RoboBEER:

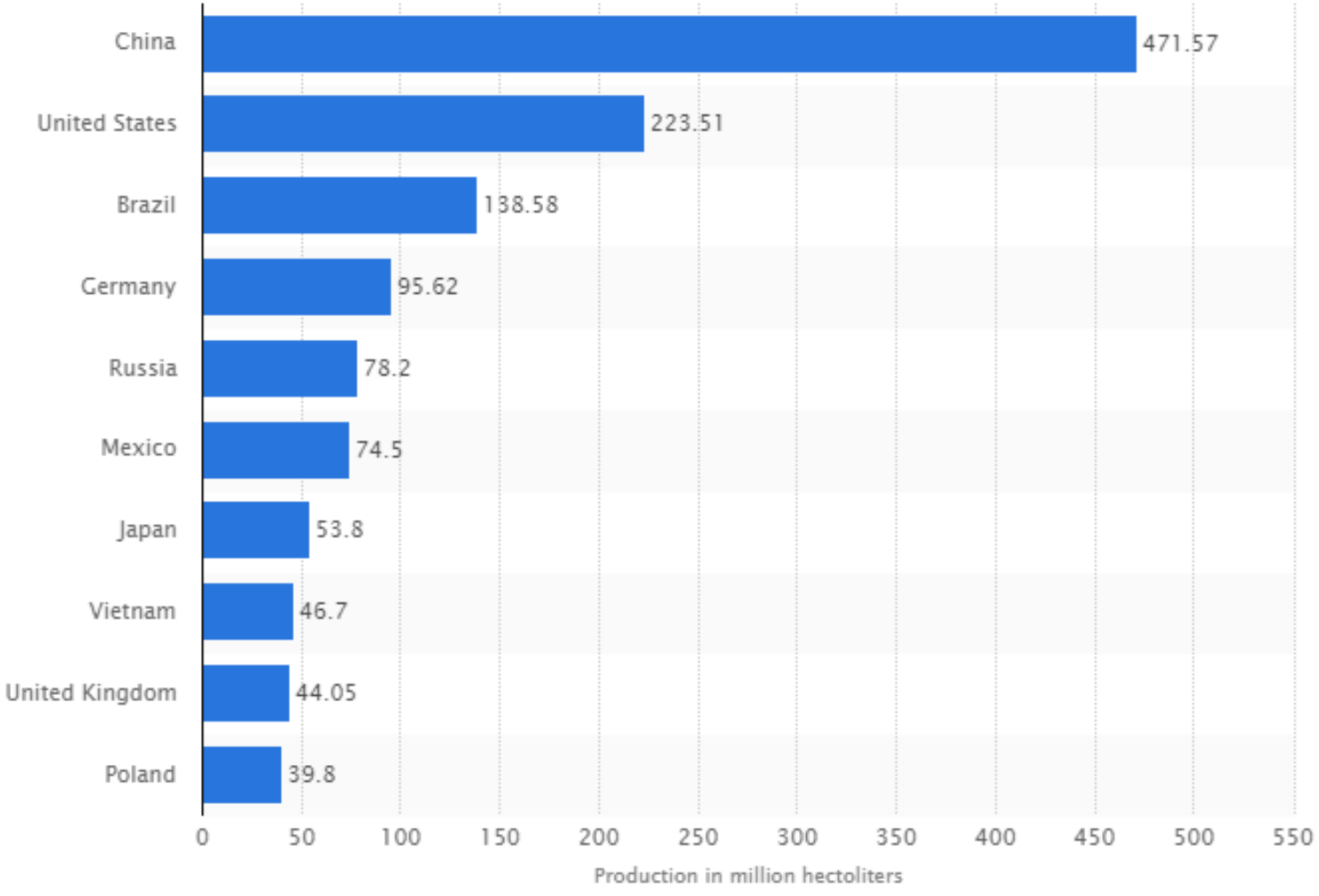
A robot made with LEGO components that showed to be not a toy when analysing beer quality parameters based on foamability using computer vision algorithms.

Claudia Gonzalez Viejo, Sigfredo Fuentes, Kate Howell, Damir Torrico and Frank Dunshea

School of Agriculture and Food, Faculty of Veterinary and Agricultural Sciences, The University of Melbourne, Parkville, VIC 3055, Australia

