AIGRETTE – Analyzing Large Scale Geometric Data Collections

Kick-Off Chaires IA

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Maks Ovsjanikov

Laboratoire d'Informatique de l'École polytechnique

ÉCOLE POLYTECHNIQUE
UNIVERSITÉ PARIS-SACLAY

AGENCE NATIONALE DE LA RECHERCHE

INSTITUT DATAIA
Science des données, Intelligence & Société

My Background

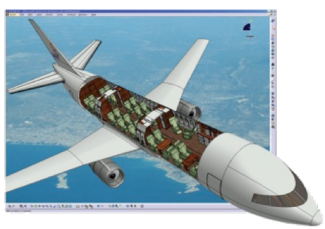
- 2005 – 2010: PhD from Stanford University (dept. of Computational and Mathematical Engineering)
- 2011: engineer at Google Inc.
- Since 2012 Professor in the Computer Science Department at Ecole Polytechnique in France (LIX lab).

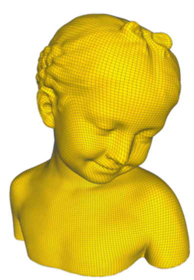
Shape Analysis at LIX – Geovic

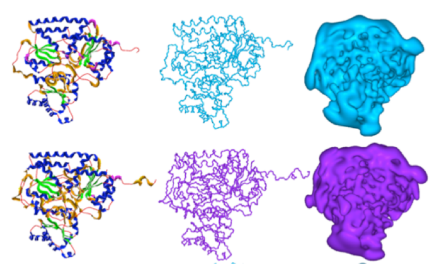
- Part of the **GeoVic** team dedicated to visual computing with 4 other permanent researchers (**Damien Rohmer**, Marie-Paule Cani, Pooran Memari, Vicky Kalogeiton).
- Many international collaborations: Stanford, MIT, UCL, KAUST, Univ. Toronto, Univ. Rome, etc.
- Currently supervising 5 PhD students and 1 PostDoc.

AIGRETTE Research Context

A deluge of *geometric* **3D data***:* Computer Aided Design, Computer Animation, Bio-medical and Cultural Heritage imaging….



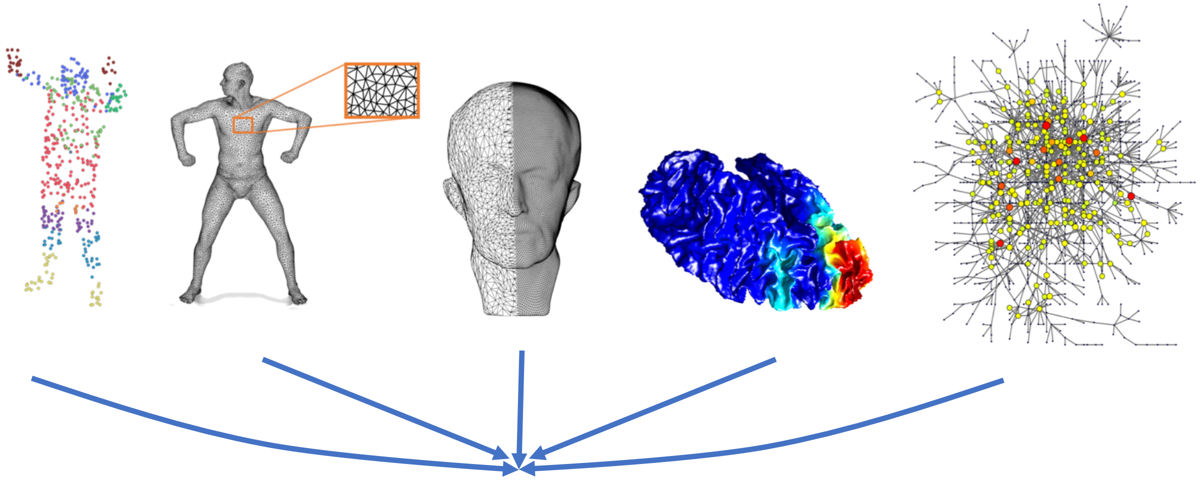




Motivation and Long Term Vision

Motivation:

A deluge of data and *its representations,* ill-suited for modern applications (point clouds, triangle, quad meshes, graphs…)



Vision:

Unified computational framework for efficient shape *processing and analysis* across different representations. Finding *detailed relations* and *differences* in the data.

