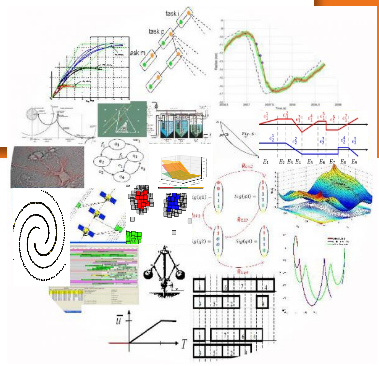
LAAS Days
Research & Technology

Artificial Intelligence, Automatic Control, Operational Research for medicine, life science and environment.

Alive Strategic Axis

Speaker: Louise Travé-Massuyès

Decision and Optimisation in the living and environment fields



Rationale: Develop constructive theoretical results and efficient computational algorithms for proposing control, supervision, diagnosis and optimization solutions

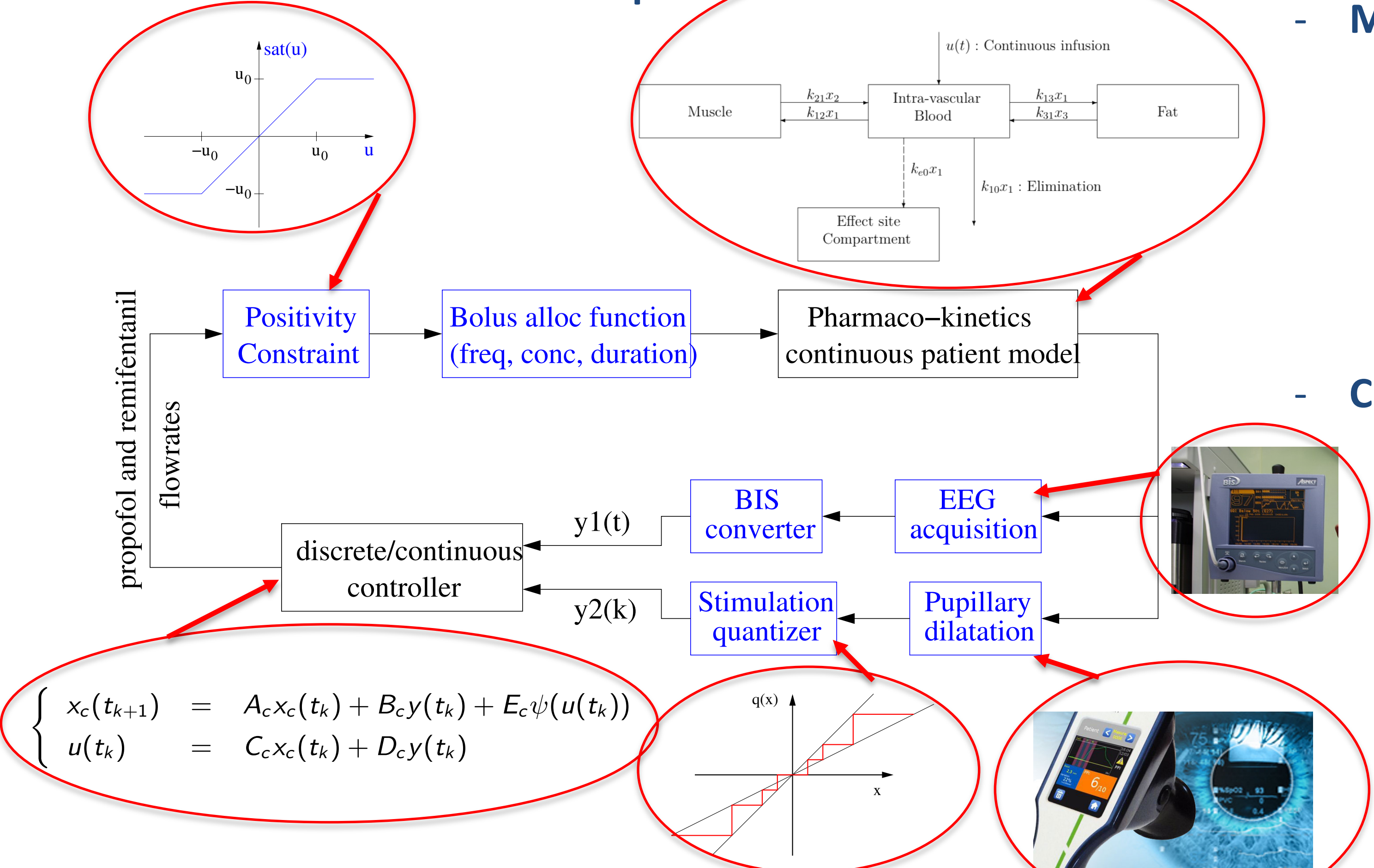
- Applied mathematics, computer science, artificial intelligence, automatic control, operations research have an everyday increasing role to play
  - More and more technology
  - More and more data

