Applied Cognitive Computing and Artificial Intelligence: How Machines Learn to "Read" the Law

Professor Vern R. Walker
Director, Research Laboratory for Law, Logic and Technology

HOFSTRA UNIVERSITY
MAURICE A. DEANE SCHOOL OF LAW

Discussion Outline

I. The Idea of a Markup Language, or Classifying or Tagging Text

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V. Rule-Based Programming for Automatic Annotation

VI. Machine Learning for Automatic Annotation

VII. The World of Commercial Cognitive Services: IBM, Microsoft, Amazon and Google

Example from EMTALA, 42 U.S.C. § 1395dd(a)

In the case of a hospital that has a hospital emergency department, if any individual …

medical condition … exists.

Markup Language: HTML (HyperText Markup Language)

In the case of a *hospital* that has a hospital **emergency department**, if any individual …

Markup Language: HTML (HyperText Markup Language)

In the case of a hospital that has a hospital emergency department, if any individual …

- **Embedded HTML code for how to display the text in a web browser (e.g., Chrome, Safari, Firefox)**
- **Start tag, end tag (e.g.,** ... **)**
- **View "page source code"**

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Example from EMTALA, 42 U.S.C. § 1395dd(a)

In the case of a hospital that has a hospital emergency department, if any individual … comes to the emergency department and a request is made on the individual's behalf for examination or treatment for a medical condition, the hospital must provide for an appropriate medical screening examination within the capability of the hospital's emergency department, … to determine whether or not an emergency medical condition … exists.

EMTALA, 42 U.S.C. § 1395dd(a): Semantic Markup for Meaning (Legal Rule Conditions, Conclusion)

In the case of a hospital that has a hospital emergency department, if any individual … comes to the emergency department and a request is made on the individual's behalf for examination or treatment for a medical condition, the hospital must provide for an appropriate medical screening examination within the capability of the hospital's emergency department, … , to determine whether or not an emergency medical condition … exists.

Markup Language: XML (Extensible Markup Language)

<LegalRule>**In the case of** <RuleCondition>**a hospital**</RuleCondition> **that** <RuleCondition>**has a hospital emergency department** </RuleCondition>**, if** <RuleCondition>**any individual …** </LegalRule>

- **Embedded XML code to classify the text in a meaningful way, for future use**
- **Start tag, end tag**
- **Human-readable and machine-readable "source code"**

Markup Languages: Layers of Semantic and Format Coding

<LegalRule>**In the case of** <RuleCondition>**a hospital**</RuleCondition> **that** <RuleCondition>**has a hospital emergency department**</RuleCondition>**, if** <RuleCondition>**any individual …** **.** </LegalRule>

- **Use HTML code to "highlight" the semantic categories in a web browser**

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Extracting Legal Rules from Statutes, Regulations, and Appellate Decisions

VI. Machine Learning for Automatic Annotation

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Formulating the Legal Rule for EMTALA Screening

A hospital must provide for an appropriate medical screening examination under EMTALA.

AND [1 of 4] Something is a hospital.

AND [2 of 4] That hospital has a hospital emergency department.

AND [3 of 4] Any individual … comes to the emergency department.

AND [4 of 4] A request is made on the individual's behalf for examination or treatment for a medical condition.

Extracted Legal Rules

- **Combine rules extracted from statutes, regulations and appellate decisions into integrated systems of legal rules**
- **Provide checklists for regulatory compliance, litigation**
- **Make legal rules "computable"**

- **Computer software does not "read" a statute, regulation or appellate decision**
- **Can process text in ways that human readers find useful and meaningful**

Automatically Extracting Systems of Legal Rules?

1. Logical connectives are fairly regular in statutes and regulations, but not in appellate judicial decisions.
2. Word usage (meaning) in statutes and regulations are fairly regular and careful, but less so in appellate decisions.
3. Legal rules are stated by most sentences in statutes and regulations, but not so in appellate decisions.
4. Fragments of legal-rule content occur in statutes, regulations and especially appellate decisions, but complete propositions must be formulated.
5. Types of appellate reasoning patterns must be defined in a comprehensive way.

