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Design for conceptual knowledge processing: case studies in applied formal concept analysis

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Design for Conceptual Knowledge Processing: Case Studies in Applied Formal Concept Analysis

A thesis submitted in fulfilment of the
requirements for the award of the degree

Doctor of Philosophy

from

University of Wollongong

by

Jon Ducrou

Faculty of Informatics

2007

CERTIFICATION

I, Jon Robert Ducrou, declare that this thesis, submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy, in the Faculty of Informatics, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Jon Robert Ducrou
December 4, 2007

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LIST OF ABBREVIATIONS

ATC Access Testing Centre

CASS Conceptual Analysis of Software Structures

CEM Conceptual Email Manager

CIS Conceptual Information System

CKP Conceptual Knowledge Processing

CLK Conceptual Landscapes of Knowledge

CSV Comma Separated Values

DSIFT Dynamic Simple Intuitive FCA Tool

ECA Email Concept Analysis

FCA Formal Concept Analysis

GIS Geographical Information System

LN Lower Neighbour

TOSCANA TOolS for Conceptual ANAlysis

UN Upper Neighbour

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‘The purpose of computing is insight, not numbers.’

Mathematician Richard Hamming (1915-1998)

ABSTRACT

Conceptual Knowledge Processing (CKP) is a knowledge management and data analysis technique that makes use of conceptual structures. Formal Concept Analysis (FCA) is a CKP methodology that uses lattice theory to represent units of thought, or concepts. When FCA is used in software applications, it makes use of a process called Mixed Initiative. Mixed Initiative breaks down the roles of user and machine, allowing each to play to their strengths. This process allows the computer, which can process vast amounts of data, to produce interaction options from which the user can select. A human can interpret semantic knowledge contained within the data that a computer cannot. This synergy of user and computer allows complex tasks to be performed. Wille [Wil99] proposed ten atomic tasks of CKP which are combined to make these more complex tasks. The ten tasks are *exploration*, *search*, *recognition*, *identification*, *analysis*, *investigation*, *decision*, *improvement*, *restructuring* and *memorisation*. Individually, these tasks represent facets of interaction with conceptual systems.

This thesis uses the ten tasks of Conceptual Knowledge Processing as a framework for experimentation with applications that use Formal Concept Analysis. The applications used for this analysis are **MailSleuth**, **SurfMachine**, **DSift**, **ImageSleuth** and **SearchSleuth**. These applications approach various problems, using FCA as the primary knowledge structure and interaction framework. Each application uses various interface components and varying degrees and types of exposure to the FCA structures on which they are based. The connection between CKP tasks and interface exposure is then explored and reported.