Some examples:

- Develop novel, personalized intervention methods for prevention, treatments, and drug administration
- Provide Machine Learning models to support predictions on the future development of diseases and also predicting the responses to specific therapies and preventive measures
- Identify novel patterns and health correlations in complex data sets
- Design AI-assisted diagnosis to help physicians decide about the relevant care at early stages of disease detection

Automatic feedback-control of general anesthesia during surgery

Context : From anaesthesiologist-based open-loop control to automated closed-loop control



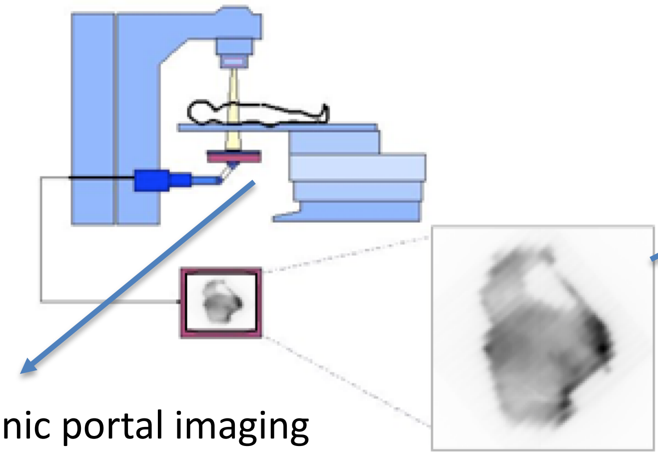
(Multi-)objective:

- **Medical point of view**
  - Fast induction
  - Maintenance
  - Avoid drug overshoot
  - Adapt to patient characteristics
- **Control theory point of view**
  - Positive system
  - Slow/fast dynamics
  - Patient uncertainty
  - Actuator saturation
  - Quantized sensor signal
  - (aperiodic) sampling

Involved: I. QUEINNEC, S. TARBOURIECH, G. GARCIA (LAAS), M. MAZEROLLES (CHU Rangueil)

Development of neural networks for 2D - quality control during radiotherapy treatment (Project DIVIN)

Context : External radiotherapy treatment.

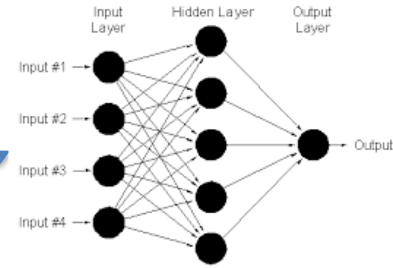


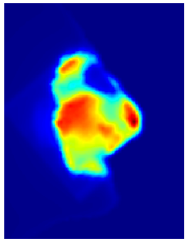
(Electronic portal imaging devEPIDice) ➔ Now, not used for improving the control before (quality control of the machine) or during the treatment

➔ If used, possibility of determination
- Absorbed dose truly received by the patient during all treatment sessions
- Re-computing the treatment plans in case of discrepancies

