COST TU1402 Training School on the Value of Structural Health Monitoring Information

Objective

The objective of the COST TU1402 Training School is to provide the basic concepts for Value of Structural Health Monitoring (SHM) Information analyses in the framework of Bayesian decision theory. Through the training school, the students will acquire knowledge and skills on probabilistic fundamentals and probabilistic modelling, structural reliability analysis, modelling measurement information and decision analyses. A student who successfully has taken part in the course will be able to:

- Perform Value of SHM Information and decision analyses
- Select appropriate decision analyses types
- Develop and apply probabilistic models of the relevant uncertainties in decision analyses, in structural reliability analyses and for measurement information modelling

Dates and venue

06.11.2017 to 09.11.2017, Villa La Collina – Cadenabbia near Lake Como, Italy (see also "How to get to Villa La Collina (Cadenabbia)" and "Accommodation").

www.kas.de/villalacollina

Lecturers

- Prof. **Michael H. Faber**, Aalborg University, Aalborg, Denmark
- Prof. **John Dalsgaard Sørensen**, Aalborg University, Aalborg, Denmark
- Prof. **Jochen Köhler**, Norwegian University of Science and Technology, Trondheim, Norway
- Prof. **Sebastian Thöns**, Technical University of Denmark, Lyngby, Denmark
- International Guest Lecturers Dr. **Carl Malings** and Prof. **Matteo Pozzi**, Carnegie Mellow University, Pittsburg, USA

All lectures will be audio and video recorded to be accessed on a sharing platform.

Training School Plan

The Training School consists of the three parts, preparation, lectures and exercises as well as a report. A certificate of the course attendance (and 2.5 ECTS points for PhD students) will be handed out, given a positive evaluation of all three parts.

The videos of the lectures, reports and developed tools will be shared on a file sharing platform.

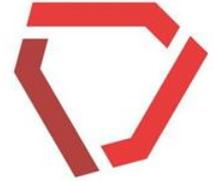For the lectures and exercises, it is recommended to bring a laptop with MATLAB.

Preparation
Faber M. H.: Statistics and Probability Theory in Pursuit of Engineering Decision Support: Springer, 2012. ISBN 978-94-007-4055-6.

Lectures and exercises

Day 1 (06.11.17): Probabilistic fundamentals and modelling

Time	Lecturer	Topics
08.30-10:00	Sebastian Thöns	**Introduction and descriptive statistics** ▪ Introduction of course and lecturers ▪ Numerical and graphical data description ▪ Data pair description
		Coffee Break
10:30-12:00	Jochen Köhler	**Probability theory fundamentals** ▪ Definitions and axioms of probability ▪ Set theory, probability theory and Bayesian updating ▪ Uncertainty modelling with random variables
		Lunch Break
13:00-14:30	John D. Sørensen	**Probabilistic Modelling** ▪ Maximum Likelihood Method ▪ Bayesian regression analysis ▪ Determination of model uncertainties
		Coffee Break
15:00		**Exercises, self-study and reading**

Day 2 (07.11.17): Structural reliability and measurements

Time	Lecturer	Topics
08.30-10:00	Jochen Köhler	**Structural reliability** ▪ Introduction to reliability analysis ▪ First order reliability method (FORM) ▪ Monte Carlo simulation ▪ Importance sampling
		Coffee Break
10:30-12:00	John D. Sørensen	**Structural system reliability analysis** ▪ Load and resistance modelling ▪ Logical systems, Daniels systems ▪ Target reliabilities
		Lunch Break
13:00-14:30	Sebastian Thöns	**Adaptation of structural reliability with measurement information** ▪ Probabilistic modelling of measurements (measurement uncertainty, probability of detection) ▪ Updating of structural reliability
		Coffee Break
15:00		**Exercises, self-study and reading**
20:00		**Training School Dinner,** Grand Hotel Cadenabbia (see last page)

Day 3 (08.11.17): Decision analyses

Time	Lecturer	Topics
08.30-10:00	Michael H. Faber	**Introduction and fundamentals of Bayesian decision analysis** ▪ Prior, Pre-posterior and Posterior decision analysis ▪ Quantification of utilities
		Coffee Break
10:30-12:00	Sebastian Thöns	**Value of Information analyses and decision analysis types** ▪ Types of Value of Information analyses ▪ Decision analyses types ▪ Derivation of decision rules
		Lunch Break
13:00-14:30	Carl Malings and Matteo Pozzi	**Value of Information analyses cont.** ▪ Introduction to Gaussian random field models ▪ Evaluation of Value of Information in Gaussian random fields ▪ Optimal sensors placement and inspection scheduling using Value of Information
		Coffee Break
15:00-16:00	Michael H. Faber	**Closing remarks**
16:00		**Exercises, self-study and reading**

