

Modelling First Person Shooter Game Traffic

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Outline

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- 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



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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
 - $X_5 = X_2 + X_3$
 - 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 X_2 and X_3
 - Eg f_{x_5} should be the convolution of f_{x_2} and f_{x_3}

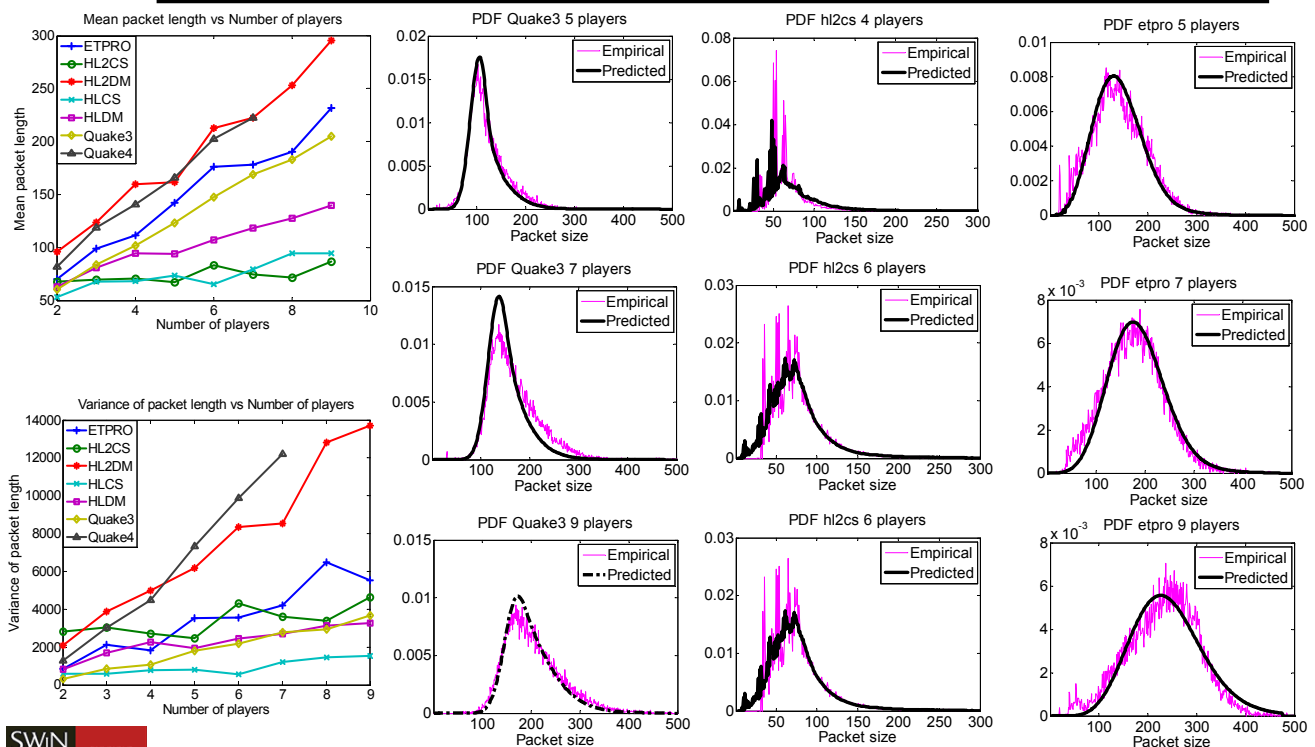


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Time independent behaviour



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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



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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)
 $Z_{n+1} = \phi Z_n + \epsilon_{n+1}$
 - Moving average MA(q)
 $Z_{n+1} = \theta \epsilon_n + \epsilon_{n+1}$
 - Combined ARMA(p,q)
 $Z_{n+1} = \phi Z_n + \theta \epsilon_n + \epsilon_{n+1}$
 - ϕ, θ constants, ϵ_{n+1} the noise terms
- A successful model should capture all the autocorrelation in the ϕZ_n and $\theta \epsilon_n$ terms
 - The noise terms (residuals, innovations) should be completely uncorrelated



