Algebraic and Coalgebraic Methods in Software Development

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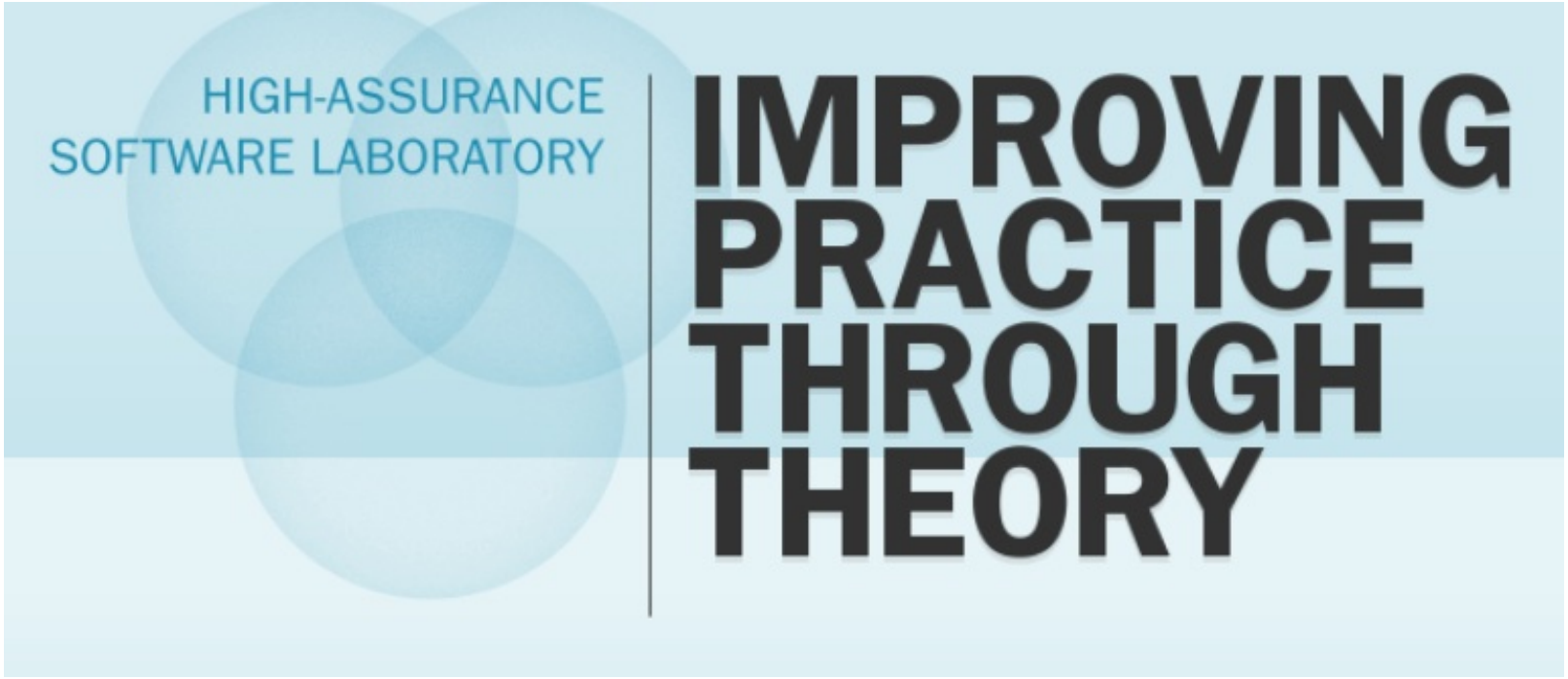
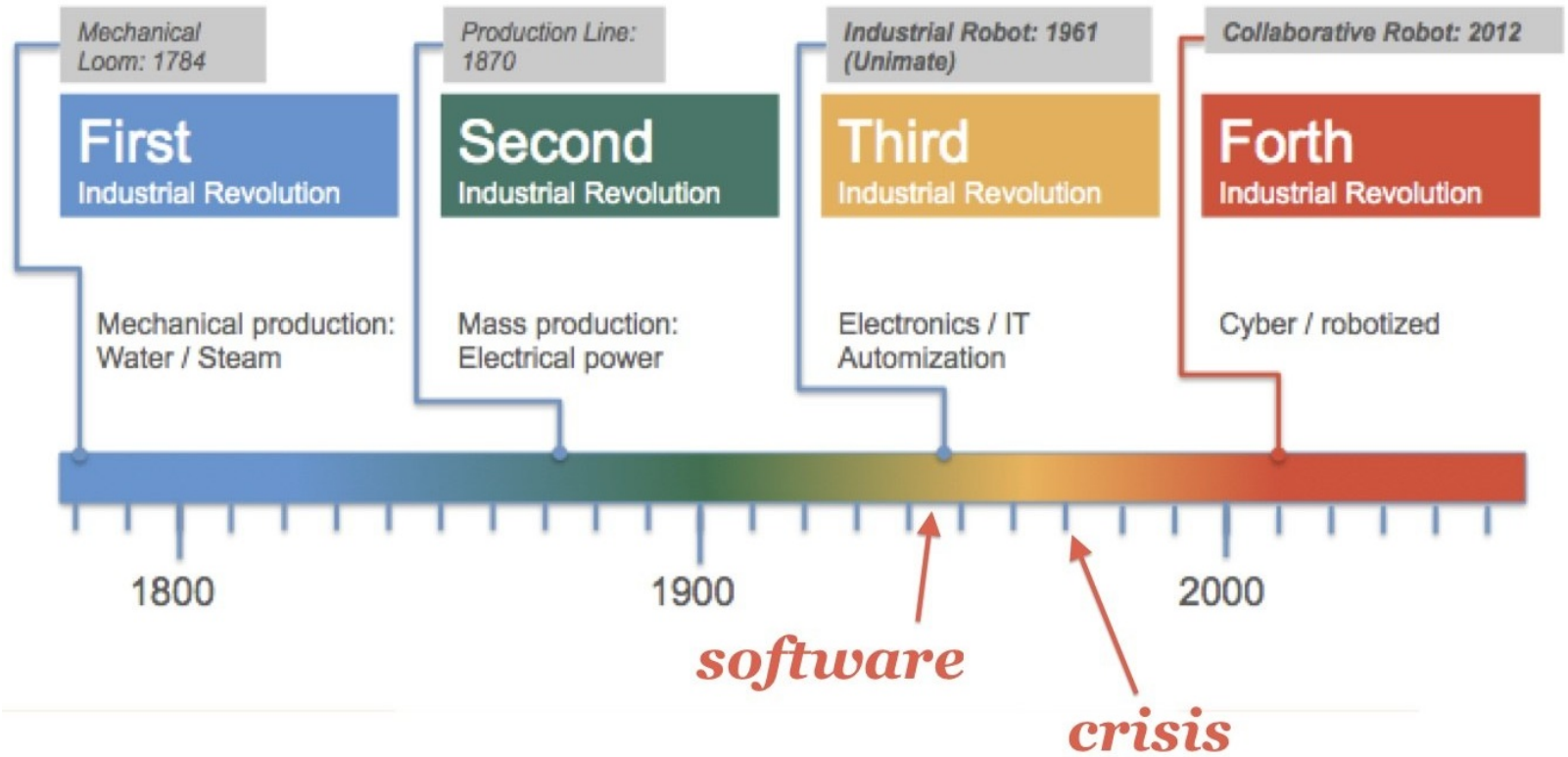
Our motto