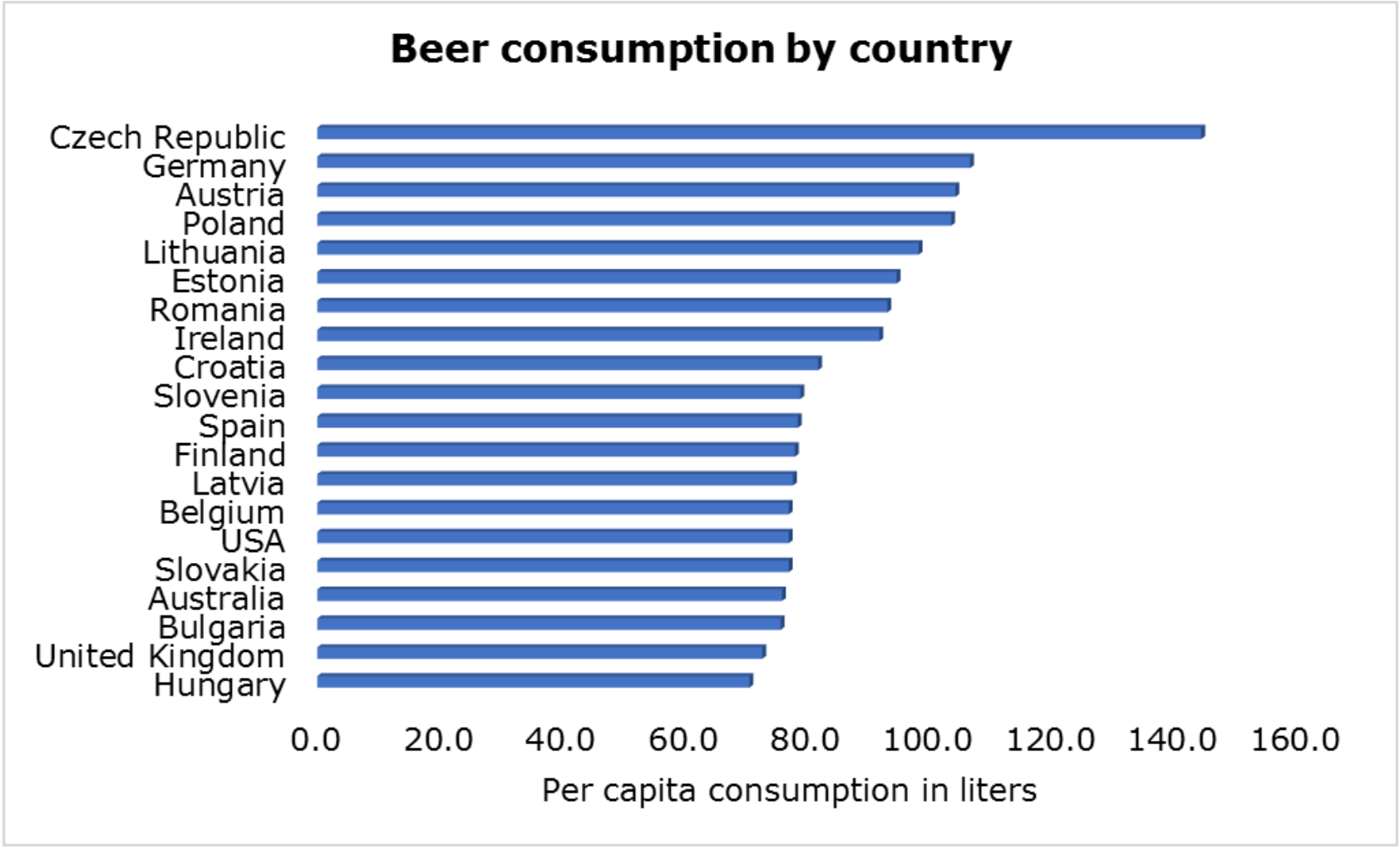
Background

Top producing countries



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

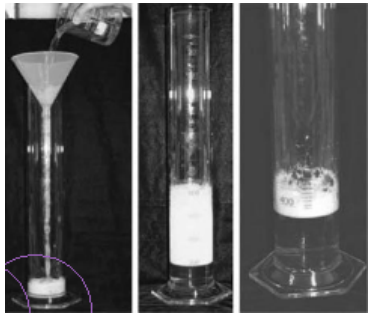
Background



(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



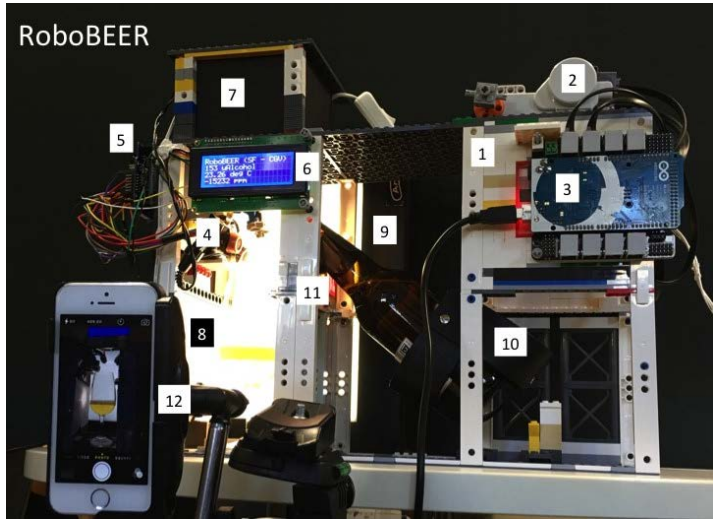
(Bamforth 2011, Cooper et al. 2002, Ferreira et al. 2005)