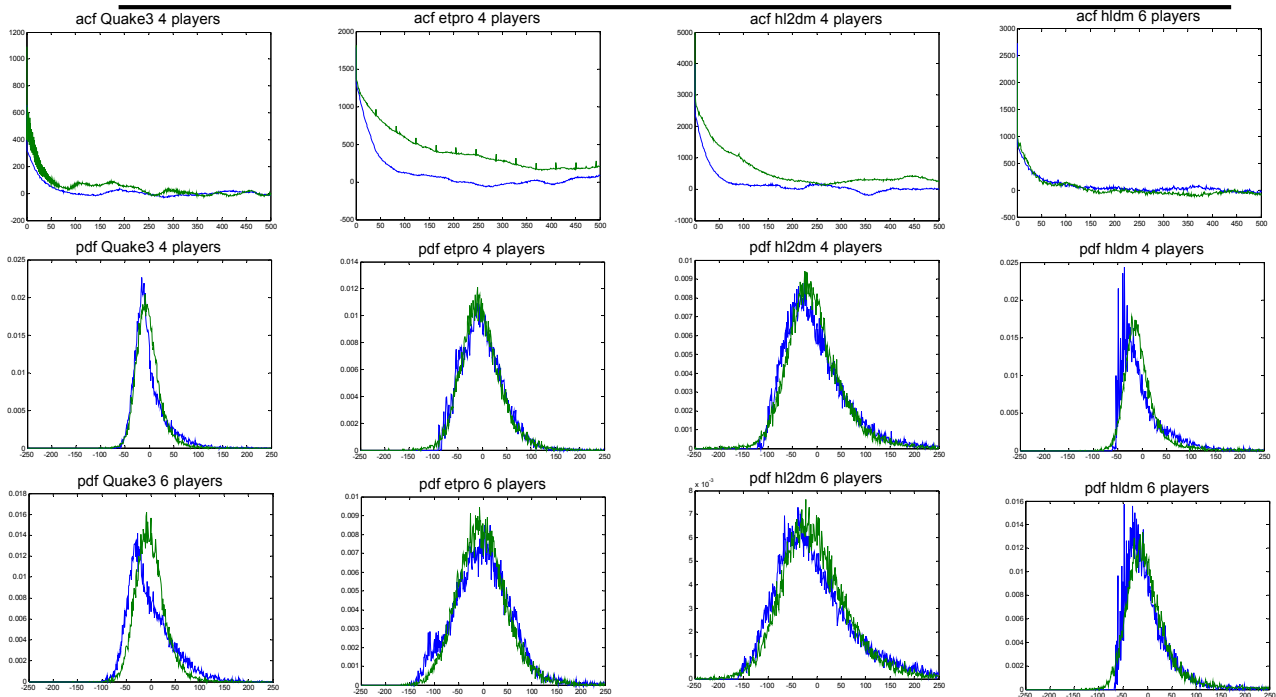
Time series analysis of FPS game traffic



- 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
$$Z_{n+1} = \phi Z_n + \theta \epsilon_n + \epsilon_{n+1}$$
- 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?



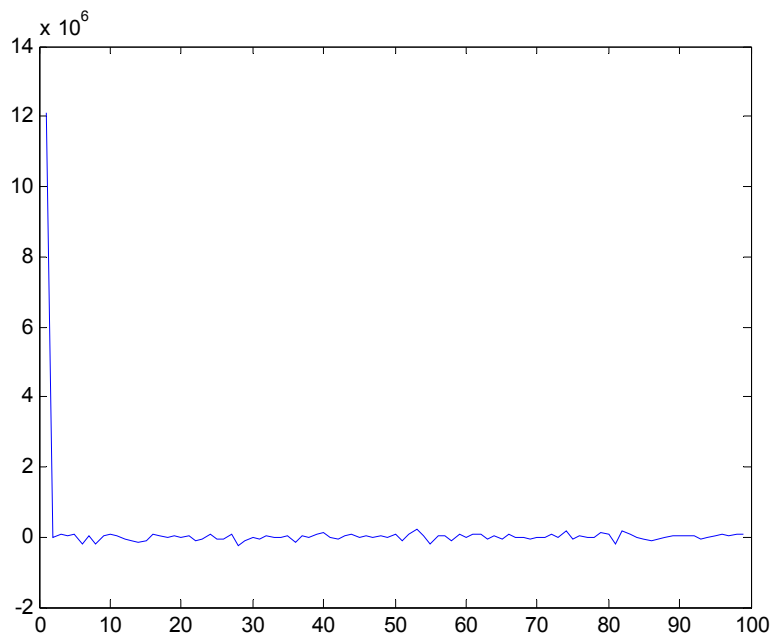
Predicted time varying behaviour



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



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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

