CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ

Big Data Processing

L01: Module Introduction

Dr. Ignacio Castineiras
Department of Computer Science

Outline

1. Presentation.
2. Learning Outcomes.
3. Syllabus Week Plan.
4. Methodology.
5. Evaluation.
6. Motivation.

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Presentation

- Ignacio Castiñeiras.
  - Lecturer at the Department of Computer Science.
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  - Office Room: C131
  - Telephone: +353 21 433 5857

- Qualification:
  - PhD. in Computer Science: 2014.
  - MEd. in Computer Science: 2011.
  - MSc. in Computer Science: 2009.
  - BSc. in Computer Science: 2007.

Dr. Ignacio Castineiras Department of Computer Science

Research Experience

[2018 -] Cork Institute of Technology
Lecturer at Dept. Computer Science
- Research Group Ríomh

[2015 - 2018] Cork Institute of Technology
Assistant Lecturer at Dept. Computer Science
- Research Group Ríomh

[2014 - 2015] University College Cork
Postdoc at Insight Centre for Data Analytics
- EU FP7 Project GENiC

[2007 - 2014] Complutense University of Madrid
PhD. & MSc. at Declarative Programming Group
- Spanish National Projects FAST & MERIT

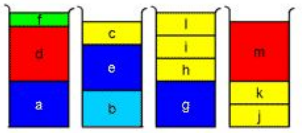
Background: Optimisation and decision analytics.
Application of **Constraint Programming** to real-life
Constraint Satisfaction and Optimisation Problems.

Research Background

- Constraint satisfaction and optimisation problems:
  - Examples: Manufacturing & service industries:
  - Feasible/optimal allocation/scheduling of company resources.
  - Challenge: Combinatorial nature.
- Constraint Programming:
  - Subfield of Artificial Intelligence.
  - High-level declarative problem formulation.
  - Problem solving: Inference process + search on top of it.

PhD. Research Experience

- Tackle real-life problems with Constraint Programming
  - Employee Timetabling Problem.
  - Bin Packing Problem.



- Comparison among multiple paradigms and solvers.
  - Algebraic - Object Oriented - (Functional) Logic Programming
  - C++, Python, SICStus Prolog, Haskell, TOY, etc.
- Implementation of constraint solvers:
  - Adapt object-oriented solver library to a logic programming environment.
  - Extend solver with high-level user defined search strategy specification.

Postdoc Research Experience

- GENiC: Globally Optimised Energy Efficient Data Centres.
  - Green computing.
  - Sustainable DCs.
  - Renewable energy sources.

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UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

TU/e Technische Universiteit Eindhoven University of Technology

IBM

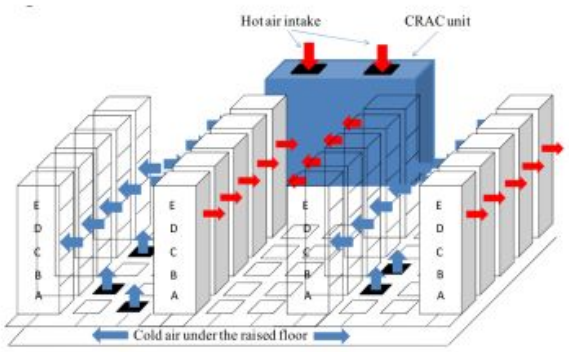
United Technologies Research Center

Atos

acciona
Infraestructuras

Postdoc Research Experience

- Develop scalable decision support tools:
  <u>Optimise workload allocation of single and distributed DCs</u>
  - Single DC: Reduce power consumption.
  - Geographically Dcs: Reduce overall energy consumption.



Lecturer Research Experience

Ríomh: Intelligent Secure Systems Group.

Research Areas:

- Future Networks & Internet of Things
- Virtualisation Technologies
  - Cloud Computing
  - Network and Information Security
- Data Analytics
  - Machine Learning
  - Optimisation Techniques

Contact us: Donna.Oshea@cit.ie (Head)

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Learning Outcomes

Module Descriptor:
https://courses.cit.ie/index.cfm/page/module/moduleId/13442

- LO1: Appraise how the velocity, volume and variety of data will impact how data is stored, managed and analysed.
- LO2: Survey the different tools that constitute a big data framework.
- LO3: Process large-scale temporal, geospatial, text and graph datasets using descriptive and analytical tools.
- LO4: Design and develop a machine learning algorithm for performing large scale distributed computation.

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Syllabus Week Plan

Week 1: September 9th – September 15th.

Lectures

- L01. Module Introduction.
- L02. Big Data.

Lab

- Lab01. Sequential-solving: Programming Exercise.

Big Data Mindset.

- *Introductory example of a Big-Data driven society.*

Syllabus Week Plan

Week 2: September 16th – September 22nd.

