CCITT SGXV
Working Party XV/1
Experts Group for ATM Video Coding

Document AVC - 314
July 1, 1992

Subject: Statistical Analysis of Video Teleconference Traffic - III

Source: Bellcore

Purpose: Discussion

1. MODELING ISSUES STUDIED AND CONCLUSIONS

This contribution presents further results supporting those presented in two previous contributions to this Experts Group (Documents AVC-61, AVC-171). Our new results corroborate the results that we presented in documents AVC-61 and AVC-171 regarding the gamma distribution of cells per frame in video teleconferences and the DAR(1) traffic model presented in AVC-61. For the contribution AVC-61, we analyzed a 30 minute sequence of video teleconference data to answer the following question: What statistical models characterize the data accurately and what models of video sources are accurate enough to be used in traffic studies? The traffic data (provided by Siemens) that we had analyzed consisted of a sequence indicating the number of cells per frame for 48,500 frames of a teleconference with no scene cuts and with moderate motion. Our major conclusions were: (1) The number of cells per frame for video teleconferences follows a gamma (or negative binomial) distribution. Also, the number of cells per frame is a stationary process. (2) The order 2 autoregressive model fits the data well in a statistical sense. However, for traffic studies, neither an autoregressive model of order 2 nor a two-state Markov chain model is good because they do not model correctly (either underestimate or overestimate) the occurrence of large values (of number of cells per frame) and these large values are a primary factor in determining cell-loss rates. (3) A model sufficiently accurate for use in traffic studies was constructed using the peak rate, mean, variance, and first-order autocorrelation coefficient of the traffic.

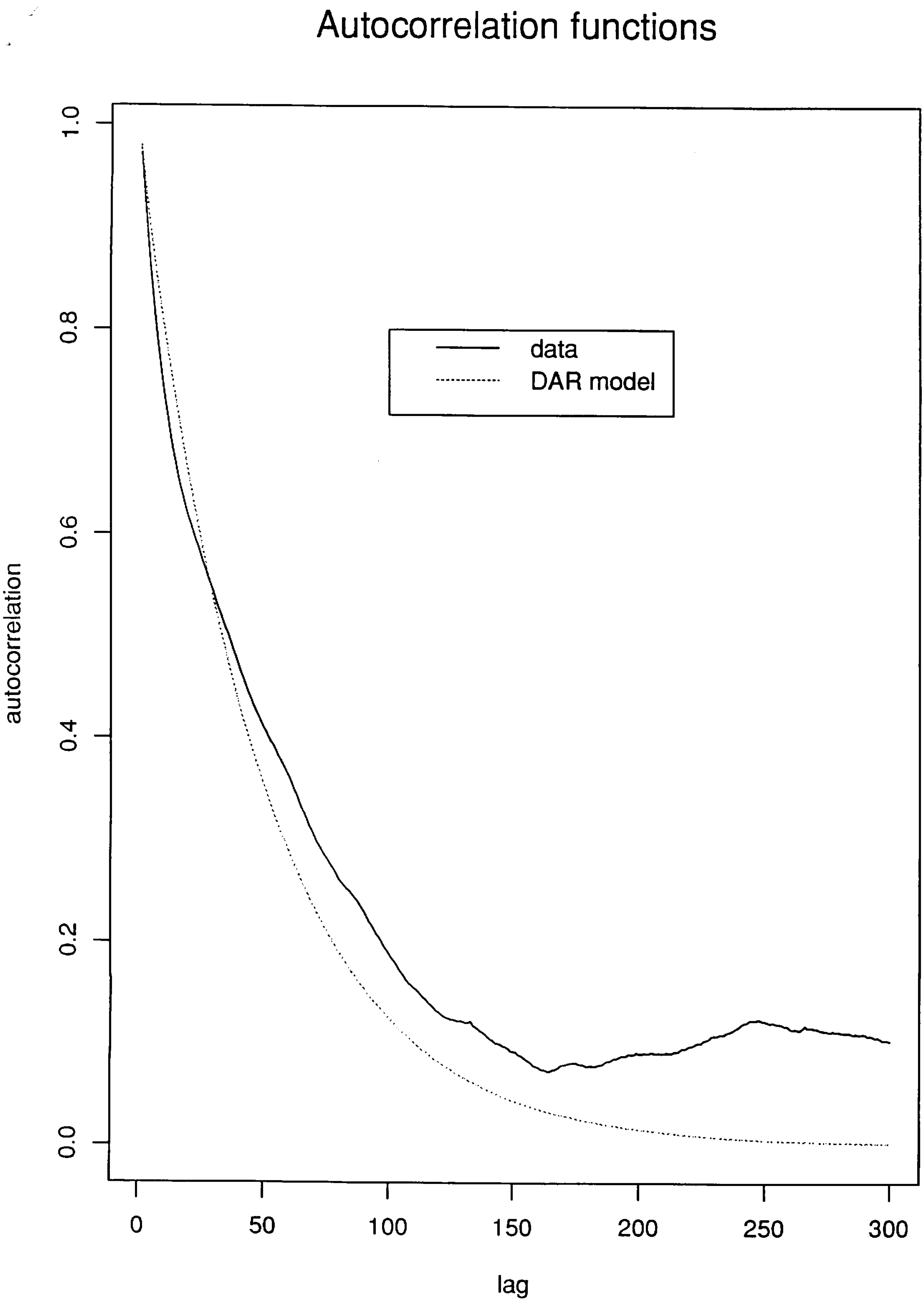
For contribution AVC-171, we analyzed two new 25 minute long (about 37000 frames) sequences of video data called "viconf" and "viphone". These sequences were provided by Alcatel in the Experts Group meeting held in August at Santa Clara, CA. The results in that contribution again showed that for video conferences the number of cells per frame follows a gamma (or negative binomial) distribution. The same was found to be true for videophones but the fit was not as good as for video conference. The autocorrelation function for both cases is exponential upto a lag of about 125 frames after which the autocorrelation of the data does not drop as much as the exponential.

