An Agent-Based Data Mining System for Ontology Evolution

Maja Hadzic and Darshan Dillon

Digital Ecosystems and Business Intelligence Institute, Curtin University of Technology
GPO Box U1987, Perth 6845, Australia
{m.hadzic, darshan.dillon}@curtin.edu.au

Abstract. We have developed an evidence-based mental health ontological model that represents mental health in multiple dimensions. The ongoing addition of new mental health knowledge requires a continual update of the Mental Health Ontology. In this paper, we describe how the ontology evolution can be realized using a multi-agent system in combination with data mining algorithms. We use the TICSA methodology to design this multi-agent system which is composed of four different types of agents: Information agent, Data Warehouse agent, Data Mining agents and Ontology agent. We use UML 2.1 sequence diagrams to model the collaborative nature of the agents and a UML 2.1 composite structure diagram to model the structure of individual agents. The Mental Heath Ontology has the potential to underpin various mental health research experiments of a collaborative nature which are greatly needed in times of increasing mental distress and illness.

Keywords: ontology evolution, data mining, multi-agent system, multi-agent system design, mental health, mental health ontology.

1 Introduction

The complex nature of mental health makes it a very interesting research topic. Most mental illnesses are poorly understood as they are caused by the interplay of multiple factors. The lack of understanding of mental illnesses, in combination with the rapid changes pervading our societies, is becoming a serious threat to mental health.

The revolutionary development of technology has resulted in the rapid introduction of cutting-edge technologies into our societies. We have become very dependent on sophisticated technologies and the ways in which they have made our lives more comfortable. However, there is evidence to suggest that this material comfort has failed to bring us better health, greater inner peace and a greater sense of meaning, purpose and satisfaction [1]. While the lives of individuals may have improved in some ways, evidence in [1] suggests that the general health and well-being of individuals within our societies have deteriorated. Since 1960: (1) the divorce rate has doubled, (2) the teen suicide rate has tripled, (3) the recorded rate of violent crime has quadrupled, (4) the prison population has quintupled, (5) the percentage of babies born to unmarried parents has increased six fold, and (6) cohabitation (a predictor of future divorce [2]) has increased sevenfold. Moreover, it appears that these problems

R. Meersman, P. Herrero, and T. Dillon (Eds.): OTM 2009 Workshops, LNCS 5872, pp. 836–847, 2009.

are increasing over time, and are gaining momentum rather than being random events. The World Health Organization predicts that depression will most probably be the major cause of disability worldwide by 2020 [3].

Due to the complexity of the mental health domain, mental health research has been extended to include research from other knowledge domains. Mental illness is not simply a case of blood tests and prescription of medications. It is much more than that. There is a need for physiologists, molecular biologists, biochemists, neurologists, neuroscientists, psychologists, psychiatrists, drug therapists, herbalists, sociologists, theologises, etc. as well as information and computer scientists, to collaborate in their research. A large number of research teams are undertaking various studies to examine the relationship between mental health and other aspects of personal well-being such as physical health, finances, social relationships, emotional well-being and spirituality [4]. We have designed the Mental Health Ontology to define and represent these various aspects of mental health [4]. However, due to the rapid increase of newly derived knowledge, this Mental Health Ontology needs to be continually updated. We used the five-step TICSA methodology [6] to design a multi-agent system that supports the dynamic update of the Mental Health Ontology. The different agents of the systems cooperate and collaborate with each other to achieve this common goal. The collaborative effort of the various types of agents determines the performance of the multi-agent systems, namely, the efficiency of the Mental Health Ontology update.

A number of techniques have been proposed for the ontology evolution and these are discussed in Section 2. In Section 3, we provide more detail about Mental Heath Ontology. In Section 4, we describe how we use the TICSA approach to design the multi-agent system for the ontology evolution. In this section, we discuss the five different steps of the TICSA methodology and explain the pattern matching approach used to validate the ontology update. We give our final remarks in Section 5.