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I. The Idea of a Markup Language, or Classifying or Tagging Text

II. Semantic Data: Capturing Interpretations of Meaning

Argument Mining from Fact-Finding Decisions

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Veterans' Disability Benefits in the U.S.

- **Under certain conditions, a veteran may be eligible for compensation for a disability that is "service-connected." Service connection is established if the veteran proves:**
  1. **the existence of a present disability;**
  2. **an in-service incurrence or aggravation of a disease or injury [in the case of posttraumatic stress disorder (PTSD), an "in-service stressor"]; and**
  3. **a causal relationship or nexus between the present disability and the disease or injury incurred or aggravated during service (or in-service stressor).**
- **Veterans satisfying these requirements are entitled to benefits.**
- **The Board of Veterans' Appeals (BVA) in the Department of Veterans Affairs is a fact-finding body.**

Board of Veterans' Appeals (BVA) Decisions

- LLT Lab / CMU / Pitt dataset = 972,522 BVA Decisions (Sept 2017), from 1992 to 2017
- Fiscal year 2018, e.g.: over 81,000 decisions signed
- Fiscal year 2015: 98% of appeals considered by the BVA involved claims for disability compensation
- Over 1,500 decisions issued per week, on average
- At perhaps 150 sentences per decision on average, an order of magnitude of 225,000 new sentences each week to analyze for reasoning patterns

The Necessity of Automation

- **Retrieve responsive decisions and extract portions of text from large datasets in answer to queries about argumentation and reasoning.**
- **Monitor consistency among large numbers of decisions on same sub-issues (the rule of law).**
- **Monitor trends in successful and unsuccessful arguments over time.**
- **Predict outcomes based on available evidence and evidence-based arguments from a large set of decisions.**
- **Improve efficiency of claims proceedings, by assisting both claimants and decision makers.**

What Practitioners Want to See (Found For Them)

Initially, the Board must determine whether the presumption of soundness under 38 U.S.C.A. §§ 1111, 1132 applies in this case. The relevant evidence on this question includes a February 2007 VA examination report where the examiner opined that it was at least as likely as not that the Veteran suffered PTSD in her youth and that this was "possibly aggravated" by service. Although this evidence suggests that an acquired psychiatric disability, to include PTSD, pre-existed entrance into service, the Board finds that the presumption of soundness has not been rebutted by clear and unmistakable evidence that an acquired psychiatric disability existed prior to service as required under 38 U.S.C.A. §§ 1111, 1132.

In this regard, the Board finds that the Veteran was found to be psychiatrically normal at a November 1984 physical examination prior to entrance into service. Further, although the Veteran has acknowledged that she had a childhood history of abuse, she has also stated that she did not have psychiatric problems upon entry into service. On a medical history survey completed in conjunction with her enlistment physical, the Veteran denied any history of nervous trouble, frequent trouble sleeping, or depression. Additionally, in the most recent June 2013 VA examination report, conducted pursuant to the Board's May 2013 remand, the VA examiner acknowledged that there was no pre-service medical documentation suggesting that the Veteran's PTSD had its onset prior to service, and thus concluded that the Veteran's PTSD did not pre-exist service.

Finding Sentence

Reasoning Sentence

Evidence Sentences

Automatically Extracting Patterns of Fact-Finding Reasoning?

1. Inferential roles of sentences in adjudicatory decisions must be well-defined, and protocols developed for identifying them.
2. Logical connectives are not as regular as in statutes and regulations.
3. Word usage (meaning) in adjudicatory decisions not as regular, careful, or authoritative as in appellate decisions.
4. Types of arguments or reasoning patterns must be defined in a comprehensive way.
5. Probabilistic reasoning is not as well-defined as deductive logical connectives.