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



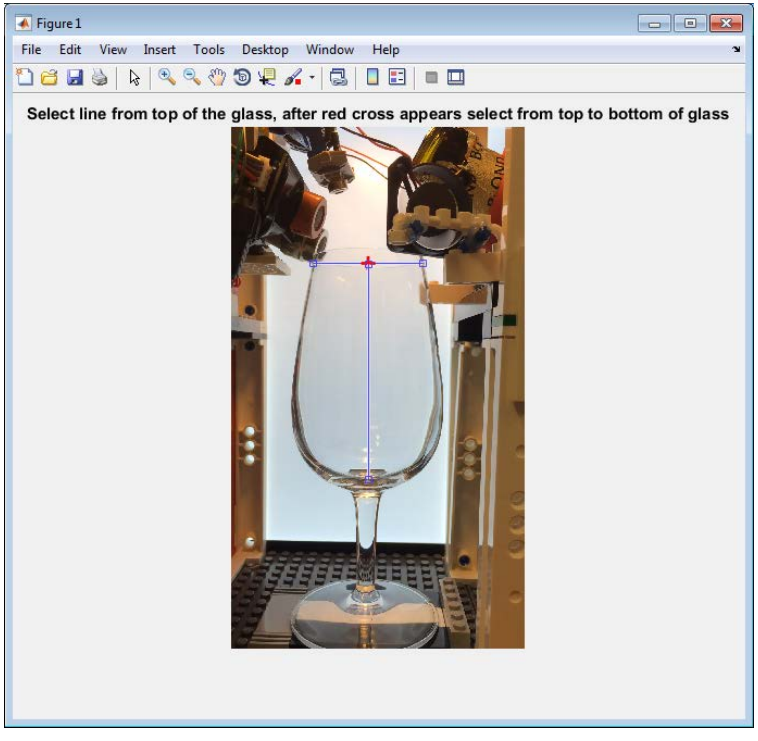
- Data processing:
  - Computer vision algorithms – Matlab®
  - Machine learning algorithms – Matlab Neural Network Toolbox™ 7

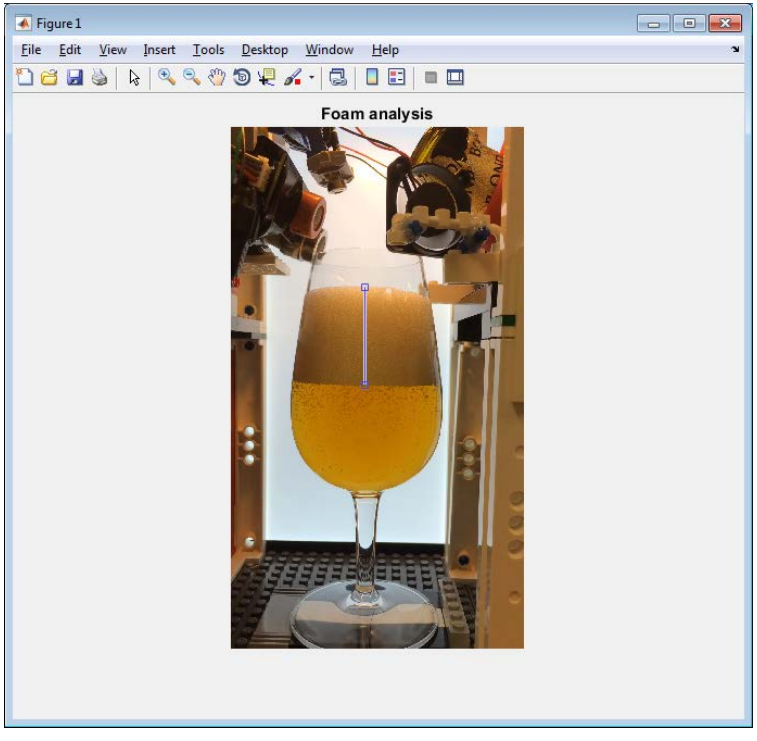
Use of Matlab

- 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)

