MSc projects at BT Innovate

Keith Briggs   keith.briggs@bt.com

Mobility Research Centre, BT Innovate & Design
http://keithbriggs.info

University of Bath MSc talk 2010-02-10 1400

BT Research - Adastral Park

Wireless networks

Distributed algorithms for graph coloring and wireless channel assignment

The world of mobile devices is moving towards autonomous behaviour. This means that no central authority decides things like wireless channel allocation and transmission power level. Devices must behave according to rules which ensure peaceful co-operation. To design these rules is a hard challenge. We will start by investigating experimentally (by computer simulation) two basic problems: to choose channels so that the whole system operates without interference; and, if this is not possible, to choose channels so that total interference is minimized. The overall theme is asynchronous distributed algorithms.

# Distributed coloring



chi=14 omega=14 Delta=23 chidash=23
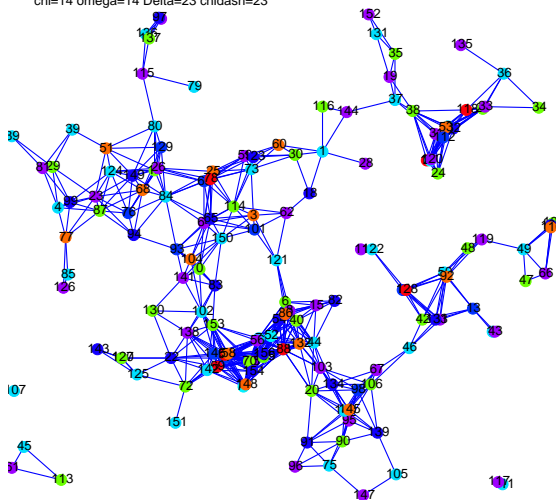
Computational geometry for wireless homehub applications

Wireless systems are evolving towards a smaller cell-size, so that we now think of house-sized cells. To model and simulate such systems requires models of house-density distributions. This information is not readily available, but a good proxy is the postcode database. This project would look at the Voronoi geometry of the postcode distribution (the figure shows an example from the Ipswich area), and calculate statistics relevant to wireless systems, such as distribution of housing density, and fractional coverage as a function of transmit power.

Computational geometry for wireless homehub application

Computational geometry for wireless homehub application

postcode=IP5, coverage radius=5 10 15 20 25 30 m
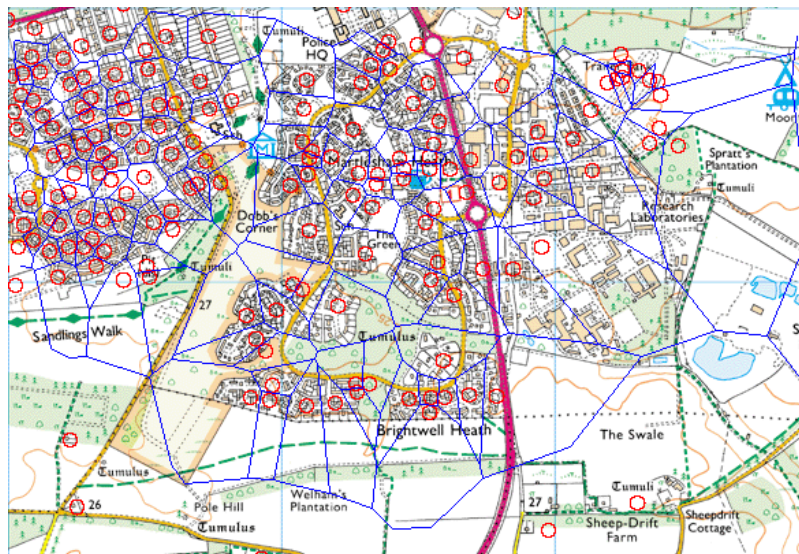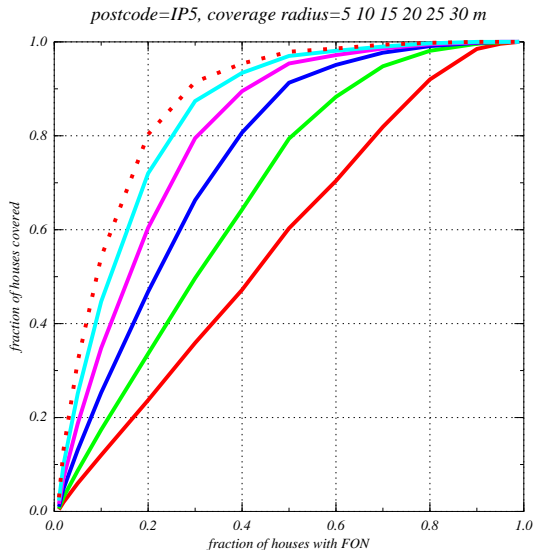
Sensing techniques for estimating the number of transmitters

The world of mobile devices is moving towards autonomous behaviour. It would be useful in practice if a device knew the number of other transmitters in its neighbourhood, so that it can avoid interfering with them (this is part of what is called cognitive radio). This estimation can be attempted by a small group of devices co-operating, so that they all measure received signal strengths and share their readings. This amount to estimating the power profile as a function of position, and from this optimization methods can be used to find the number of transmitters.

Maximum-likelihood period estimation

This project would be to study the paper *Maximum-likelihood period estimation from sparse, noisy timing data*, by Robby McKilliam and I. Vaughan L. Clarkson and write a program to implement the method. This is an important problem area with applications in telecoms.

Haartsen's modulation technique based on noise

Haartsen has proposed a wireless modulation technique based on noise. This project would build software simulators for this system, and investigate its performance, which would be compared with the theory.

