SWINBURNE UNIVERSITY OF TECHNOLOGY

Modelling First Person Shooter Game Traffic

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Outline

- Modelling of traffic
- First Person Shooter games
- Main question is
  - If we have statistics of 2 and 3 player games, can we predict traffic statistics of 4, 5, 6, … player games?
  - Knowing the mean, variance and Probability Mass Function (histogram) of games with small numbers of players can we predict the same for games with larger numbers of players
  - Can we model game traffic?
- Assumptions used in modelling game traffic
- Comparisons of predictions with empirical results
  - Time independent behaviour
  - Time dependent behaviour

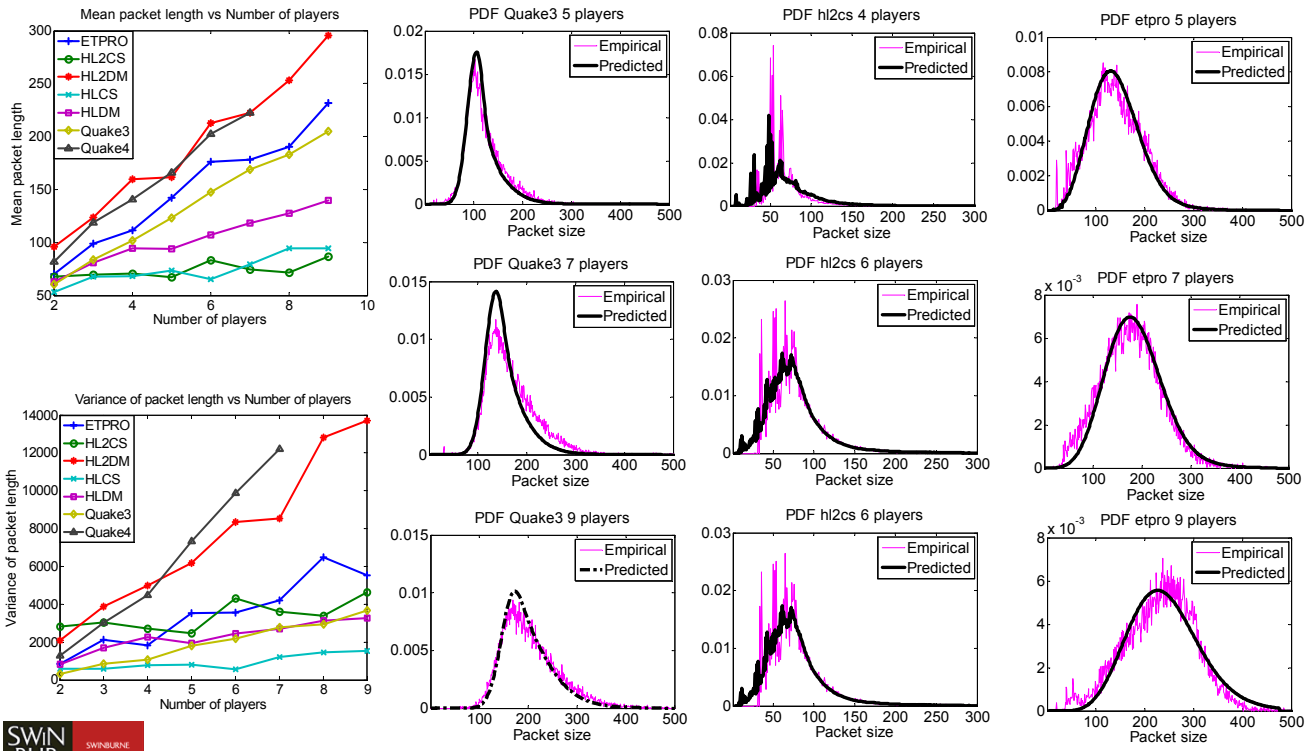
First Person Shooter Games

- FPS Games client-server architecture
- Traffic from the clients transmitted to the server
- Server processes inputs from clients and determines consequences
  - Eg explosions, game points, character deaths etc
- Random variables of interest include
  - Client to server packet rates
  - Client to server packet lengths
  - Server to client packet rates
  - **Server to client packet lengths**
- Server to client packet lengths of most interest
- Detailed analysis of game traffic from seven different games
  - Q3, Q4, ETPro, HLDM, HLCS, HL2DM and HL2CS

