Kriton Speech

Artificial Intelligence and Mental Health

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Overview

- Motivation and Background.
- Artificial Intelligence (AI) and Kriton.
- An application: The ADHD Ontology.
- Heuristic Problem Soving in AI.
- Machine Learning: Schizophrenia.
- Conclusions.

Motivation

- **Easy** and convenient knowledge acquisition from human experts (e.g. mental health professional).
- Immediately employ this knowledge to automate repetitive and time-demanding tasks in assessment and therapy.
- Human input and expertise where it is really necessary (e.g. risk management).
- Low cost mental health services worldwide through mobile devices.

Artificial Intelligence and Kriton

What is knowledge?

... field of artificial intelligence (AI) dedicated to representing information about the world in a form that a computer system can utilize to solve complex tasks such as diagnosing a medical condition or having a dialog in a natural language. (Wikipedia: Knowledge representation and reasoning)

human (x) => mortal (x)

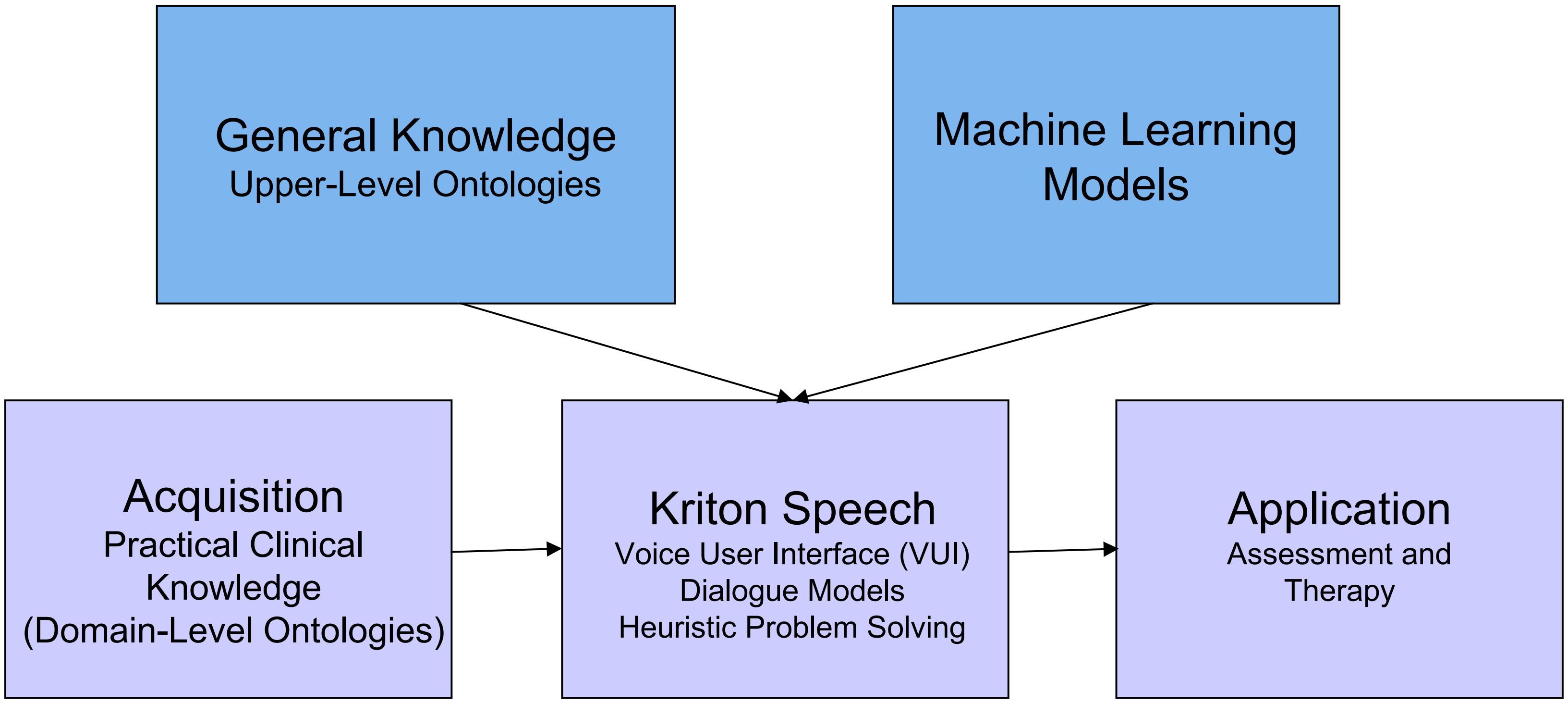
History, so much history

- Kriton = Student of Socrates
- First text-only implementation and publications between 1985-87.
- Interlisp-D on Xerox Workstation.
- Follow up systems such as KARDS.
- None of these systems uses speech.

