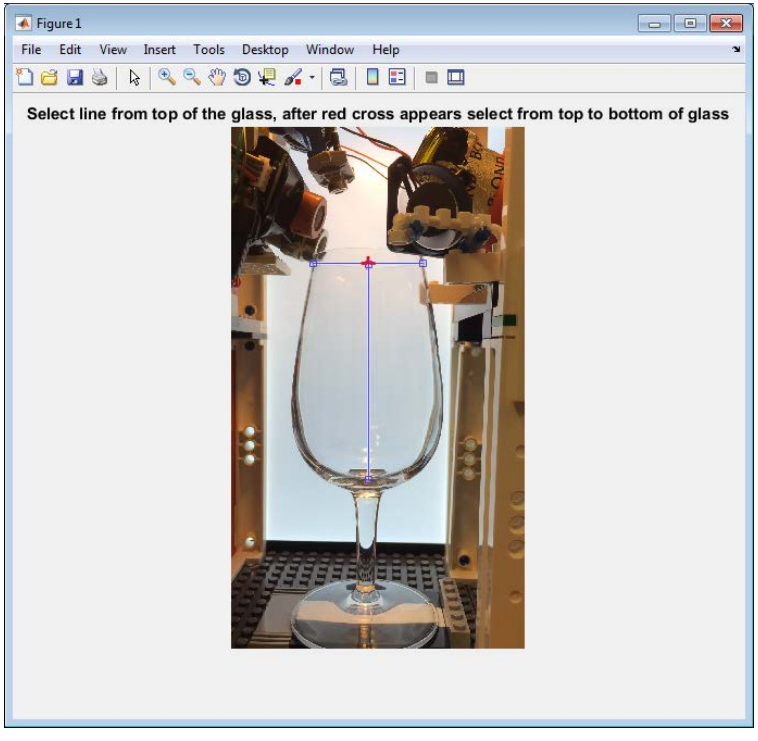


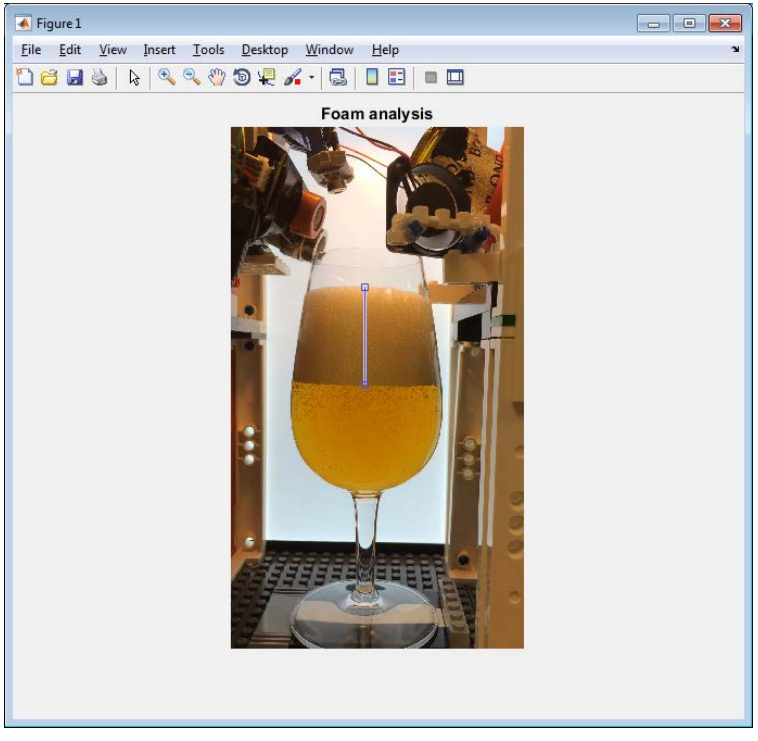
- Data processing:
  - Computer vision algorithms – Matlab®
  - Machine learning algorithms – Matlab Neural Network Toolbox™ 7

Use of Matlab

- Open source sensors:
  - CO_2, alcohol gas release, temperature
- Computer vision algorithms to assess:
  - Colour (RGB and CieLab)
  - Maximum volume of foam (MaxVol)
  - Total lifetime of foam (TLTF)
  - Lifetime of foam (LTF)
  - Foam Drainage (FDrain)
  - Bubble size distribution (small, medium and large)

