POLYTECHNIQUE MONTRÉAL

UNIVERSITÉ D'INGÉNIERIE

SCAN ME

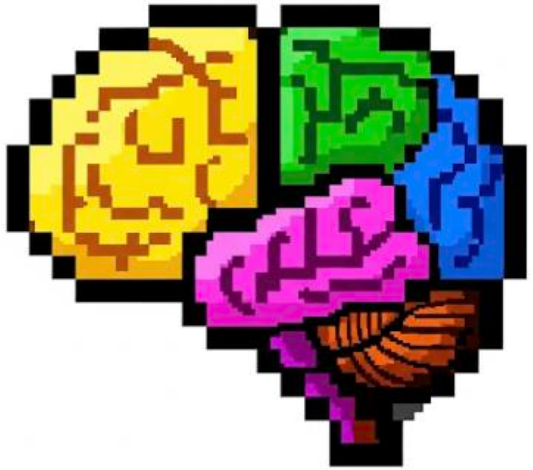
[Course Website]

Shape Analysis & Learning in Medical Imaging

GBM6953 HE – Winter 2026

Prof. Hervé Lombaert

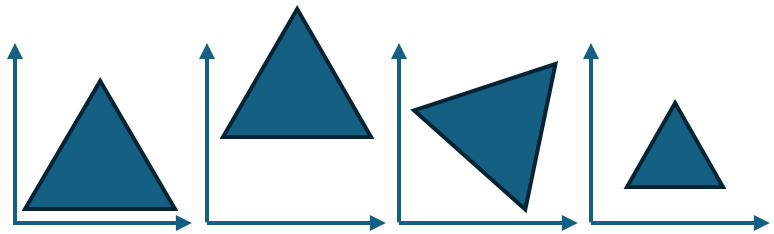
École Polytechnique de Montréal



Shape Analysis

[Course Website]

- What is the **average shape?**



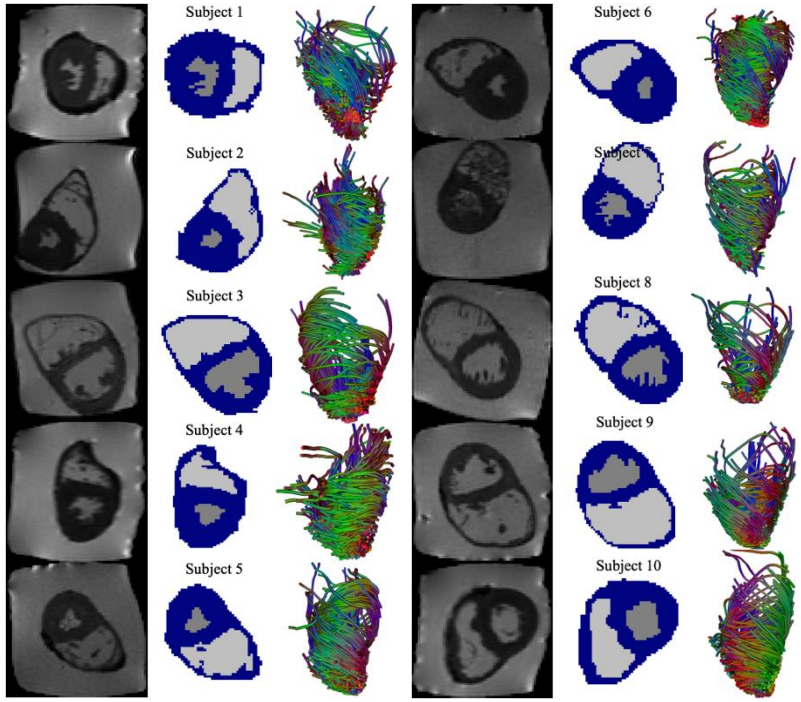
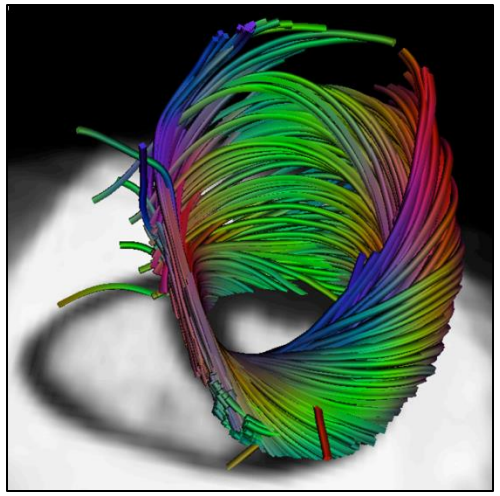
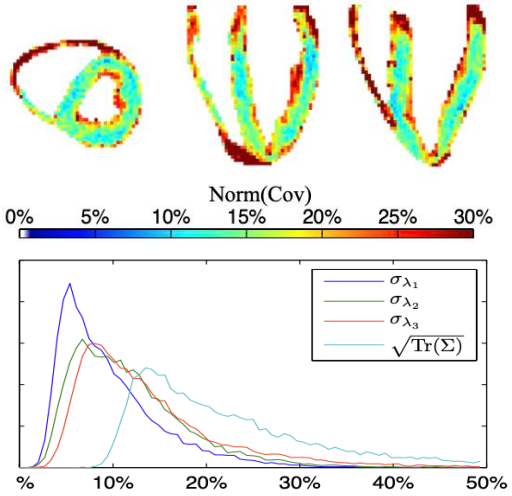