Why Speech: Attention Economy

- *Attention economy* treats human attention as a limited commodity.
- Simon (1971) outlined that in an information rich world there is a limitation of the resource that consumes information: human attention.
- *Visual user interfaces* consume the one resource that is limited: human attention.
- Kriton Speech *uses speech only to interact with the user and therefore does not require any visual attention.*
- This enables the user to direct attention to other information sources and to perform physical actions while building a knowledge-based system.

Kriton Speech: Acquisition and Application



Kriton Speech Architecture

- Upper-Level Ontologies

YAGO2

OpenCyc

APA

ICD-10

- Domain-Level Ontologies

ADHD

ASD

Dialogue Management:
Rule Sets for Psychological Assessment and Therapy

- Machine Learning
  - Text & Speech Analysis

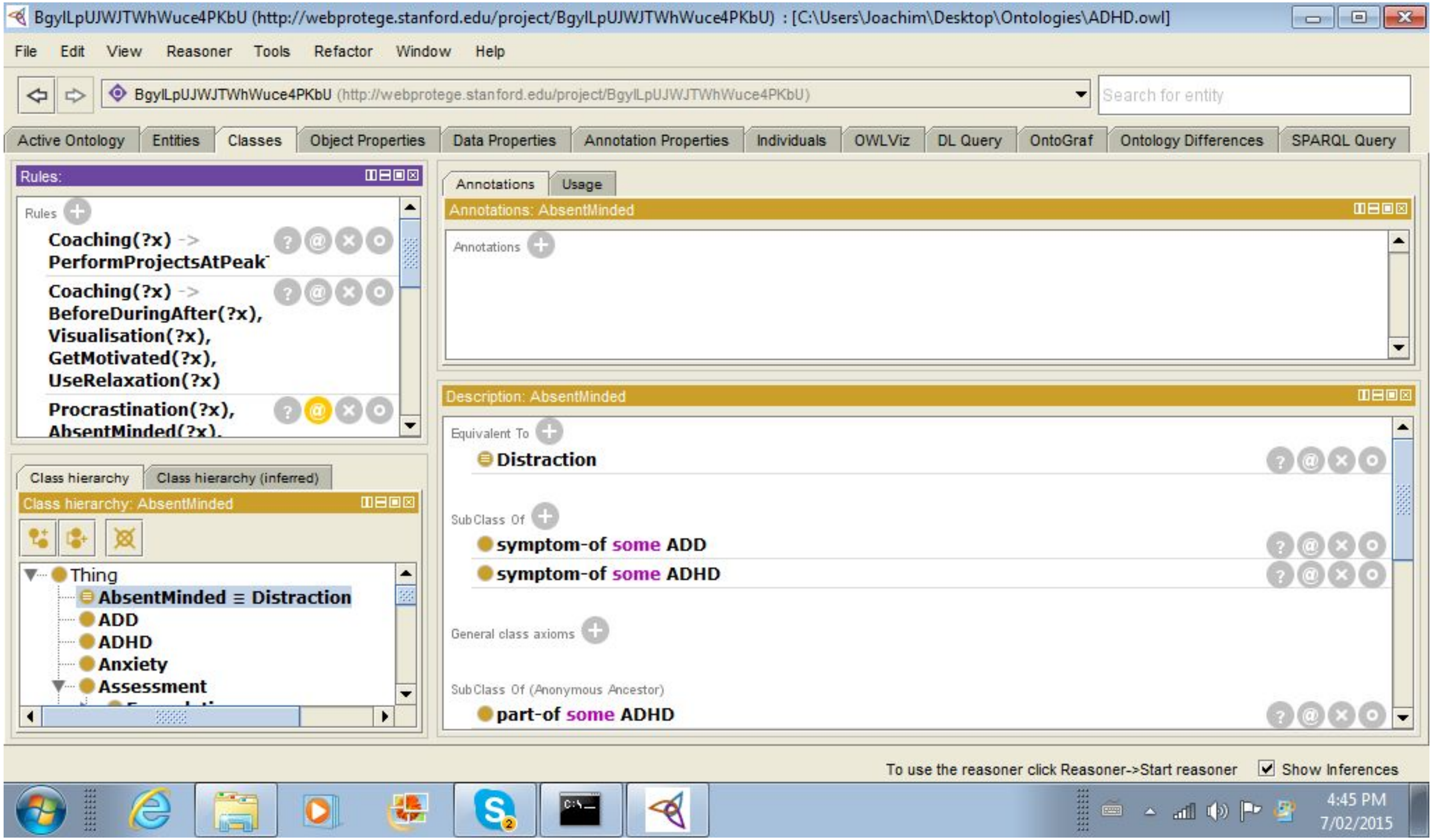
Knowledge Acquisition Techniques

- Interview
  - A variety of psychological interview techniques.
- Protocol Analysis
  - A psychological method that elicits verbal responses from subjects. Problem solving/thinking.
- Text Mining (ExRay)
- Machine Learning (Support Vector Machines)