A key point in both the previous contributions is that the coding scheme did not use motion compensation. Since motion compensation is a very important technique, for this contribution we analyzed a 32,000 frame traffic data sequence produced by a codec using motion compensation (an H.261 codec). The data was provided by Siemens and was recorded during a teleconference (head-and-shoulders scene) with a fixed frame rate of 30 Hz and a fixed quantization level (Q = 2).

Analysis of this data once again corroborates our previous result that the number of cells per frame for video conferences follows a gamma (or negative binomial) distribution. In fact, the fit is even better for this motion compensated sequence than for the sequences without motion compensation used for our previous contributions. The autocorrelation function is exponential upto a lag of about 150 frames after which the autocorrelation of the data does not drop. Our analysis for contribution (AVC-61) had shown an exponential autocorrelation function and this was used to synthesize the DAR(1) model proposed in that contribution. We are testing whether the previously suggested DAR(1) model could be retained as a model accurate enough for traffic studies when using motion compensated coders.

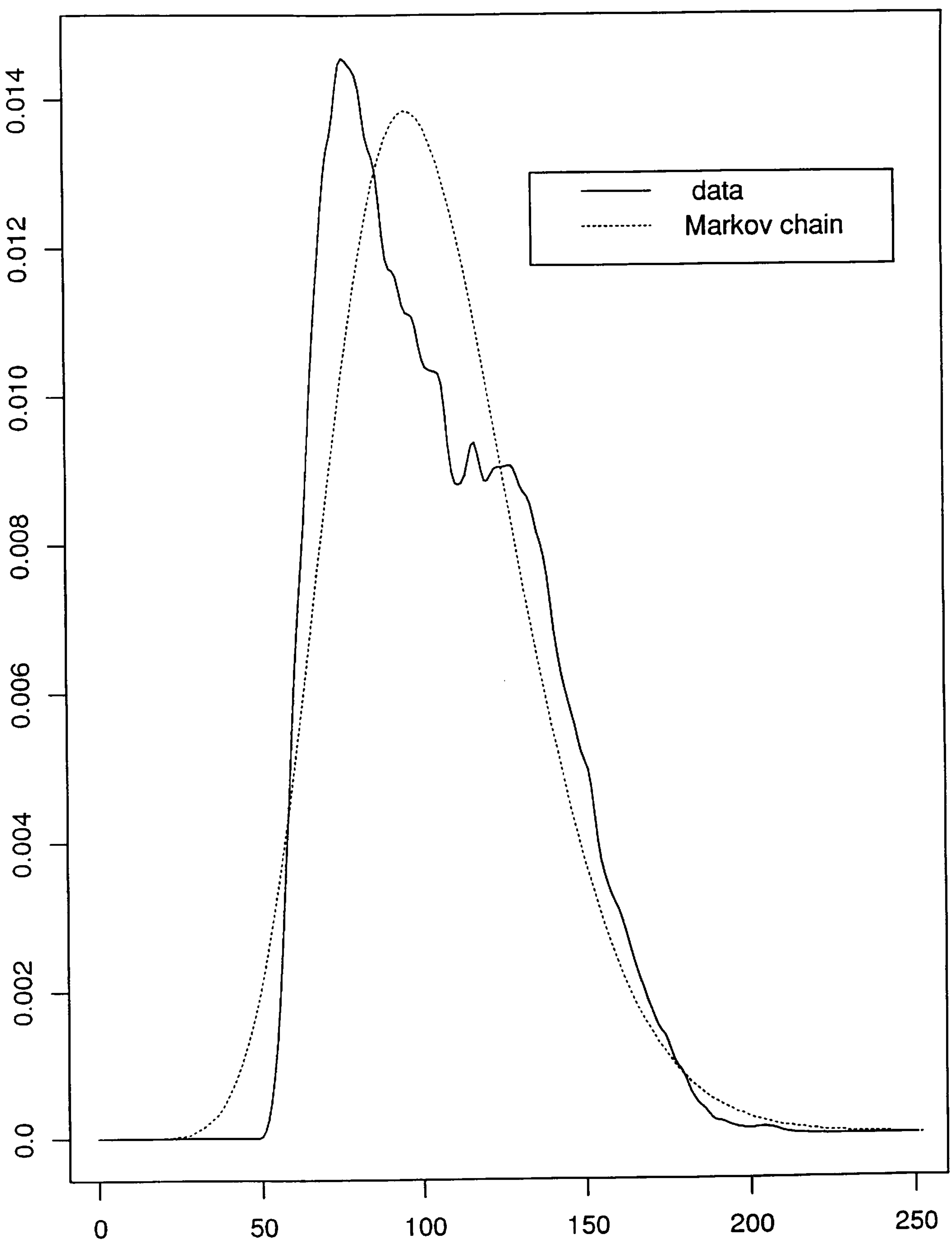
2. SUMMARY OF NEW STATISTICAL ANALYSIS

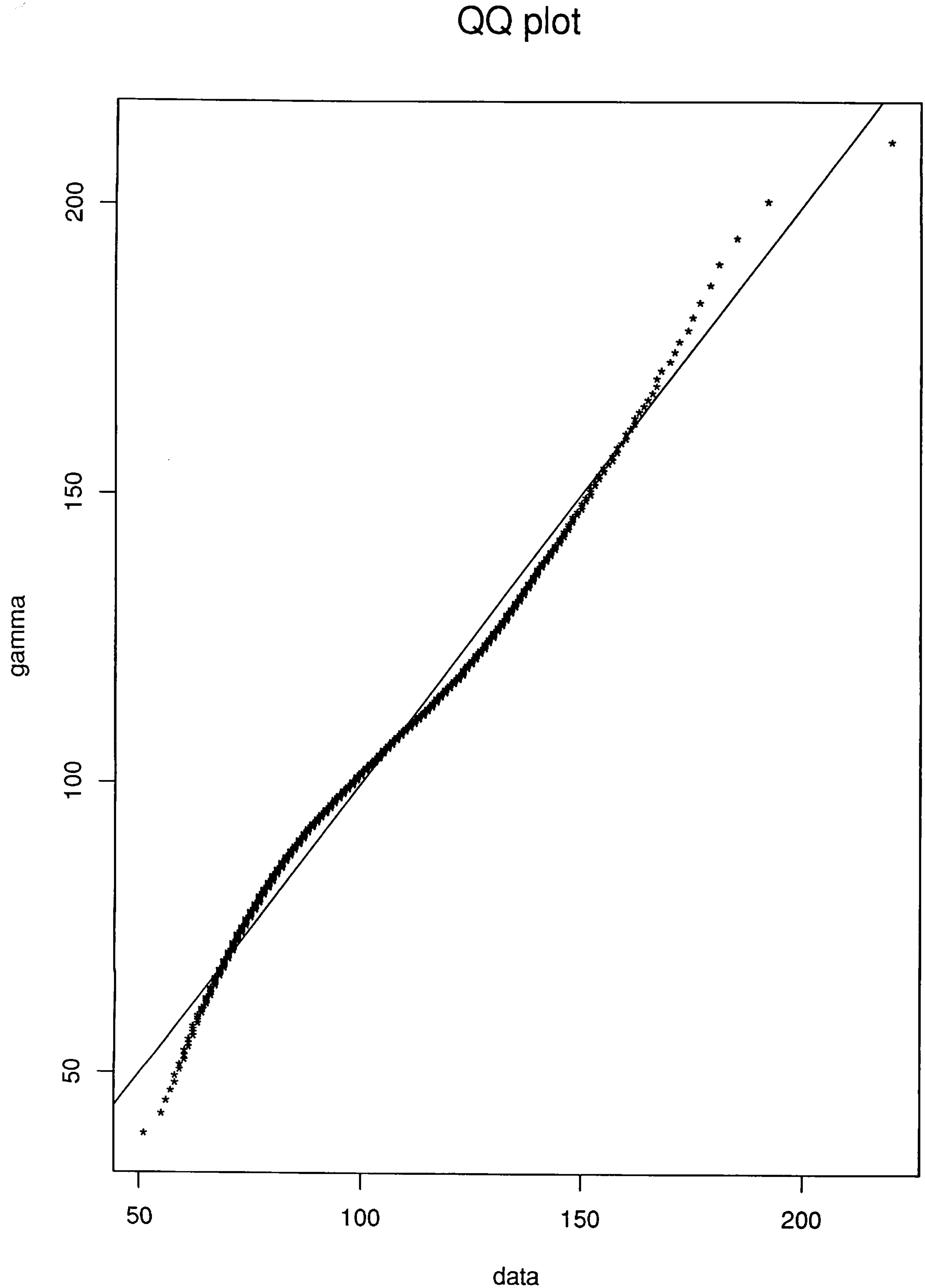
The empirical density function looks negative binomial and this is validated by the Q-Q plot. The Q-Q plot, which plots the quantiles of the data vs. the quantiles of the fitted distribution, is a powerful goodness-of-fit test. The Q-Q plot for the data and the gamma distribution is shown in Fig. 1. Figure 2 plots the empirical density function (of the motion compensated data) with that of a Markov chain constructed to model the motion compensated traffic source. Fig. 3 shows the autocorrelation of the sequences and compares it to the exponential. It can be seen that the autocorrelation drops off exponentially upto a lag of about 160 frames.



Autocorrelation functions
data
DAR model
autocorrelation
lag
0.0
0.2
0.4
0.6
0.8
1.0
0
50
100
150
200
250
300

Density Functions





QQ plot
gamma
data
50
100
150
200
50
100
150
200