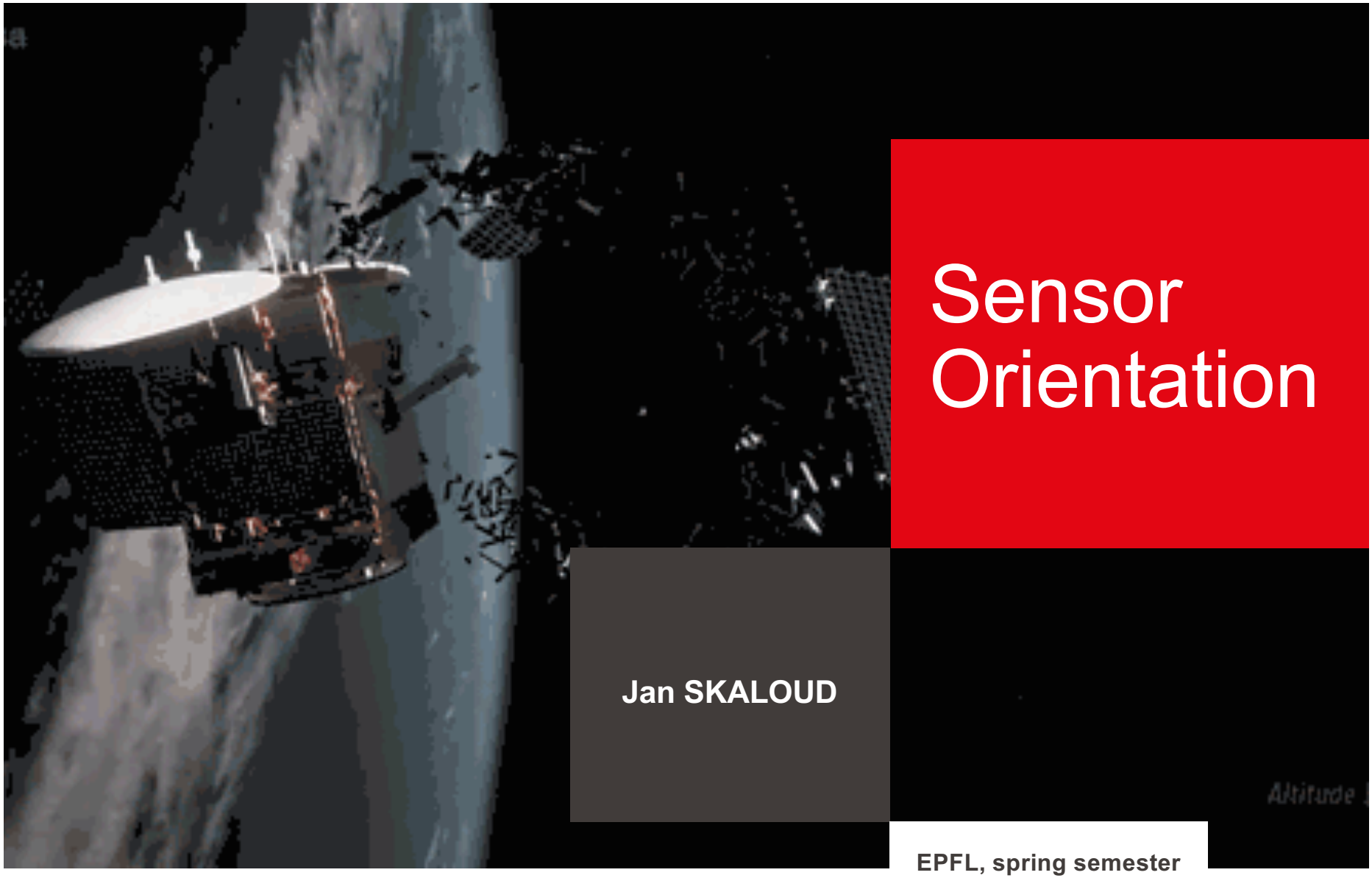
EPFL



Sensor Orientation

Jan SKALOUD

École polytechnique fédérale de Lausanne

EPFL, spring semester

Welcome to the SO course!

You will learn foundations in:

Orientation (inertial) sensors

- How they provide observations, how to quantify its quality?

Position, velocity, attitude (PVA) determination

- How to convent the observed signal for navigation, orientation in 3D?

