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BreatheEasy:
AI and Data Analytics for Wellness

University of Southampton, UK
@DamewendyDBE
Web Science Institute

• Established in the year “2014”

• Interdisciplinary research – Brings together computer scientists, healthcare experts, psychologists, sociologists, political scientists and lawyers

• Mission - Research for benefit of the Society

More about WSI: https://www.southampton.ac.uk/wsi/index.page?
Current Research @ Web Science Institute

- **Social Media Analytics**
  - Real-time analytics on Twitter, Wikipedia, etc.
- **Social Machines**
  - SOCIAM : The Theory and Practice of Social Machines
- **Southampton Web Observatory**
  - Observing and Visualizing the Web and society
- **Cyber Security**
  - IoT Observatory: Microsoft Azure sponsored research demonstrator
- **Online Health**
  - Designing Digital Interventions for Chronic Illnesses

Web and Internet Science Group: [http://www.wais.ecs.soton.ac.uk](http://www.wais.ecs.soton.ac.uk)
Web Observatory

• Attempt to understand the Web through datasets and applications

• WSTNet Laboratories and others perform interdisciplinary research on these datasets to understand data insights, policies, and privacy concerns

• Social machines such as Twitter, Facebook can be considered as a rehearsal for the IoT++ social machines on the Web.

Web Observatory @ Southampton: https://webobservatory.soton.ac.uk
IoT Observatory (1)

Inspired by the Web Observatory

Anyone can share a dataset/stream (publisher)

Anyone can locate a dataset/stream (user) for access across nodes

Public datasets: anyone can access

Private datasets: access can be granted by publisher

Datasets can be kept on Publishers’ site

More on: IoT Observatory @PETRAS
IoT Observatory: [https://iotobservatory.io](https://iotobservatory.io)
Enabling Legitimate Access

Fine-grained access control
- Formal description of permitted processing in metadata of datasets

Negotiating access
- Evaluation of User credentials – access permissions, requests, purpose of use

Legal and Ethical challenges
- Terms of Data Use
Discover and Search

- [http://search.webobservatory.org/](http://search.webobservatory.org/)

Searching across IoT/Web Observatory sites
UK PM seeks 'safe and ethical' artificial intelligence

Independent report
Growing the artificial intelligence industry in the UK

From: Department for Digital, Culture, Media & Sport
for Business, Energy & Industrial Strategy
Part of: Industrial strategy and UK and the Commonwealth
Published: 15 October 2017

This independent review, carried out by Professors and Jérôme Pesenti reports on how the Artificial Intelligence can be grown in the UK.

Use of GOFAI in Data Analytics

https://www.slideshare.net/jahendler/kr-in-the-age-of-deep-learnign

- Natural Language Processing
- Machine Learning
- Sentiment Analysis
- Image Processing
- Video Processing
- Speech Recognition
- Access controls
- Intervention protocols
- Multi-agent systems
Medical encyclopedias, literature now available on the Web

Social engagement on the Web

Open data on the Web

"Big" health data and communities fostered by social machines have paved way for newer technologies to empower wellbeing

Chat bots for remote digital interventions

Towards "Digital Health"
Observatories for Wellbeing

• Availability of IoT devices in a number of domains requires data reuse and sharing to minimize costs and increase utility.

• Improvements in governance, research, IoT data processing and analytics are driven by data and application sharing

• Moving from sharing scientific data to sharing sensor data
  • Correlations with social media data, weather forecasts, timetables required for data insights

• Concerns for sharing IoT data and tools – Ownership, Interoperability, Querying, Access Control
Chronic Illnesses

- Chronic illness requires significant allocation of healthcare resource
  - Over 80% of GP consultations
  - Type 2 diabetes: 10% of total NHS budget (7% prescribing budget)
  - Asthma: particular concern in Southampton because of pollution

- Rural areas are more challenging...
  - Limited resources, difficult to access, disjoint, ad-hoc, multi-agency care

- Some chronic illnesses can be self-managed by patients
  - Delivered through hand-held devices
  - Design of novel, innovative interventions
  - Requires understanding of personal health parameters and population level contextual factors
Work in progress in collaboration with Southampton City Council to design a cross-platform application to deliver digital interventions for asthma patients.

Captures the personal wellbeing of a patient through a questionnaire and location.

Next steps: Analyze data in context with weather data, pollen levels, social media data to design novel interventions.