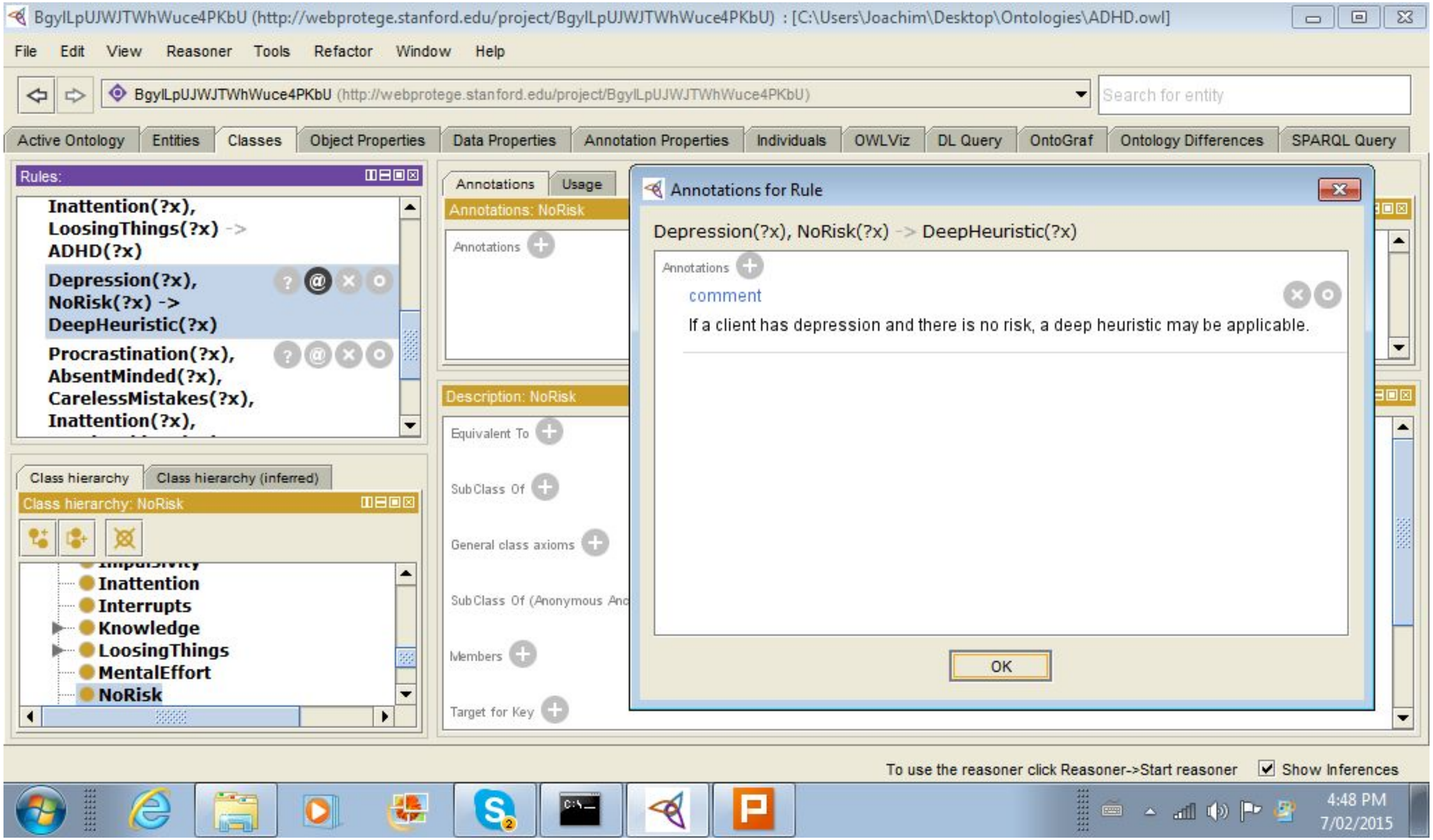
The ADHD Ontology

Partially built by Kriton Speech

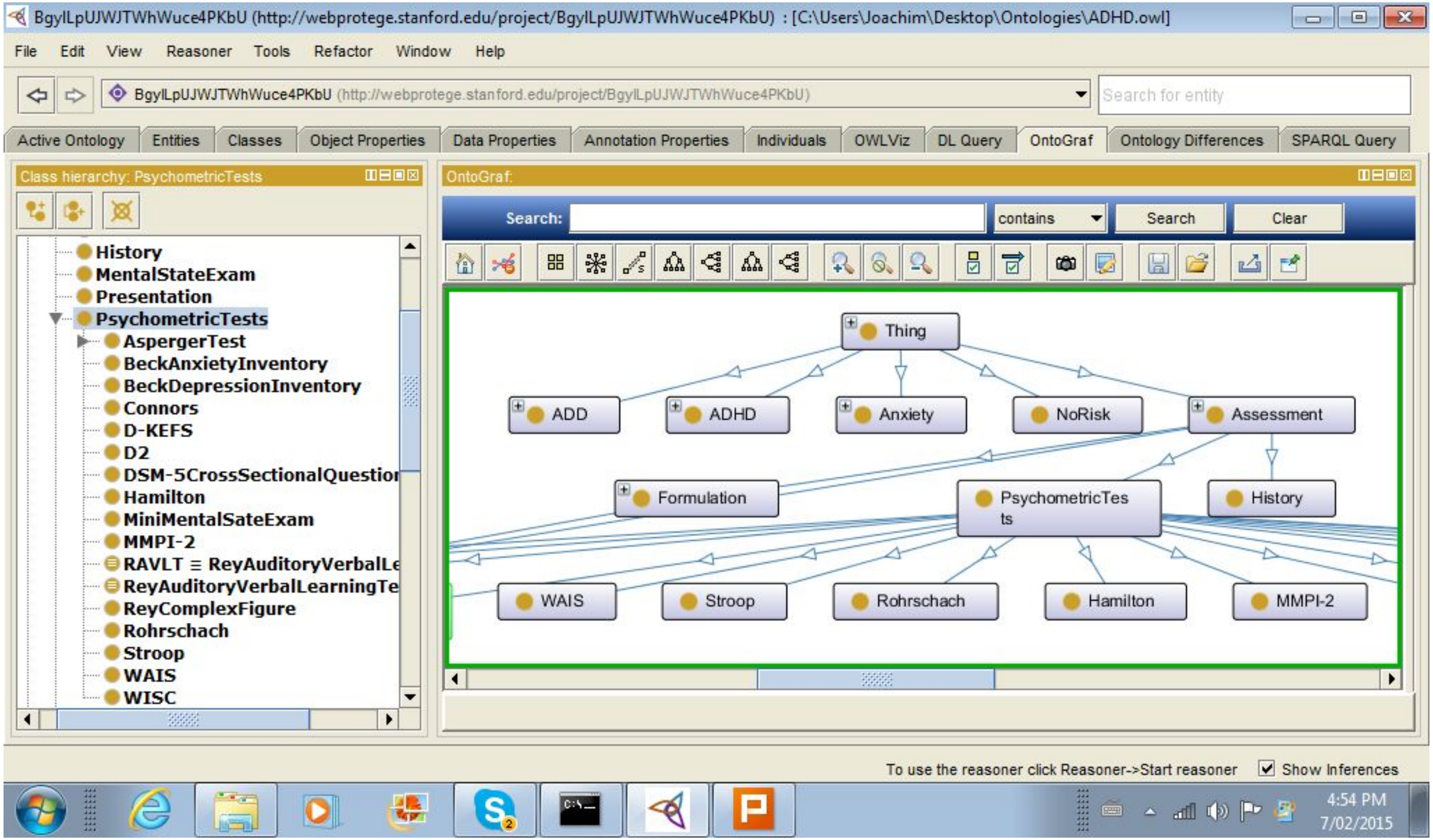
Domain knowledge for ADHD



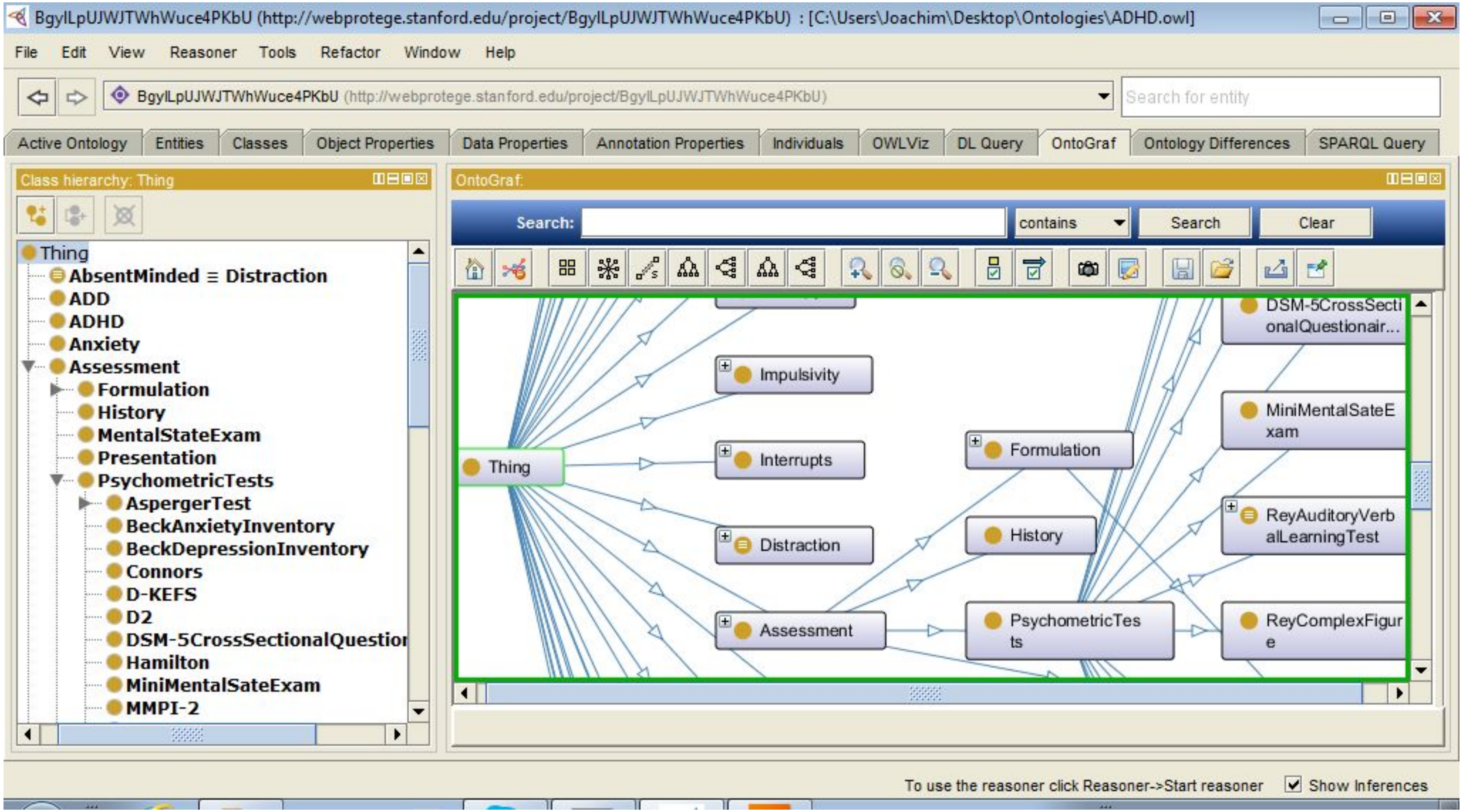
ADHD Knowledge Base with Deep Heuristic



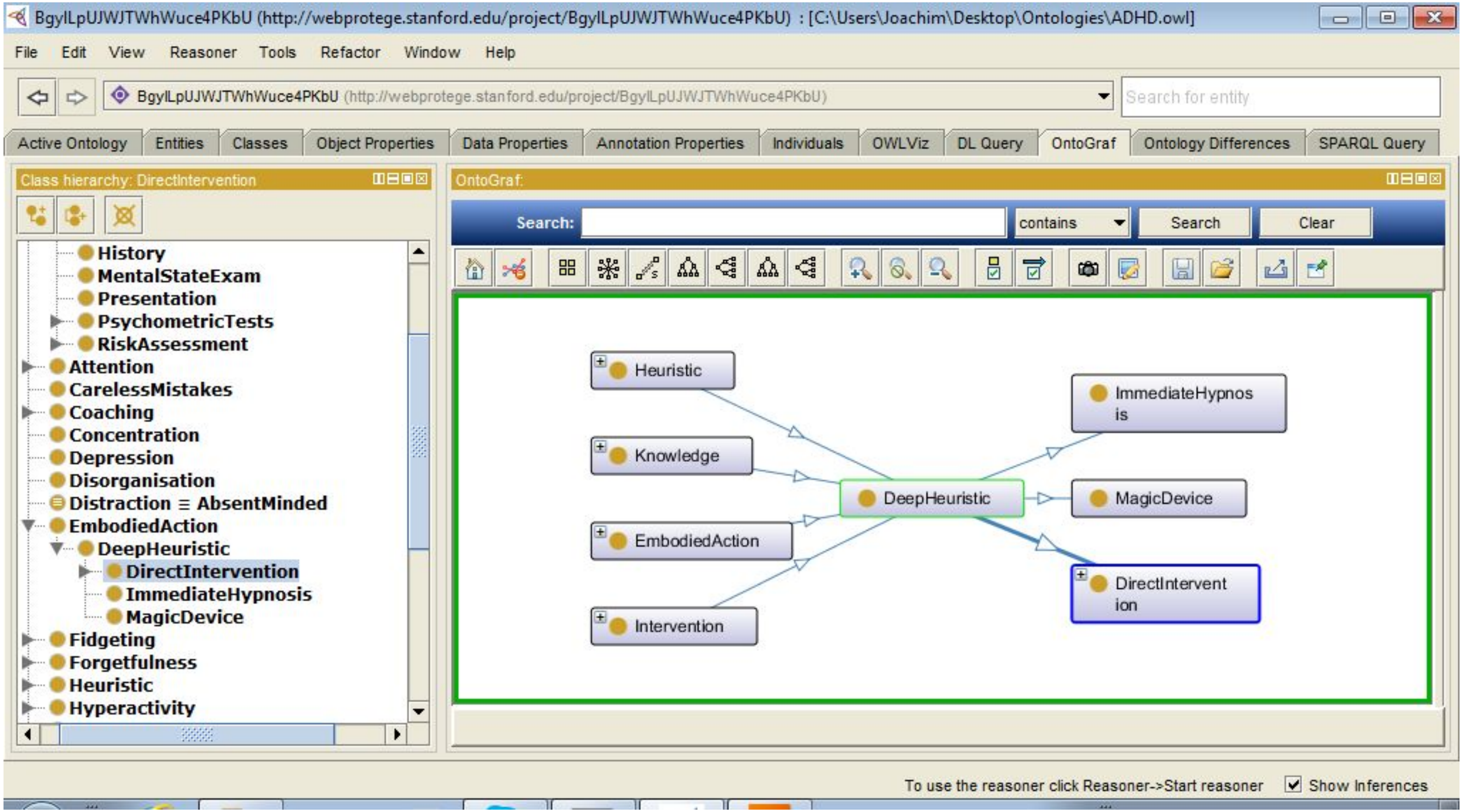
OntoGraph View 1



OntoGraph View 2



OntoGraph View: Deep Heuristic



Problem Solving in Artificial Intelligence

Problem Solving

- Start state (e.g. client with a set of symptoms).
- Goal state (e.g. client is free of symptoms).
- The means of transforming one state to another.