Model of game traffic

- Assumptions
  - The nature of game play for individual players does not change significantly regardless of the number of players.
  - Players have similar behaviour.
  - Game software compresses its output.
- From the assumptions we can make a number of predictions
  - N-player game statistics should be predictable from 2 and 3 player game statistics, for example
    - The probability distribution of packet lengths of a 5-player can be predicted from the prob. dist of a 2- and 3-player games
    - X5 = X2 + X3
  - Statistics to evaluate are the mean, variance and Probability Mass Function
  - Mean and Variance should increase linearly as number of players increase
  - PMFs should be predictable from X2 and X3
    - Eg f_{x5} should be the convolution of f_{x2} and f_{x3}

Time independent behaviour



Time varying behaviour

- Autocorrelated nature of game traffic not captured by simple probability mass functions
- We would expect game traffic to exhibit some autocorrelation
  - Periods of intense actions last for seconds
    - Will generate trains of large packets
  - Quiet periods also last for seconds
    - Will generate trains of short packets
  - Would expect that the length of the current packet will be a good predictor of successive packets
    - In other words we would expect to see some autocorrelation between packet lengths

Time series modelling

- We have a sequence Z_n
- Given Z_n, what do we predict Z_{n+1} to be?
- Many models of time series behaviour
  - Autoregressive model AR(p)

    $Z_{n+1} = \varphi Z_n + \varepsilon_{n+1}$
  - Moving average MA(q)

    $Z_{n+1} = \theta\varepsilon_n + \varepsilon_{n+1}$
  - Combined ARMA(p,q)

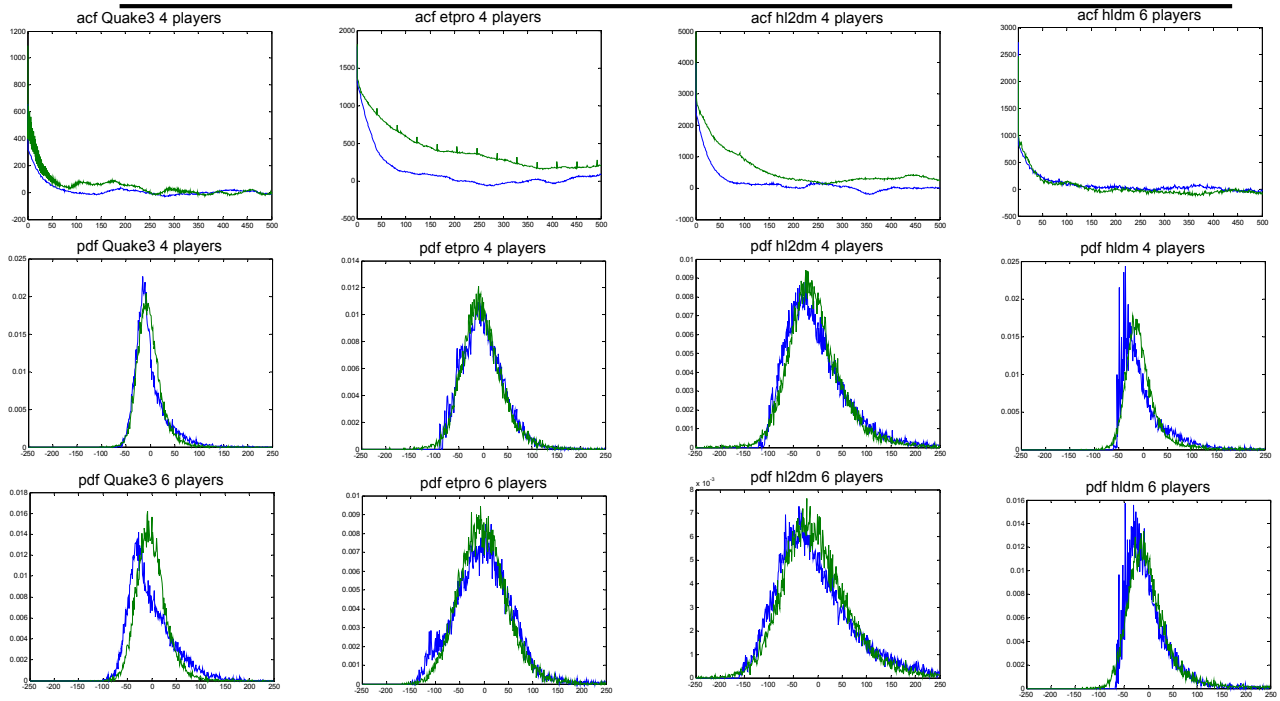
    $Z_{n+1} = \varphi Z_n + \theta\varepsilon_n + \varepsilon_{n+1}$
  - Φ, θ constants, ε_{n+1} the noise terms
- A successful model should capture all the autocorrelation in the φZ_n and $\theta\varepsilon_n$ terms
  - The noise terms (residuals, innovations) should be completely uncorrelated