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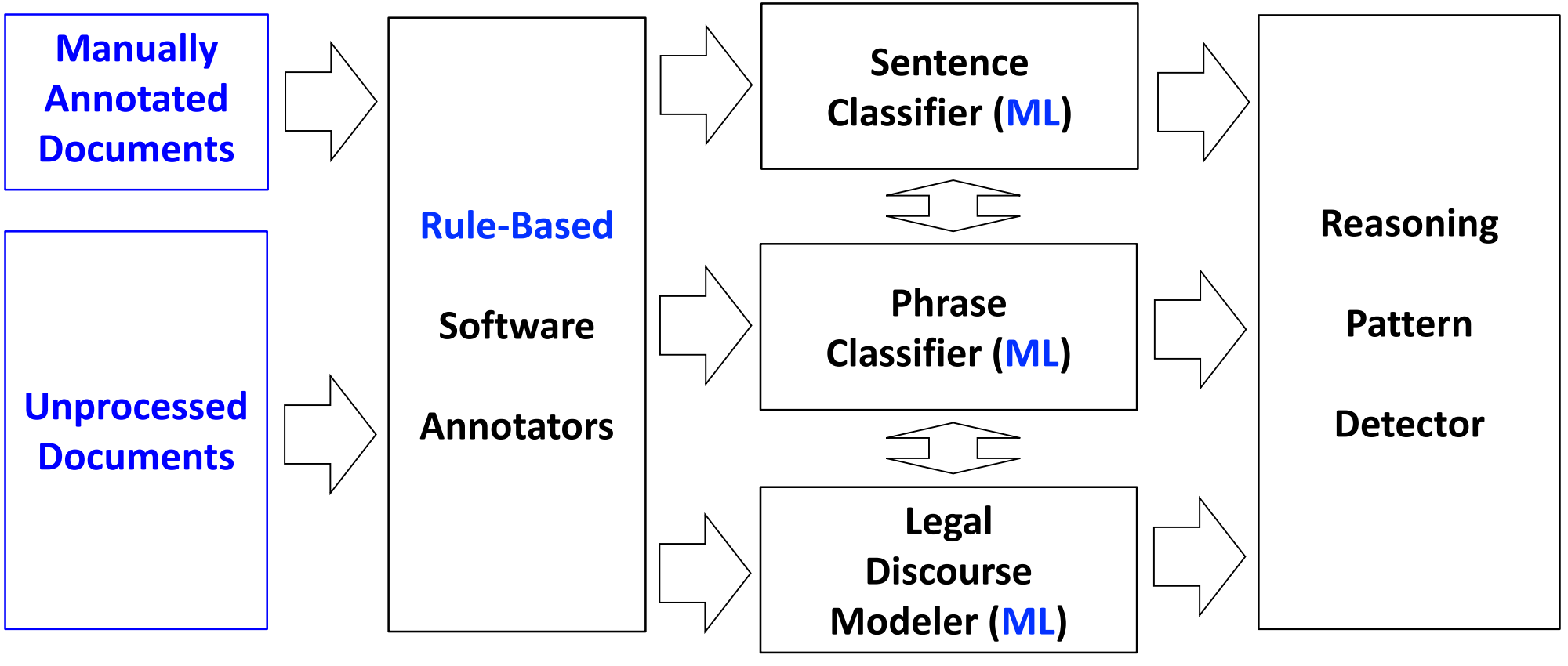
Automatically Annotating Spans of Text for Extraction: Rule-based Programming

1. Inferential roles of sentences or clauses and logical connectives expressed by words, phrases, and punctuation might be identifiable with the help of rule-based software programming.
2. Protocols are needed to train human annotators, evaluate the quality of manual annotations, and provide insights into possible rule-based programming.
3. "Ruta" programming rules ("Rule-based Text Annotation") provide an example of such programming.
4. "Pipeline" of "scripts" (sets of Ruta rules) can be run, sequentially, on a text, providing layers of semantic annotation.