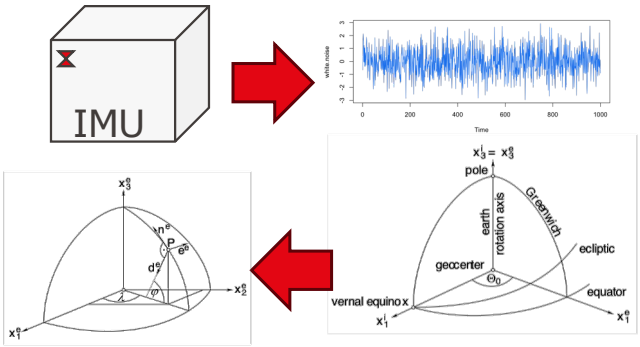
Sensor fusion

- How to integrate input of other sensors in space and time to concurrently improve the estimation and calibrate sensor?

Welcome to the SO course!

J. Skaloud, ESO

This translates into three rough big areas



1. Fundamentals
   - How to characterize sensor noise
   - How to transform from the sensed signals to navigation frame?
2. Position, velocity, attitude (navigation)
   - How to formulate navigation equation in different frames?
   - How to resolve them numerically?
3. Sensor fusion
   - How to formulate models for sensor fusion?
   - How to implement it in optimization and use it for mapping?

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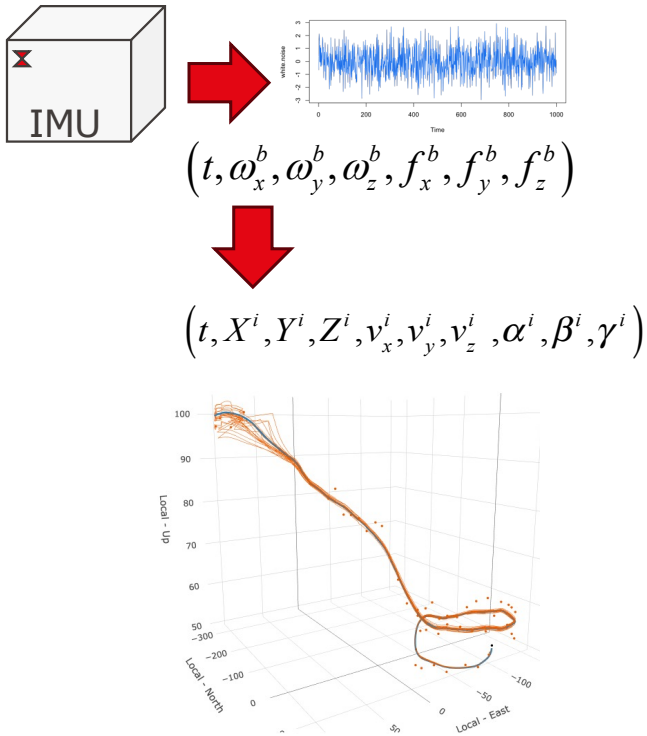

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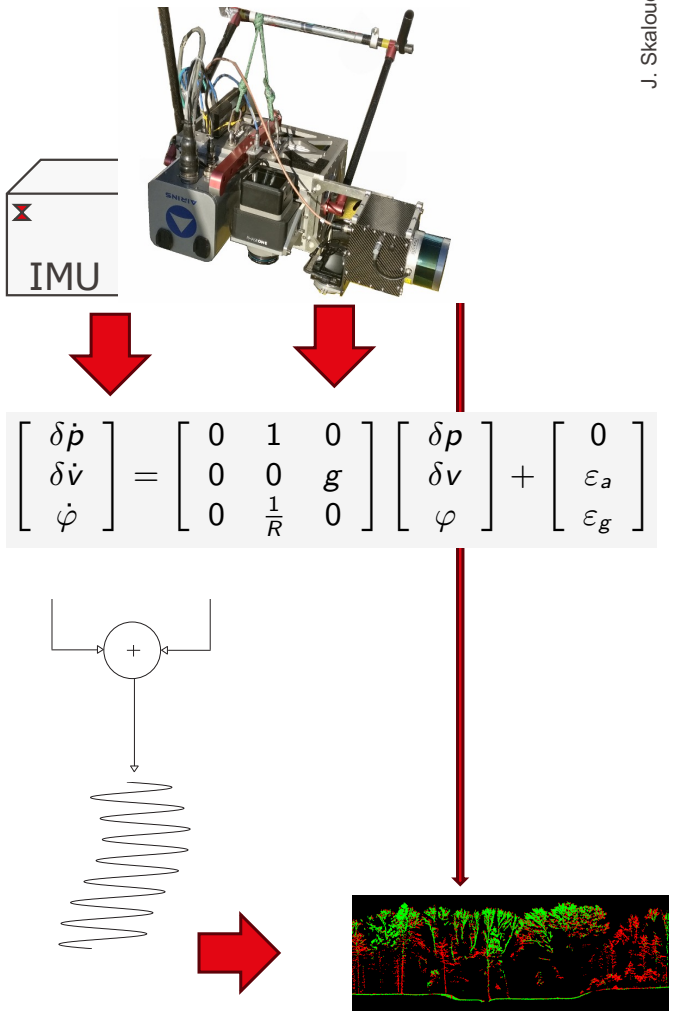

