Intelligent Data Analysis for Complex Systems

CIDA

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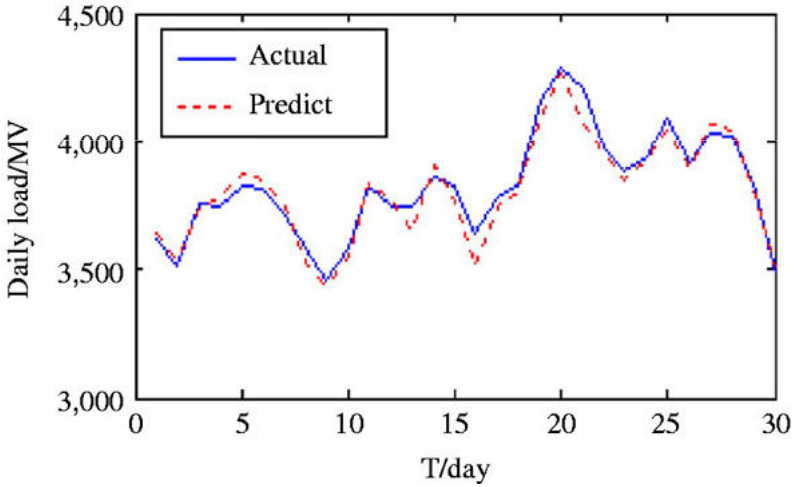
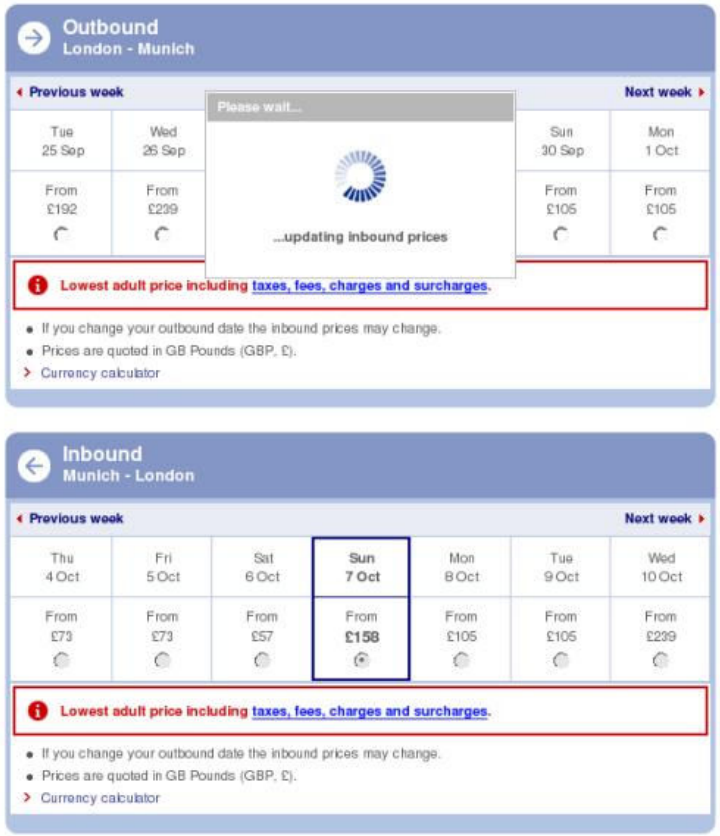
Brunel University

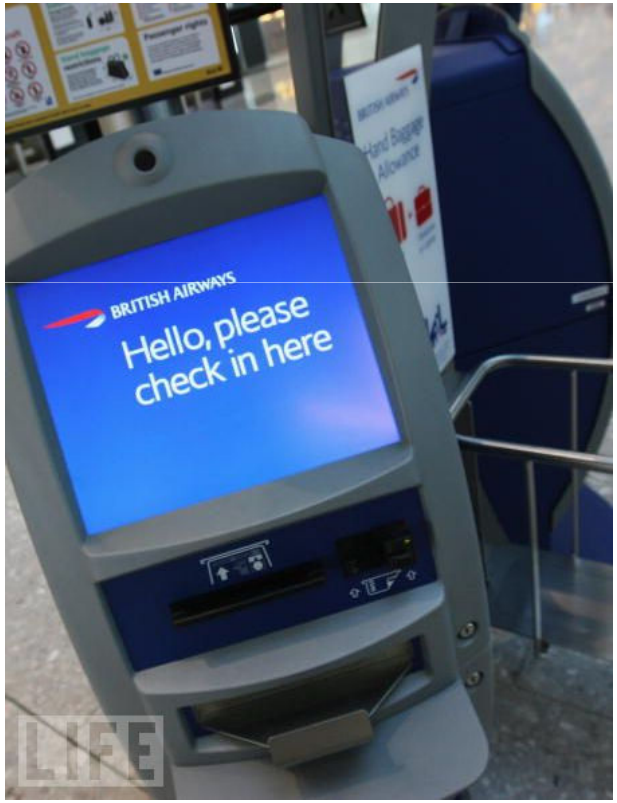
Managing complex systems: Knowledge is power (1987)…