2 State of Play

A number of systems have been proposed and used for ontology evolution. Mao *et al.* [7] introduced a large-scale Web Ontology for Traditional Chinese Medicine (TCM). The authors highlight the need for ontologies to self-evolve and specialize in their domain knowledge. Specifically, they refer to the context-specific elements of the large-scale ontologies, namely, sub-ontologies. The local repository called an ‘ontology cache’ uses the sub-ontologies as they evolve. The sub-ontology evolution approach is based on a genetic algorithm for reusing large-scale ontologies. Triple-based encoding, fitness function, and genetic operators were used to support the evolution.

In the system proposed by Afsharchi and Far [8], agents consult each other to identify new concepts and design an ontology to include these new concepts. Individual agents create and learn their own conceptualization. The learning of new concepts is supervised by other agents. The supervising agent uses positive and negative examples to teach this concept to an interested agent. The learning agent feeds this information into a concept learner. Voting and elimination of examples is used to resolve conflicts. This system has the potential to improve communication between different agents that operate using different ontologies.

Ottens *et al.* [9] have developed Dynamo, a self-organizing multi-agent system, which (1) uses automatic text processing to create an ontology draft, and (2) interacts with a domain expert to finalize the ontology construction. The system uses newly added information to adapt the existing network of concepts. The system and the ontology designers modify the network in a cooperative way.

Li and Yang [10] discuss an agent-based approach for managing ontology evolution in a Web services environment. They examine the inter-processes between different ontologies from the agent's perspective and apply an agent negotiation model in reaching agreement. Additionally, the authors describe an extended negotiation strategy which is expected to provide sufficient information in decision making in each round of negotiation.

Numerous existing ontology-evolution systems make use of software agents. The difference between the existing approaches and our approach is that we aim to use data mining algorithms in the ontology evolution process.

3 Mental Health Ontology

In our previous work [5], we introduced Mental Health Ontology as being composed of three sub-ontologies: Illness Type, Symptoms, Factor (Cause) and Treatment (see Figure 1).

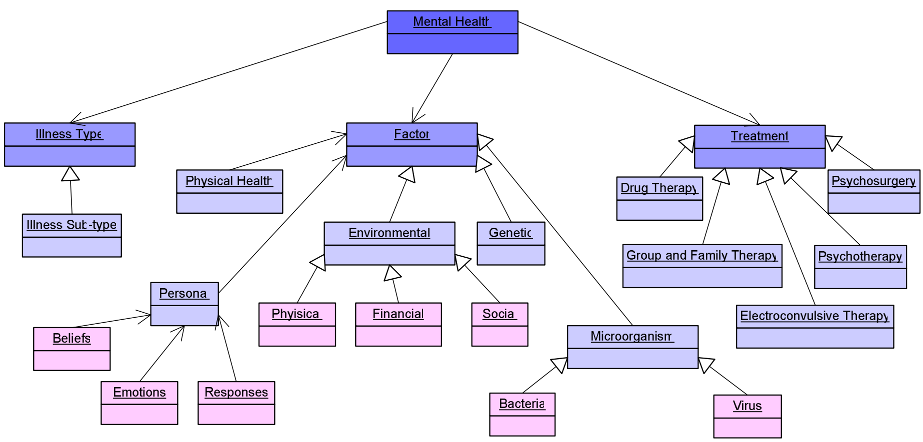

Fig. 1. Top-level hierarchy of Mental Health Ontology

By collating information from the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10) published by the World Health Organization (WHO) [11] and the Diagnostic and Statistical Manual of Mental Disorders, Fourth Revision (DSM-IV) by the American Psychiatry Association [12], we have identified thirteen types of mental illnesses, including among others: psychotic disorders, anxiety disorders, personality disorders, mood disorders, substance-related disorders, etc. Each of the types is further classified into it subtypes. For example, ‘anxiety disorder’ is classified into eight different sub-types such as obsessive-compulsive disorder, panic disorder, social phobia, etc.

The exact causes of mental illness are still unknown. We have classified the factors that affect mental health under the following five categories: (1) genetic, (2) physical, (3) environmental, (4) personal and (5) microorganisms. The genetic, physical, environmental, personal and microbial factors are interconnected and mutually dependent on one another. For this reason, we need to approach mental health as being a function of multiple dimensions. This necessitates the analysis of each dimension both individually and in relation to other dimensions.