Haartsen's modulation technique based on noise

★ carrier (white noise): $c(t)$

★ signal (modulation): $m(t)$

★ transmitted signal: $s(t){=}c(t{-}\tau){+}c(t)m(t)$ where τ is a fixed delay

★ recovery: let

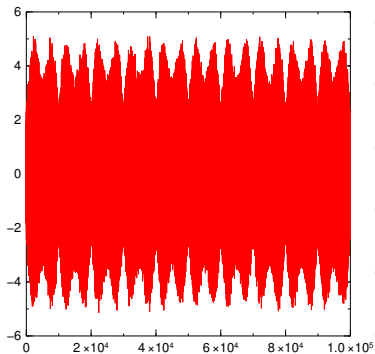$$z(t){\equiv}s(t)s(t{-}\tau){=}[c(t{-}\tau){+}c(t)m(t)][c(t{-}2\tau){+}c(t{-}\tau)m(t{-}\tau)]$$

and apply low-pass filtering. All terms except $c(t{-}\tau)^2 m(t)$ average to zero

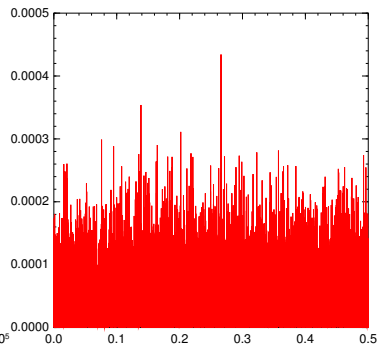★ need to choose τ longer than coherence time of noise, and shorter than time-scale of changes in $m(t)$

Transmitted signal

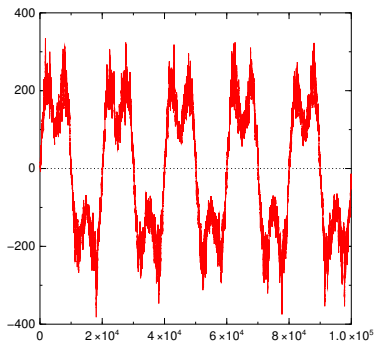$m(t) = \sin(10\pi t) + \frac{1}{2}\sin(30\pi t)$
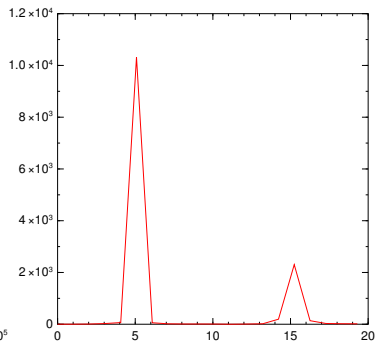

transmitted signal

spectrum of transmitted signal

Recovered signal

Statistics of train arrival delays

A previous project looked at statistical models in the delay to departure time of trains. An interesting result was obtained - that the delays follow a q-exponential distribution. This project would do the same thing for arrival delays, and, by extension, we can then study the distribution of trip delays. These statistical models have important applications to algorithms for optimal trip planning in the presence of random delays. I already have developed software for this problem, and part of the project would be to add the new arrival time model to the software.

Statistics of train arrival delays
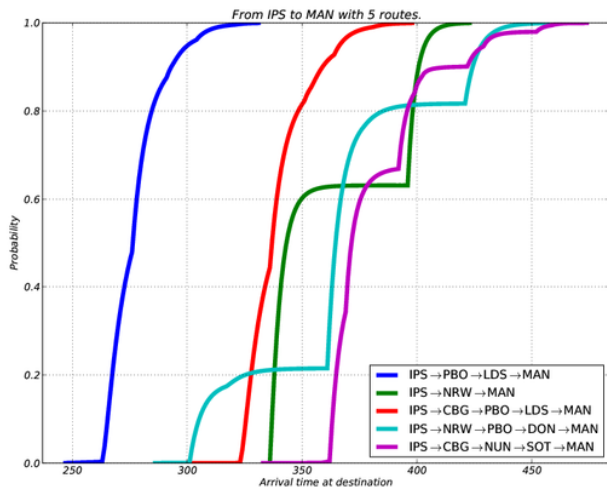
Satisfiability algorithms (SAT)

The SAT (satisfiability) problem is a very basic problem in logic: to determine whether a given Boolean function has an input which makes the output true. There are many good heuristics now available to solve SAT problems, and many practical problems are equivalent to, and can be translated into SAT.

This project would make a comparison of available solvers, and study their application to some practical problems in optimization, scheduling, and graph coloring. The fun part would be writing programs to translate these into SAT!

Fast counting

This project is inspired by the paper HyperLoglog: the analysis of a near-optimal cardinality estimation algorithm of Flajolet et al. How do we estimate (rapidly, and with minimal storage) the number of distinct items in a very large set (or data stream)? In other words, the problem concerns estimating the cardinality of a multiset. Flajolet et al. previously developed their loglog algorithm, and I worked on an efficient C implementation of this. They have now improved this with the hyperloglog algorithm, and this project would be to implement this and compare its performance in practice with alternatives.

The algorithm should have practical applications in informatics; for example, counting the number of different packet types in a network.

Fast random selection

Consider the problem: a large number N of objects are presented to us one by one, and we wish to either:

- Select exactly some specified number $n \leqslant N$ of them
- Select each with some specified probability p

The problem becomes hard to solve efficiently when p is small, because to generate a random number which usually results in a rejection is inefficient. It would be better to skip over a block of items. Ways to do these were proposed by Vitter in ACM Trans Math Soft 13, 58 (1987).
This project would investigate these methods and check their efficiency in practice. There are applications to the generation of large random graphs.