THE UNIVERSITY OF MELBOURNE

Use of Matlab



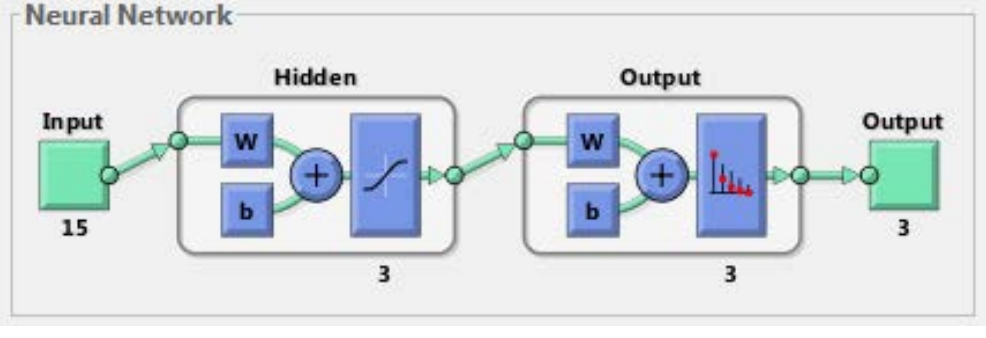


Use of Matlab

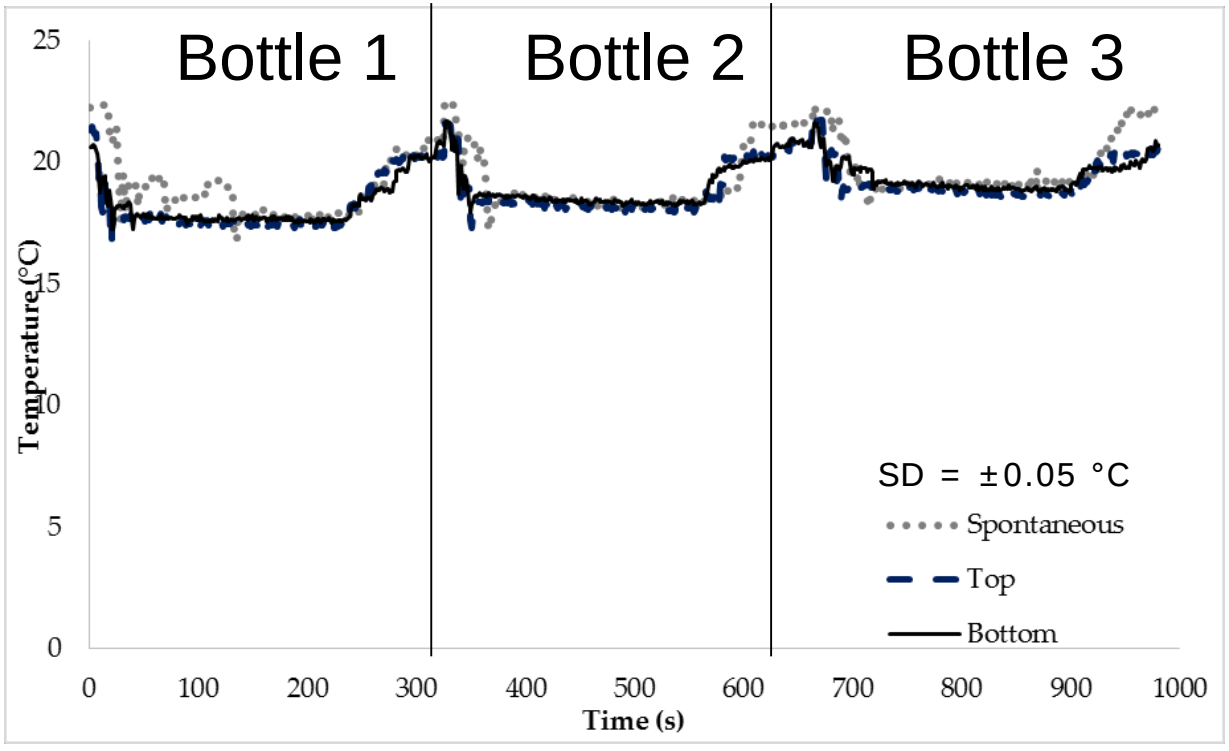
https://www.youtube.com/watch?v=sN37HkpcjhA

Use of Matlab

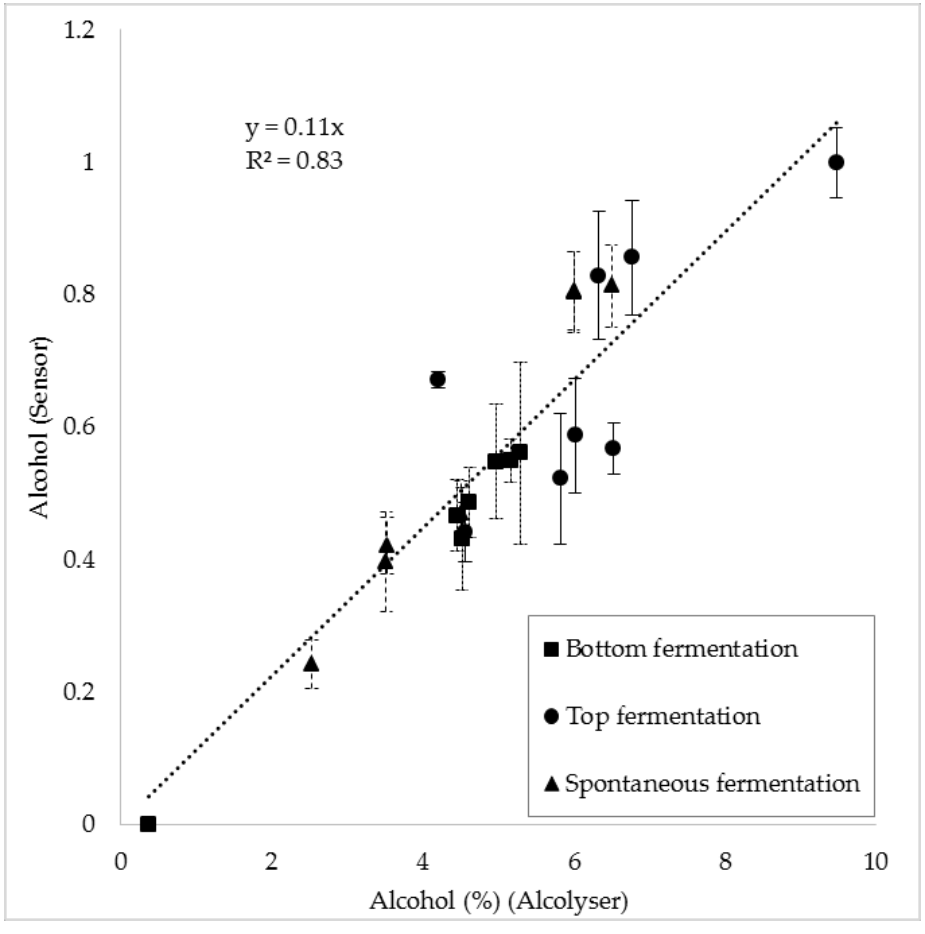
- Matlab® code to analyse results using principal component analysis (PCA) and cluster analysis
- Machine learning using Matlab Neural Network Toolbox™ 7 for pattern recognition and regression