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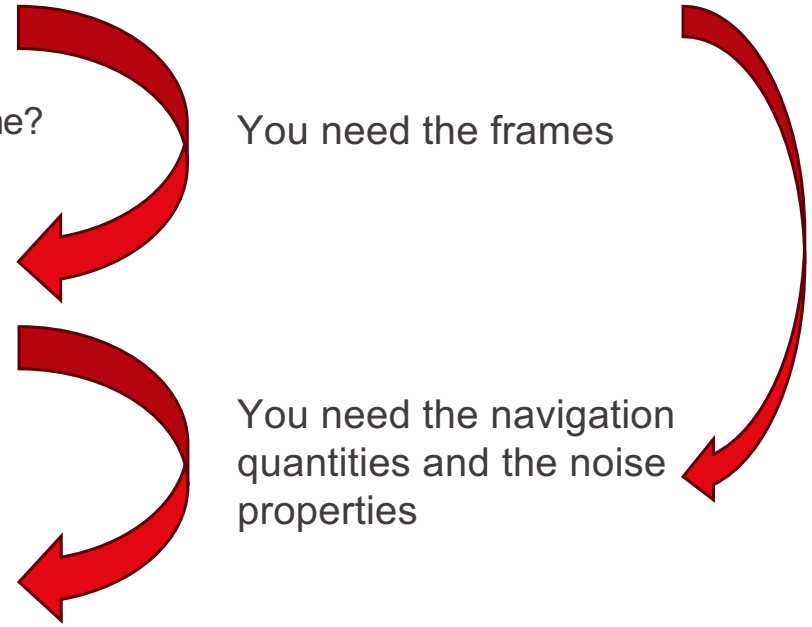

Cockpit view of SO course's topics

How to reach integrated sensor orientation?

Sensor Fusion

J. Skaloud, ESO

Cockpit view of SO course's topics

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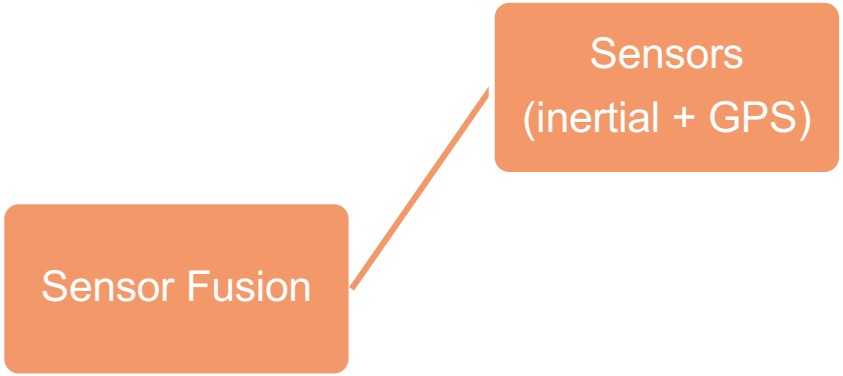