Day 4 (09.11.17): Keynote presentation and supervised work on report task

08:30 – 09:30	**Work on report task**
	Coffee Break
10:00 – 12:00	**Supervised work on report task** ▪ WG1 Supporters: Michael H. Faber, Sebastian Thöns, Jianjun Qin ▪ WG2 Supporters: Michael Döhler, Alan O'Connor ▪ WG3 Supporters: Eleni Chatzi, Costas Papadimitriou, Elisabeth Bismuth
	Lunch Break
13:00 – 16:00	**Supervised work report task** ▪ WG1 Supporters: Michael H. Faber, Sebastian Thöns, Jianjun Qin ▪ WG2 Supporters: Michael Döhler, Alan O'Connor ▪ WG3 Supporters: Eleni Chatzi, Costas Papadimitriou, Elisabeth Bismuth
	Coffee Break

Report

A report has to be prepared and to be sent via email to Sebastian Thöns (sebt@byg.dtu.dk) until the 24th of November 2017. The report should contain a Value of Information analysis; task details will follow during the course.

How to get to Villa La Collina (Cadenabbia)

Public transports
There are three airports in Milan: **Malpensa, Linate, Orio al Serio.** A further option could be Lugano airport in Switzerland.

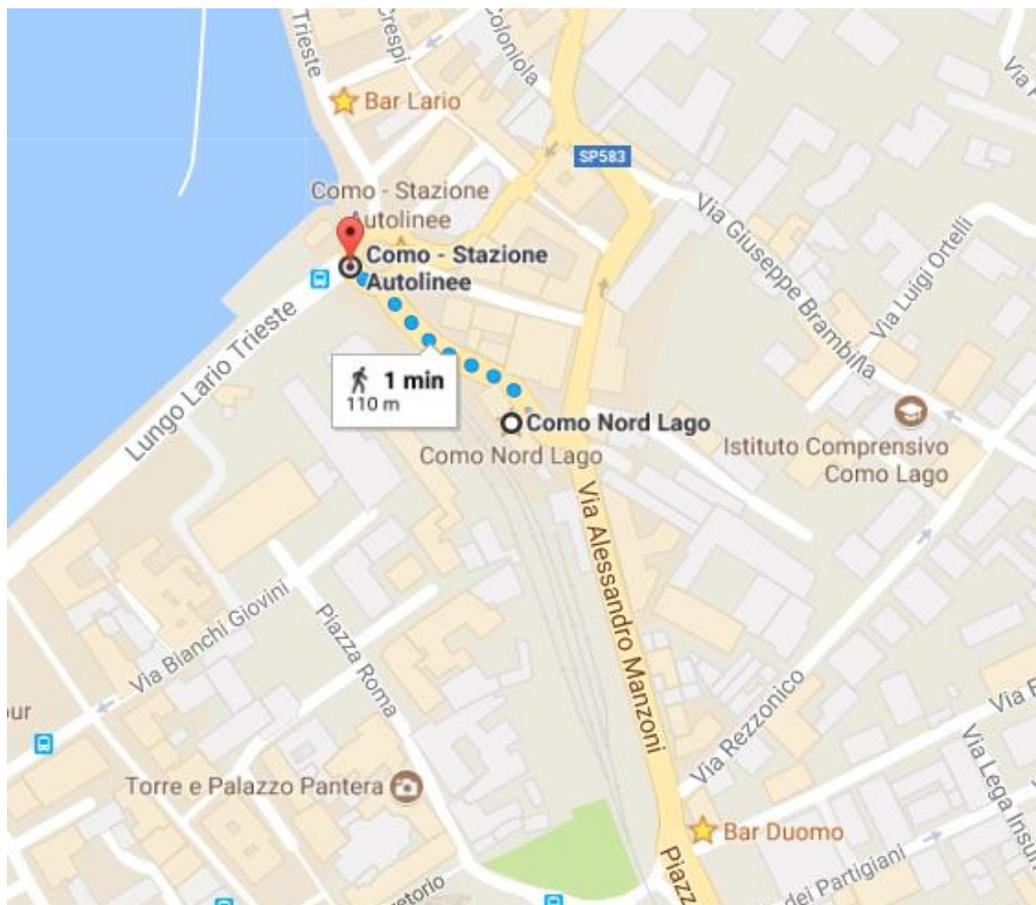From **MALPENSA AIRPORT** (approximately 2h30)
You can take the train "Malpensa Express" in direction of Milan (both directions Milano Cadorna and Milano Centrale are ok and both trains stop at Terminal 1 and 2) and change in **Saronno** for the regional train toward **Como Nord Lago.**
The full ticket from Malpensa to Como Lago Nord costs €21,80. Timetable and purchase of the tickets available at the airport or on line at http://www.trenitalia.com/.

