Big Data in the French Public Health System

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CENTRE NATIONAL
DE LA RECHERCHE
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UNIVERSITÉ PARIS-SACLAY

Data Science and Public Health

- Data Science (Satistical Analysis) has always been at the heart of health-related problematics
- Strong health impact (HIV, cigarettes, Mediator, . . .)
- Strong economical impact (first state budget in France)
- Many “Big Data” sets in France : CNAMTS, AP-HP, . . .
- But “Big Data techniques” hardly used

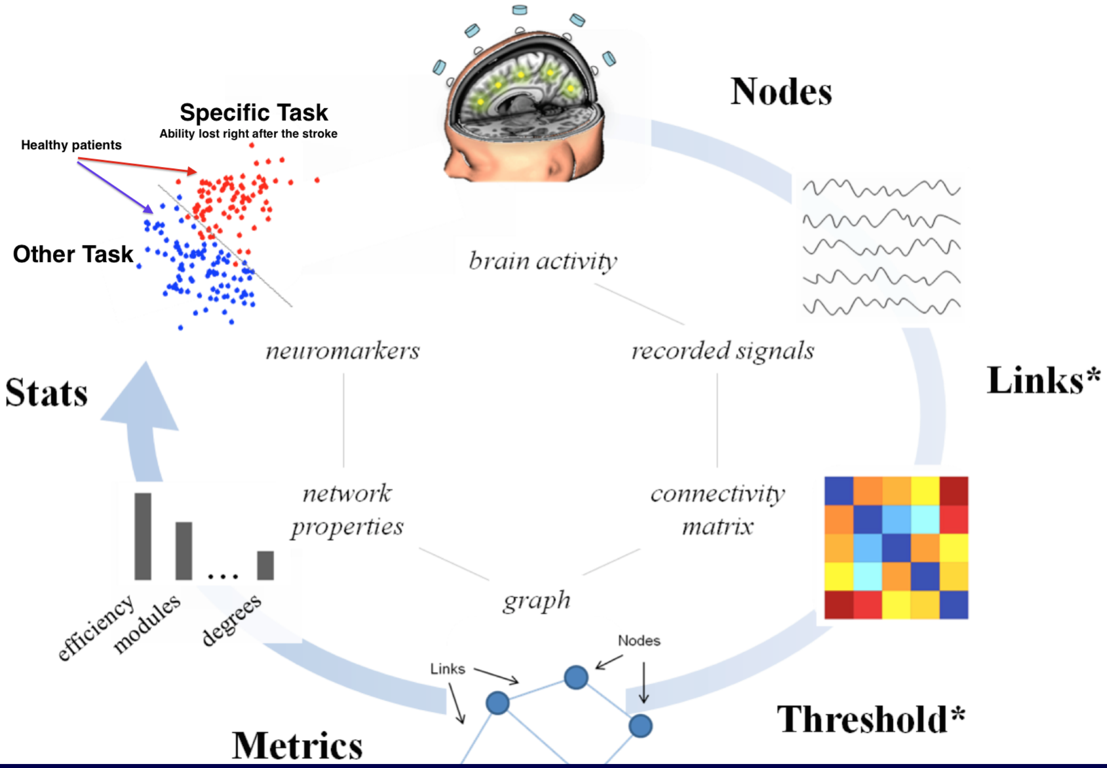
Big Data and Public Health at Ecole Polytechnique

- A team with various skills : signal/image processing, statistics, machine learning, computer science, . . .
- Both Maths Lab (CMAP) and Computer Lab (LIX) are involved
  - 10 Researchers : S.Allassonière, E.B., Y.Diao, S.Gaiffas, A.Guilloux (UPMC/X), J.Josse, M.Lavielle, E.Moulines, E.Scornet, M.Vazirgiannis
  - 11 Phd students or PostDocs
  - 5 "Big Data" engineers
  - Many internships
  - More to come !
- Many partners : AP-HP, CNAMTS, HEGP, Tenon, ICM, . . .