AIGRETTE – Challenges

Challenges:

Most successful learning methods rely on

1. A lot (!) of labeled training data
2. Convolutional Neural Networks (CNNs)

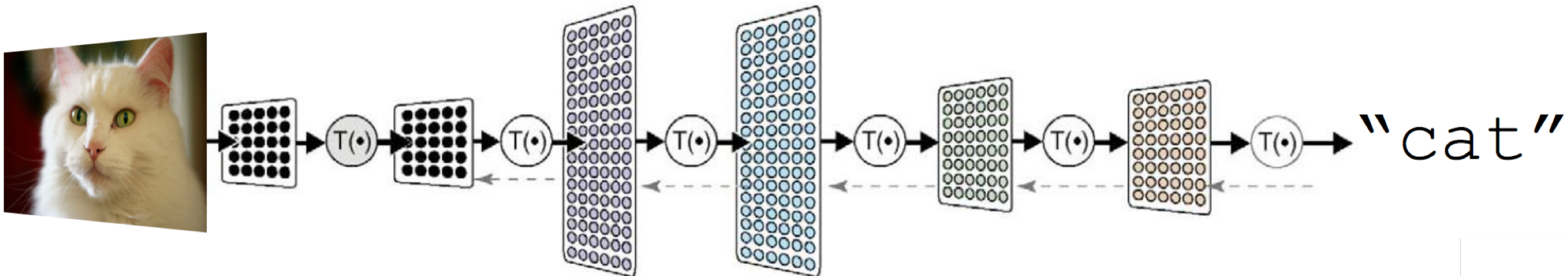
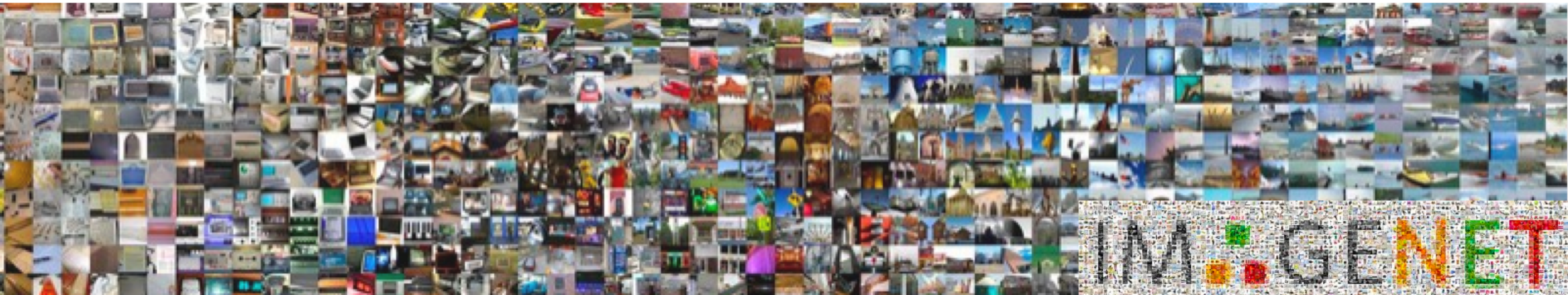


