

**Data Analysis, Robotics and  
Mobile Applications of Chemical Sensors**

**Technical Programme**

**Overview**

The Course explores the area of Data Analysis, Robotics and Mobile Applications for Chemical Sensors. We have put together an exciting program which will provide attendees with both theoretical background and practical experience in the above areas.

The Course covers the basic concepts of chemical sensors and sensor arrays, robotics and data analysis necessary for the successful application of chemical sensors in mobile applications. Commonly used chemical sensors as well as passive and active infrared thermographic and spectroscopic measurement methods for remote sensing will be introduced. Data analysis covers such concepts as data exploration, feature extraction, and feature selection techniques – all currently used. We will also look at linear and non-linear methods, supervised and unsupervised techniques, and parametric and non-parametric techniques. Algorithms for orientation and tracking as well as source localization and distribution mapping of gases will be covered in the robotics part.

The Course consists of lectures in the morning and exercises/demonstrations in the evening. Exercises cover data analysis of standard data-sets and real-time data from a small gas sensor system. Robot exercises will be carried out in a simulator and with a number of simple robots equipped with gas sensors in a group competition. Demonstrations include measurement systems for remote fluid leakage sensing and advanced robots for gas distribution mapping.

The Course is ideal for anyone with an interest in chemical sensor systems and robotics and is new to the field; for example, PhD students, researchers, technologists and industrialists. The computing laboratories can be carried out on a standard laptop or personal computer running the Microsoft Windows. Data-sets, software, measurement systems and robots will be provided.

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<b>School Directors:</b>	Dr Jan Mitrovics Prof Julian Gardner	JLM Innovation GmbH, Germany University of Warwick, UK
<b>Additional Lecturers:</b>	Prof Antonio Pardo Prof Andreas Kroll Dr. Marco Trincavelli	University of Barcelona, Spain University of Kassel, Germany University of Örebro, Sweden
<b>Laboratory supervisors:</b>	Victor Hernandez Samuel Soldan	University of Örebro, Sweden University of Kassel, Germany

For further information visit: [www.olfactionsociety.org/wintercourse2012/](http://www.olfactionsociety.org/wintercourse2012/)

## Schedule

### Thursday 12th January

17:30 – 19:00 Registration and laptop preparation  
20:00 Dinner (always in Hotel)

### Friday 13<sup>th</sup> January

#### 1. Introduction to sensors and data processing

##### *Morning Session: Theory*

08:30 – 09:30	Lecture 1: Introduction to chemical sensors	<b>Julian Gardner</b>
09:30 – 09:50	Coffee break	
09:50 – 10:50	Lecture 2: Sensor arrays, micro sensors and smart sensors	<b>Julian Gardner</b>
10:50 – 11:50	Lecture 3: Single sensor data processing	<b>Jan Mitrovics</b>
12:00	Lunch	

##### *Evening Session: Computer Lab*

17:30 – 19:30	Single sensor experiments and data analysis	<b>Jan Mitrovics</b>
20:00	Dinner	

### Saturday 14<sup>th</sup> January

#### 2. Linear methods and remote sensing

##### *Morning Session: Theory*

08:30 – 10:00	Lecture 4: Linear methods in smart sensor arrays (PCA, LDA, PCR, PLS,..)	<b>Jan Mitrovics</b>
10:00 – 10:20	Coffee break	
10:20 – 11:50	Lecture 5: Infrared thermographic and spectroscopic measurement methods	<b>Andreas Kroll</b>
12:00	Lunch	

##### *Evening Session: Sensing Lab and Demonstration*

17:30 – 19:30	Remote fluid leakage sensing Data analysis with linear methods	<b>Samuel Soldan</b> <b>Jan Mitrovics</b>
20:00	Dinner	

**Sunday 15<sup>th</sup> January**

**3. Advanced algorithms for data analysis, introduction to robotics**

*Morning Session: Theory*

08:30 – 09:30	Lecture 6: Analysis of time-dependent data-sets	<b>Antonio Pardo</b>
09:30 – 09:50	Coffee break	
09:50 – 10:50	Lecture 7: Non-linear data analysis with artificial neural networks	<b>Antonio Pardo</b>
10:50 – 11:50	Lecture 8: Mobile robot olfaction: Robotics prerequisites	<b>Marco Trincavelli</b>
12:00	Lunch	

*Evening Session: Computer Lab*

17:30 – 19:30	Data analysis with artificial neural networks Simple experiments with mobile robots	<b>Jan Mitrovics</b> <b>Victor Hernandez</b>
20:00	Dinner	

**Monday 16<sup>th</sup> January**

**4. Robotics**

*Morning Session: Theory*

08:30 – 09:50	Lecture 9: Problems of sensor drift, time-varying parameters and aging	<b>Julian Gardner</b>
09:50 – 10:10	Coffee break	
10:10 – 11:50	Lecture 10: Mobile robot olfaction: Challenges	<b>Marco Trincavelli</b>
12:00	Lunch	

*Evening Session: Robotics Lab*

17:30 – 19:30	Demonstrations with a TurtleBot Robot competition	<b>Marco Trincavelli</b> <b>Victor Hernandez</b>
20:00	Dinner	

**Tuesday 17<sup>th</sup> January**

**5. Future trends and real life applications**

*Morning Session: Theory*

08:30 – 09:30	Lecture 13: Biologically-inspired signal processing	<b>Antonio Pardo</b>
09:30 – 09:50	Coffee break	
09:50 – 10:50	Lecture 14: Robot applications	<b>Marco Trincavelli</b>
10:50 – 11:50	Lecture 15: Real life applications of chemical sensors	<b>Jan Mitrovics</b>
11:50 – 12:00	Concluding remarks and farewell	<b>Julian Gardner</b>
12:00	Lunch and end of ISOCS School	

About the lecturers:

**Julian Gardner** is Professor of Electronic Engineering in the School of Engineering at Warwick University, UK. He is a Fellow of the Royal Academy of Engineering and has worked with more than 25 companies in the past 20 years developing CMOS gas sensors and electronic noses. His current research interests include the fields of smart sensors, biomimetic MEMS devices, and artificial olfaction.

**Antonio Pardo** is associate professor in the Department of Electronics at Barcelona University. He has been involved in several scientific and technologic projects in which the chemical instrumentation has a key role. His research interests include signal processing for gas sensors and pattern recognition as well as hardware and software developments for electronic noses.

**Andreas Kroll** is head of the Department for Measurement and Control in the Faculty of Mechanical Engineering at the University of Kassel. Research interests include methods for nonlinear modeling and control, complex systems, remote sensing and data processing. Application interests include mobile robots, automotive/mechatronic as well as power and processing plants.

**Marco Trincavelli** is a postdoctoral researcher at the Applied Autonomous Sensors System research center, Örebro University, Sweden. He has worked at the Tokyo University in the lab of Prof. Hiroshi Ishida and the BioCircuits Institute at the University of California, San Diego. His research interests include machine learning and artificial olfaction with particular focus on mobile robotics application.

**Jan Mitrovics** co-founded a spin-off company to commercialize electronic nose technology in 1997. In 2004 he started JLM Innovation where he develops sensor systems, sensor networks and data analysis tools. Jan has been involved in the development of many different sensor array platforms that are used in a broad range of industrial, consumer, safety and research applications.