Genetic factors include variations/mutations of human DNA that affect mental health, such as the mutations in G72/G30 gene complex which is associated with schizophrenia [13].

Physical factors define and describe physical conditions that may affect mental health. For example, Vitamin B deficiency may result in depression, liver failure may cause hallucinations, multiple sclerosis may result in mood disorders, and tubercular meningitis may result in personality disorders. Additionally, it has been reported that physically active people tend to have better mental health [14]. For this reason, physical activity has been successfully used as a non-pharmacological treatment for depression [15,16]. Physical activity may reduce the symptoms of anxiety, improve social skills and cognitive functioning, and be a beneficial adjunct to programs that target alcoholism and substance abuse [17].

Environmental factors include factors surrounding us over which we have less control. These include our physical, financial and social environments. For example, our physical environment is determined by climate, living conditions, noise, pollution, etc. Social environment captures factors determined by our relationships with others. Kawachi & Berkman [18] highlight the beneficial roles that social ties play in individuals’ mental well-being. However, not all relationships are beneficial. It has been reported that the financial environment affects our health. Studies of the Data from the National Health Interview Survey, the National Survey of Families and Households, the Survey of Income and Program Participation indicate that increases in income significantly improve mental health [19]. However, the same study claims that increases in income increase the prevalence of alcohol consumption which in its turn may be damaging to both physical and mental health.

Personal factors relate to the factors surrounding us over which we have more control. These include our beliefs, emotions and responses. Bergin [21] evaluates the effect of spirituality on mental health. He makes it clear that religion can have both positive and negative effects. The negative situations are marked by evil masquerading as religious dogma, namely, misuse of religion for selfish interests. The positive impact is marked by a highly individual experience, a true personal conviction or commitment and is manifested in dramatic personal healing or transformation. The effect of emotions on mental health has also been examined. Dr Colbert [20] defines destructive emotions in terms of their origin, nature and manifestations. He also explains the negative effect of these emotions on our health. Our immediate responses to complex situations can have a long-term impact on our mental health.

Recently it was reported [22] that microorganisms such as ‘viruses’ or ‘bacteria’ may exist that could affect mental health. More research is required to explain why mental illness appears to be transmittable; is this caused by a microorganism or is the wellness/illness ‘contiguous’ ?

As the mental health domain is still a grey area and the exact causes of mental disorders are unclear, the precise strategies for treatment cannot be developed at this stage. A number of studies have established the correlation between chemical imbalances in the brain and specific psychiatric conditions which subsequently led to the development of pharmacotherapy for mental health [27, 28]. However, a large number of psychoactive drugs produce serious side effects [23, 24, 25, 26]. In recent years, significant advances have been made in the field of psychotherapy, an interpersonal intervention which employs one or more of a range of specific psychological techniques facilitated through a psychotherapist. These include behavioral therapy [29, 30], cognitive therapy [31, 32], humanistic therapy [33], play therapy [34], psychodynamic therapy [35, 36] as well as rehabilitation programs. Group and family therapies are also often useful in assisting individuals to cope with stress. Most studies suggest that an integrated treatment approach involving both drugs and psychotherapy is more effective than either treatment method used alone [37, 38].

The three ontology ‘dimensions’ contain very different information and are orthogonal to each other. The Illness Type sub-ontology is more a classifying ontology and is strongly hierarchically supported. The Factor (Cause) sub-ontology is strongly based on scientific research and exposes the different kinds of factors that may affect our mental health, both positively and negatively. The Treatment sub-ontology is a combination of classification and research ontology. Designing new drugs is research work but, for example, all the discovered drugs can be hierarchically classified. All three dimensions are different from each other and each dimension is unique. But jointly, they give an overall picture and a good overview of the current knowledge about mental health.

