

Cyber-Physical Programming

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Cyber-Physical Systems

Contents of the module

Logistics

Cyber-Physical Systems



Computational devices that interact with their physical environment



Another example of a cyber-physical system

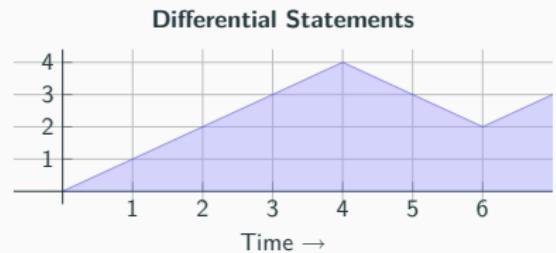


SpaceX's Starship | SN8

Computer Science meets Analysis



`(wait 2); x := x + 1; (wait 1) ...`



```
while (true) {
    if v ≤ 2
        then (v = 1 for 2)
    else (v = -1 for 2) }
```

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Genesis: David Hilbert and its
Entscheidungsproblem (circa 1928)



The problem fuelled the appearance of the first two models of computation ...

- Turing machines (circa 1936): state-based computation, part of automata theory
- λ -calculus (circa 1936): function-based computation, can be seen as a prototypical programming language

Contents of the module pt. I

We will study a myriad of models for cyber-physical computation

- timed automata,
- a hybrid while-language,
- λ -calculus extended with computational effects (**monads!**)

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and often make detours through the **mathematical foundations** of
automata and programming language theory . . .

Contents of the module pt. II

We will also get acquainted with a number of tools

- **Uppaal** – verification of real-timed systems modelled by (networks of) timed automata
- **Lince** – agile analysis of cyber-physical systems modelled by a hybrid while-language
- **Haskell** – a platform to study λ -calculus with effects

How deep will we go into the rabbit hole?

Our learning path will intersect theory and practice,
from the very basics to the state-of-the-art —
we will face current limitations and see what
challenges lie ahead



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Useful information

Relevant class material and announcements will be posted on the website periodically

<https://haslab.github.io/MFP/PCF/2122/index>

E-mail: nevrenato@di.uminho.pt

Office hours: wednesday afternoon (please send an email the day before if you wish to meet)

Assessment

Assessment will consist of

- an individual **asynchronous** test (20%)
- a group assignment on modelling and analysis of real-timed systems via Uppaal (40%)
- ...