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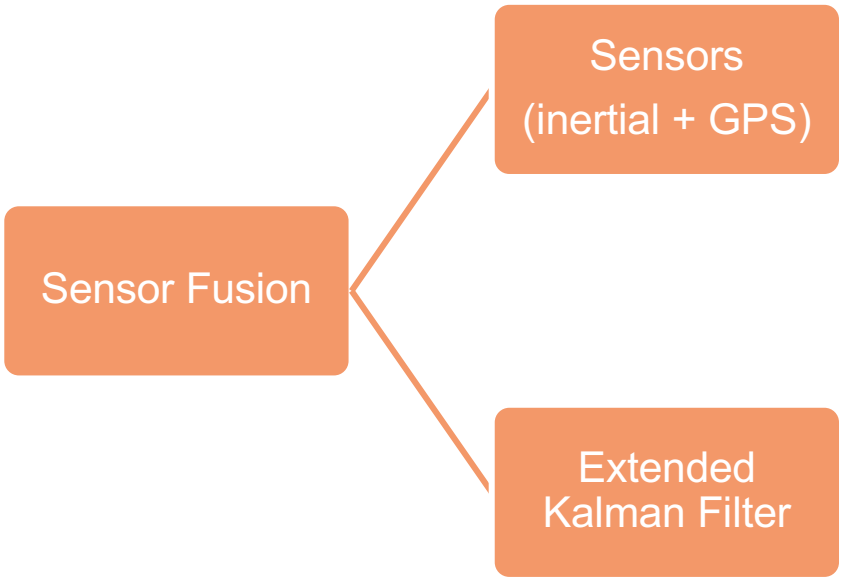

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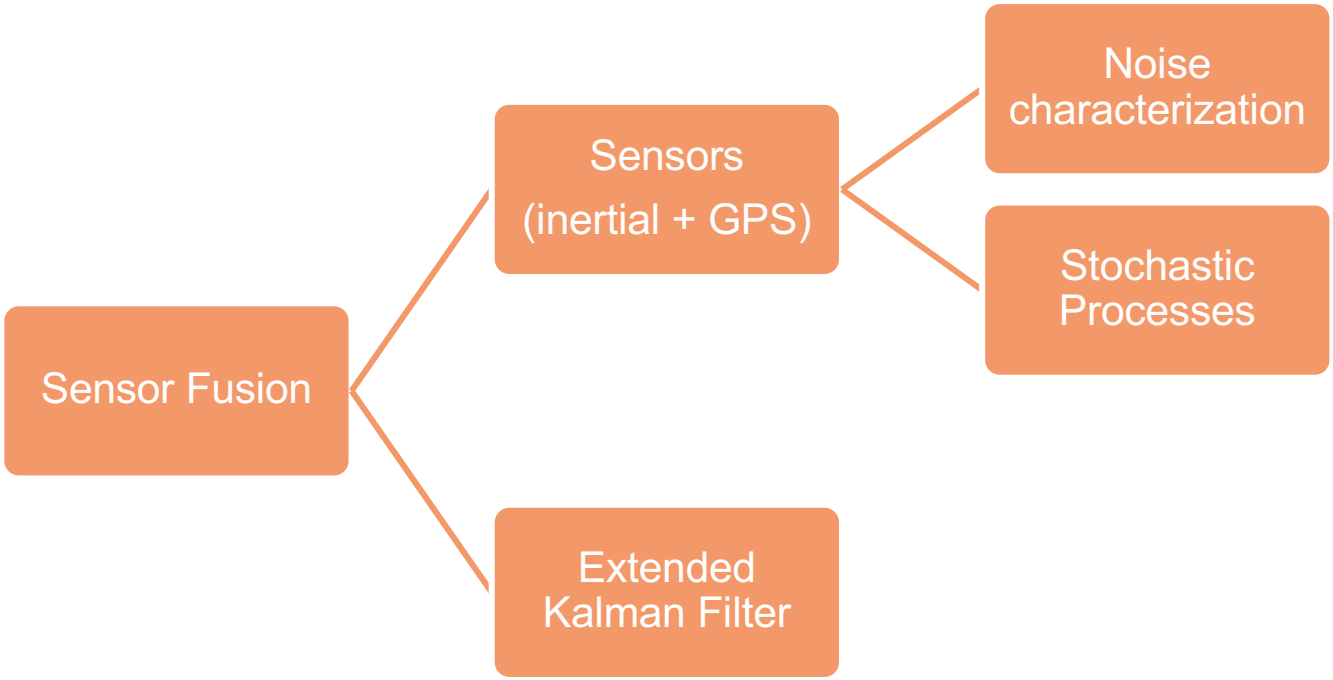