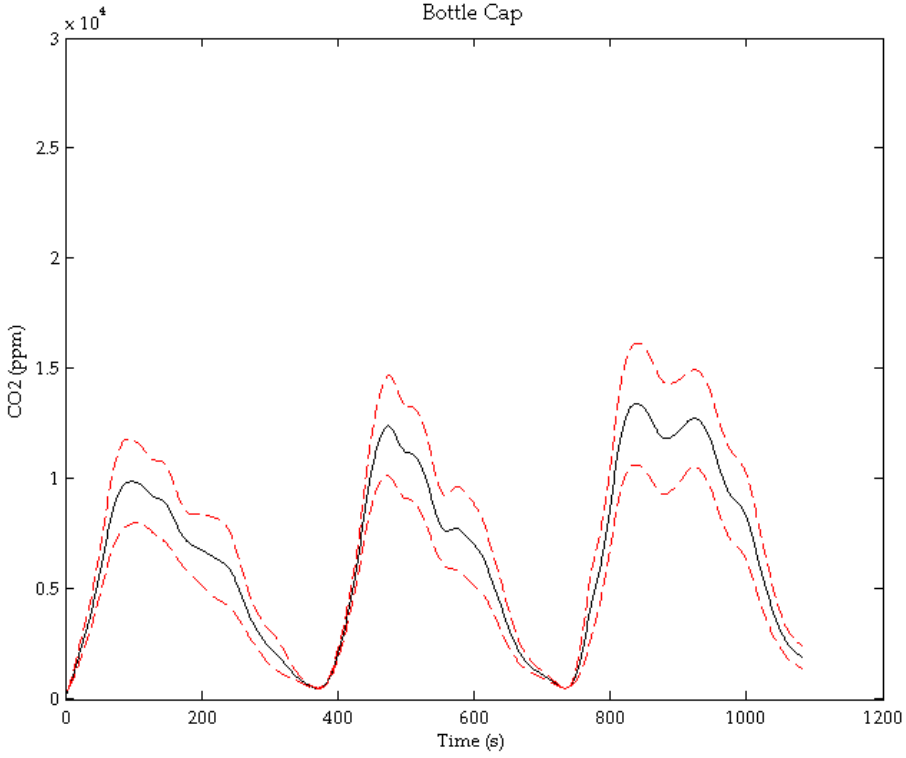
Results – Temperature



Results – Alcohol



Results – CO_2



