

# A Tool for Analysing Think-Aloud Protocols Relating to Time-Series Data

Jim Hunter

Department of Computing Science, University of Aberdeen

**Abstract. Objectives:** One of the aims of the COGNATE project is to investigate and compare the abilities of clinicians and nurses (both senior and junior) to extract meaningful information from monitor trend data as presented by a neonatal ICU cot-side computer system. One approach was to replay off-line two hour sections of historical data, and to ask the subject to think out loud about their interpretation. The data is sampled once per second and was presented to the subject one screenful (i.e. about seven minutes) at a time; the channels displayed were: heart rate, transcutaneous O<sub>2</sub> and CO<sub>2</sub>, core and peripheral temperatures and mean blood pressure. The spoken commentary was recorded and subsequently transcribed; the state of the computer screen was captured by a video camera. The transcripts were manually segmented; each individual segment was annotated with the time of the seven minute interval it related to and with any pointing gestures observed on the video, and coded according to the nature of the statement (e.g. descriptive, interpretative, etc.). The aim of the work described here was to allow the person analysing the protocols to relate each segment as closely as possible to the actual data.

**Methods:** The Time Series Workbench (TSW - a PC-based tool) allows the flexible display of multi-channel time series data. It also allows the transcribed protocol segments for a given subject to be displayed one at a time together with an indication on the data display of the time period each segment relates to (initially seven minutes). However it is often possible, given the content of the segment and (occasionally) information on gesture, for the analyst to relate the segment to a specific data channel and/or to a more limited time interval. The TSW allows this refinement to be carried out interactively. It also allows the analyst to select one or more symbolic descriptors to summarise each segment; for COGNATE these descriptors include information about the level and slope of the signal, its variability and its interpretation. The refined data is stored for further analysis. In addition, segments from other subjects which relate to the same time period can be presented in a similar way to allow detailed inter-subject comparison. Various tools for data summarisation are provided, including one which determines intervals for which there is maximal agreement between the subjects that an event of a particular type is occurring.

**Results:** The detailed results of protocol analysis within the COGNATE project to compare the performances of junior and senior clinicians will be reported elsewhere. In summary however, the results are consistent with the existing literature on expertise and diagnostic thinking. Our data shows senior doctors' superior ability to focus on relevant aspects of the monitored data as indicated by their ability to detect and correctly interpret many more relevant physiological patterns and to generate a larger number of hypotheses than juniors.

**Conclusions:** A tool that allows the flexible inspection of and interaction with time-series data can be extremely valuable both in protocol analysis (see above) and in knowledge acquisition (see paper by Hunter and McIntosh in the main proceedings). Currently we are working to enhance the TSW by enabling direct recording and replay of verbal comments in synchrony with interactions with the display.