Lectures

- L03-04. Distributed Programming.

Lab

- Lab02. Divide-Map-Reduce Lab Demonstration.

Big Data Mindset.

- *The thinking or mental shift big data requires: Sampling => All data.*

Syllabus Week Plan

Week 3: September 23rd – September 29th.

Lectures

- L05. Functional Programming.
- L06. Gentle Introduction to Apache Spark.

Lab

- Lab03. Divide-Map-Reduce Solving: Programming Exercise.

Big Data Mindset.

- *The thinking or mental shift big data requires:*
  Clean experiments => Messy experiments.

Syllabus Week Plan

Week 4: September 30th – October 6th.

Lectures

- L07-08. Spark Model of Parallel Computing: RDDs.

Lab

- Lab04. Functional Programming Exercises.

Big Data Mindset.

- *The thinking or mental shift big data requires: Causation (Why?) => Correlations (What?)*

Syllabus Week Plan

Week 5: October 7th – October 13th.

Lectures

- L09-10. Anatomy of the Execution of a Spark Program.

Lab

- Lab05. Inside Spark Lab Demonstration.

Big Data Mindset.

- *Datification (or the art of extracting data from the most surprising places).*

Syllabus Week Plan

Week 6: October 14th – October 20th.

Lectures

- L11-12. Spark Core API.

Lab

- Lab06. Assignment 1 - Part 1

Big Data Mindset.

- *Data Reuse: Data's multiple lives.*

Syllabus Week Plan

Week 7: October 21st – October 27th.

Lectures

- L13. Spark Core API.
- L14. Spark SQL: RDDs vs DataFrames/Datasets. Catalyst and Tungsten.

Lab

- Lab07. Assignment 1 - Part 2

Big Data Mindset.

- *Data regulations: Data ownership and its accountability.*

Syllabus Week Plan

Week 8: November 4th – November 10th.

Lectures

- L15-16. Spark SQL API.

Lab

- Lab08. Assignment 1 - Part 3

Big Data Mindset.

- *The dark side of big data: I know who you are. I guess what would you do.*

Syllabus Week Plan

Week 9: November 11th – November 17th.

Lectures

- L17. Spark SQL API.
- L18. Spark Streaming: Concepts and Infrastructure.

Lab

- Lab09. Assignment 1 - Part 4

Big Data Mindset.

- *Big data industry revolution: Education as a use-case: Get to know students better.*

Syllabus Week Plan

Week 10: November 18th – November 24th.

Lectures

- L19-20. Spark Streaming API.

Lab

- Lab10. Assignment 2 - Part 1

Big Data Mindset.

- *Big data industry revolution: Education as a use-case: Adaptative learning.*

Syllabus Week Plan

Week 11: November 25th – December 1st.

Lectures

- L21. Structured Streaming: Concepts and Infrastructure.
- L22. Structured Streaming API.

Lab

- Lab11. Assignment 2 - Part 2

Big Data Mindset.

- *Big data industry revolution: Education as a use-case: The dark side again.*

Syllabus Week Plan

Week 12: December 2nd – December 8th.

Lectures

- L23. Structured Streaming API.
- L24. Module Wrap-Up

Lab

- Lab12. Assignment 2 - Part 3

Big Data Mindset.

- *Big data: What do you think?*

Syllabus Week Plan

Week 13: December 9th – December 15th.

Lectures

Lab

- Lab13. Assignment 2 - Part 4

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Methodology

- 1h lecture (twice per week):
  - Concepts explanation.
  - Application via code examples.
  - Put together to extract conclusions.

- 2h lab session (once per week):
  - Reinforce the concepts seen in the lectures.
  - Assignments split by weeks.
  - Weekly parts: Solve a bunch of exercises and submit.
  - Assignment demo after submission.

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Evaluation

Module Descriptor:
https://courses.cit.ie/index.cfm/page/module/moduleId/13442

Assignment 1:

- Use Spark Core and Spark API to perform descriptive analytics of an real-world open source dataset.
- Compare and contrast the efficiency and expressiveness of both approaches.

Marks: 50
Deadline: Week 9 - November 17th - 11.59pm

Evaluation

Module Descriptor:
https://courses.cit.ie/index.cfm/page/module/moduleId/13442

Assignment 2:

- Use Spark Streaming and Spark Structured Streaming to perform offline and online analytics of an real-world open source dataset.
- Compare and contrast the efficiency and expressiveness of both approaches.

Marks: 50
Deadline: Week 13 - December 15th - 11.59pm

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Motivation

Why is important to study this module?

For any module I teach I usually take some minutes during lecture 1 to justify/motivate why to study the module.

In this case, the motivation has grown so much that it has become part of the indicative content: Big Data Mindset.

But, in a single point: Why to study big data?
Because it is transforming our society.

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Thank you for your attention!