- Often there are multiple or complex goals (e.g. client is free of symptoms and well supported by a social network).

Search in Artificial Intelligence

- The *input* to a search problem is a
  - description of the initial state
  - a description of the goal state
  - and a procedure that *produces the successors of an arbitrary state.*
- The *output* should be a <u>sequence of states</u> starting with the given initial state and ending with the goal state.

Problem Formulation

- A problem is defined by four items
  - 1. Initial state
    - E.g. “Client has a set of symptoms”
  - 2. Successor function
    - S(x) = set of <u>*action-state pairs*</u>
    - E.g. S(Client) = {<Depression->LearnRelaxation, StartCBT>, <…->…, …>}
  - 3. Goal test
    - Can be explicit … E.g. x = “BDI<"5”
    - Or implicit … E.g. NoSymptoms(Client)
  - 4. Path cost (additive)
    - E.g. sum of distances, number of actions executed, etc.
- **A solution is a sequence of actions leading from the initial state to the goal state.**

Heuristic Search

- Try to skip non-promising parts of the state space
  - *reasonable* answer in *reasonable* time
- Domain specific
- Heuristic Functions
  - An estimate of goodness of a state.
    - f(n) is real desirability of the state
    - f'(n) is the estimated desirability of the state

Machine Learning Exeriments

EX-Ray

The Technology

The World Health Organisation reports neuro-psychiatric disorders, such as depression, as responsible for 13% of all disease economic and social burden. While current anti-depressant medications are effective, onset time and side effect profiles could be improved. To trial new drugs and determine their efficacy, pharmaceutical companies need valid sample sets. However, due to the subjective nature of conventional psychiatric diagnostic methods, reliable patient populations are often difficult to determine and currently no clinically-validated screening tool exists on the market.