Time series analysis of FPS game traffic

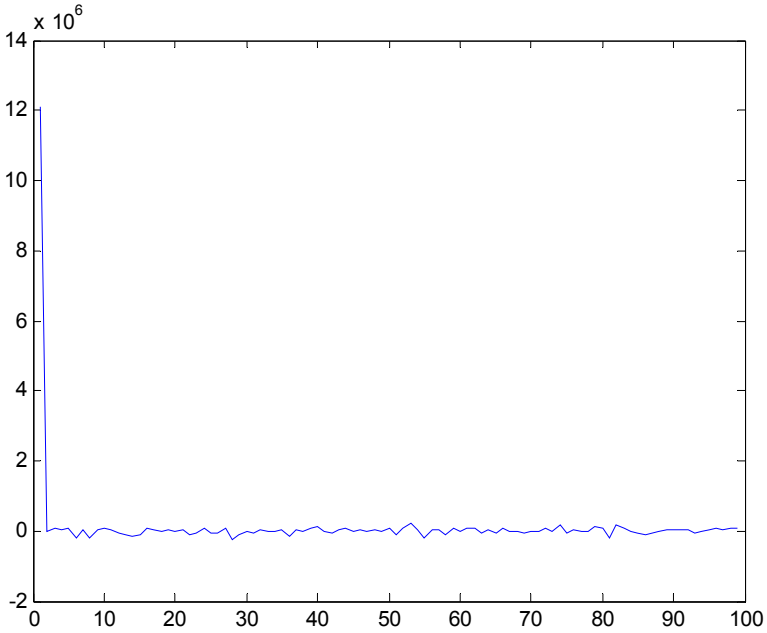
- Some success in modelling it with a Markov Chain (simplified AR(1) model)
- Much more success in modelling FPS game traffic with an ARMA(1,1) model

  $$Z_{n+1} = \varphi Z_n + \theta\varepsilon_n + \varepsilon_{n+1}$$
- Research question
  - Can we extrapolate ARMA(1,1) model of game traffic for 2 and 3 player games to predict ARMA(1,1) model of game traffic for games with more players?

Predicted time varying behaviour



Noise term (ε_{n+1}) for Quake3, predicted 6 player game



Comments and Future work

- Some obvious questions
  - Why not just look at the source code?
  - Same game engine in all the games?
  - Why only FPS games?
- Work elsewhere
  - Lots of ‘stamp-collecting’ type work
  - Some dubious work on long range dependence
- Future work (here)
  - Applicability of techniques to other game genres
  - Further exploration of the ARMA(1,1) model