Engineering Tripos Part IIA Project, SF1: Data Analysis, 2019-20

Leader

Prof S J Godsill [1]

Timing and Structure

Fridays 9-11am plus afternoons, Tuesdays 11-1pm

Prerequisites

3F1 and 3F3 recommended though not essential

Aims

The aims of the course are to:

- To introduce non-parametric signal analysis and processing metthods in the transform domain
- To apply non-paremetric processing methods to real audio datasets
- To study and apply parametric methods to signals, with an emphasis on probabilistic techniques (likelihood and Bayesian) and incuding model choice
- To carry out an extended application in Matlab in audio processing for noise reduction, packet concealment, declipping or interpolation.

Content

This project introduces signal modelling/processing techniques and applies them to audio and musical signals. First non-parametric methods based on transforms such as the Discrete Fourier Transform (DFT) and its fast variant the FFT are studied and experiments are carried out with windowing, frequency resolution etc. These methods are then applied in an audio noise reduction setting, processing sound signals using overlap-add analysis/processing/synthesis to perform noise reduction. Then parametric models are introduced, with estimation using least squares., maximum likelihood and Bayesian techniques. The autoregressive (AR) model is used as an example here, and model choice is studied within likelihood and Bayesian probabilistic settings. Once again, the techniques are applied in audio signals, using models to perform packet loss concealment and interpolation of missing data in audio, as well as constrained interpolation for clipped and/or heavily quantised signals. Students will have the opportunity to incude their own ideas into the applied schemes and there will be a competition for the best noise reduction performance from test audio datasets, evaluated using mean-sqaured error, perceptual criteria and (informal) listening tests.

FORMAT

Students will work in pairs.

ACTIVITIES

Week 1:Non-parametric analysis processing in the transform domain – DFT, FFT, windows, window length, overlap-add processing and application to denoising of audio signals.

Week 2:Parametric modelling of signals using maximum likelihood and Bayesian techniques, including Bayesian model choice, autoregressive models and sinusoidal models.

Weeks 3 & 4:Extended application in audio to denoising, packet loss concealment de-clipping or interpolation. Investigation of several of the week 1 and 2 techniques in real signal application. Competition for best noise reduction performance (Matlab code must be original and run-able by the markers!).

Coursework

Coursework	Due date	Marks
Interim report 1	Thu 14 May 2020	15
Interim report 2	Thu 21 May 2020	15
Final report	4pm Fri 5 June 2020	50

Examination Guidelines

Please refer to <u>Form & conduct of the examinations</u> [2].

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Links
[1] mailto:sjg30@cam.ac.uk
[2] https://teaching22-23.eng.cam.ac.uk/content/form-conduct-examinations