4 System Design

In this section, we describe a multi-agent system that uses data mining algorithms in the intelligent update of the Mental Health Ontology. We have adopted the TICSA approach described in [6] to design the multi-agent system. The TICSA methodology consists of the following five steps:

1. Identify Agent **T**ypes According to Their Responsibilities
2. Define Agent’s **I**ntelligence
3. Define Agent’s **C**ollaborations
4. Protect the System by Implementing **S**ecurity Requirements
5. **A**ssemble Individual Agents

4.1 Identify Agent Types According to Their Responsibilities

In this step, we identify specific agent types and the corresponding function required to enable the intuitive flow of processes involved in the ontology evolution. Each agent works on a specific aspect of the overall problem with the various types of agents having different but complementary functions.

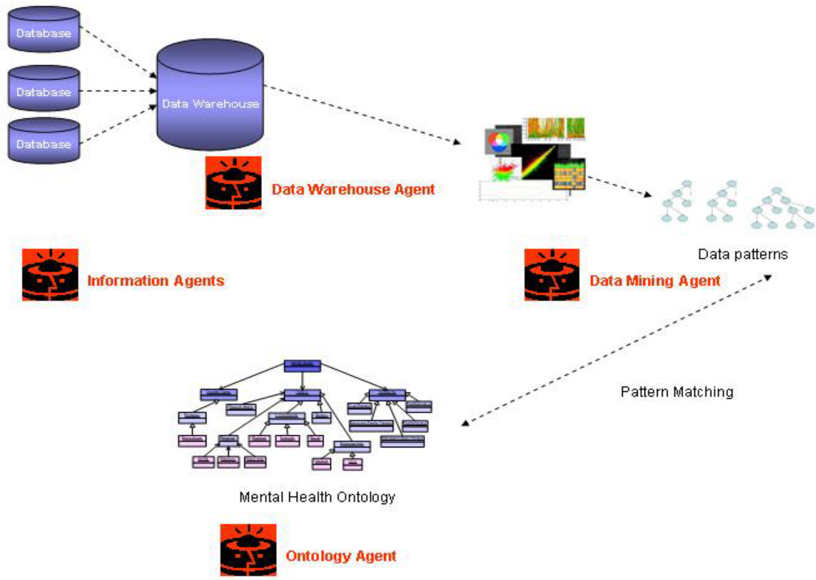

Fig. 2. Information, Data Warehouse, Data Mining and Ontology agents

In our system, we make use of four different types of agents as shown in Figure 2:

(1) Information agents, to extract raw data from various databases and upload them to a dedicated data warehouse;
(2) Data Warehouse agent, to systematically manage the data within the data warehouse;
(3) Data Mining agent, to mine the data from the warehouse, reveal interesting patterns from the data and derive new knowledge;
(4) Ontology agent, to employ the derived knowledge to update the Mental Health Ontology.

4.2 Define Agent's Intelligence

The agents of the system need to be equipped with the knowledge that enables them to perform their task intelligently. They need to be able to identify and extract target data, to systematically store and manage data, to intelligently analyze the data, to communicate with each other, etc. The knowledge base has been predominantly used to provide agents with intelligence and enable them to perform their role efficiently and effectively. Some researchers prefer to use oontology rather than a knowledge base as the ontology is a more expressive knowledge model [39]. We use a combination of knowledge bases and ontologies in our system.

4.3 Define Agent's Collaborations

The effective collaboration between the different agent types contributes greatly to the efficiency of the system's performance. In the multi-agent structure shown in Figure 1, the processing cycle starts from the *Information agents*. Information agents are situated over various databases and have access to mental health information such as experiential data and results. This network of Information agents can be set up for one specific research centre which undertakes several mental health projects. In this case, each database contains data and results specific to a particular research project. Another option is to set up the network of Information agents for an alliance of research centres sharing the same vision but working on different aspects of a mental health problem. In this case, each database contains data and results specific to a particular research centre. It is also possible for one research centre to have more than one database.

Each Information agent extracts data of interest from its own database and sends it to the *Data Warehouse agent*. The database architecture is consistent throughout the system; i.e. the data found in different databases has the same format. This can be achieved with the help of ontologies. The consistent data structure enables the Data Warehouse agent to manage and integrate the data more easily. As the data originates from various databases, it is very likely that some overlaps and redundancies in the data will appear. The Data Warehouse agent analyses the incoming data and selects valid data. The selected data are systematically added to the data warehouse.

