Real-time Spatio-temporal Surveillance: the AEGISS Project

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Background

The goal of AEGISS (Ascertainment and Enhancement of Gastro Intestinal Surveillance Statistics) was to use spatio-temporal statistical methods to enable timeyy detection of anomalies in the spatial distribution of incident cases of non-specific gastro-intenstinal disease in Hampshire, UK.

Data: daily records, residential postcodes of all NHS Direct calls reporting gastrointestinal symptoms resident in Hampshire, with no recent travel history.

Methodology: Use historic data to build a statistical model of the natural variation in the the spatio-temporal point process of incident cases.

Implementation: Daily updating of a risk-map, showing at each location the probability that local incidence exceeds a pre-declared threshold.

Model

$$\text{Incidence}(x,t) = \lambda(x)\mu(t)R(x,t)$$

- $\lambda(x) =$ **spatial incidence**
  - smoothly varying, non-parametric surface to reflect geography and demography of NHS Direct users
- $\mu(t) =$ **temporal incidence**
  - log-linear model with terms for season, day-of-week and long-term trend
- $R(x,t) =$ **spatio-temporal interaction**
  - unobserved stochastic process
  - large values of $R(x,t)$ identified as **anomalies**, for further investigation

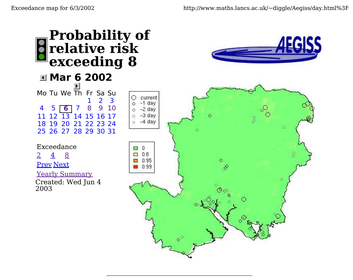
Real-time spatial prediction

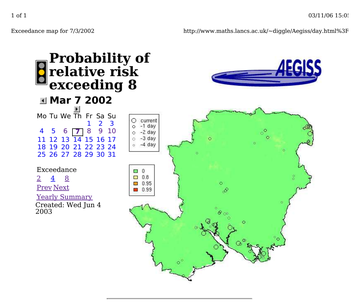
- Fit the model to historic data with no proven outbreaks
- Choose an interventon threshold, $c > 1$
- Derive predictive equation for $\mathrm{P}(R(x,t) > c|\text{data})$
- Update predictive equation daily, and re-draw maps overnight for web-posting

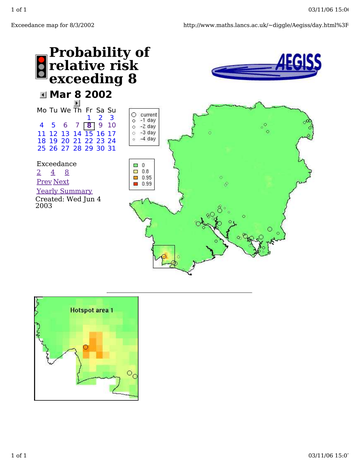
Results

- Plot exceedance probabilities, NOT estimates of risk
- traffic light gives quick summary
- colour-coding chosen to de-emphasise uninteresting fluctuations
- Options to track back in time, and to adjust intervention threshold

Centre panel shows risk-maps over three successive days:







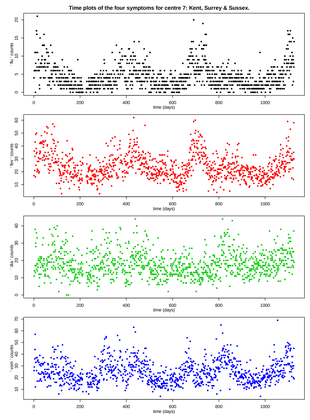
Current work

The AEGISS project was specific to gastro-intestinal symptoms in Hampshire, and aimed at fine-scale spatial coverage.

Current project in collaboration with NHS Direct:

- operates at call-centre level
- considers a range of symptom-codes
- aims to integrate across call-centre and symptom codes, so as to exploit spatial and symptomatic associations

Time series for four symptom-codes in Kent, Surrey and Sussex:



References

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DIGGLE, P.J., ROWLINGSON, B. and SU, T-L. (2005). Point process methodology for on-line spatio-temporal disease surveillance. *Environmetrics*, **16**, 423–34.

Acknowledgments

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