Data Important too (1988)…

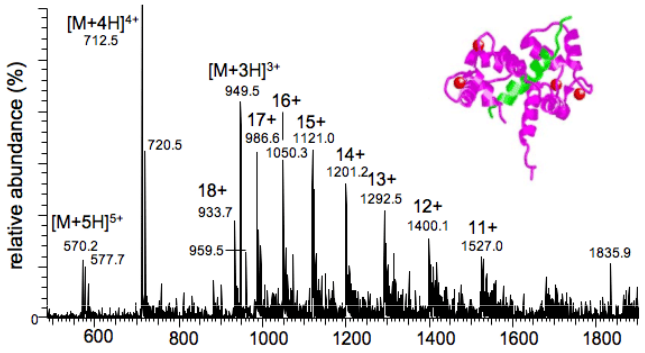


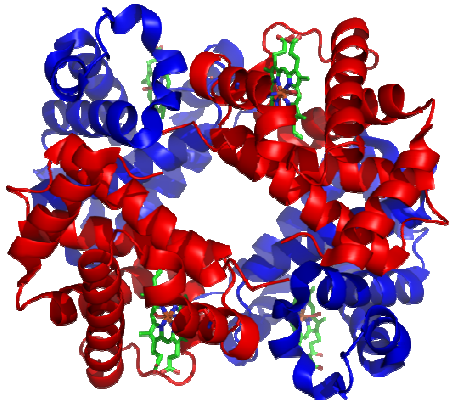
Human Factor Difficult (early 90's)…





More and more data (90's)…

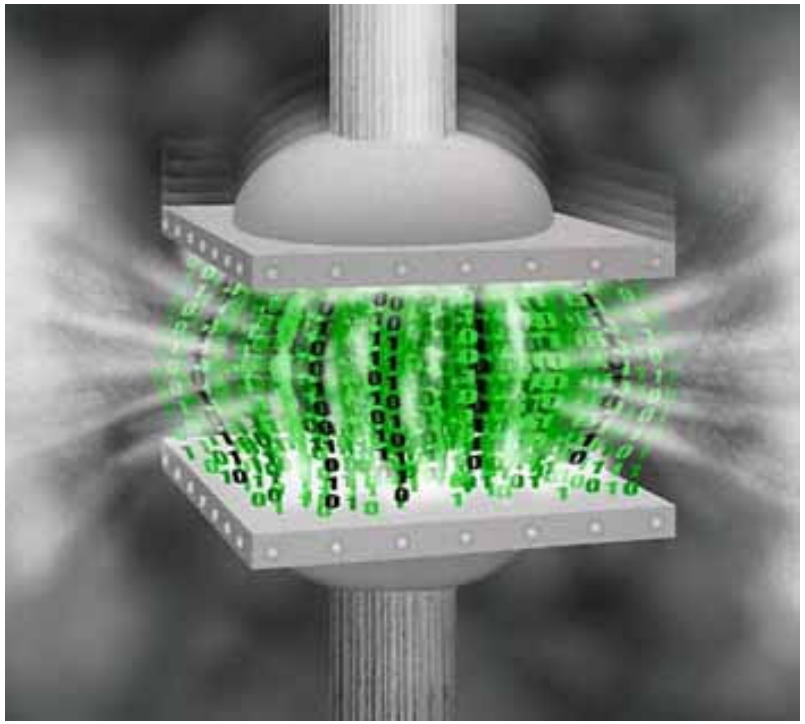


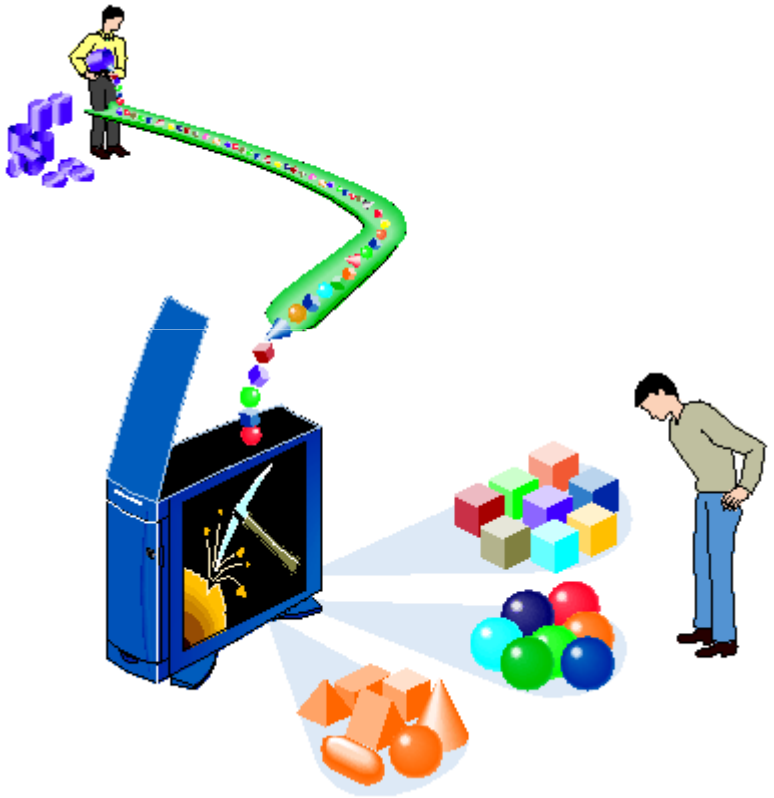


Data Analysis

17th Century -

Data mining: alternative meanings





Statistics versus Computing (1)

"Data Mining: Threat or Opportunity"? (1998; RSS)

Statistics versus Computing (2)

- “Is statistics being left behind by computing?”