The systematic addition of data enables the *Data Mining agent* to understand the data and mine them for interesting patterns. We have developed a number of data mining algorithms for both structured and semi-structured data. The Data Mining agent uses the existing algorithms such as those discussed in [40, 41] to derive interesting patterns from the mental health data. The derived information is forwarded to the Ontology agent.

Ontology agent matches the newly derived information with the information contained in the Mental Heath Ontology. If exact overlap is found, the structure of the Mental Heath Ontology remains unchanged. If the comparison reflects some differences, the newly derived information is incorporated into the ontology structure. This last step is semi-automatic, requiring the assistance of a human agent to validate the newly introduced change.

The multi-agent system can be represented using the UML 2.1 sequence diagram where composite classes have more than one port and can be used to represent different roles of the same agent. This will enable us to represent agents which play more than one role concurrently. A sequence diagram is generally defined across the page by a series of rectangles, each of which represents a class. A distinct agent can be represented by a rectangle at the head of the sequence diagram. Each of these rectangles has a dotted line running vertically down the page. These dotted lines are known as 'lifelines'. As one goes down the page, time passes as messages flow between the agents. A single rectangle (agent) could have many ports (roles) without changing the semantics of the UML 2.1 sequence diagram.

There are three points worth noting in our sequence diagram:

(1) The lifelines of agents are solid throughout since agents tend to be persistent
(2) Each rectangle represents a composite class which implements an agent type, and
(3) Each distinct role played by an agent is represented by a distinct port on the rectangle with its own lifeline.

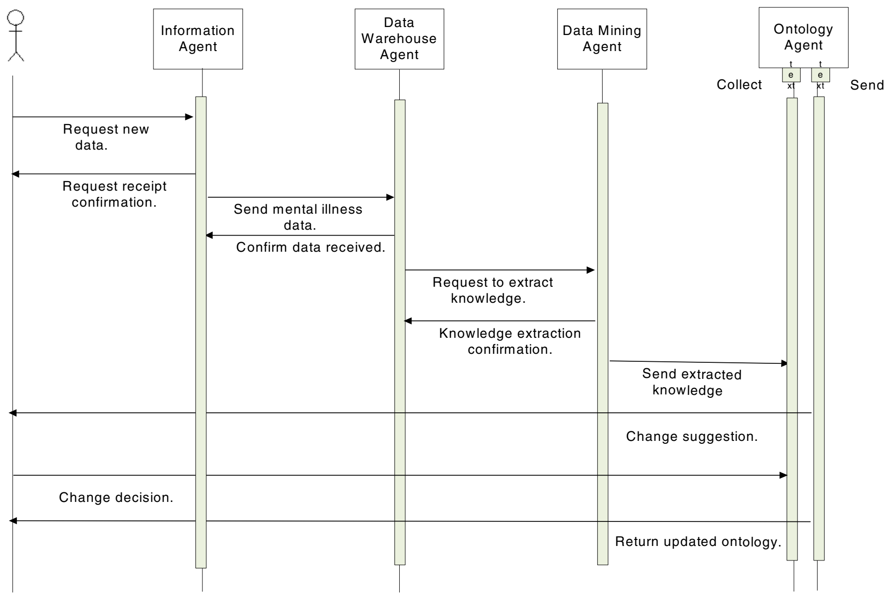

Fig. 3. UML 2.1 Sequence Diagram that models inter-agent communication

From the sequence diagram shown in Figure 3, we can see that the user makes an initial request to the Information agent to extract data about mental illness from databases where it is stored (request new data). The Information agent responds to the user (request receipt confirmation) indicating that it has received the request. Once the Information agent has extracted this data, it sends the data to the Data Warehouse agent (send mental illness data) with a request that this agent input it into the data warehouse. As soon as the Data Warehouse agent gets the data from the Information agent, it sends a message back to the Information agent confirming that it has received the data (confirm data received). Once the Data Warehouse agent has put the new data into the data warehouse, it usually sends a request to the Data Mining Agent to use this data to extract new knowledge (request to extract knowledge). The Data Mining agent responds to the Data Warehouse agent to indicate that it received a request to extract knowledge from the data (knowledge extraction confirmation). Once the Data Mining agent has finished extracting the knowledge from the data, it sends that knowledge to the Ontology agent (send extracted knowledge). The Ontology agent uses that knowledge to do a comparison between the new knowledge and the existing ontology to see if there are any differences. The Ontology agent is then able to return a suggestion to the user as to whether or not the ontology should be updated, and if so, what the changes should be (change suggestion). The user then makes a decision as to what changes should be made, if any (change decision). Finally, the Ontology agent returns the final version of the ontology to the user (return updated ontology). As illustrated, the sequence diagram is a very rich modeling tool for describing the entire cycle from user request to user deliverable for this particular application with respect to inter-agent dynamics.