Use of Matlab



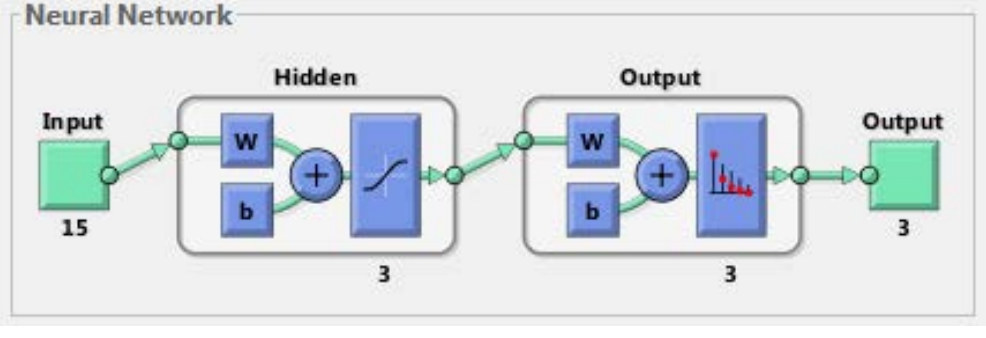


Use of Matlab

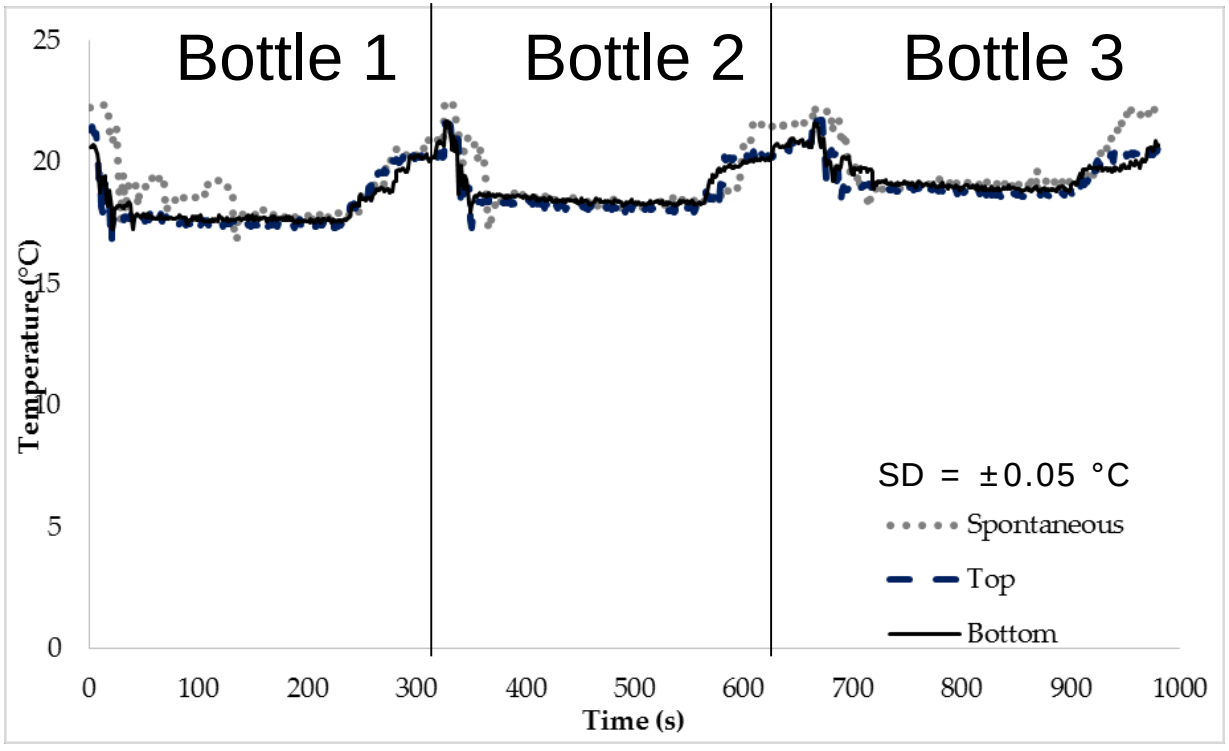
https://www.youtube.com/watch?v=sN37HkpcjhA

