From Information Retrieval (IR) to Argument Retrieval (AR) for Legal Cases: Report on a Baseline Study

Kevin D. Ashley a and Vern R. Walker b

a University of Pittsburgh School of Law, Intelligent Systems Program

b Maurice A. Deane School of Law, Hofstra University
Research Laboratory for Law, Logic and Technology

With thanks to Matthias Grabmair and Prof. Eric Nyberg, CMU.
Summary

- Commercial legal information retrieval (IR) system users often want argument retrieval (AR), retrieving:
  - not just sentences with highlighted terms, but
  - arguments and argument-related information.
- We conducted baseline study of how two legal IR systems
  - responded to standard queries
  - using a corpus of argument-annotated legal cases.
- We identify ways in which IR systems do not meet the need for AR,
  - illustrate how additional argument-relevant information could address some inadequacies, and
  - briefly describe how to develop an AR system to retrieve argument-related information from legal decisions.
Vaccine/Injury Project (V/IP) Corpus*

- Legal decisions: does claim comply with National Vaccine Injury Compensation Program?
- Claimant compensated IFF vaccine caused the injury.
    - the petitioner must establish, by a preponderance of the evidence, that:
      1. a “medical theory causally connects” the type of vaccine with the type of injury;
      2. there was a “logical sequence of cause and effect” between the particular vaccination and the particular injury; and
      3. a “proximate temporal relationship” existed between the vaccination and the injury.

- Court of Federal Claims “Special Masters”:
  - decide which evidence is relevant to which issues of fact,
  - evaluate plausibility of evidence in the legal record,
  - organize evidence and draw reasonable inferences, and
  - make findings of fact.

- Corpus = all decisions in 2-years applying *Althen* test of causation-in-fact
  - 35 decision texts, 15-40 pages per decision

---

*Research Laboratory for Law, Logic and Technology (LLT Lab), Maurice A. Deane School of Law at Hofstra University in New York.*

---

Copyright Kevin D. Ashley, Vern R. Walker. 2013
Partial Rule Tree for Vaccine Decisions, Showing Three Causation Conditions of \textit{Althen}
Ms. Cusati has provided more than preponderant evidence that Eric’s intractable seizure disorder led to Eric’s death…. Dr. Kinsbourne and Dr. Kohrman agree that MMR vaccine causes fever…. Dr. Kinsbourne and Dr. Kohrman agree that fever causes seizures…. Dr. Kinsbourne and Dr. Kohrman agree that a child who suffers a complex febrile seizure has a greater chance of developing epilepsy…. As such, Dr. Kohrman’s reports and testimony, and the medical literature, do not assist the special master in evaluating Ms. Cusati’s “legal cause” claim.
## 2. Presuppositional Concepts: Entities, Events & Relations

<table>
<thead>
<tr>
<th>Semantic Relations</th>
<th>Meaning (objects or event referents)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Covered-vaccine</td>
<td>a vaccine covered by the VICP</td>
</tr>
<tr>
<td>2. Specific-date</td>
<td>a specific month, day, year</td>
</tr>
<tr>
<td>3. Specific-vaccination</td>
<td>a vaccination with a Covered-vaccine on a Specific-date</td>
</tr>
<tr>
<td>4. Generic-injury</td>
<td>a type of injury, adverse condition or disease</td>
</tr>
<tr>
<td>5. Injury-onset</td>
<td>a symptom, sign or test result associated with the onset of a Generic-injury</td>
</tr>
<tr>
<td>6. Onset-timing</td>
<td>time interval between Specific-vaccination and the earliest Injury-onset</td>
</tr>
<tr>
<td>C1. Medical-theory-assertion</td>
<td>assertion that a medical theory causally connects vaccination with a Covered-vaccine with the occurrence of a Generic-injury</td>
</tr>
<tr>
<td>C2. Causal-chain-assertion</td>
<td>assertion that a Specific-vaccination caused an instance of a Generic-injury</td>
</tr>
</tbody>
</table>

**Noun Phrases: 1-6; Causal Assertions: C1-C2**
Baseline Study

- Ten cases in V/IP Corpus involving the first *Althen* condition:
  - five for petitioner (*Cusati, Casey, Werderitsh, Stewart, Roper*)
  - five for government (*Walton, Thomas, Meyers, Sawyer, Wolfe*).