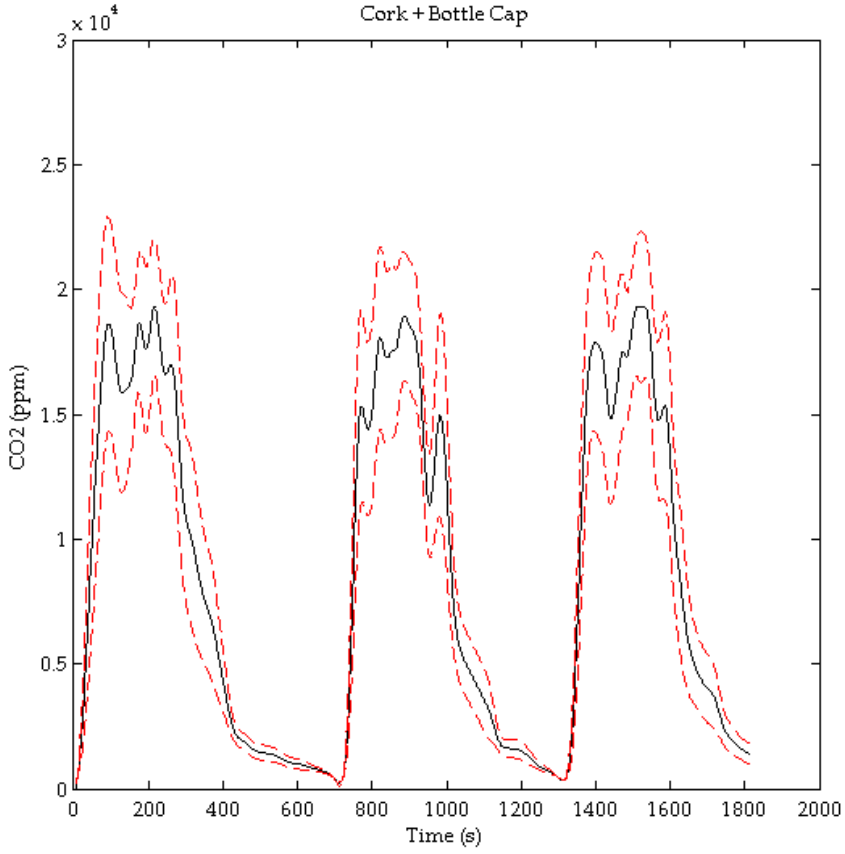
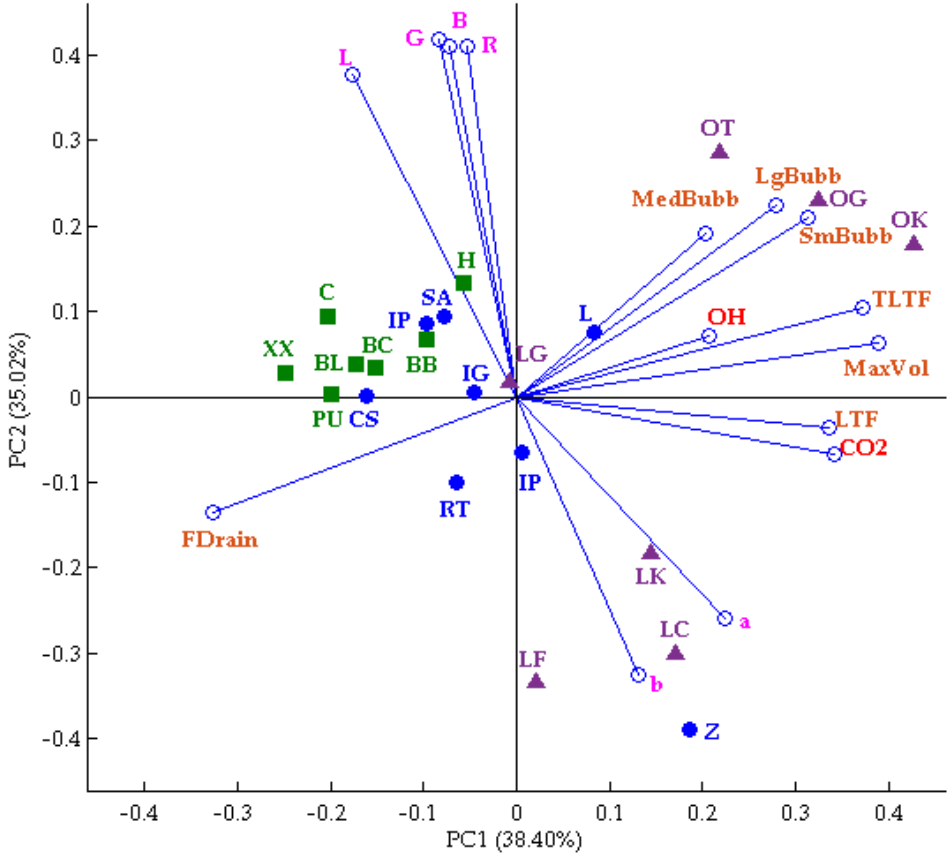
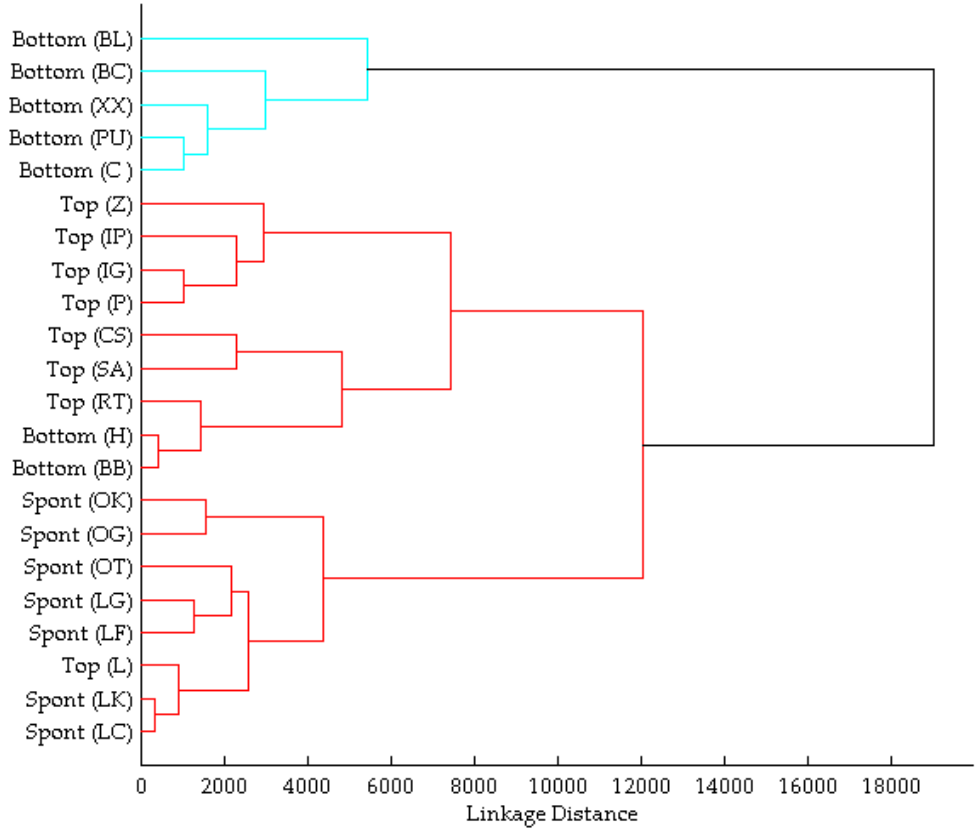