ICM (Institut du cerveau et de la moëlle épinière) - La Pitié Salpétrière Hospital

Modelling brain connectivity using sparse graphical model
Application to stroke evolution analysis

S.Allassonière, F.Deloche (Polytechnique), F. de Vico Fallani (ICM)



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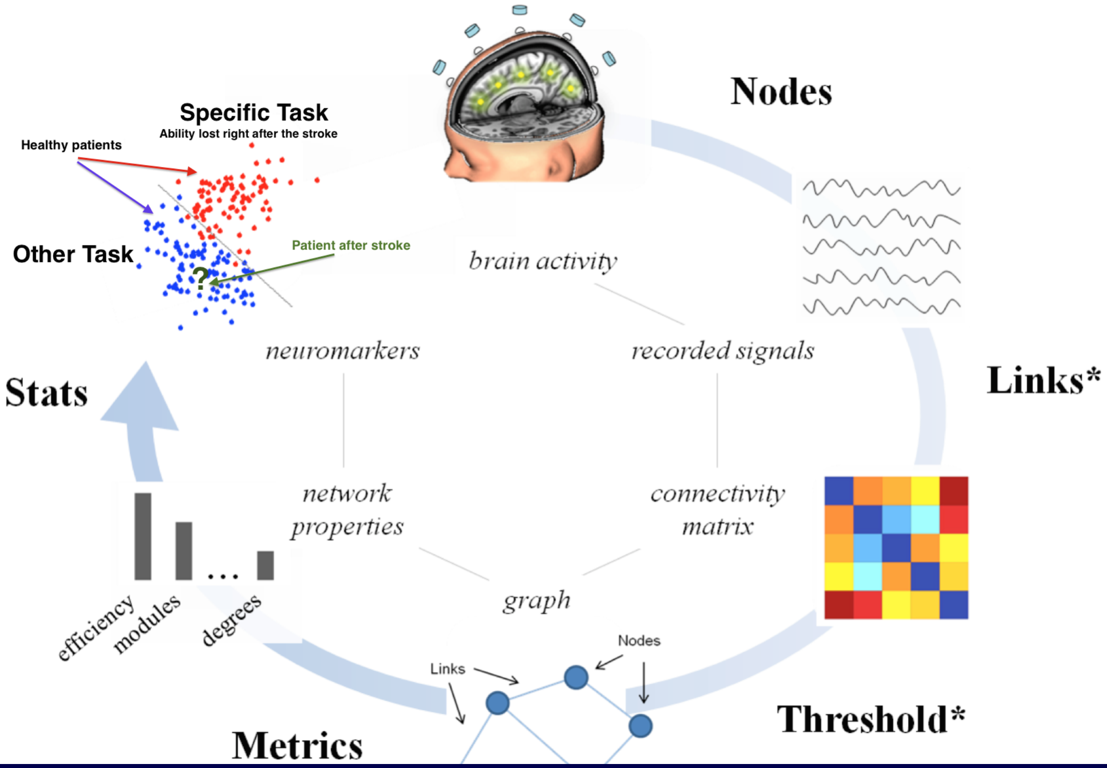

Diagnostic Aid

S.Gaïffas, S.Bussy (Polytechnique), A.Guilloux (UPMC,Polytechnique) A-S.Jannot (HEGP)

The Database at HEGP : one of the largest Hospital data center in France

- 1.4 million patients
- 15 year historic
- All the data of the patient's hospital stay (X-rays, biological data, prescriptions, . . .)
- Specialized in *complex* pathologies

One particular pathology : Vaso-Occlusive Crisis (in drepanocytosis) :

- This crisis calls for hospitalization (morphine for a few days)
- When does the crisis stop ? When to stop morphine ?
- Hospitalization monitoring
- Minimize the rate of re-hospitalization

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Prediction of arrival flows in emergency services

P.Aegerter (AP-HP), E.B., S.Gaïffas, M.Wargon (AP-HP)

The Database :

- Arrival flows over 5 years
- $>$ 80 Emergency services in Ile-de-France
- Specific data on arrivals

Forecast :

- Forecast at various time-horizons and different scales
- Influence of various environmental factors
- Characterization of the emergency services network
- Typology of the different services

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The data from the Caisse Nationale d'Assurance Maladie (CNAMTS)

- **The SNIIRAM database** :
  - Accounting (main) database +
  - PMSI database (hospital data) +
  - Hypocrate database (physician data) +
  - . . .

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- **The SNIIRAM database** :
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  - ...

- **SNIIRAM** $\simeq$ **largest health database in the world**
  - 65 million people
  - $\simeq$ 500 Terabytes !

Statistical analysis of SNIIRAM database

Very strong potential impact

- **Health impact**
  → 2013 : used to show that 3rd generation contraception pill increases pulmonary embolism risk
  → 2014 : Cartography of 54 important pathologies (HIV $\simeq$ 50 criteria)
- **Economical impact** (budget $>$ 170 billion euros/year)
  → medico-economical chart to quantify the cost of the different pathology

The partnership Polytechnique-CNAMTS

- **3-year partnership** (2015-2017) Polytechnique-CNAMTS
- **CNAMTS opens all SNIIRAM to Polytechnique research team**
- **Many themes of research**
  - Identifying useful factors in medico-economic path-ways of given pathologies
  - Weak signal detection or anomaly detection in pharmacoepidemiology
  - Fraud detection
  - . . .