  (2002 RSS International Conference; Plymouth)

Statistics

- Methods and Principles for data analysis

Interdisciplinary

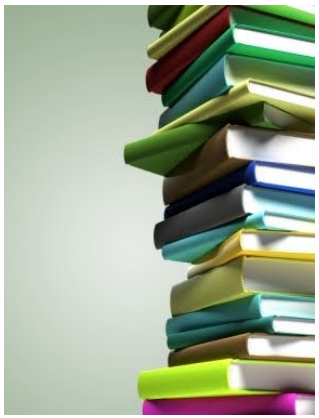
- Bayesian networks
- Support Vector Machines
- …

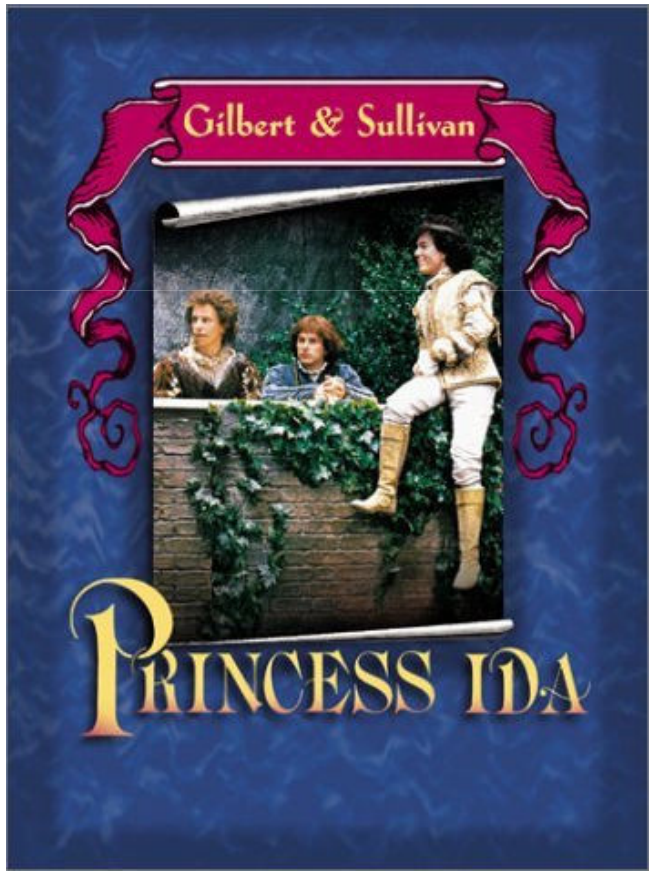
Computing

- Computational infrastructure
- New analysis approaches

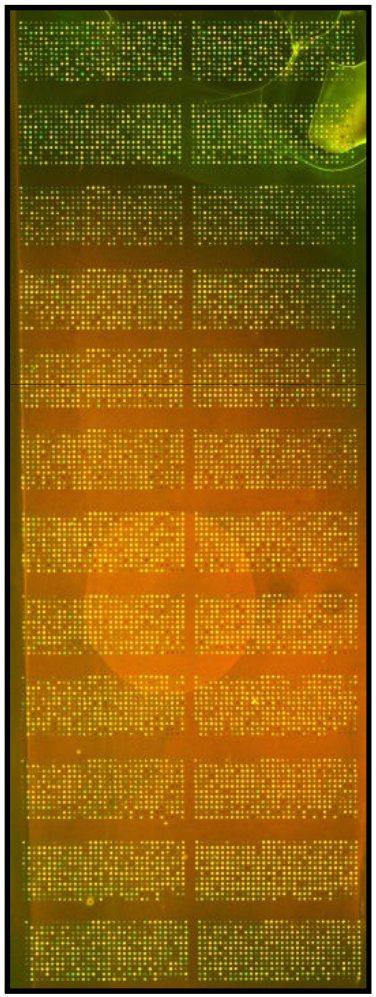
Intelligent Data Analysis

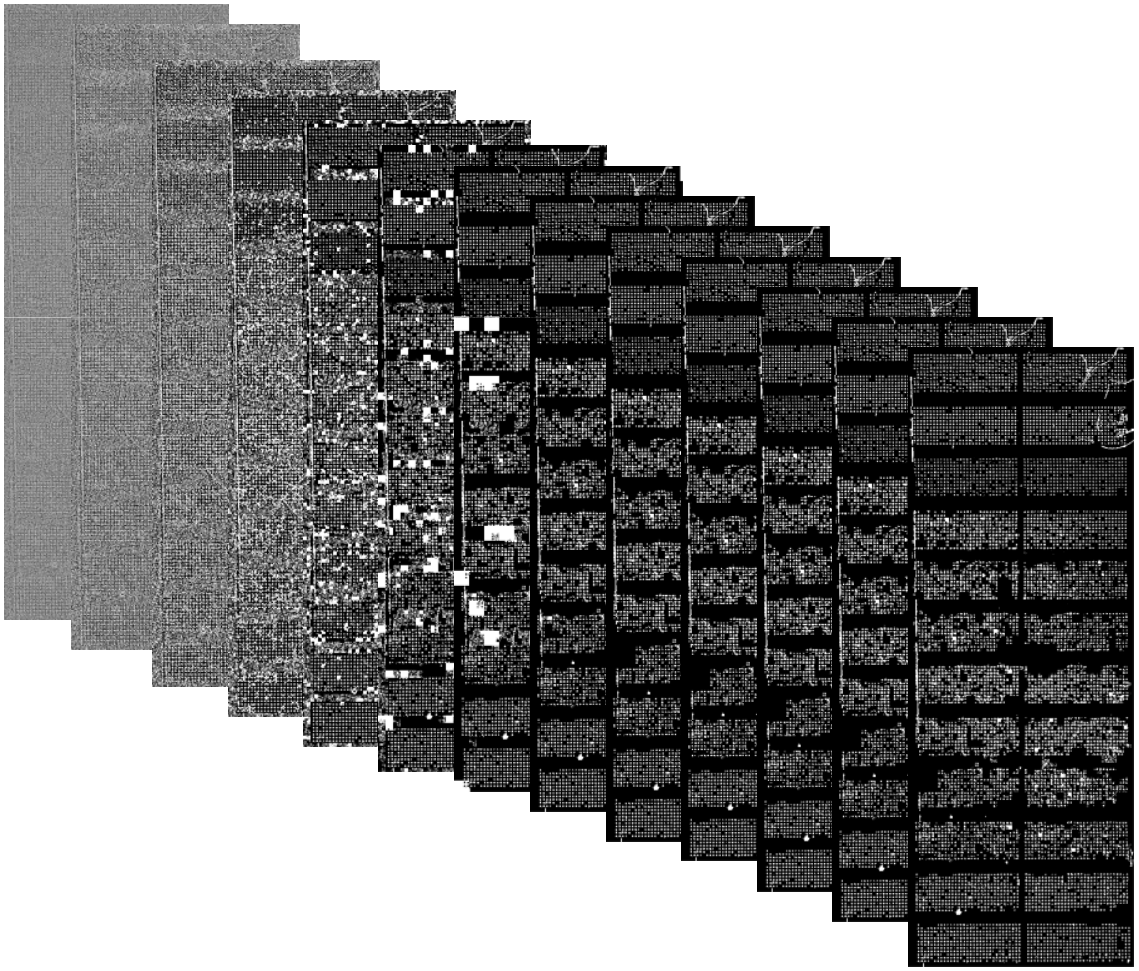
- An interdisciplinary study concerned with the effective analysis of data