Use of Matlab

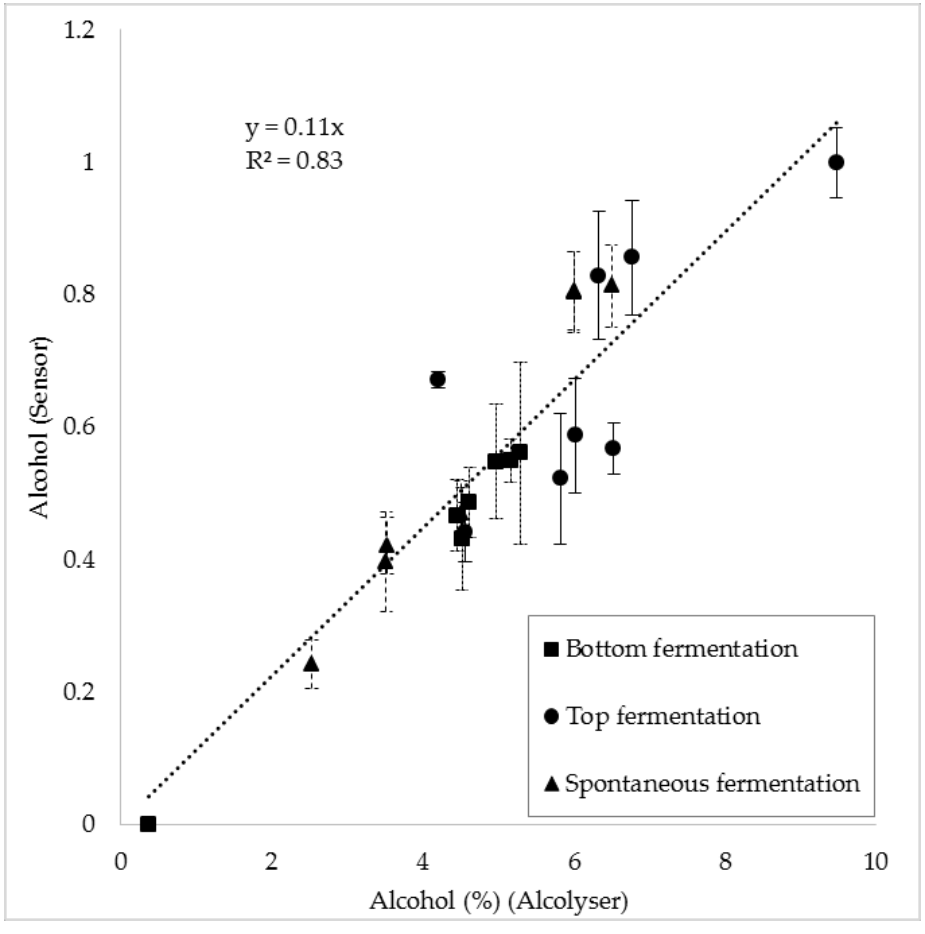
- Matlab® code to analyse results using principal component analysis (PCA) and cluster analysis
- Machine learning using Matlab Neural Network Toolbox™ 7 for pattern recognition and regression