Objective : 2D(3D) absorbed dose reconstruction

inputs



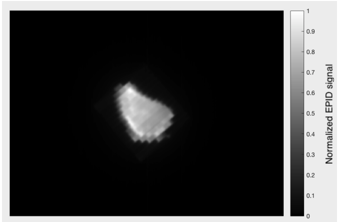


outputs

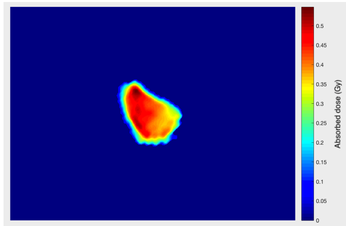
Learning phase = treatment planning system (TPS) absorbed dose distribution considered **like the truth**

➔ spatial configuration to reproduce spatial diffusion

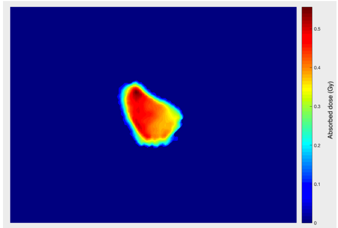
Example : *Intensity-modulated radiotherapy* (10 il/O datasets)



EPID image

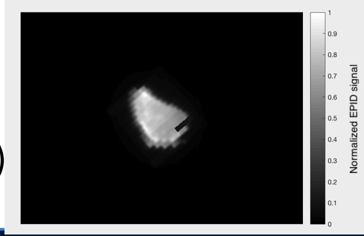


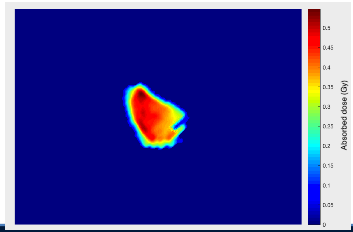
Reconstructed absorbed dose (ANN)



Planned absorbed dose (TPS): target

Detection of leaf mis-position



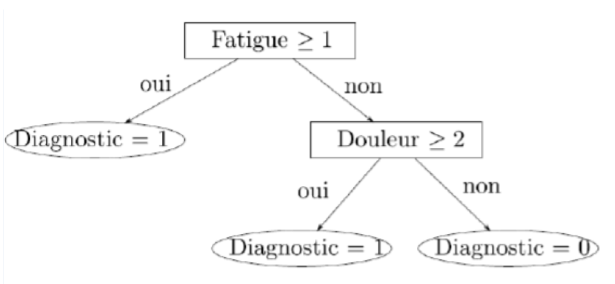


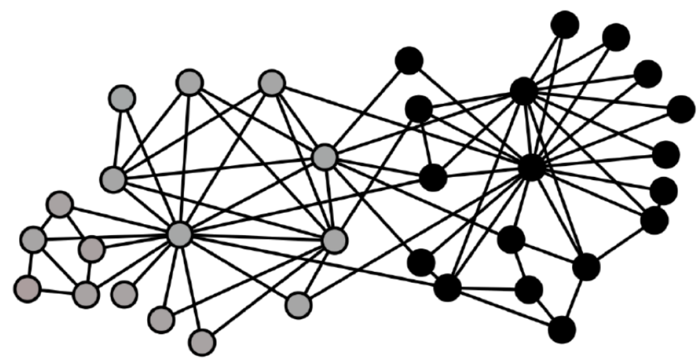
Comparison of γ index

Involved : F. CHATRIE (PhD, LAAS), MV LE LANN(LAAS/DISCO)
X. FRANCERIES (ONCOPOLE)

Combinatorial Optimization for the analysis of big amounts of biomedical data

- **Big data** to be analyzed for biomedical diagnosis
- Goal:
  - Characterize two classes: patients with pathology and patients without
  - Provide easily **interpretable rules** of the form IF condition THEN class 0/1
  - Handle discrete and continuous variables
- Minimize the number of cutting points to binarize continuous variables
- Find the support of observations (patterns covering all the set of clinical cases): set cover problem
- Reduce the support if too big: graph partitioning based on graph density to identify groups of patterns and select one single pattern to represent all the group





Involved : J. MONCEL (LAAS),
N. BRAUNER, J. DARLEY (G-SCOP)

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