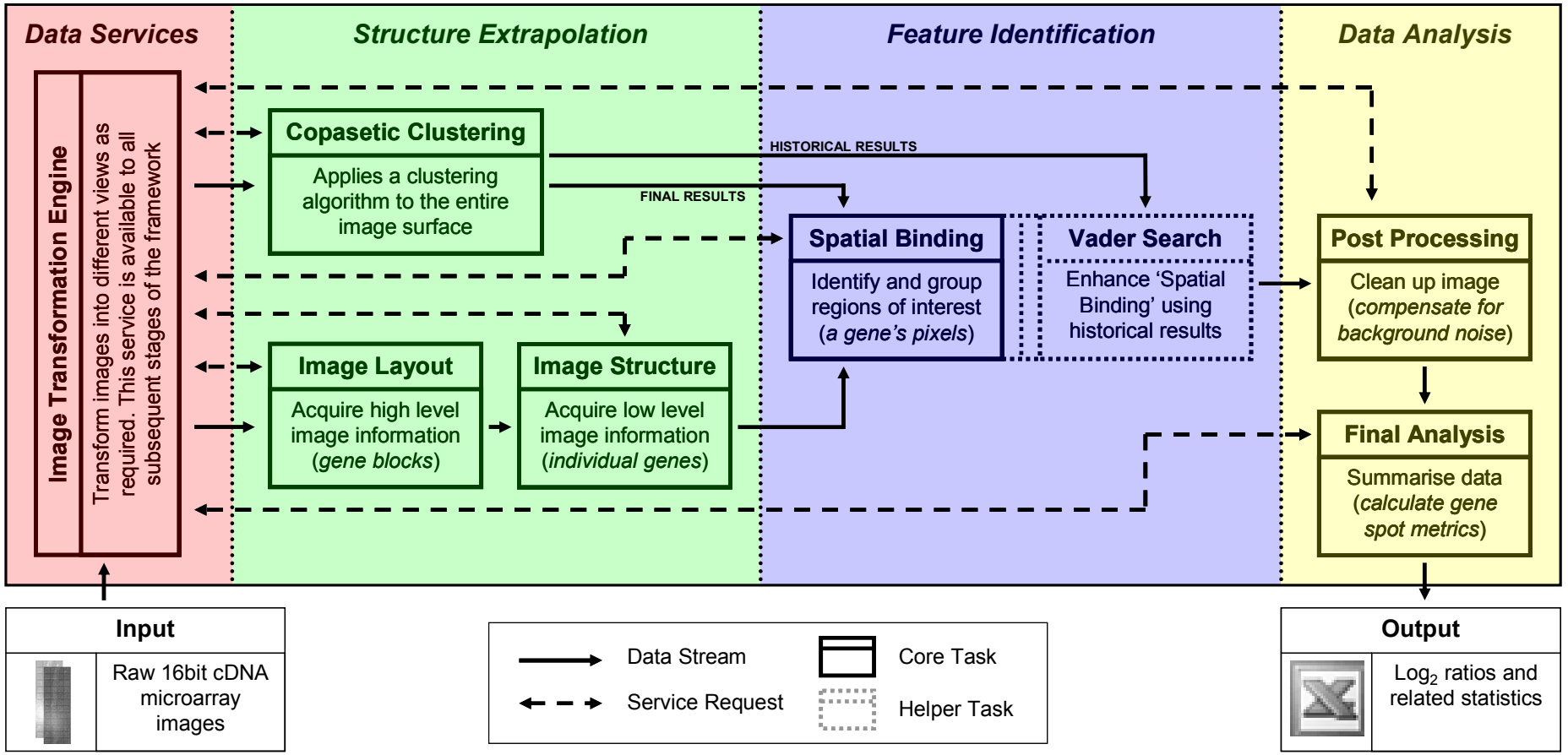


Technology (Immature)