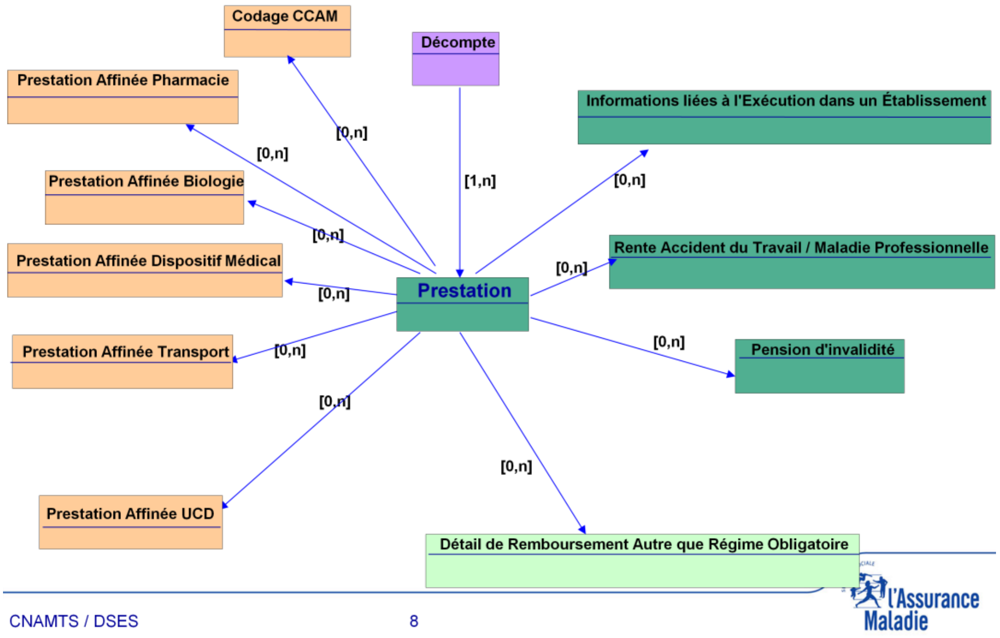
Main challenges

- **Design of scalable machine learning algorithms**

Main challenges

- **Design of scalable machine learning algorithms**

- **HOWEVER : Implementation requires . . .**
  $\Longrightarrow$ Pre Processing of the database
  - SNIIRAM : Oracle relational database with .... $\simeq$ 1000 tables !
  - Allowance oriented


Codage CCAM
Décompte
Prestation Affinée Pharmacie
Informations liées à l'Exécution dans un Établissement
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Prestation Affinée Biologie
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Rente Accident du Travail / Maladie Professionnelle
Prestation Affinée Dispositif Médical
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Prestation Affinée UCD
Détail de Remboursement Autre que Régime Obligatoire
CNAMTS / DSES
8
l'Assurance Maladie

Pre processing of the database

- SNIIRAM needs to be "flattened" (Parquet)
  - Patient oriented
  - Doctor/Institution oriented
  - . . .

⟹

- Very few constraints
- Efficient request
- BUT :
  - Significant increase in storage size (redundancy)
  - flattening process is a very heavy process

Pre processing of the database

Event representation

- **“Low-Level” structure** $\simeq$ SNIIRAM original structure
- **“High-level” structure** (done with a medical expert)
  - Pathology definitions ?
  - Structuring health path-ways (periodic/continuous treatment,. . .) ?
  - Medication structuring (same molecules, . . .) ?
  - . . .

A “smaller” project with Tenon Hospital : around the Prostate Cancer

- **Observapur database** : 10-year old subset of SNIIRAM database restricted on identified prostate cancer patients.
  - Pr. B.Lukacs, Tenon Hospital and Pr. E.Vicault, URC Saint-Louis Lariboisière Fernand-Widal
  - Since 2004 : $\simeq$ 2.4 million patients total
- **Information** (lightly) **structured** (thanks to expert)
- **Research themes**
  - Automatic structuring of implications of Prostate Cancer
    → Unsupervised learning for identifying “latent implications”
  - Specificity of Type II Diabetes in prostate cancer pathways
    → Design of new scalable algorithm in survival analysis
  - . . .

Big Data in French Public Health System at Ecole Polytechnique

- **Big** Data
- **Big** Projects
- **Big** scientific challenges (Maths + Computer science)
- (potentially) **Big** impacts
- not **Big** enough Team ☹ : **WE ARE HIRING !**

BIG Adventure!