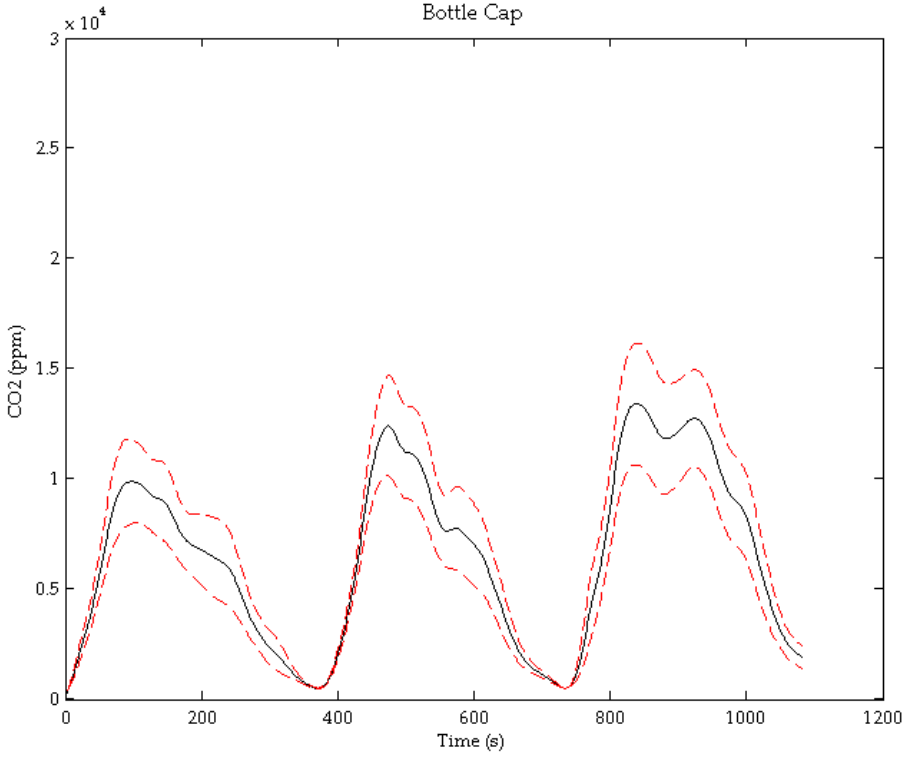
Results – Temperature



Results – Alcohol



Results – CO_2