Image Processing
(segmentation, registration)



Computing
(atlas construction)



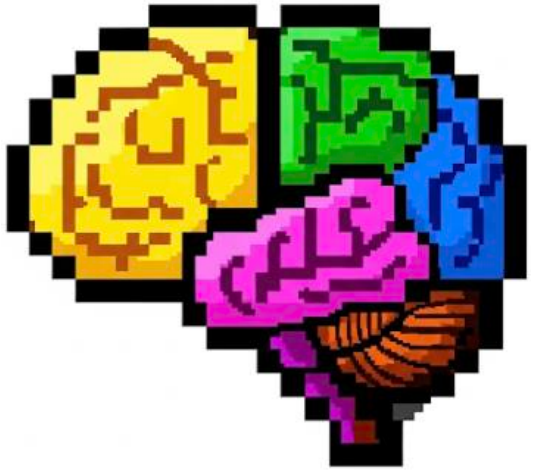
Analysis
(statistics, visualization)

H. Lombaert et al, Human Atlas of Cardiac Fiber Architecture, IEEE TMI 2012

Description

[Course Website]

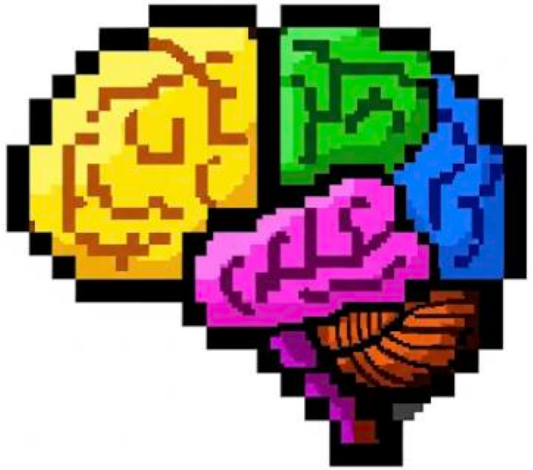
- Present and Study the **Principles of Shape Analysis** in Medical Imaging:
  - **Image & Shape Analysis** in Medical Imaging
  - **Atlas** Construction
  - **Statistical Shape Models**
  - Shape-based **Machine Learning**
- Study of **Applications in Medical Imaging**
- Review of Recent **Scientific Articles**