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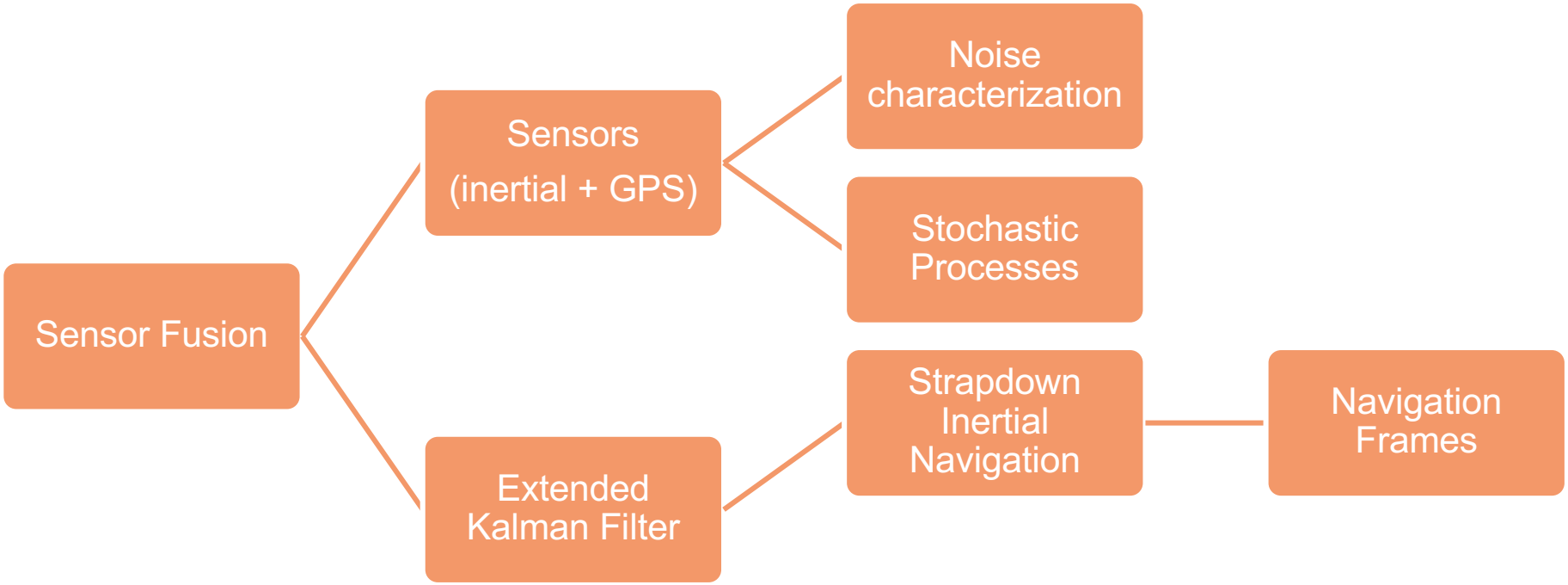

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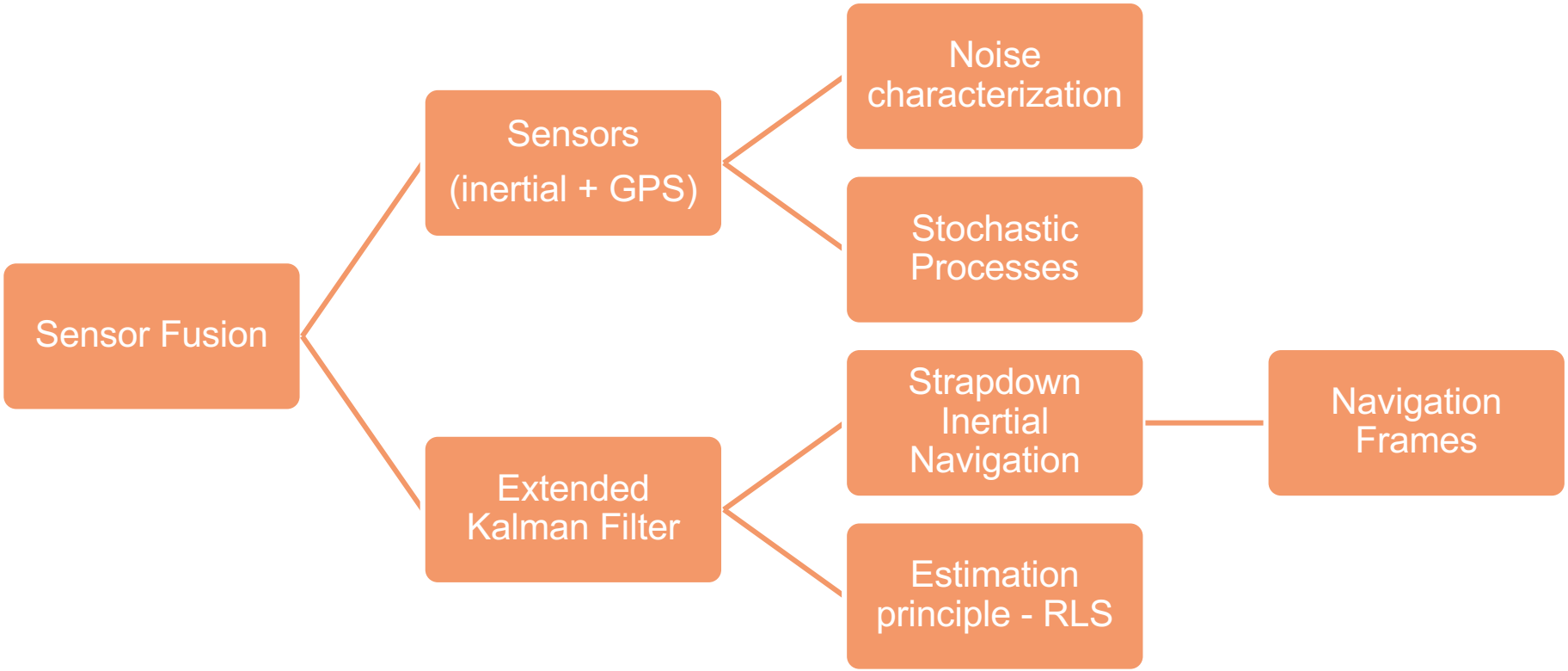