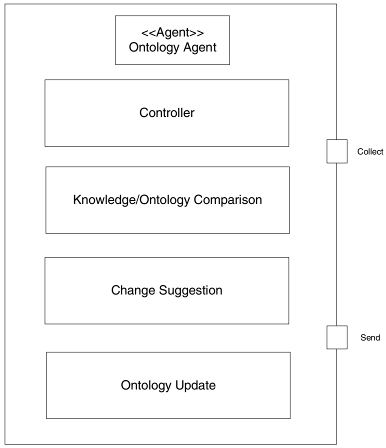

Fig. 4. UML 2.1 composite structure diagram that models the Ontology agent

4.4 Protect the System by Implementing Security Requirements

In our multi-agent system, all nine security requirements mentioned in [42] must be addressed. We discuss here the security requirements for Information agents. Analogously, we also address security requirements for other agents.

We must ensure that the data available via databases are available only to Information agents (confidentiality). The access rights of the Information agents must be defined (access control). Identity of the Information agents must be verified (authentication). The ease of access and use of data by Information agents needs to be ensured (availability). Information agents must guarantee that the data provided to the Data Warehouse agents are identical to the data at the source database (integrity). Information agents must verify their involvement in communication/interaction with the database (non-repudiation). The Information agents must comply with the given set of rules and regulations established by the system designers (compliance). The Information agents must provide relevant and reliable information to the Data Warehouse agent (service). The Information agents must be fully committed to accomplishing their own goals and the overall goals of the system (commitment).

4.5 Assemble Individual Agents

The structure of individual agents can be represented by a UML 2.1 composite structure diagram with parts and ports. Each part represents a distinct area of processing within the agent. Each port represents a different role played by the agent. Since a regular composite structure diagram does not have these semantics, we have created the <<Agent>> stereotype to reflect these additional meanings. Here we will discuss the internal structure of the Ontology agent. An analogous approach applies for the other agent types.

The following is a UML 2.1 composite structure diagram based on this stereotype [40]. It represents the internal processing of the Ontology agent. It has four distinct areas of processing. Firstly, there is a Controller part that manages all the other parts and directs inputs, outputs, and internal data flows. The part labeled Knowledge/Ontology Comparison is responsible for taking the new knowledge extracted by the Data Mining agent, and comparing it with the ontology to determine any differences between the two. This will provide a basis for suggested updates to the ontology, if any. The next processing step for the Ontology agent is to determine whether changes are required and if so, what they could be (Change Suggestion). Finally, once the user makes a decision, the Ontology agent will need to actually make the required changes to the existing ontology (Ontology Update). The Ontology agent plays two distinct roles and these are reflected by the two ports (Collect, Send) at the border of the composite structure diagram. Our use of UML 2.1 permits us to effectively model some of the key internal characteristics of the Ontology agent.

5 Conclusion

We have developed an evidence-based ontological model that defines the mental health domain. Due to the constant increase of knowledge regarding mental health, this Mental Health Ontology requires continual update. We have utilized the TICSA (Types, Intelligence, Collaboration, Security and Assembly) approach to design a multi-agent system that will automate the ontology update using the synergy of data mining and agent technologies. We have envisioned this project to involve various mental health research centres which will provide data in order to address and encompass different aspects of mental health. This architecture will support the creation of a world-wide collaborative environment which is greatly needed in a time of increasing mental distress and illness. We are in the early implementation stage of the system, and our progress will be reported in subsequent papers.