Integration with data about biomarkers to deliver quality healthcare.
Self Management of Asthma

Crowd-sourcing

Citizen engagement for crowd-sensing, design their privacy profiles, trust evaluation

Analytics and Visualizations

Real-time observation and analyses of data and geospatial data visualizations, prescription patterns to understand public health

Self Management of Asthma

Data Integration/Fusion

Link personal parameters with environmental and other contextual data

Chat-bots/Automated Interventions

Can “pollen robo” and “Pepper” talk to chat-bot about what intervention is needed

Analytics and Visualizations

Self Management of Asthma

Data Integration/Fusion

Chat-bots/Automated Interventions
Self-Management of Chronic Illnesses

- Reducing healthcare costs, overcoming social stigma, and cultural differences
- Diabetes, depression, asthma, and heart condition are prevalent in both developed and developing countries
- A number of clinical and technological barriers need to be overcome to support self-management of chronic illnesses
- Requires understanding of personal and population level indicators (Sheth, 2017)
- Engagement with healthcare experts and local authorities in cities of Southampton and Manchester is key to this work!
Smart Cities and Wellbeing

- Requirement gathering and use-case formation: Part of HEALTH-I project with Cisco Smart City demonstrator, CityVerve (Manchester) and Southampton City Council (SCC). Funded through PETRAS project

**Wellbeing in Smart Cities**

- Lamp Posts
  - Use lamp posts for installation of air quality sensors
  - Use data collected for reducing asthma symptoms

- Train Routes
  - Cars drive around car-parks to find space, causing more pollution
  - Challenge is to monitor air quality around a car park at low cost
  - Use of low-cost sensors and lighting system to collect data

- Parking

- Healthcare Service Management
  - Unavailability of real-time guidance for people with health conditions to avoid areas with pollutions that can trigger an attack
  - Lack of understanding on to what extent the improvement of air quality could reduce health risk and healthcare cost

- Asthma

**Acknowledgements:** CityVerve, Manchester (PETRAS user partner)
Data Acquisition

- **Social Media Datasets** – Twitter, health social machines, other social media datasets

- **Open government datasets** – weather, geospatial datasets

- **Local datasets about people’s behaviors, attitudes and preferences** (User-Study and BreathEasy app)

- **U-BIOPRED** (Unbiased BIOmarkers in PREDiction of respiratory disease outcomes)
  - Sufferers lung condition

- **Sensor datasets about people and environments** from IoT Observatory and PETRAS community
Data Acquisition & Management

- **Social Media Datasets** - Web Presence of Patients

- **Open government datasets** — Environmental Factors

- **Local datasets about people’s behaviors, attitudes and preferences** — Lifestyle Monitoring

- **U-BIOPRED (Unbiased BIOmarkers in PREDiction of respiratory disease outcomes)** — History of Patient Illness

- **Sensor datasets about people and environments** — Physiological and Environmental Context

**Research Challenges**

- Define data management protocol for data collection, storage, sharing and knowledge mining
- Identify privacy risks and ethical challenges
Monitoring Exercise and Lifestyle: BreatheEasy Application

- Cross-platform wellbeing mobile application
- Captures general wellbeing of patients on a daily-basis
  - Lifestyle and physical activity
- Personal data captured – username, password and their geo-location
BreatheEasy: Wellbeing Questionnaire

1. {"user":"Asthma","activityID":"resumed","timestamp":1499352629764},
   {"user":null,"timestamp":null,"latitude":null,"longitude":null}
2. Asthma,1499420248072,50.93618063,-1.39604538
3. Asthma,149942692066,50.93650371,-1.3954991
4. Asthma,1499421751128,50.93678506,-1.39590097
5. Asthma,1499437269130,50.93646619,-1.39554336
6. 12.ironside@gmail.com,1500878016353,53.45250153939486,-2.1180496733212824
7. {"user":"Asthma","activityID":"paused","timestamp":1499353364306},
   {"user":null,"timestamp":null,"latitude":null,"longitude":null}
8. Asthma,1499353661313,50.9365368698
9. Asthma,1499353861358,50.93653888730
10. Asthma,1499354252579,50.93654760388
11. Asthma,1499354764055,50.93654765903
12. Asthma,1499354817728

More than normal

Well
An Example Intervention

- **GP Briefing**: Enhanced Patient History (sensing based environment, lifestyle, exercise monitoring)
- **Daily-basis**
  - **Questionnaire Prompt**
  - **Air Quality Prompt**
  - **Medication Prompt**
  - **BreatheEasy App**
    - Warnings for triggers, predictive analysis of response to prescribed treatment plan and medication
    - Real-time monitoring Exacerbation Warning
    - Personalized adjustments to medication, treatment plan and guidance
- **GP De-briefing**