EX-Ray, an e-technology developed at The University of Queensland, analyses a 2-5 minute video sample (including integrated image, speech and text) in a machine-learning environment to make an assessment of the patient. Initial tests indicate that this external 'x-ray' can quantitatively screen for, and monitor, a wide range of psychiatric and physical conditions with a high degree of accuracy (84%) and conformity to human diagnosis - virtually providing the accumulated knowledge of an expert psychiatrist.

Reliable screening for depression and mood disorders

This technology is suited to automated production, allowing a central analysis service to handle large volumes of tests with minimal human resource requirements.

EX-Ray was initially developed for authorship identification and topic detection in written works and is also very precise for this purpose.

Schizophrenic Language

- More than 100 years of study, impairments at all linguistic levels have been identified (and disputed).
- Focus on the lexical and semantic aspects of the language of thought-disordered schizophrenics such as
  - Poverty of word choice,
  - Repetitions,
  - Word approximations and neologisms.
  - Semantic dysfunctions, e.g. overinclusion (“a bee is a bird”) as well as an impairment of priming.

Text Classification and Mental Health

- This study compares two observer-rated scales, the Thought, Language and Communication Scale (TLC) and the Clinical Language Disorder Rating Scale (CLANG) with text classification.
- It was hypothesized that Ex-Ray would outperform the accuracy rates of scales in differentiating between schizophrenic subjects and normal (non-psychotic) participants.Observer-rated scales are based on subjective judgements.

Method

- 20-minute audio-recorded unstructured interviews with 54 Singaporean participants (27 schizophrenics and 27 normal participants).
- Rated by use of the TLC and CLANG scales.
- Transcribed texts of the interviews were computationally analysed by Ex-Ray and the three methods were compared.

Thought, Language and Communication(TLC)

More pathological

- Poverty of speech
- Poverty of content of speech
- Pressure of speech
- Distractible speech
- Derailment
- Tangentiallty
- Incoherence
- Illogicality
- Clanging
- Neologisms
- Word approximations

Less pathological

- Circumstantiality
- Loss of goal
- Perseveration
- Blocking
- Echolalia
- Stilted speech
- Self-reference

No TLC disorder. Occasional instances of the less pathological forms and no more than one instance of the more pathological (which is felt in context to be clinically insignificant).

1 Mild TLC disorder. Occasional instances of TLC disorder which are felt in context to be mild but clinically significant.

2 Moderate TLC disorder. Significant and unquestionable impaired verbal output which leads to a moderate disturbance in communication at least from time to time.

3 Severe TLC disorder. Disorder significant enough to impair communication for a substantial part of the interview; many instances of the more pathological manifestations of TLC.

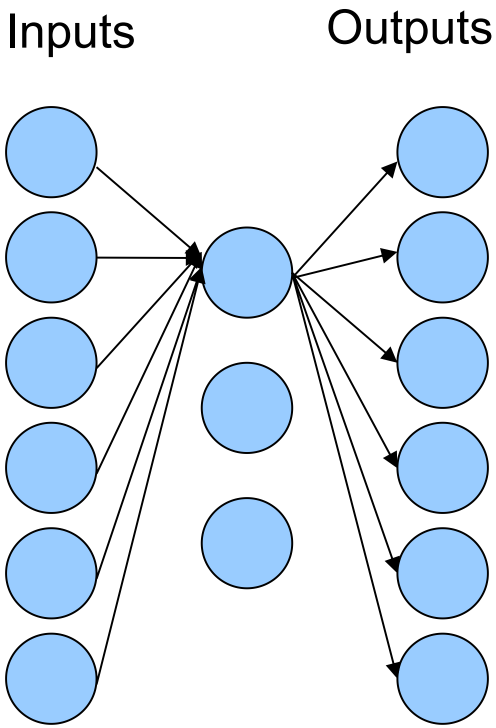
4 Extreme TLC disorder. TLC disorder so severe that communication is difficult or impossible most of the time.