image by Jeff Dean

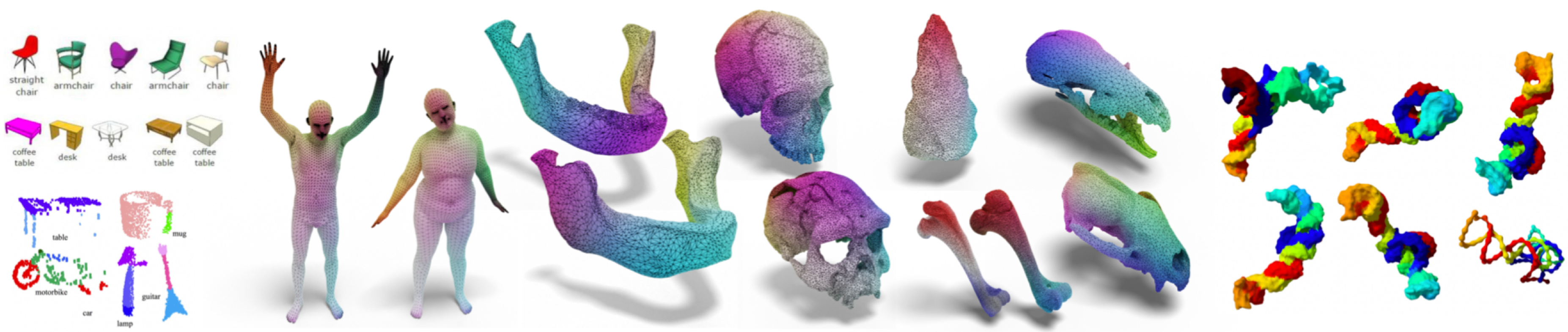


AIGRETTE – Challenges

Challenges:

Geometric data is typically:

1. Poorly labeled (maybe thousands vs millions of instances)
2. Unstructured (CNNs don’t apply)
3. Heterogeneous – different representations, riddled with noise, outliers, acquisition errors, etc.



ShapeNet
55k+ 3D models

MPI FAUST human,
20k+ models

Data from partners (Muséum national d'Histoire naturelle, Musée de l'Homme, RNA molecule structure), 100s – 1000s of 3D models

AIGRETTE – main tasks

Main Objective:

Develop efficient algorithms and mathematical tools for analyzing diverse *geometric data collections.*

Axes of Study:

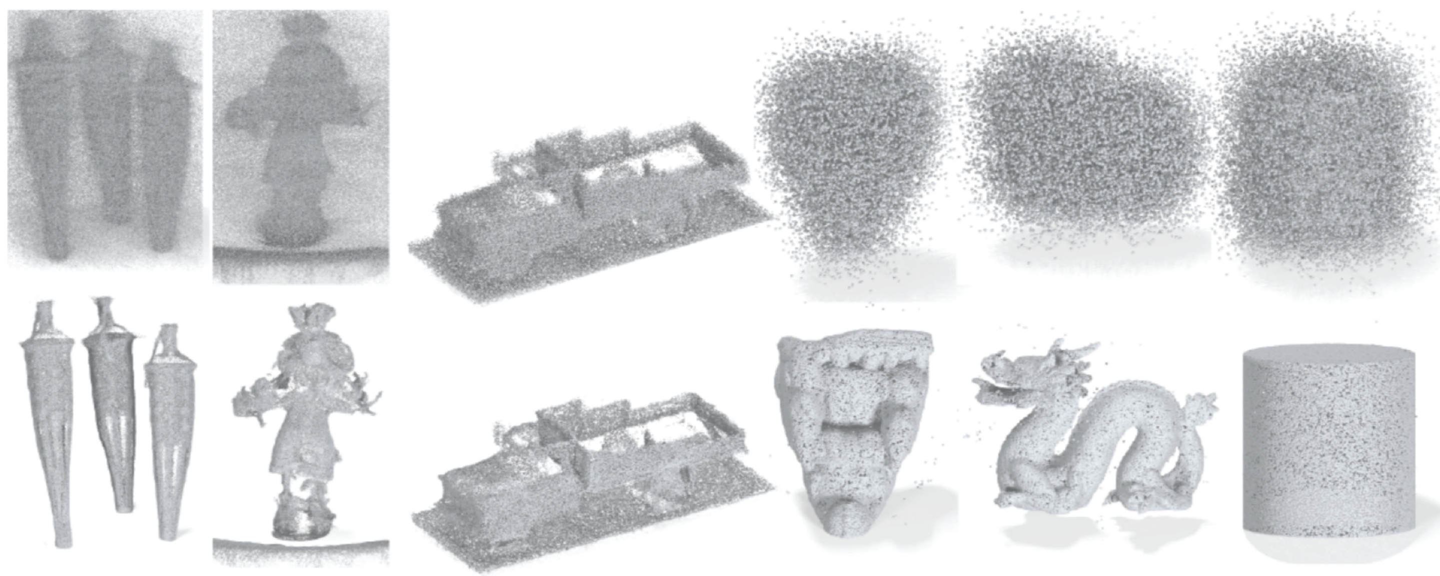
1. Develop *representations* of geometric data, suitable for modern learning pipelines.
2. Design of methods for *injecting geometric prior information* :
   - Geometric features (normals, curvature, etc.)
   - Consistency measures across individual objects to handle scarcity of labeled data
3. Develop *robust methods* capable of handling noise and artefacts.
4. Incorporate diverse data sources.