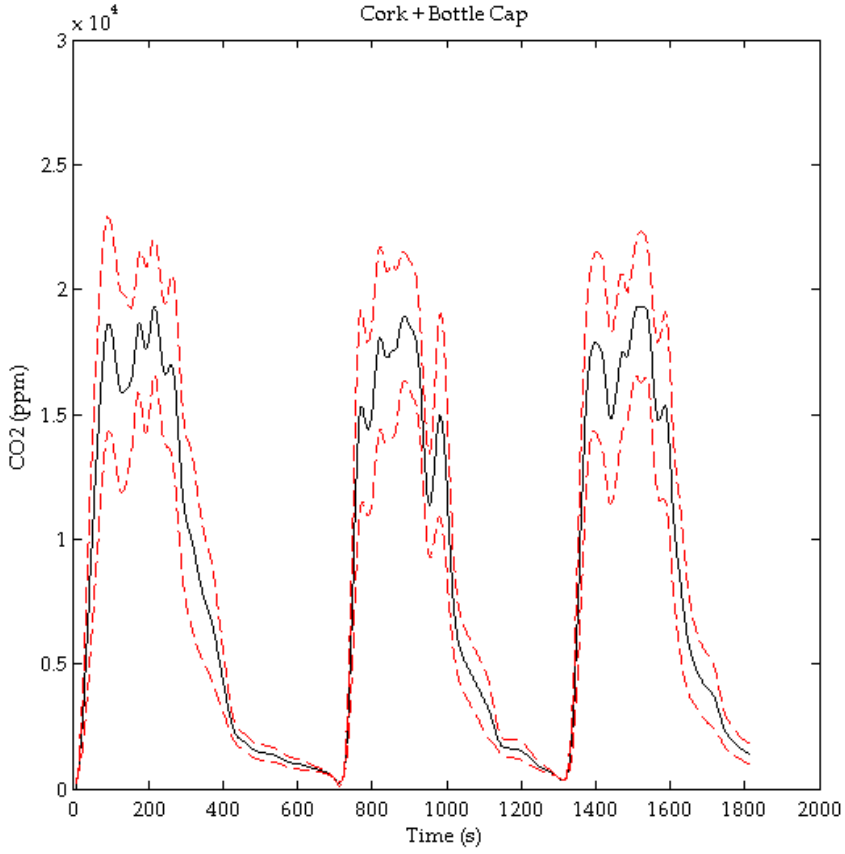
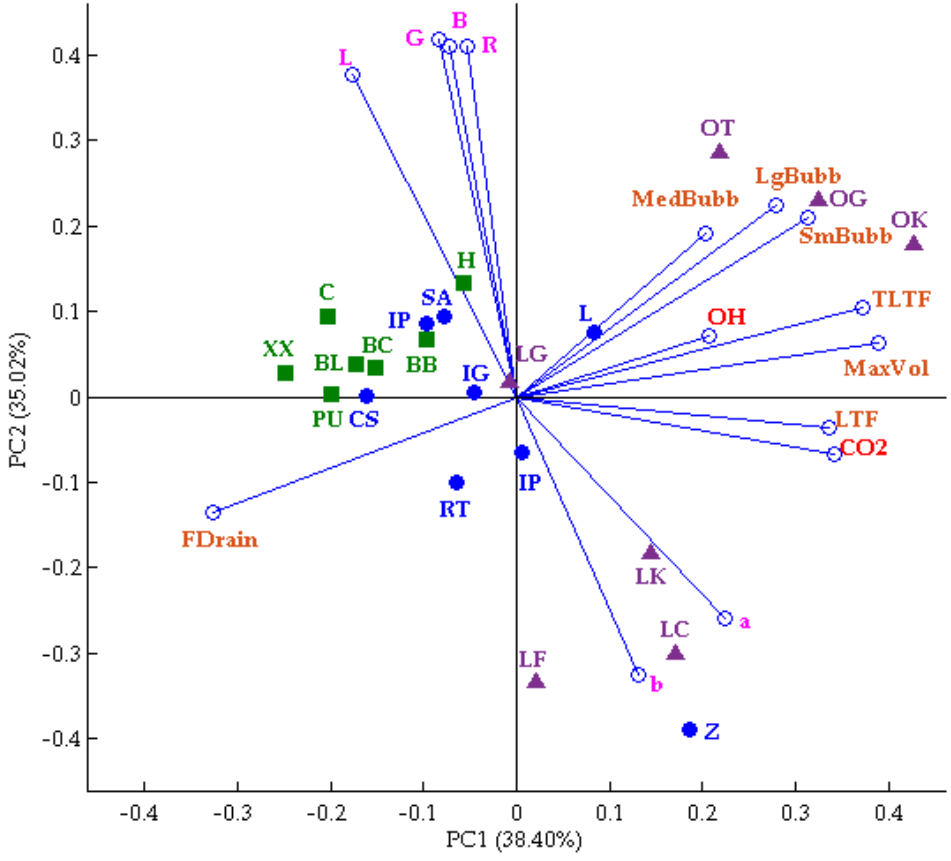
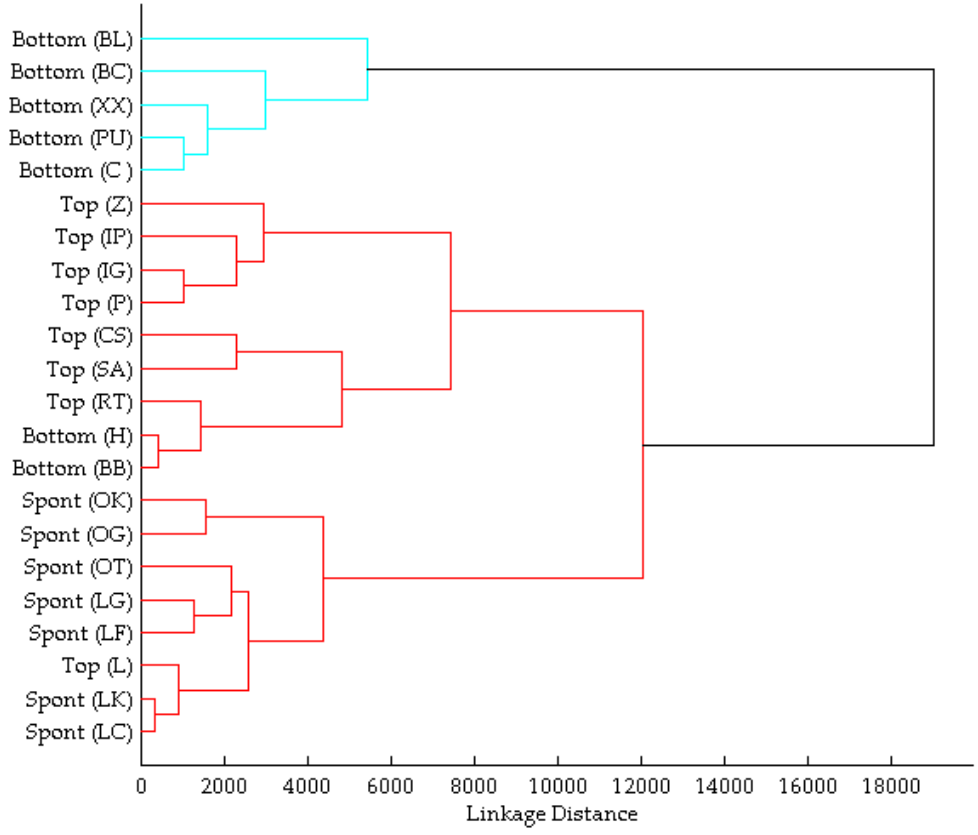


