IMA Overview

Prof. Jon Garibaldi
Head of Group

- Intelligent Modelling and Analysis Research Group
  - 8 academic staff
    - Jon Garibaldi, Uwe Aickelin, Guoping Qiu, Julie Greensmith, Peer-Olaf Siebers, Jamie Twycross, Daniele Soria, Christian Wagner
  - 6 research fellows
  - 32 PhD students
  - £5m as PIs; £25m as Co-Investigators

- Mission
  - to intelligently analyse and model complex data
    - creating new techniques
    - novel methods of addressing real-world problems
Novel Techniques

Representing Knowledge
**Novel Data Mining**

- **motif detection**

- **sequential (incremental) data mining**

<table>
<thead>
<tr>
<th>Drug</th>
<th>ADR</th>
<th>Ours</th>
<th>Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raltegravir</td>
<td>Inferior myocardial infarction</td>
<td>83</td>
<td>305  196 1215</td>
</tr>
<tr>
<td>Raltegravir</td>
<td>Heart failure</td>
<td>121</td>
<td>605  504  582</td>
</tr>
<tr>
<td>Remicade</td>
<td>Depressed mood</td>
<td>16</td>
<td>32   15   68</td>
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<tr>
<td>Remicade</td>
<td>Depressive disorder NDC</td>
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<tr>
<td>Eribulin</td>
<td>Acute pancreatitis</td>
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<td>Naproxen</td>
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<td>Hepatitis unspecified</td>
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<tr>
<td>Naproxen</td>
<td>Suicide and self-inflicted injury</td>
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<td>223  242  1996</td>
</tr>
</tbody>
</table>

**Techniques for Unusual Data**

- **artificial immune systems**
Real-World Applications

Breast Cancer Clustering
New Breast Cancer Classes

Breast Cancer

ER+ Luminal CK+

HER2+

Luminal

ER+

HER2/ER+ Class 6A (3.6%)

HER2/ER+ Class 6B (7.9%)

new subclasses

ER-

HER2/ER- Class 5 (11.7%)

p53 altered Class 4 (8.1%)

p53 normal Class 5 (8.1%)

p53+

p53-

Basal

ER- Basal CKs+

Mixed Class (7.1%)

PGK+

HER3+ HER4+

Luminal A Class 1 (24.5%)

HER3- HER4-

Luminal B Class 2 (13.6%)

Luminal N Class 3 (11.5%)
GCHQ Threat Assessment

- GCHQ cyber-security project
  - measuring / modelling variation in expert opinions
    - data gathering and analysis
    - novel techniques for representing aggregated expert opinions using general type-2 fuzzy sets

Expert Dispersion

- All Groups
- Consultants and Technical Groups
Current Activity

Advanced Data Analysis Centre (ADAC)

- UoN investment in ‘data to knowledge’ infrastructure
  - provide data analysis service across UoN
  - Garibaldi, Aickelin, Soria
  - two further data analyst posts imminent

- ADAC supports high-class research
  - providing analysts to help
    - development of research strategy
    - grant writing
    - independent interpretation of complex data
Example Projects

- **Research in the Wild**
  - *Towards Data-Driven Environmental Policy Design*
  - EPSRC funded: Wagner; 1 RA 18 month
- **Horizon**: Affective computing; Vicarious
  - Garibaldi, Wagner + 1 RA
- **Network for Integrated Behavioural Science (NIBS)**
  - ESRC 5-yrs with Economics (behaviour modelling)
  - Siebers, Aickelin; RA/PhD posts?
- **GP THIN data mining**
  - Garibaldi, Aickelin, + PhDs
- **BBSRC/EPSRC Synthetic Biology Research Centre**
  - £14.3m collaboration with Prof. Minton, CBS
Doctoral Training

- International Doctoral Innovation Centre (IDIC)
  - UNNC/UNUK joint venture to train 100 PhDs over 5yrs
    - 50 ‘engineering’; 50 ‘digital economy’
    - Qiu; Valstar
- Current Horizon DTC and recent renewal
  - co-supervisions with Rodden and Benford
  - Wagner assisting in delivering Horizon training
- Developing closer data analytics / HCI linkage
  - person-centric data analysis
    - the form of data (statistically) alters the end decision!

Capabilities

- Machine learning
  - clustering, classification algorithms
  - decision support
  - fuzzy methods, including type-2 and others
- Simulation
  - agent-based and discrete event simulation
- Data analysis
  - biomedical and digital economy applications
Gaps / Complementarities

- Optimisation
  - combinatorial optimisation
  - GA, SA, tabu-search, meta-heuristics
  - multi-objective optimisation
- Operational research
  - practical algorithms
  - theoretical analysis
- Hyper-heuristics?
  - raising the level of generality

Multi-Disciplinary

- Complex Data
- Complex Problems
- New Techniques
- New Understanding