Example Relevant Projects

1. PointCleanNet - *Learning to Denoise and Dense Point* Clouds

Noisy input

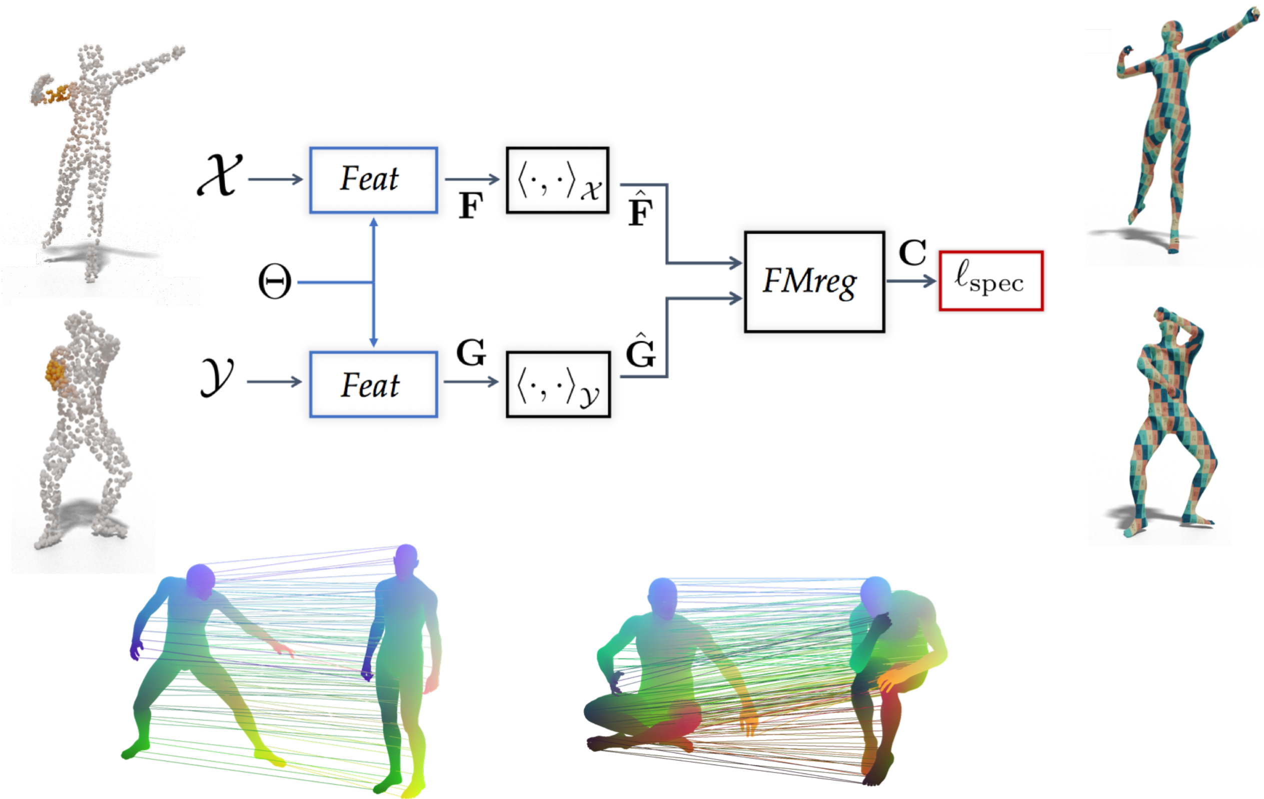
After PointCleanNet



PointCleanNet: Learning to Denoise and Remove Outliers from Dense Point Clouds,
M.-J. Rakotosaona, V. La Barbera, P. Guerrero, N. Mitra, M. O., CGF 2019

Example Relevant Projects

2. Deep Learning for ***Dense Non-rigid Shape Matching*** (Correspondence)

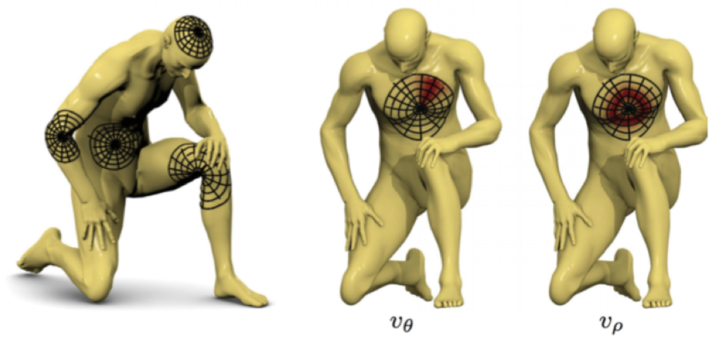


Deep Geometric Functional Maps: Robust Feature Learning for Shape Correspondence, N. Donati, A. Sharma, M. O., CVPR 2020 (Best Paper Award Nominee)

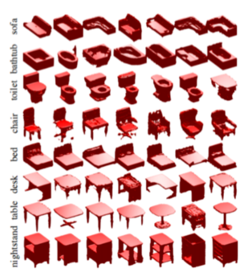