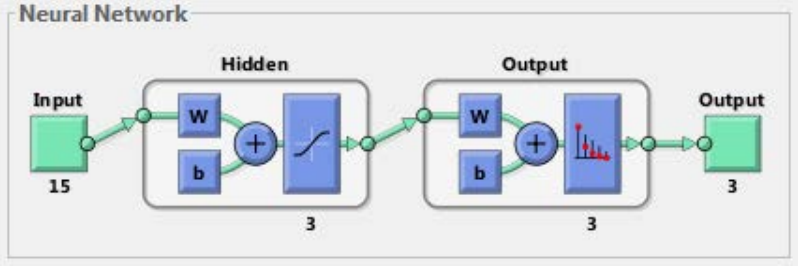
Image source: http://www.dailybeerreview.com/2012/03/

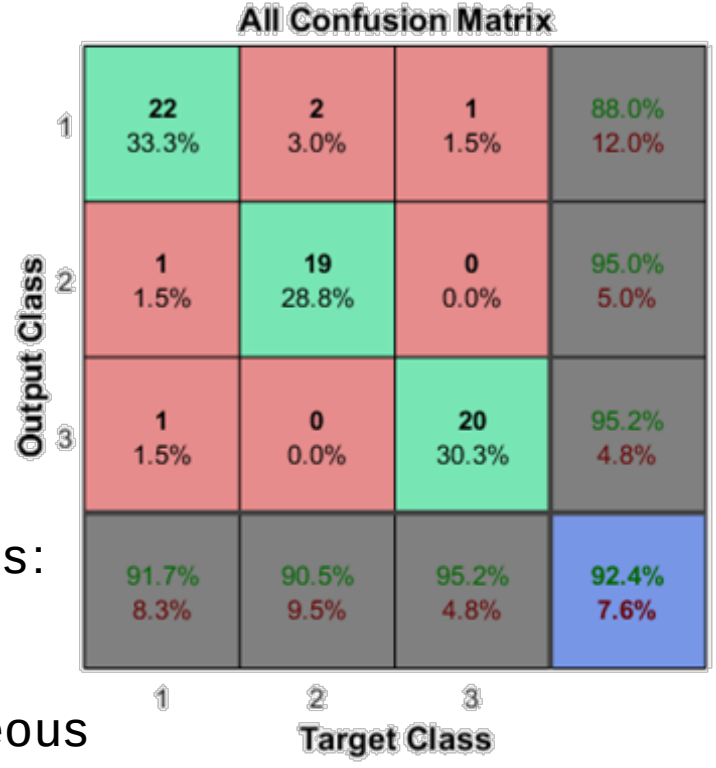
Results – PCA and Cluster

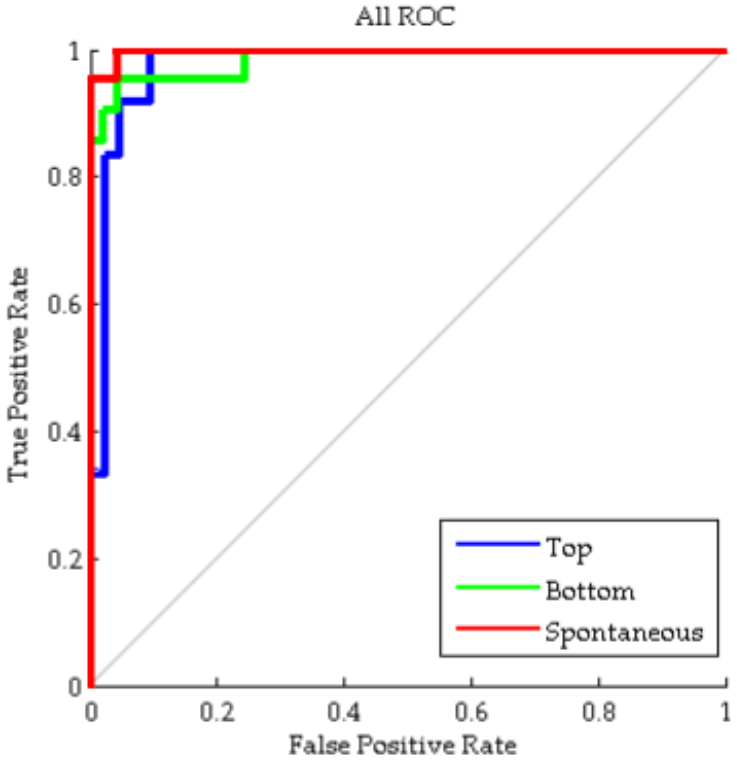




Results – ANN Pattern Recognition

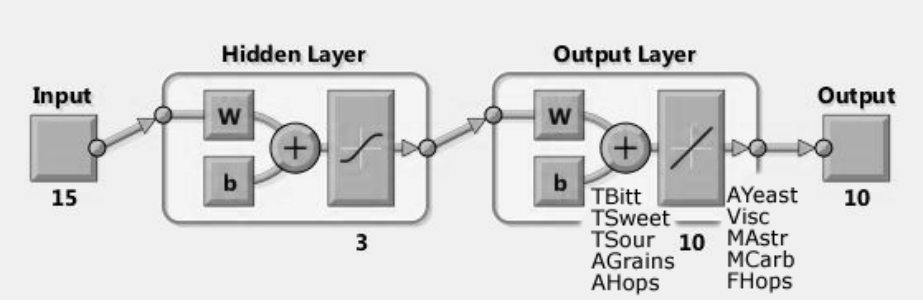






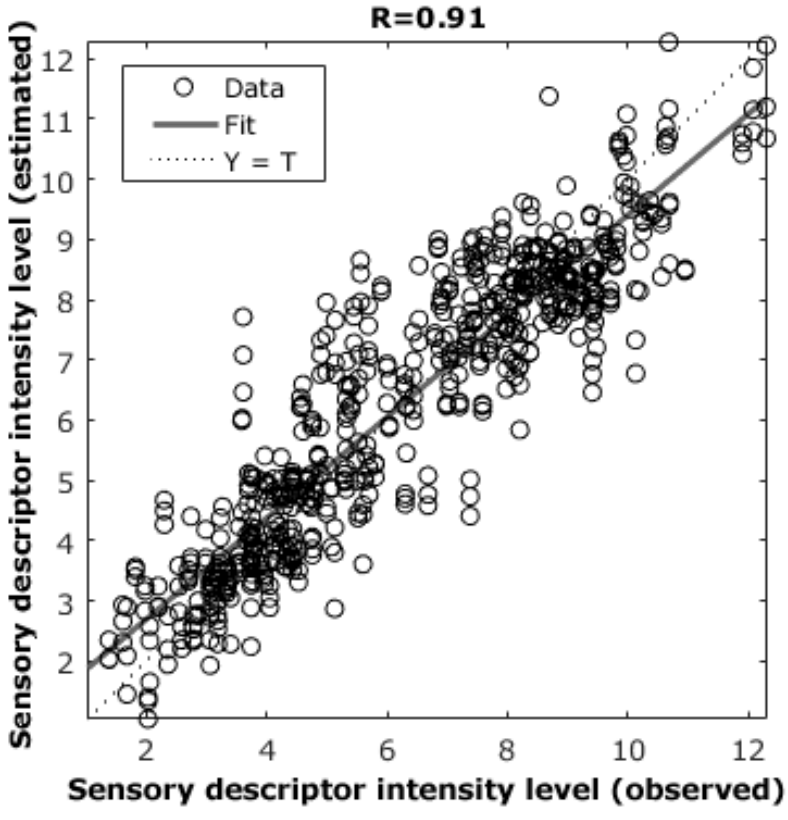
Class / Targets:
1 = Top
2 = Bottom
3 = Spontaneous

Results – ANN Regression



Intensity of sensory descriptors:

- Bitterness
- Sweetness
- Sourness
- Aroma grains
- Aroma hops
- Aroma yeast
- Viscosity
- Astringency
- Carbonation mouthfeel
- Flavour hops



Conclusions

- Use of RoboBEER, computer vision and machine learning algorithms: cost effective and rapid tool to assess foamability
- Accessible tool for industry. Quality assurance of beer and packaging at the end of production line.
- ANN highly accurate model for beer classification using RoboBEER
- ANN regression high correlation for prediction of intensity levels of sensory descriptors

References

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