Objectives

[Course Website]

- Provide the principles of shape analysis in medical imaging
  - **Processing** of image and shape information
  - **Understanding** of statistical shape models
  - **Hands-on manipulation** of algorithms for shape analysis
  - **Developing** an application for shape analysis

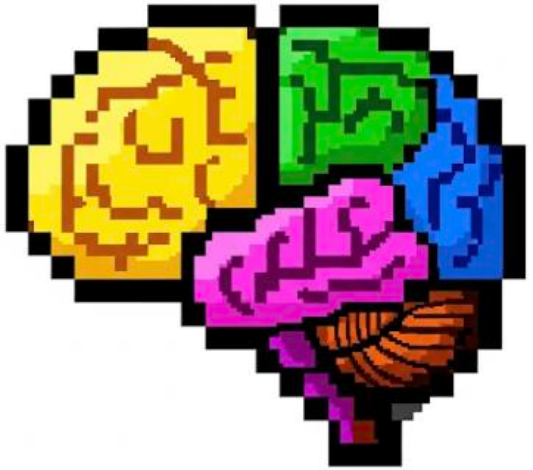


Gained Skills

[Course Website]

- At the end of this course, **you will be able to**:
  - Explain the **principles** of shape analysis to analyze 2D and 3D images
  - Describe and select **statistical shape models** to meet clinical needs
  - Analyze **shape variations** to detect anatomical abnormalities
  - Construct a statistical **shape atlas** to study populations
  - Analyze and apply recent algorithms for **medical image analysis**

- You will be ready to:
  - Develop a **shape analysis software** to analyze datasets of images
  - Work in an **internship or job** in the field of medical image analysis

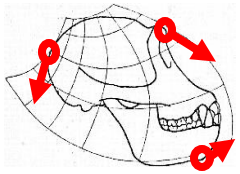


Courses

[Course Website]

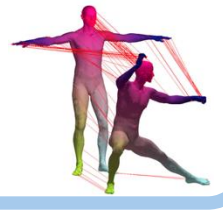
1. Intro – Context & History

- Class Syllabus
- Intro and history of shape analysis



2. Shape Descriptors

- Shape characteristics
- Contour and region-based methods



3. Segmentation

- Traditional and learning-based methods
- Evaluation

4. Registration

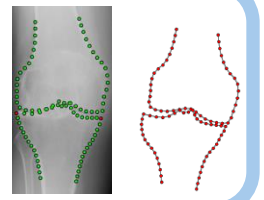
- Diffeomorphic deformations
- Learning-based, evaluation

5. Atlas Construction

- Population Representation
- Atlas Construction

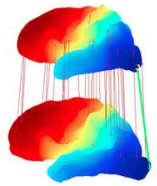
6. Statistical Shape Analysis

- Representation of Shape Statistics
- Shape Spaces



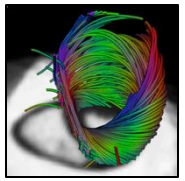
7. Spectral Shape Analysis

- Spectral Geometry
- Geometric Deep Learning



8. Recent Advances

- Recent Advances in Atlas Construction
- Recent Advances in Geometric Learning



Syllabus & Evaluation (Wednesday's PM / W2025)

40%

1. Intro – Context & History
2. Shape Descriptors — paper pres
3. Segmentation — paper pres
4. Registration — paper pres
5. Atlas Construction — paper pres
6. Statistical Shape Analysis — paper pres
7. Spectral Shape Analysis — paper pres
8. Recent Advances — paper pres

(relâche)

Exam

15%

9. Paper Review 1
10. Paper Review 2

15%

11. Project Presentation 1
12. Project Presentation 2

~~**No Final Examen**~~

10%

Lab1. **(10%)**

Image Processing

Lab2. **(10%)**

Atlas Construction

(relâche)

20%

Project. **(15%)**

Your Choice

SCAN ME

[Course Website]