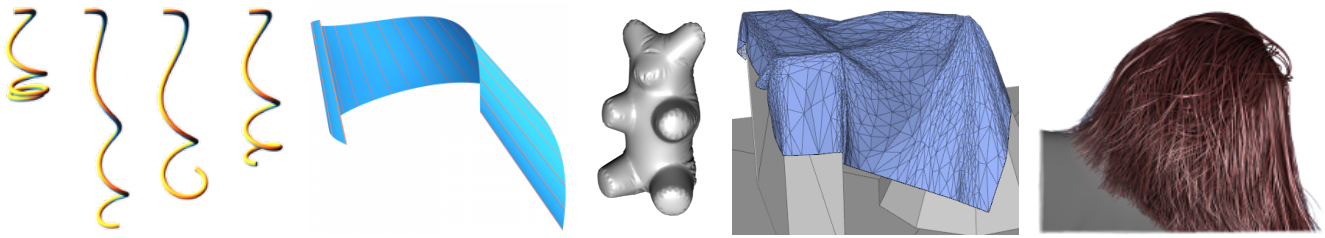
Class on numerical mechanics:

From Lagrangian mechanics to simulation tools for computer graphics



Florence Bertails-Descoubes [1], Mélina Skouras [2], Mickaël Ly [3]

2020, September 8 - ENS Lyon

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[2] melina.skouras@inria.fr
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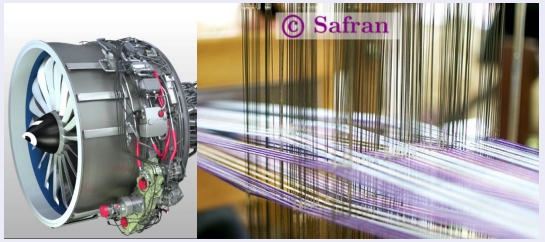
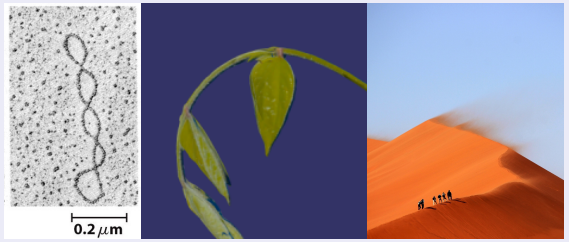
Motivation

Increasing need for effective mechanical simulators

Movie industry



Virtual prototyping



Natural sciences

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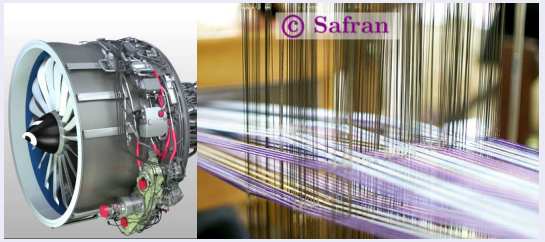

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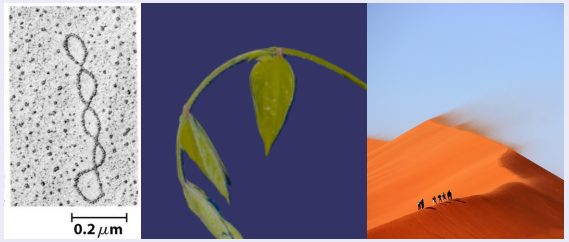
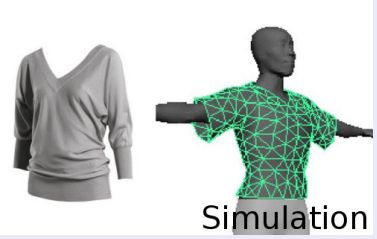
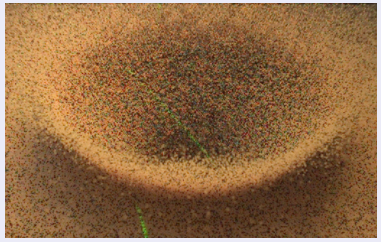
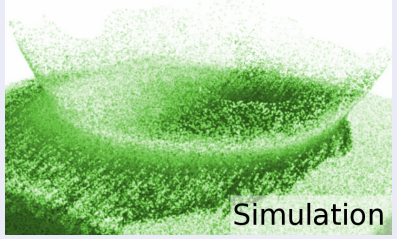


Natural sciences

Requires the numerical modeling of objects with complex shapes and motion







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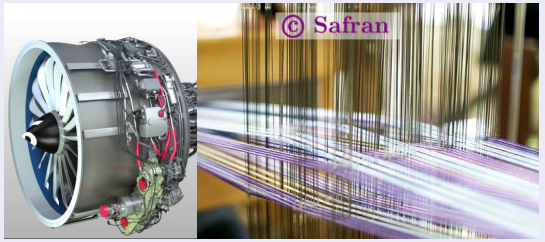

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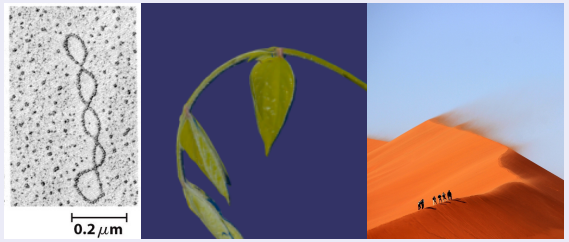

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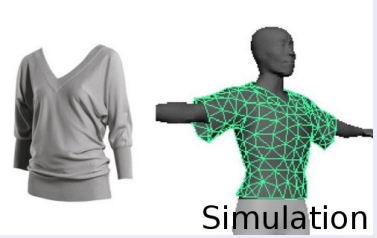