Example Relevant Projects

3. Deep Learning **directly on surfaces** in 3D

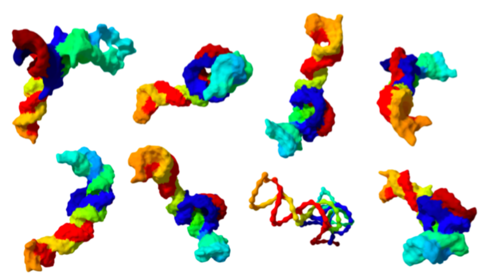
Defining equivariant convolution on a 3D surface



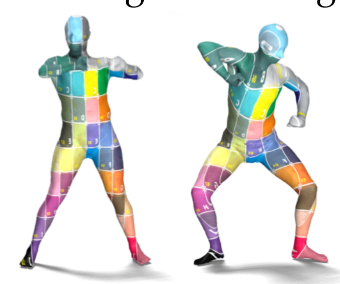
Classification



Segmentation



Non-rigid matching



Multi-directional geodesic neural networks via equivariant convolution,
Adrien Poulenard, M. O., Proc. SIGGRAPH Asia 2018

Thank You

Questions?

Acknowledgements:

A. Poulenard, M.-J. Rakotosaona, R. Huang, S. Melzi, J. Ren, N. Donati, A. Sharma, J.-M. Rouffosse, E. Corman, D. Nogneng, L. Guibas, E. Rodolà, P. Wonka, N. Mitra, P. Guerrero ….

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