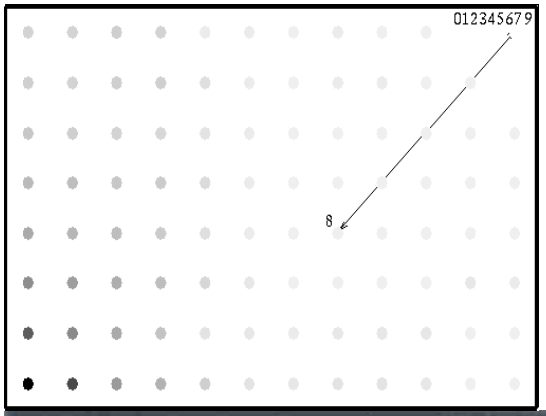


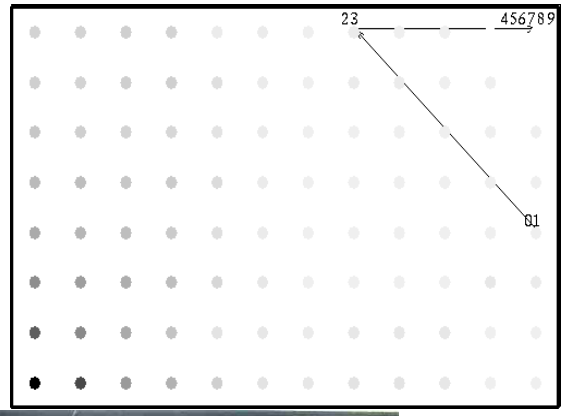


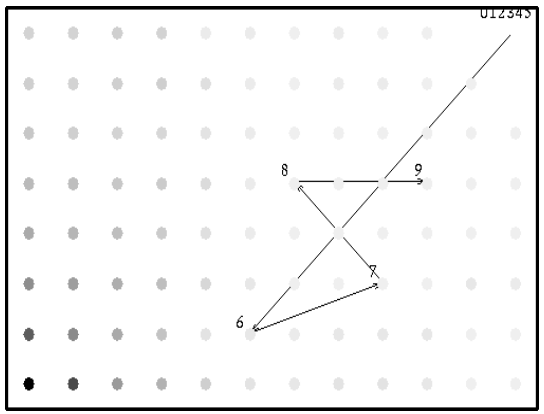
Automating large-scale image analysis
(Fraser/Wang/Liu 2010 Chapman & Hall/CRC)

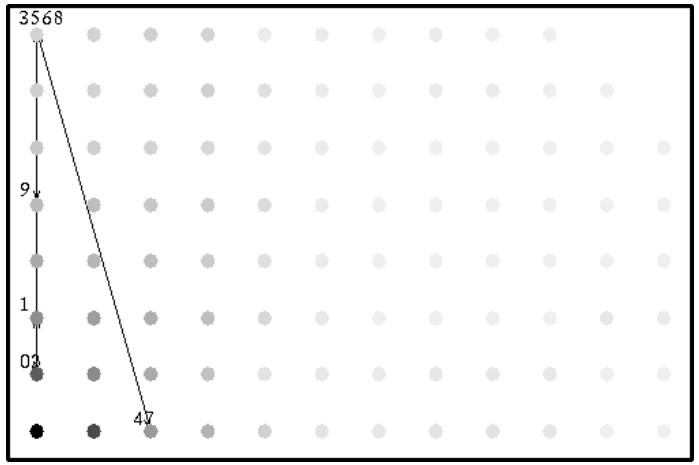


Human behaviour/data quality





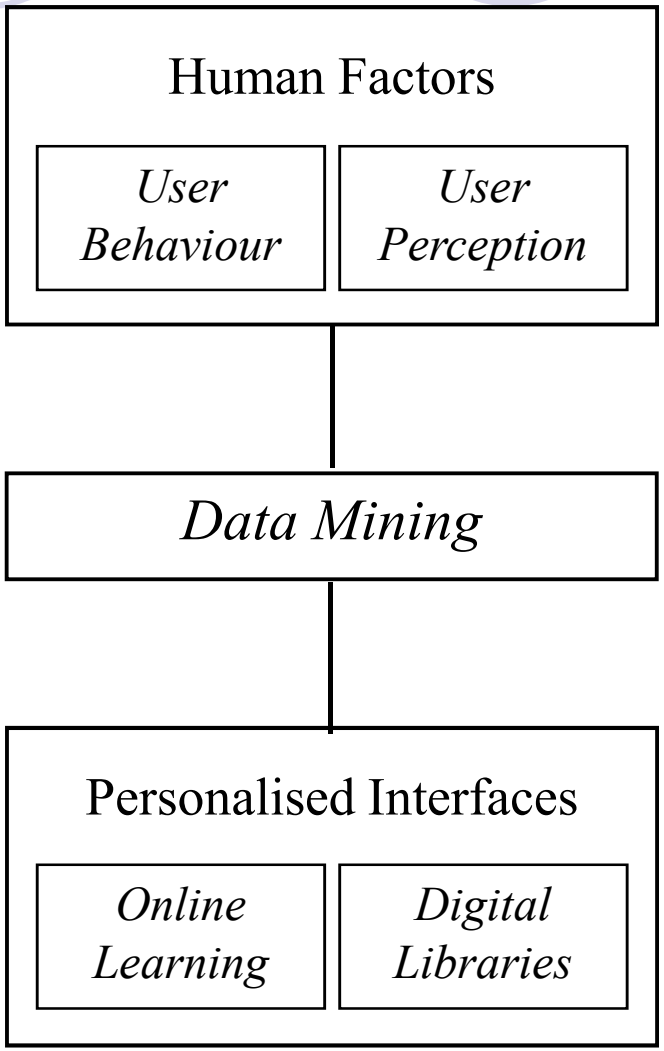




Liu, Cheng and Wu (2002)
IEEE Trans on KDE

Understanding individual differences

Frias-Martinez, Chen, Liu (2006)
J. American Society for Information Science and Technology



