UiO : University of Oslo

dScience

David Cameron

1 Introduction

ITEVU4130 – Digital Twins for Science and Applications

Digital Twins for Science and Applications

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This course of 2.5 ECTS will introduce the idea of a digital twin as an integrating framework for data and computational science. Digital twin was the Gartner hype-curves hype word of the year in 2018 and 2019. This has resulted in activity to build digital twins in many fields beyond its original home in engineering and physical sciences. High level policy makers now talk of building twins of people, cities, oceans, indeed the whole world.

Despite all this interest, there is little agreement on what a digital twin is and how it is best built. This course aims to generate clarity about this, based on Oslo's long-term work on the application of digital twins in industry, science and society and on the supporting mathematics, informatics, chemistry and physics that is needed to build useful digital twins.

Despite the hype, the digital twin provides a valuable framework and template for getting impact from data and computational science.

This course:

- Introduces the concept of digital twin and discusses its history and relationship to data science.
- Presents the architectural elements of a digital twin: sensor information that is fused with modelling and static information about a system to support decisions.
- Introduces core scientific topics needed for digital twins.
  - Semantic representation.
  - Model identification and assimilation.
  - Dynamics and handling of time-series data.
  - Decision support using digital twins.
- Examines examples from industry, science, social applications and smart cities.
- Allows hands on work with time-series data from real industrial processes

Practical Details

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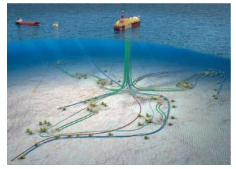
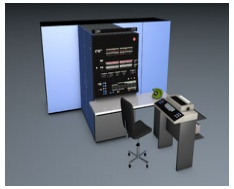
- Three sessions of four hours, spread over three days:
  - Monday 17th January
  - Tuesday 18th January
  - Friday 28th January
- Starting at 9:00 am
- Lunch from 12:00 noon – 1:00 pm
- End at 2:00 pm

- Assignment due Monday 14th February at 5pm.

A bit about my background.

1982	1986	1988	1993	2000	2007	2011	2013	2015
Chemical engineering trainee in steel industry. Thesis on physical properties of oil and CO_2	Blast furnace simulation and on-line systems. New steel technologies. 	Dynamic data reconciliation using process simulators. Use of Kalman filters on chemical processes.	Simulation and optimization of fertilizer, chemical and petroleum plants.	Whole plant simulators. Advanced control. On-line simulators. 	Virtual flow metering and on-line systems for complex sub-sea plants. 	Technical and business consultancy for IT in chemicals and petroleum	Business development for IT in petroleum, energy & industrial sector	Centre for Scalable Data Access. Research entrepreneur and translator between business and academics
								

Course Plan

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Introduction

On Digital Twins

The Data Foundation for a Twin

Analysing Digital Twins

Set-up of Industrial Data Case

Modelling and Analysis

Choosing Modelling Approaches

Industrial Applications

Looking at Industrial Data

Social and Scientific Applications

Workshop on applications

Ethics, Business and Sustainability

Review of Report Ideas

Block 1: On Digital Twins

17th January

09:00-09:10	1: Introduction	
09:10-09:20	G1: Your background and expectations	
09:20-09:40	2: What is a Digital Twin?	
09:40-10:00	Break	
10:00-10:30	3: Models and Architectures for Digital Twins	
10:30-10:50	G2: Analysis of some examples of digital twins	
10:50-11:00	Break	

Block 2: The Data Foundation for a Twin

17th January

11:00-11:20	4: Measurements, Observations and Events	
11:20-11:40	G3: Open Industrial Data – Set-up and Overview	
11:40-12:00	5: Static information in digital twins	
12:00-13:00	Lunch Break	
13:00-13:30	6: Organising Knowledge in Digital Twins	
13:30-13:50	G4: Looking at some knowledge models for Digital Twins	
13:50-14:00	Summary and Feedback on Day One	

Block 3: Modelling and Analysis

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18th January

09:00-09:10	Welcome to Day 2: Expectations and review of day 1	
09:10-09:30	7: Modelling, Simulation and Machine Learning	
09:30-09:50	G5: Choice of modelling approach for specific problems	
09:50-10:00	Break	
10:00-10:20	8: Limitations of Data, Modelling and Analysis	
10:20-10:40	G6: Investigating the industrial data set	
10:40-11:00	9: Defining the Digital Twin: The Digital Twin Canvas	
11:00-12:00	Lunch Break	

Block 4: Industrial Applications

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18th January

13:00-13:20	10: Digital Twins in Industry 4.0	
13:20-13:40	11: Industrial Frameworks for Digital Twins	
13:40-14:00	G7: Introduction to assignment and work for Day Three	

Block 5: Social and Scientific Applications

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28th January

09:00-09:10	Welcome to Day 3: Expectations and review of day 2	
09:10-09:30	12: Digital Twins in the Physical Sciences	
09:30-09:50	G8: Scoping a digital Twin for a scientific application	
09:50-10:00	Break	
10:00-10:20	13: Your Digital Twin: Medicine, Social Credit and Big Brother	
10:20-10:40	G9: Scoping a personal twin application	
10:40-11:00	14: Smart Cities, Twin-Driven Policy and the Built Environment Twin	
11:00-12:00	Lunch Break	

Block 6: Ethics, Business and Sustainability

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28th January

13:00-13:20	15: Ethics and Digital Twins	
13:20-13:40	16: Realising Digital Twins: Business Cases and Projects	
13:40-14:00	G10: Questions on Assignment. Review of Course