Preprocessing and Decision Making

Neural Network
(or SVM or C5)

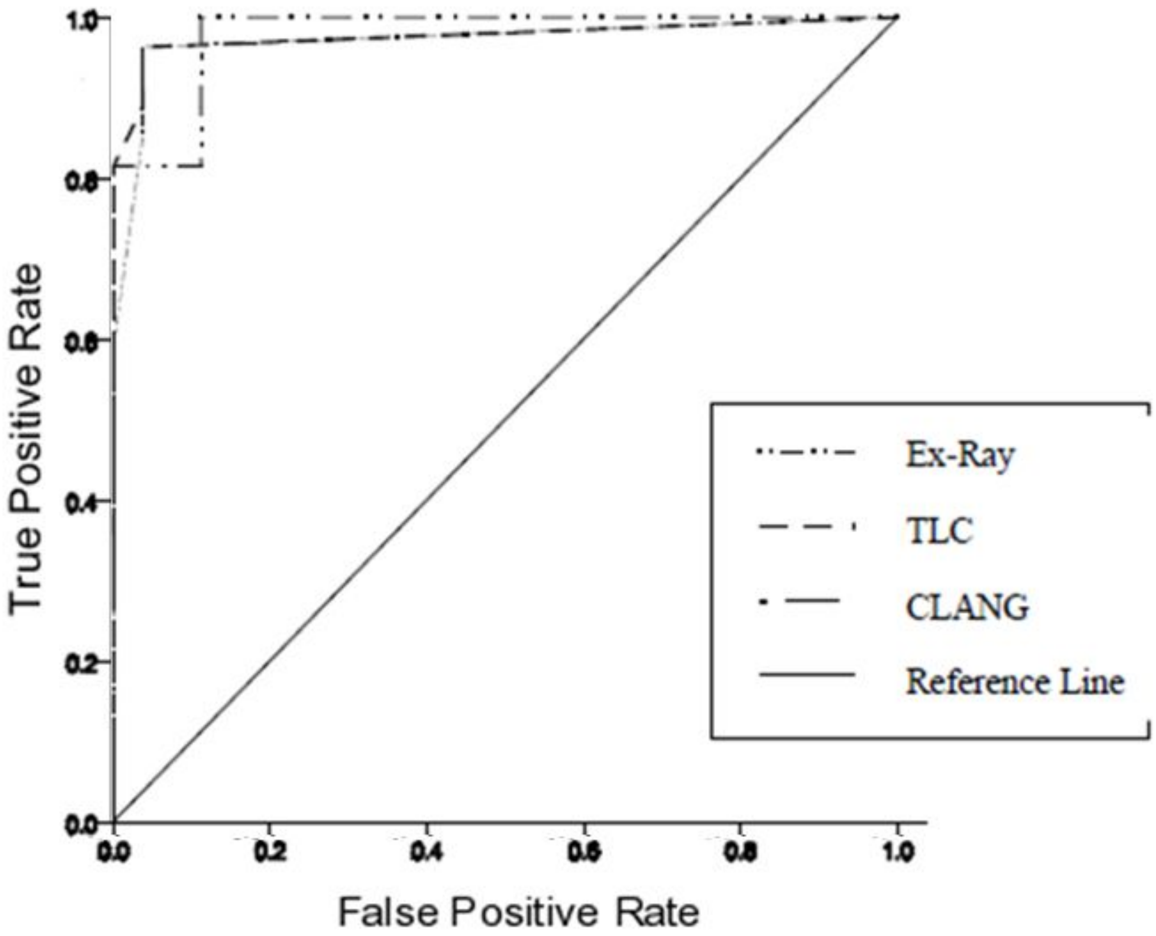
Input:
Bag-of-words

Pre-processing:
Filtering (stoplist)
Stemming
Word Frequency
Transformations
Ngrams/TF/IDF



Output:
diagnostic category/or
expert ranking

ROC for TLC,CLANG & ExRay



Results

- Ex-Ray correctly differentiated schizophrenic from normal subjects with a high accuracy rate of 98%.
- However, Ex-Ray did not outperform the scales at a significant level.
- Two reasons: (1) the unusual high inter-rater reliability of the human assessors and (2) the uneven ethnic representation of the sample population.

Conclusion

- The combination of automated knowledge acquisition and clinical applications generates AI systems informed by clinical practice.
- Kriton Speech learns through human input, updated background knowledge and experience (machine learning).
- The promise of low-cost mental health care through mobile devices.