Welcome to the SO course!

What is this course transmitting in terms of “fusion”?

1. Fusion of inertial and positioning sensors via Extended Kalman Filter (EKF) at conceptual level

2. Exposing you to to tools to quantify & model the noise on different sensors

3. Exposing you to rigorous formulation of navigation/orientation equations in 3D (without limits to area size, speed, etc.)

Welcome to the SO course!

What is this course NOT about

1. It is NOT a programming course
2. NO use of REAL sensor data for fusion; ONLY CONCEPTUAL* understanding + implementation

*** With the concepts, you can play with real-data during a project**

Some admin about ENV-548

Optional course

4 credits ECTS

4h / week,

~50% lectures: Friday afternoon 13.15h-15h

~50% exercises, labs (Matlab or Python-based): Friday 15.15h-17h

Exercises & labs
are …

Key for understanding the content of the lectures!

They follow each other, and often you need the result of one as the input to the next!

Come prepared and be regular!

Do it yourself & right! (self-control possible)

6 LABs – formal evaluation, exercises not

About the exercises & labs (2)

Tools

- Programming language not imposed, gradually you build pieces of your code and re-use them in a larger structure
- Matlab or Python programming recommended & supported

The TA-s are there to help and we will provide solutions (in data and/or in code, e.g. for crucial integration into to a larger code-base).

Expectation from students

1. Regular attendance during LECTURES / EXERCISES / TUTORIALS / LABS.

2. Advance course: Homework + Reading + 3 Tests + 6 Labs = Regular work expectation.

3. Active participation and interaction during lecture & exercises

Evaluation

Labs: 30%

- Evaluate the implementation of everything: completeness & correctness & style – the real weight is higher, because it is the base for oral exam.

Midterm 20%:

- Evaluate understanding of part I & part II (fundamentals and inertial navigation)

Oral exam: 50%

- Evaluate the understanding of part III – modelling for sensor fusion, interpretation results, concepts of sensors (stands upon part I and II)

Support – Polycopié #279

It is only a useful support !

In other words: polycopié completes but does not replace the lectures & exercises !!!

Print on demand & PDF on Moodle

Key background
- Recursive least-squares
- Stochastic processes
- Reference frames

Navigation details
- 3D navigation equation
- Initialization

Other concepts
- GPS
- INS/GPS integration
- Direct sensor orientation

EPFL

Sensor Orientation*

Jan Skaloud, EPFL
Klaus Legat, TU Graz

September 2019

* Parts of these lecture notes are taken from Skaloud (1999), Legat (2005), as well as Hofmann-Wellenhof et al. (2003).

Support – Moodle

Cores

- Slides
- Assignments
- Exercises

Complementary

- Some videos (derivation)
- Some PDF (derivation)

Sensors

- Student presentation