References

[1] Myers, D.G.: The American Paradox: Spiritual Hunger in an Age of Plenty. Yale University Press (2000)

[2] Hall, D.R., Zhao, J.Z.: Cohabitation and Divorce in Canada: Testing the Selectivity Hypothesis. Journal of Marriage and the Family 57, 421–427 (1995)

[3] Lopez, A.D., Murray, C.C.J.L.: The Global Burden of Disease, 1990-2020. Nature Medicine 4, 1241–1243 (1998)

[4] Hadzic, M., Chen, M., Brouwer, R.: A Modern Approach to Total Well-being. In: Ulieru, M., Palensky, P., Doursat, R. (eds.) IT Revolutions 2008. LNICST, vol. 11, pp. 140–150. Springer, Heidelberg (2009)

[5] Hadzic, M., Chen, M., Dillon, T.S.: Towards the Mental Health Ontology. In: Proceedings of the IEEE International Conference on Bioinformatics and Biomedicine, USA (2008)

[6] Hadzic, M., Chang, E.: TICSA Approach: Five Important Aspects of Multi-agent Systems. In: Proceedings of the International IFIP Workshop on Semantic Web & Web Semantics, On The Move Federated Conferences, Mexico (2008)

[7] Mao, Y., Wu, Z., Tian, W., Jiang, X., Cheung, W.K.: Dynamic sub-ontology evolution for traditional Chinese medicine web ontology. Journal of Biomedical Informatics 41, 790–805 (2008)

[8] Afsharchi, M., Far, B.H.: Automated Ontology Evolution in a Multi-Agent System. In: Proceedings of the First International Conference on Scalable Information Systems, Hong Kong (2006)
[9] Ottens, K., Aussenac-Gilles, N., Gleizes, M.-P., Camps, V.: Dynamic Ontology Co-Evolution from Texts: Principles and Case Study. In: Proceedings of the International Workshop on Emergent Semantics and Ontology Evolution, Korea (2007)
[10] Li, L., Yun, Y.: Agent negotiation based ontology refinement process and logo mechanisms for service applications. In: Service Oriented Computing and Applications, vol. 2/1, pp. 15–25. Springer, Heidelberg (2008)
[11] World Health Organization: International Statistical Classification of Diseases and Related Health Problems, 10th Revision, World Health Organization (2007)
[12] American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders, 4th edn., Text Revision (DSM-IV-TR). American Psychiatric Publishing (2000)
[13] Goldberg, T.E., Straub, R.E., Callicott, J.H., Hariri, A., Mattay, V.S., Bigelow, L., Coppola, R., Egan, M.F., Weinberger, D.R.: The G72/G30 Gene Complex and Cognitive Abnormalities in Schizophrenia. Neuropsychopharmacology 31, 2022–2032 (2006)
[14] U.S. Surgeon General's Report on Physical Activity and Health (1996)
[15] Phillips, W.T., Kiernan, M., King, A.C.: Physical Activity as a Nonpharmacological Treatment for Depression: A Review. Complementary Health Practice Review 8(2), 139–152 (2003)
[16] Pilu, A., Sorba, M., Hardoy, M.C., Floris, A.L., Mannu, F., Seruis, M.L., Velluti, C., Carpiniello, B., Salvi, M., Carta, M.G.: Efficacy of Physical Activity in the Adjunctive Treatment of Major Depressive Disorders: Preliminary Results. Clinical Practice and Epidemiology in Mental Health 3 (2007)
[17] Taylor, C.B., Sallis, J.F., Needle, R.: The Relation of Physical Activity and Exercise to Mental Health. Public Health Report 100(2), 195–202 (1985)
[18] Kawachi, I., Berkman, L.F.: Social Ties and Mental Health. Journal of Urban Health 78(3), 458–467 (2001)
[19] Ettner, S.: New Evidence on the Relationship between Income and Health. Journal of Health Economics 15(1), 67–85 (1996)
[20] Colbert, D.: Deadly Emotions: Understand the Mind-Body-Spirit Connection that can Heal or Destroy You. Thomas Nelson (2003)
[21] Bergin, A.E.: Values and Religious Issues in Psychotherapy and Mental Health. American Psychologist 46(4), 394–403 (1991)
[22] Wenner, M.: Infected with Insanity: Could Microbes Cause Mental Illness. Scientific American (2008), `http://www.sciam.com/article.cfm?id=infected-with-insanity`
[23] Pacher, P., Kecskemeti, V.: Cardiovascular Side Effects of New Antidepressants and Antipsychotics: New Drugs, Old Concerns? Current Pharmaceutical Design 10(20), 2463–2475 (2004)
[24] Check, E.: Antidepressants: Bitter pills. Nature 431, 122–124 (2004)
[25] Friedman, R.A., Leon, A.C.: Expanding the Black Box-Depression, Antidepressants, and the Risk of Suicide. The New England Journal of Medicine 356, 2343–2346 (2007)
[26] Werneke, U., Northey, S., Bhugra, D.: Antidepressants and sexual dysfunction. Acta Psychiatrica Scandinavica 114(6), 384–397 (2006)
[27] Schildkraut, J.J.: The catecholamine hypothesis of affective disorders: a review of supporting evidence. American Journal of Psychiatry 122, 609–622 (1965)
[28] Oke, A.F., Adams, R.N.: Elevated thalamic dopamine: possible link to sensory dysfunctions in schizophrenia. Schizophrenia Bulletin 13(4), 589–604 (1987)