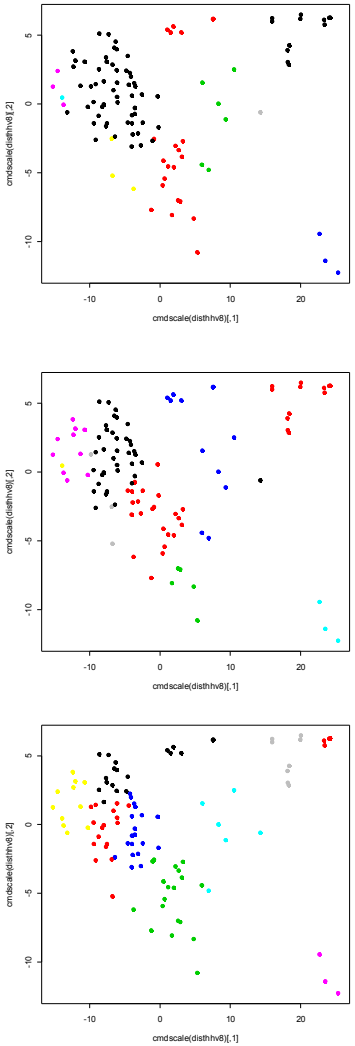
Chen & Liu (2008)
ACM Transactions on Computer-Human Interaction

Clewley Chen and Liu (2010)
Journal of Documentation

Frias-Martinez, Chen, Liu (2006)
IEEE Trans on SMC: Part C

Clustering via Consensus

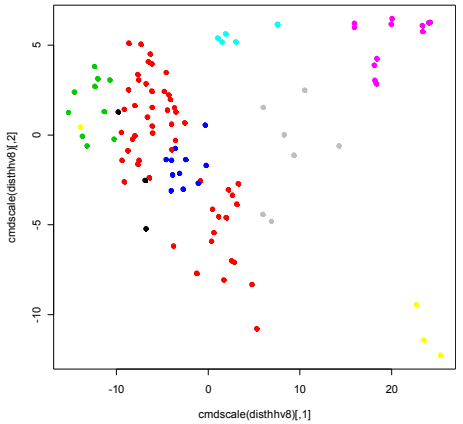
Input Cluster Results



Agreement Matrix

$$\begin{bmatrix} 0 & f_{12} & f_{13} & f_{14} & \cdots & \cdots & \cdots & \cdots & \cdots & f_{1n} \\ \vdots & 0 & f_{23} & f_{24} & \cdots & \cdots & \cdots & \cdots & \cdots & f_{2n} \\ \vdots & \vdots & 0 & f_{34} & \cdots & \cdots & \cdots & \cdots & \cdots & f_{3n} \\ \vdots & \vdots & \vdots & \ddots & \ddots & & & & & \vdots \\ \vdots & \vdots & \vdots & & \ddots & \ddots & & & & \vdots \\ \vdots & \vdots & \vdots & & & \ddots & f_{ij} & & & \vdots \\ \vdots & \vdots & \vdots & & & & \ddots & \ddots & & \vdots \\ \vdots & \vdots & \vdots & & & & & \ddots & \ddots & \vdots \\ \vdots & \vdots & \vdots & & & & & & \ddots & f_{n-1n} \\ 0 & 0 & 0 & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & 0 \end{bmatrix}$$

Consensus Clusters

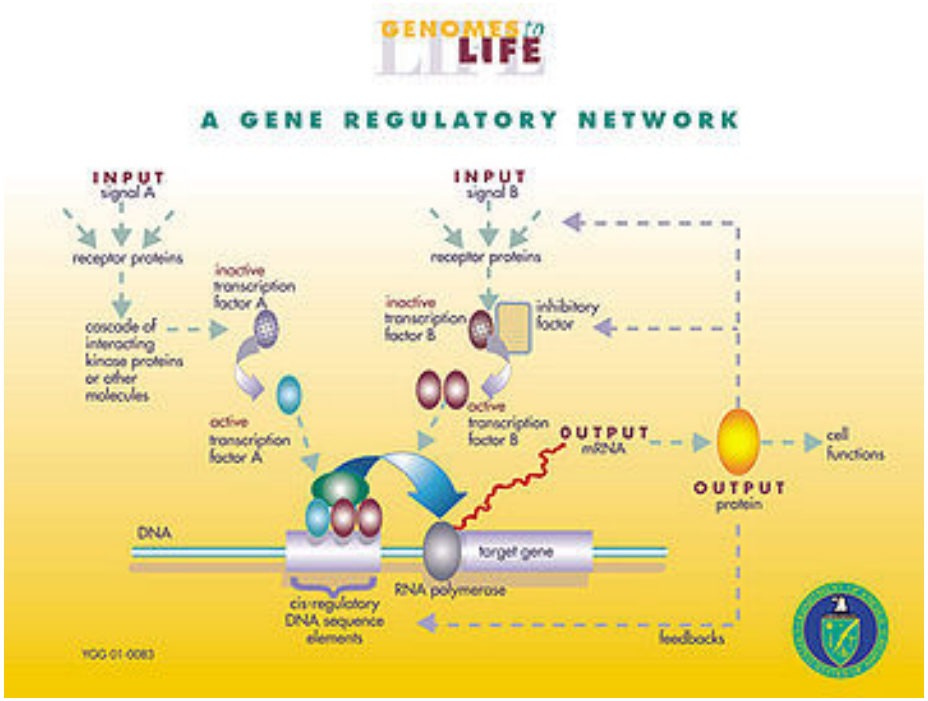


Swift et al ***Genome Biology*** 2004
Hirsch et al ***J Computational Biology*** 2008
Li et al ***Intelligent Data Analysis*** 2010