From Como Stazione autolinee (100m from **Como Nord Lago** train station, see Map 1) to **Cadenabbia** take the bus ASF Autolinee, line **C10** direction Menaggio-Colico (it takes about 50 minutes).
Check http://www.sptlinea.it/content/en/home for the timetable.
The ticket can be purchased at Bar Lario (closed on Monday) in Lungo Lario Trieste or at Bar Duomo (closed on Sunday) in Piazza del Popolo 2 (see Map 1).

Map 1

For the way back in Cadenabbia the ticket can be purchased at the shop 'Supermarket' in via Roma 6.
The bus stop in Cadenabbia is "Cadenabbia -Majolica"

Follow the Map 2 to reach Villa La Collina from the bus stop

 Map 2

From **LINATE AIRPORT** (approximately 3h)
You can get any shuttle to **Milano Central Station** (tickets (5€) can be purchased on board) and then
a train to **Como San Giovanni.** The ticket from Milano Central Station to Como San Giovanni costs
14€ (pay attention to take the fast train). Timetable and purchase of the tickets available at the
station or on line at http://www.trenitalia.com/.

From **Como San Giovanni** to **Cadenabbia** there is a bus (but stop just in front of the station ASF
Autolinee, line **C10** direction Menaggio-Colico (it takes about 50minutes).
Check http://www.sptlinea.it/ for the timetable.
The ticket can be purchased at the newspaper kiosk (edicola) in Piazzale San Gottardo (see Map 3)
For the way back in Cadenabbia the ticket can be purchased at the Supermarket in via Roma 6.

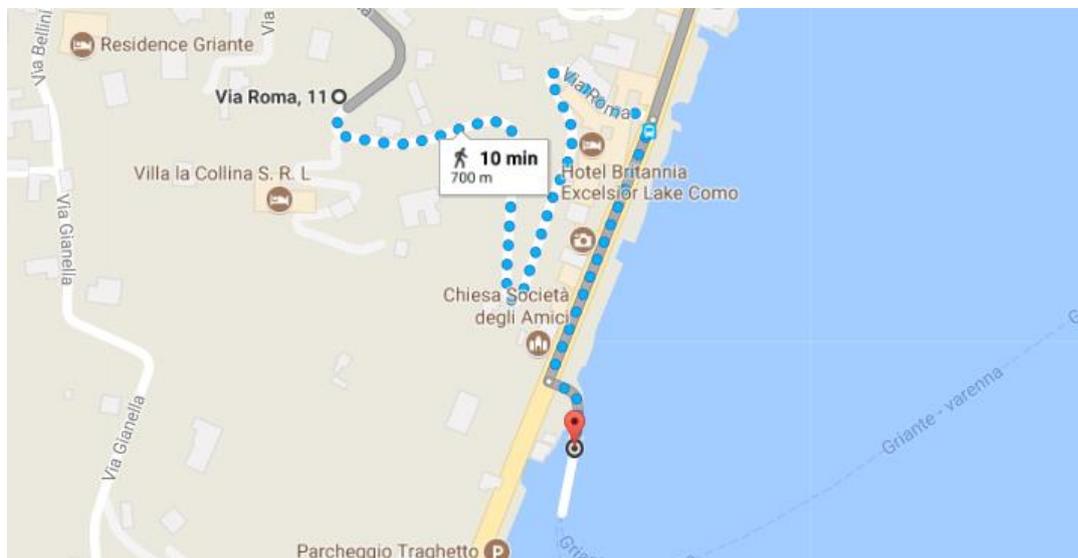Follow Map 2 to reach Villa La Collina from the bus stop.

Map 3

From **ORIO AL SERIO AIRPORT** (approximately 3h30)
You have 2 options:

1) you can take a shuttle to **Milano Central Station** (http://www.autostradale.it/ 5€, or http://www.orioshuttle.com/, 4€) and then follow the instructions reported for arrival to Linate Airport. The ticket can be purchased at the airport or on the websites.