HIGH-ASSURANCE
SOFTWARE LABORATORY
IMPROVING
PRACTICE
THROUGH
THEORY

Big picture

Industrial revolutions:



1st NATO Conference on **Software Engineering**, Darmstadt, October **1968**

Big picture

Industrial revolutions made possible by advances in

- Physics
- Software

Industry 4.0 will rely on **software** on an unprecedented scale (CPS, data-mining, robotics...)

However

- Physics is a **truly scientific** discipline
- Software is a **pre-scientific** discipline

Uupps!

> *As happened in physics, the software sciences need to find a* **unified theory**.

This course

This course is about such **unifying theory**.

This will provide you with **better** knowledge of what **computing** is all about.

Abstraction essential to better knowledge,

> *"The purpose of* **abstraction** *is not to be* **vague**, *but to create a new semantic level in which one can be* **absolutely precise**." *(E. Dijkstra)*

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even where you would expect the opposite (next slide).

Why abstraction matters

From a Robot Programming Tutorial on the web:

> *"The fundamental challenge of all* **robotics** *is this: It is impossible to ever know the true state of the* **environment**. *A* **robot** *can* **only guess** *the state of the real world based on measurements returned by its* **sensors**."

There is a sound theory for such (safe) **guessing** called abstract interpretation — and tools supporting it.

About the course title

Intimidated by

> *Algebraic and Coalgebraic Methods in Software Development ?*

Don't worry — you've seen this before without noticing:

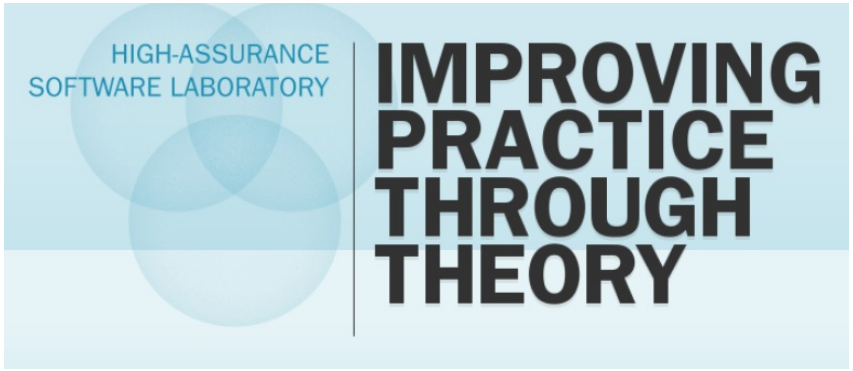
Programs = Algebras + Coalgebras

Examples:

- a **programming language** forms an **algebra**
- an **automaton** forms a **coalgebra**

Want to know why? — come to the course :-)

What for?



Which **practice**?

- data mining
- cyber-physical systems
- software architecture
- risk analysis
- probabilistic programming
- ....

Course structure

Course plan:

1. **Category theory for computer science** (JNO)
2. **Advanced Category theory** (DH)
3. **Coalgebras and coalgebraic modelling** (LSB)
4. **Algebras and algebraic specification** (MAM)
5. **Modal logics – a logics on-demand approach** (AM)

where

- AM — Alexandre Madeira, UMinho
- DH — Dirk Hoffman, UAveiro
- MAM — Manuel Antonio Martins, UAveiro
- LSB — Luís Soares Barbosa, UMinho
- JNO — José Nuno Oliveira, UMinho

Course structure

Operating mode

- Organized in 5 modules (one per lecturer)
- One lecture per afternoon (with breaks!)

Bibliography

- Papers / books suggested by lecturers

Grading

- Paper recitation (individual assessment).