Dynamic Modelling

Wang et al (2009)
IEEE/ACM Trans on Computational Biology & Bioinformatics

Tucker et al (2005)
Artificial Intelligence In Medicine

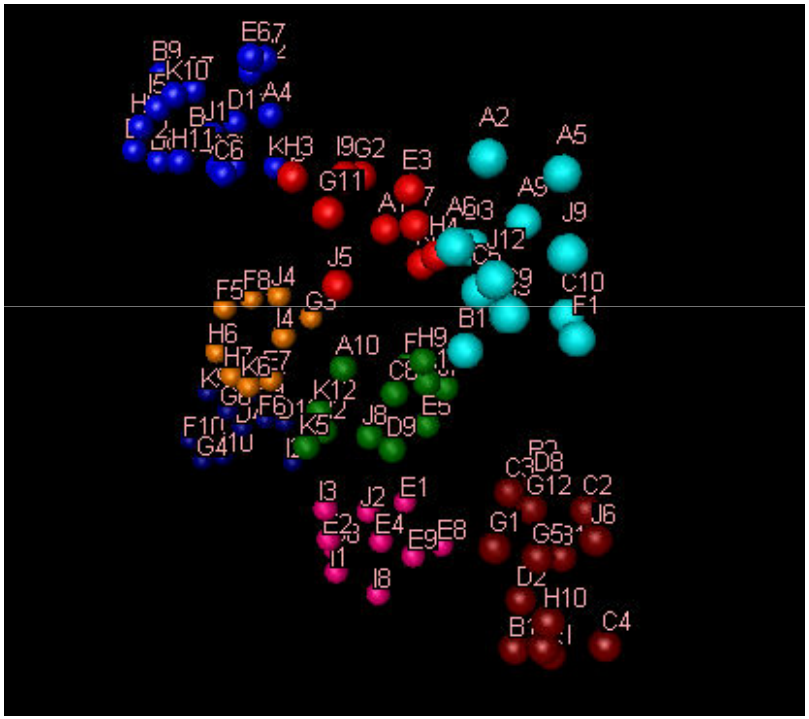


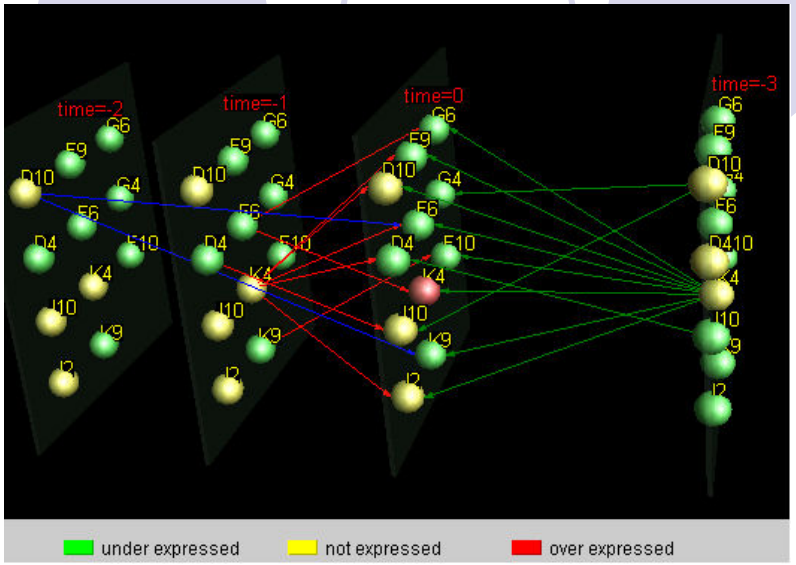
Swift et al (2006)
Natural Computing

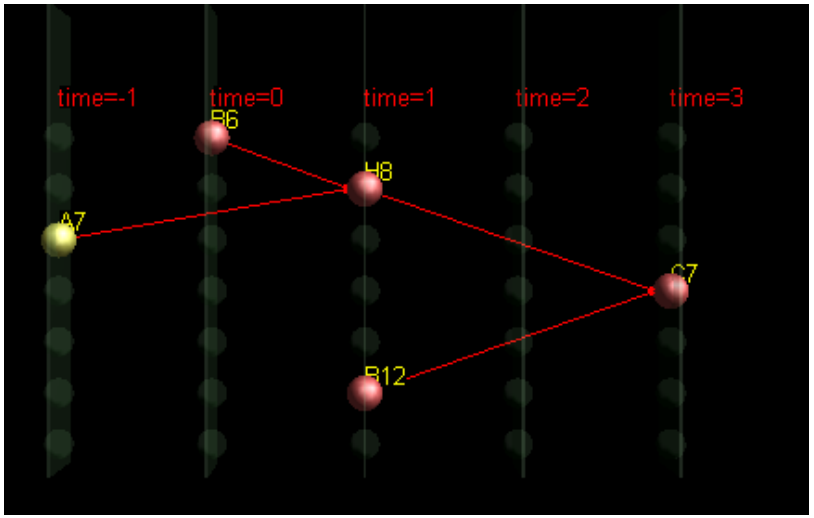
Wei et al (2009)
Math Biosciences

Khanin et al (2006)
PNAS

Visual Analytics

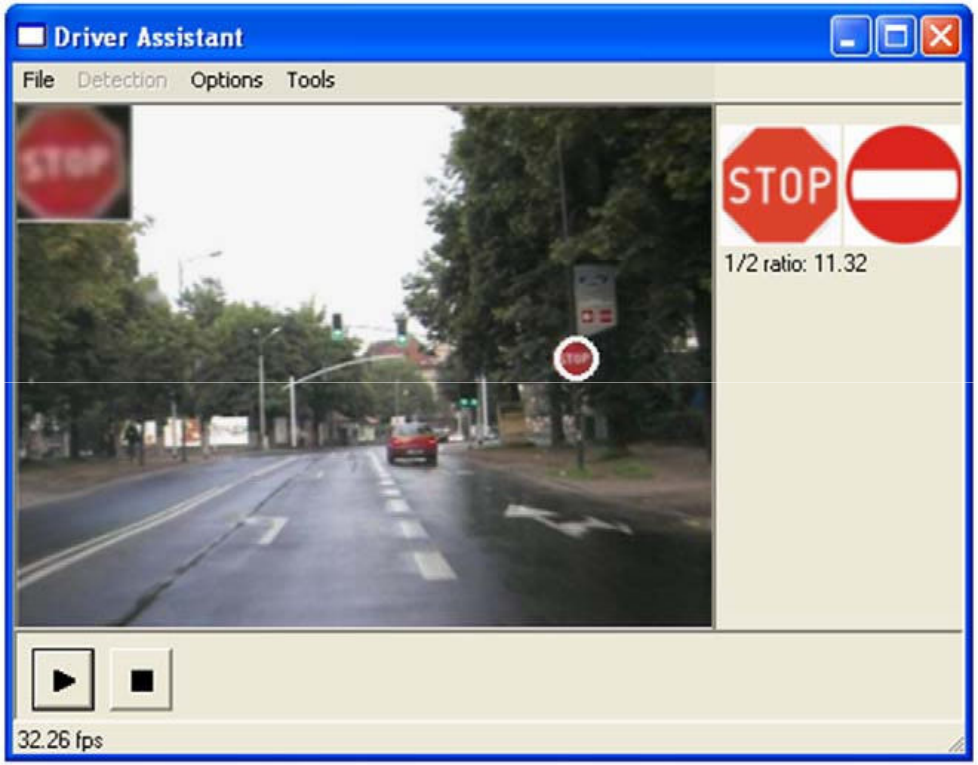






Zhang, Kuljis and Liu (2008)
IEEE Transactions on SMC Part C
Zhang et al. (2005)
Visualisation and Data Analysis 2005

Real-Time Modelling



Ruta, Li and Liu (2010)
Pattern Recognition

Ruta, Li, and Liu (2010)
IEEE Transactions on Intelligent Transportation Systems

Understanding the nature

Cyber Defence

'Cyber attacks and terrorism head threats facing UK'
BBC News 18 Oct 2010

EFACTS
EUROPEAN FRIEDREICH'S ATAXIA CONSORTIUM FOR TRANSLATIONAL STUDIES
RESEARCH FOR A BETTER FUTURE

David Gilbert, XiaoHui Liu , Crina Grosan, Chris Paterson, Annette Payne (SISCM) and Mark Pook (SHSSC)

Brunel UNIVERSITY WEST LONDON

EFACTS

EFACTS (the European Friedreich's Ataxia Consortium for Translational Studies) assembles a body of expertise to adopt a translational research strategy for the rare autosomal recessive neurological disease, Friedreich's ataxia (FRDA). FRDA is a severely debilitating inherited disease that leads to loss of the ability to walk and dependency for all activities.

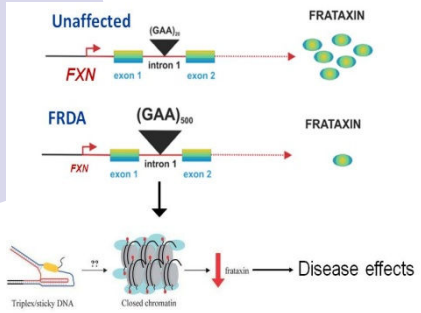
EFACTS strongly believes that, 12 years after European researchers discovered the FRDA gene, frataxin, when new treatments for FRDA are being developed, the time is ripe to invest in FRDA research in a concerted Europe-wide fashion.

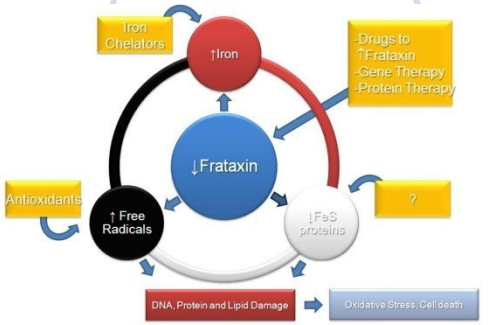
EFACTS Project Partners
UNIVERSITÉ LIBRE DE BRUXELLES
UNIVERSITAETSKLINIKUM AACHEN
KATHOLIEKE UNIVERSITEIT LEUVEN