[29] Lindsley, O., Skinner, B.F., Solomon, H.C.: Studies in behavior therapy (Status Report I). Metropolitan State Hospital, Walthama (1953)
[30] Clark, D.M., Fairburn, C.G.: Science and Practice of Cognitive Behaviour Therapy. Oxford University Press, Oxford (1997)
[31] Beck, A.T.: Cognitive Therapy and the Emotional Disorders. International Universities Press (1975)
[32] Scott, J., Williams, J.M., Beck, A.T.: Cognitive Therapy in Clinical Practice: An Illustrative Casebook. Routledge (1989)
[33] Aanstoos, C., Serlin, I., Greening, T.: History of Division 32 (Humanistic Psychology) of the American Psychological Association. In: Dewsbury, D. (ed.) Unification through Division: Histories of the divisions of the American Psychological Association. American Psychological Association, V, Washington (2000)
[34] Ray, D., Bratton, S., Rhine, T., Jones, L.: The effectiveness of play therapy: Responding to the critics. International Journal of Play Therapy 10/1, 85–108 (2001)
[35] Leichsenring, F.: The effectiveness of psychodynamic therapy, A review using criteria of evidence-based medicine. Zeitschrift Fur Psychosomatische Medizin Und Psychotherapie 48/2, 139–162 (2003)
[36] Reck, C., Mundt, C.: Psychodynamic therapy approaches in depressive disorders. Pathogenesis models and empirical principles. Der Nervenarzt 73(7), 613–619 (2002)
[37] Klerman, G.L., Dimascio, A., Weissman, M.: Treatment of depression by Drugs and Psychotherapy. American Journal of Psychiatry 131, 186–191 (1974)
[38] Saeed, A.: Integrated Psychiatric Treatment for Mental Disorders. The Journal of the Royal Society for the Promotion of Health 108/3, 107–109 (1988)
[39] Maedche, A.D.: Ontology Learning for the Semantic Web. Kluwer Academic Publishers, Norwell (2003)
[40] Hadzic, F., Dillon, T.S., Tan, H., Feng, L., Chang, E.: Mining Frequent Patterns using Self-Organizing Map. In: Tanier, D. (ed.) Advances in Data Warehousing and Mining Series. Idea Group Inc. (2007)
[41] Hadzic, M., Hadzic, F., Dillon, T.S.: Domain Driven Tree Mining of Semi-structured Mental Health Information. In: Cao, L., Yu, P.S., Zhang, C., Zhang, H. (eds.) Data Mining for Business Applications. Springer, Heidelberg (2009)
[42] Dillon, D.S., Dillon, T.S., Chang, E.: Using UML 2.1 to model Multi-Agent Systems. In: Proceedings of the 6th IFIP Workshop on Software Technologies for Future Embedded and Ubiquitous Systems, Italy (2008)