2) You can go take the ATB Bus 1 to **Bergamo Station** (https://www.atb.bergamo.it/it/viaggia-con-noi/turismo-a-bergamo/airport-bus) and then a train to **Varenna** (here the timetable: http://www.trenitalia.com/). The ticket costs 5.5€ and can be purchased at the station or on line. **From Varenna** a ferry boat goes to **Cadenabbia** (30-45 min depending on the time of departure). Check http://www.navigazionelaghi.it/eng/ for the timetable. Follow Map 4 to reach Villa La collina from the ferryboat port.
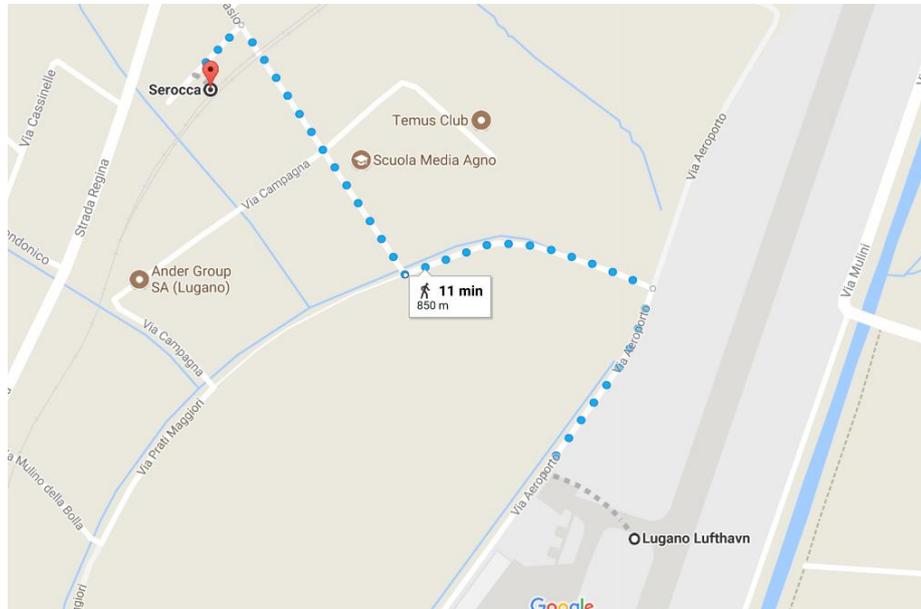

Map 4

From **LUGANO AIRPORT** (CH) (approximately 3h).
You can take the train at **Serocca station** (11 minutes by foot from the airport) or the shuttle bus to the Railway Station i**n Lugano**. Check price and timetable here for the train http://flpsa.ch/ and here for the shuttle: http://www.lugano-airport.ch/en/facilities/taxi-shuttle and http://www.shuttle-bus.com/ .

From **Lugano Station** you can take the train to **Como San Giovanni**. Check ticket and timetable here: https://www.sbb.ch/en/home.html .
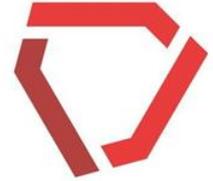From **Como San Giovanni** to **Cadenabbia** follow the instructions reported for arrivals to Linate airport.

Taxi

From Malpensa and Linate to Cadenabbia by taxi it takes around 1.30 hours (approximately 130€)
From Orio al Serio it takes about 1h (approximately 90€) to Varenna where you have to take the boat to Cadenabbia.

Shuttle

If there is a sufficient number of interested participants, we can try to organize a shuttle from the airports or from Milan Central Station (easily reachable from all the airports) to Villa La Collina.
Inform Maria Pina Limongelli if you are interested.

Accommodation

Villa La Collina ***
http://www.kas.de/villalacollina/en/
17 rooms have been reserved and will be available for reservation up to September 15.
The price of a room for the COST event is:
83€/night breakfast included for 1 persons
106€/night breakfast included for 2 persons.
To book send an email to: cadenabbia@villalacollina.it using the subject **COST TU1402.**

Booking has to be confirmed through a bank transfer of one night rate to the account:

Banca Popolare di Lecco – Deutsche Bank
IBAN: IT 65 O 03104 51520 000000018821
Agency in Menaggio BIC: DEUTITM 1023
Piazza Garibaldi, 17
I – 22017 Menaggio (Como)

Cancellation free up to October 20. Later cancellations or no show will be charged one night room rate.

Hotel Britannia Excelsior *** (5 minutes walk from Villa La Collina).
http://www.hotelbritanniacadenabbia.com/.

Please consider that in November most of the hotels in Cadenabbia are closed so early booking is warmly suggested.

Training School dinner

Grand Hotel Cadenabbia.
www.grandhotelcadenabbia.it

Via Regina, 1. Cadenabbia.
At 15 minutes walking from Villa la Collina