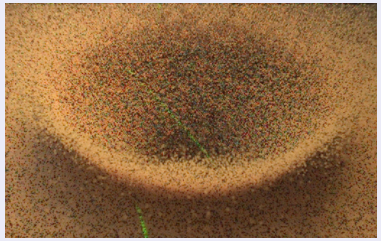

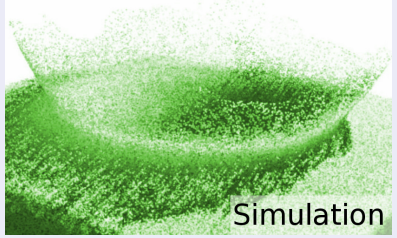

→ Challenges: nonlinear and even nonsmooth regimes

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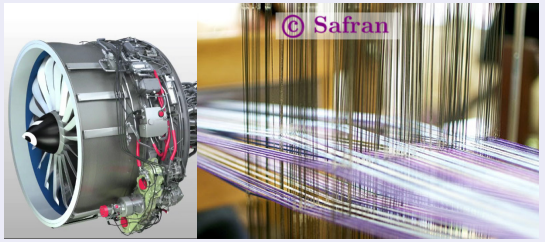

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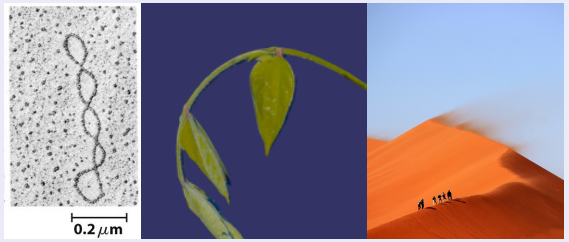

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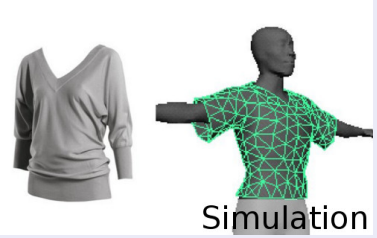

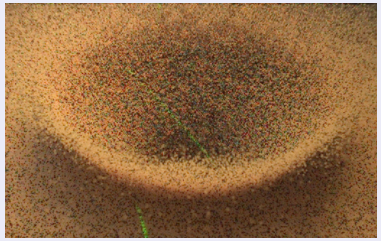

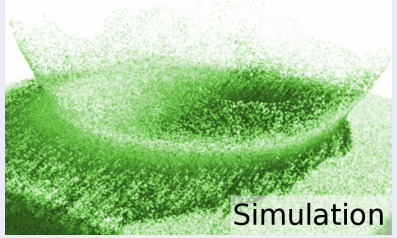

→ Challenges: nonlinear and even nonsmooth regimes

Goal: design dedicated numerical models

Realism + robustness + efficiency + user control

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Discover important concepts and techniques behind simulation

- acquire some fundamentals of numerical mechanics

  at least for deformable solid objects
- get a sense of good practices for numerical modeling
- have the right pointers to go further by yourself...

  and at some point create your own impressive simulations!

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How we have built this course

- The kind of course we would have liked to have ourselves before our PhD!
- Not a review of recent research papers, but really a course on fundamentals
- A balanced mix between mechanics and numerics
- A balanced mix between theory and practice
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Second time we deliver this course → feel free to give us feedback!!

Content of the course

Mechanics + Numerics

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- Topic 1: Lagrangian mechanics and finite differences
- Topic 2: 3D elasticity and first steps into finite elements
- Topic 3: Thin elastic rods and numerical optimization
- Topic 4: Inverse problems and constraint-based optimization
- Topic 5: Frictional contact and nonsmooth optimization

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Teaching team

- Lecturers: Mélina Skouras and Florence Bertails-Descoubes (Inria researchers)
- Teaching assistant: Mickaël Ly (3rd year PhD student at Inria)

Organization

Schedule

- 8 weeks in total, on Tuesday afternoon, starting from now and ending on 10/11
- Break: Toussaint holidays (no class on 20/10 and 27/10)

First slot (1:30pm - 3:30pm)

Alternately, lecture on mechanics or numerics + exercises
Lecturers: F. Bertails-Descoubes (weeks 1,2,5,6,8) and Mélina Skouras (weeks 3,4,7)

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Second slot (3h45 pm - 5h45 pm)

In general, practice on machine (python)
Teaching assistant: Mickaël Ly (+ presence of the other lecturer)

Evaluation

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Write practice reports

- Each Tuesday during the course, one practice sheet will be given to you
  4 practice sheets in total (some of them split in 2 parts)
- Contains a series of problems to implement and think about, with the help of **python**
- You have to write one report to describe your solution and analyze your results
- The report in PDF for each practice sheet has to be sent to mickael.ly@inria.fr
- Deadline: Monday before the next class
- Done preferably by pairs of students
- Evaluation scores will be delivered at the end of the course series ($\approx$ mid-November)

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Recommendations (you will have more details in the mid-afternoon)

- Do not wait the last minute to write your report
- The report should be well-written, clear and concise (done in LaTeX)
- It should be a (well-argumented) analysis of your results
- It should not contain code listings (code is not evaluated by itself)
- Don't hesitate to include figures and algorithms in pseudo-code
- Feel free to ask as many questions as you want during the course, or by email!

Before starting...

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A few words about BBB

White board 1/4

White board 2/4

White board 3/4

White board 4/4