Identifying microbes by combining spectral fingerprints with artificial intelligence and Bayesian machine learning

Supervisory team:
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Project description:
Microbes are used in a vast range of industrial processes to produce commercially valuable products, for example fuels, fine chemicals and in brewing. These living systems can easily become contaminated with microbes that alter or damage the industrial processes, which can be extremely costly. At present there is no routine and quick way to identify these contaminants, with present approaches being unreliable and slow. The project develops a solution based on fluorescence spectroscopy combined with Bayesian machine learning to overcome this commercially expensive bottleneck. We have developed an approach based on the ultra-violet fluorescence of microbes that provides an accurate chemical 'fingerprint' of different microbe species, strains and pathogenic forms. We wish to apply this approach to industrial fermentation processes to continuously monitor the 'health' of the fermentation, identifying contamination as it occurs in real-time.

To leverage the power of these data and to achieve the goal of continuous monitoring, spectral fingerprint variation will be captured by developing a library of generative probabilistic machine learning models. These models may then be deployed as a principled statistical mechanism for discrimination of individual fingerprints. Disambiguating fingerprints derived from varying combinations of microbes will be addressed by combining these generative models using Bayesian inferential techniques.

The interdisciplinary project will allow us to develop our technology, which has huge commercial potential, and to cement new collaborative interactions between Biology, Maths and Engineering and our industrial partners. We anticipate high level publishable outcomes relating to the approach as well as industrially relevant data. The project would allow us to develop a platform on which the interdisciplinary team can develop. The cross-disciplinary training potential for the student is outstanding, with training in contemporary spectroscopy, biophysics, statistics and chemical engineering. The student will have the advantage of being part of the Institute of Mathematical Innovation, which is ideally placed to promote mathematical solutions to industrial problems. We anticipate the student will spend time with the industrial partner to best understand the industrial process requirements and their link to the project.