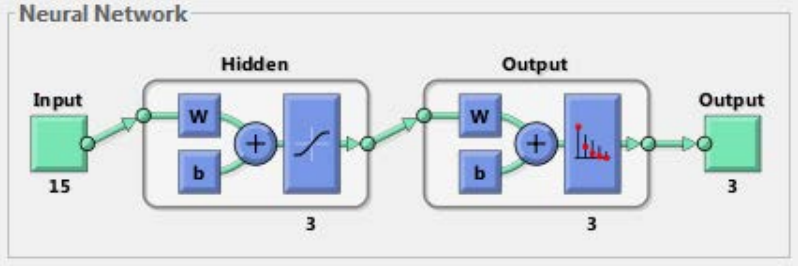
Image source: http://www.dailybeerreview.com/2012/03/

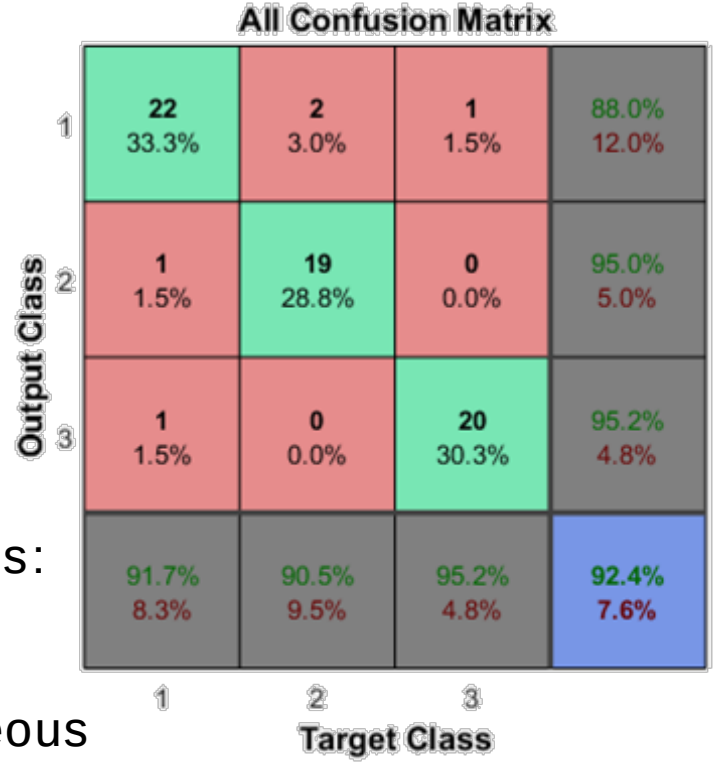
Results – PCA and Cluster

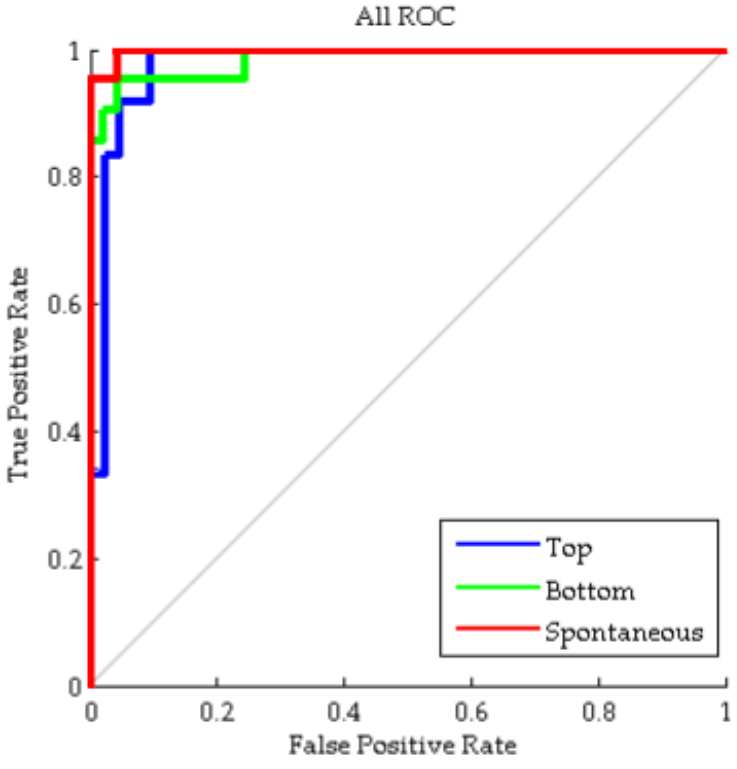




Results – ANN Pattern Recognition

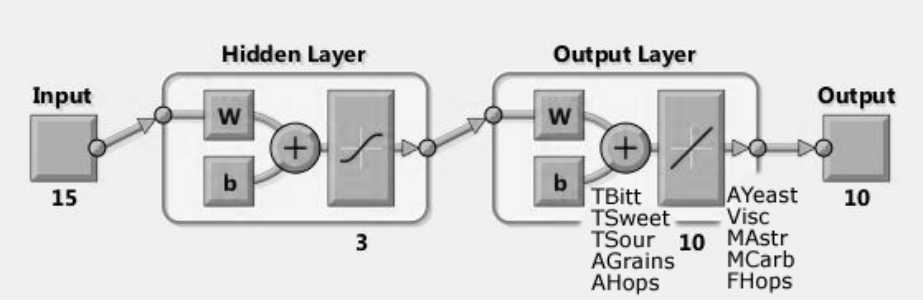






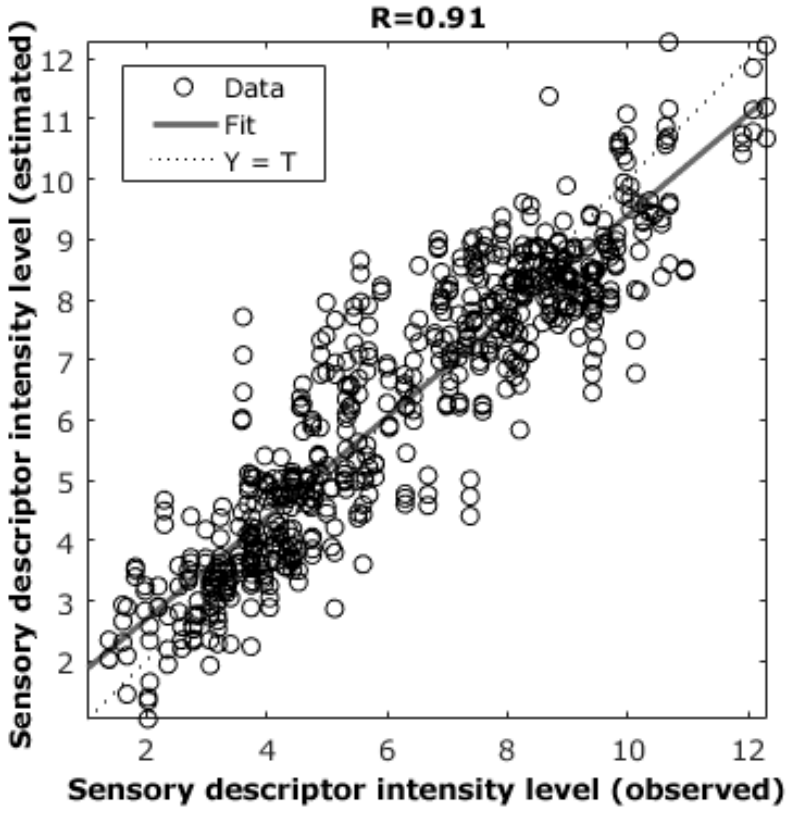
Class / Targets:
1 = Top
2 = Bottom
3 = Spontaneous

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

THE UNIVERSITY OF MELBOURNE

References

- Gonzalez Viejo, C., Fuentes, S., Li, G., Collmann, R., Condé, B. and Torrico, D., 2016. Development of a robotic pourer constructed with ubiquitous materials, open hardware and sensors to assess beer foam quality using computer vision and pattern recognition algorithms: RoboBEER. *Food Research International*, *89*, pp.504-513.
- Bamforth, C., Russell, I., & Stewart, G. (2011). *Beer: A Quality Perspective*: Elsevier Science.
- Cooper, D. J., Husband, F. A., Mills, E. N. C., & Wilde, P. J. (2002). Role of Beer Lipid-Binding Proteins in Preventing Lipid Destabilization of Foam. *Journal of Agricultural and Food Chemistry, 50*(26), 7645-7650, doi:10.1021/jf0203996.
- Euromonitor-International (2015). Beer in Australia. (pp. 15): Euromonitor International.
- Euromonitor-International (2016). Statistics - Alcoholic Drinks. http://www.portal.euromonitor.com.ezp.lib.unimelb.edu.au/portal/statistics/tab. Accessed 26 April 2016.
- Euromonitor-International (2017). Alcoholic Drinks: Euromonitor from trade sources/national statistics. http://www.portal.euromonitor.com.ezp.lib.unimelb.edu.au/portal/statistics/tab. Accessed 20 April 2017.
- Ferreira, I. M. P. L. V. O., Jorge, K., Nogueira, L. C., Silva, F., & Trugo, L. C. (2005). Effects of the Combination of Hydrophobic Polypeptides, Iso-α Acids, and Malto-oligosaccharides on Beer Foam Stability. *Journal of Agricultural and Food Chemistry, 53*(12), 4976-4981, doi:10.1021/jf047796w.
- Statista. (2015). Leading 10 countries in worldwide beer production in 2015 (in million hectoliters). https://www.statista.com/statistics/270269/leading-10-countries-in-worldwide-beer-production/ Accessed 23 April 2017

THE UNIVERSITY OF
MELBOURNE

© Copyright The University of Melbourne 2011