FONDAZIONE IRCCS ISTITUTO NEUROLOGICO CARLO BESTA
MEDIZINISCHE UNIVERSITAET INNSBRUCK
UNIVERSITY COLLEGE LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE
BRUNEL UNIVERSITY
MEDICAL RESEARCH COUNCIL
OXFORD UNIVERSITY
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS
CENTRE EUROPEEN DE RECHERCHE EN BIOLOGIE ET MEDECINE
INSTITUT NATIONAL DE LA SANTE ET DE LA RECHERCHE MEDICALE

This project proposal has the following scientific and technological objectives:

1. Comprehensively populate a European FRDA database, linked to a bio bank
2. Define a panel of clinical assessment tools
3. Build on the knowledge base of frataxin structure and function
4. Build on the knowledge base of the pathogenic cascade
5. Build on the knowledge base of epigenetic mechanisms of frataxin silencing
6. Develop new cellular and animal models for the study of FRDA
7. Identify FRDA biomarkers
8. Identify genetic modifiers of FRDA
9. Develop therapeutics for FRDA

Friedreich's Ataxia (FRDA)





Friedreich ataxia is caused by a GAA repeat expansion mutation in the *FXN* gene leading to decreased expression of the essential mitochondrial protein 'frataxin'.

Decreased frataxin protein in cells leads to a defect in iron-sulphur cluster enzyme activities, iron accumulation and increased free radical damage to DNA, protein and lipid. Therapeutic strategies are aimed at reversing these disease effects.

Summary

- Handling data, knowledge and human factors with care.
- Data quality is key. Technology and human are two major issues.
- Statistics and computing are inseparable when it comes to data mining and complementary in their strength.
- Data from complex systems tend to offer interesting analysis challenges.

Opportunities

Acknowledgements

- All CIDA members, past and present.
- All collaborators, past and present.
- All funding agencies.

- ALL OF YOU for your attention!