The Concept of a Pipeline of Annotators



Examples of Semantic Layers and Simple Ruta Rules

- **"Seed annotations" (e.g., SW = word containing all lower-case letters; NUM = any digit or sequence of digits; PERIOD = the period character of punctuation)**
- **Sentence (spans of characters constituting a sentence)**
- **Ruta rule example (annotating a specific phrase throughout the document as being of a semantic type):**

  "finds that"{-> MARK(VerbFindingPhrase)};
- **FindingSentence (any sentence that primarily states a conclusion of the trier of fact whether a condition of a governing legal rule has been proved by the evidence)**

Examples of Ruta Rules in a Script

```
Sentence{CONTAINS(VerbFindingPhrase)->MARKSCORE (2,
        PossibleEvidenceFindingSentence)};

Sentence{CONTAINS(SubjectBoardPhrase)->MARKSCORE (2,
        PossibleEvidenceFindingSentence)};

Sentence{CONTAINS(RuleConditionContent)->MARKSCORE
        (2, PossibleEvidenceFindingSentence)};

Sentence{CONTAINS("Federal Circuit")->MARKSCORE (-2,
        PossibleEvidenceFindingSentence)};

PossibleEvidenceFindingSentence{SCORE(5)->MARK
        (ProbableEvidenceFindingSentence)};
```

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Automatically Annotating Spans of Text for Extraction: Machine Learning

1. Inferential roles of sentences or clauses and logical connectives expressed by words, phrases, and punctuation might be identifiable with greater accuracy using machine-learning software.
2. Input = texts annotated with rule-based programs.
3. Algorithm = formula using additional text features derived from training data ("gold-standard" annotated dataset) to "predictively code" how a human would manually annotate that text.
4. Output = additional layers of semantic annotation, associated with confidence measures based on training data.

Features and Algorithms Common in Machine Learning

Text Features might include (for rhetorical roles of sentences):

- Pairs or triples of successive words (e.g., "*Federal Circuit*")
- Parts of speech, main verb present tense (e.g., verb = "*finds*")
- Types of surrounding sentences (e.g., instances of EvidenceSentence)
- Position in the document (e.g., heading = "*Reasons for Findings*")

Algorithms used to code predictively typically include:

- Logistic Regression (predicts sentence type using weighted values for all text features, calculating weights from the values of all sentences in the training set – the "gold standard")
- Support Vector Machine (SVM) (predicts match between a query and every sentence, based on a similarity function)

Machine Learning Ingredients

- **Human feedback** on target semantic types ("gold standard"; provides training + testing data)
- **Text features** with machine-determinable values
- **Algorithm** correlating values of text features to gold standard ("correct" vs. "incorrect" spans)
- **Predictive coding** on would-be human annotation
- **Confidence score** on accuracy of prediction

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Amazon and Google

Commercial Cloud-Computing Services: "Cognitive Computing" Pipelines on a Provider's Server

1. **Commercial service providers:**
   - IBM Watson Services (https://www.ibm.com/cloud/ai)
   - Microsoft Azure (https://azure.microsoft.com/en-us/?v=18.27)
   - Amazon Web Services (aws) (https://aws.amazon.com)
   - Google Cloud (https://cloud.google.com)
2. **Off-the-shelf analytic services from such providers (e.g.):**
   - Natural language analysis (e.g., "sentiment analysis")
   - Translation between natural languages
   - Speech to text / text to speech
3. **API ("Application Programming Interface") for accessing**

Conclusion: Machines "Reading" the Law?

- **An essential task in any "intelligent" action (whether by humans or machines) is boundary determination and classification (tagging, annotation) – whether text, image or audio**
- **"Smart" or "cognitive" or "intelligent" software: computation methods NOT = how people read "the law"**
- **The good question: Does the software do something that humans find useful when they read legal documents?**

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Welcome to the Beginning!

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