- Each case used as a “source case” to construct a standard search query based on its facts by:
  - substituting values from each “source” case for Covered-vaccine, Generic-injury, and Onset-timing into two templates:
    - Q1. <Covered-vaccine> can cause <Generic-injury>
    - Q2. <Covered-vaccine> can cause <Generic-injury> <Onset-timing>

- For example:
  - *Casey* Q1: “Varicella vaccine can cause encephalomyeloneuritis”.
  - *Casey* Q2: “Varicella vaccine can cause encephalomyeloneuritis within four weeks”.

Copyright Kevin D. Ashley, Vern Walker. 2013
1. Doe/17 v. Secretary of Health and Human Services


Health - Vaccines. Special Master in Vaccine reasonably found lack of credibility as to claimant, given evidentiary contradictions.

... Petitioner's theory of causation posited that she had a pre-existing condition of CVID, which was significantly aggravated by her varicella vaccinations, as evidenced, in part, by the onset of diarrhea and other flu-like symptoms approximately two weeks after receiving the second varicella vaccination on June 4, 2001....

...Special Master did not act arbitrarily and capriciously, in “off-table” Vaccine Act case in which claimant alleged aggravation of preexisting condition after receiving varicella vaccine, by relying on claimant's Social Security disability records preceding vaccinations; records showed that claimant had suffered from chronic irritable bowel syndrome (IBS) before receiving vaccinations, which was contrary to her representations in Vaccine Act claim, and undermined her theory of causation and her credibility. National Childhood Vaccine...

...Claimant in “off-table” Vaccine Act case must present: (1) medical theory causally connecting vaccination and injury; (2) logical sequence of cause and effect showing that vaccination was reason for injury; and (3) showing of proximate temporal relationship between vaccination and injury. National Childhood Vaccine Injury Act, 42 U.S.C.A. §§300aa–11(c)(1)(C)(ii), 300aa–13(a)(1)(A)....

... At a scheduled interview twenty-four weeks after receiving the second vaccination there were no adverse effects of the vaccine recorded....

2. Stapleford ex rel. Stapleford v. Secretary of Dept. of Health and Human Services

United States Court of Federal Claims. | October 05, 2009 | 89 Fed.Cl. 456 | 2009 WL 3380616 | 03-234V

Health - Vaccines. Child's seizures and developmental delays were not caused by varicella immunization.

... Having concluded that the varicella vaccine could not have caused Devon's injury, the Special Master held that the varicella vaccine did not cause Devon's injury in this case....
<table>
<thead>
<tr>
<th>Document Title</th>
<th>Jurisdiction</th>
<th>Court</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>In sum, petitioner was vaccinated against varicella on June 9, 1995. The attenuated virus in the varicellavirus both directly attacked petitioner’s nervous system and caused an immune-mediated inflammatory response in her nervous system. As a result, within four weeks of her varicella vaccination, petitioner began to experience the onset of symptoms of her encephalomyeloneuritis. One such symptom was cerebellitis, a condition particularly associated with a natural varicella infection, which ...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overview:</strong> Petitioner was able to prove by a preponderance of evidence that a varicella vaccine was the cause in fact of her neurological injuries, rendering her entitled to compensation pursuant to the National Childhood Vaccine Injury Act, 42 U.S.C.S. §§ 300aa-1 to 300aa-34.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| After the hearing, Petitioner identified as the primary issue whether the varicellavirus can cause encephalomyeloneuritis within four weeks hours after its administration in a 56-year-old man. Pet’r’s Post-Hr’g Br. at 2. Petitioner stated that “[t]he only peer-reviewed literature available on the subject simply states that adverse reactions to the varicellavirus have not been reported within seventy-two hours in petitioner’s age group.” Id. |                |                     |                  |
| **Overview:** In action under Vaccine Act, petitioner had not established prima facie case of causation because, inter alia, there was no reliable theory explaining how varicella vaccination could have caused symptoms of which petitioner complained, and there was not preponderant evidence of a logical sequence of cause and effect between vaccination and illness. |                |                     |                  |

| This news release, coupled with Dr. Pike’s assertions and VAERS research, does not constitute preponderant evidence that the meningococcal varicellavirus GBS, particularly in light of the absence in the ensuing seven years of any case reports, studies, or other evidence suggesting that the spike in cases was more than coincidence. Furthermore, a 2008 study based on a mass meningococcal vaccination campaign in Canada showed no increased risk of GBS within eight weeks of vaccination. Haber ... |                |                     |                  |
| **Overview:** Petition for compensation under National Vaccine Injury Compensation Program was dismissed because decedent’s respiratory infection, which began two weeks before onset of Guillain-Barré syndrome (GBS) symptoms, was well-recognized cause of GBS, occurred at appropriate temporal interval before onset of symptoms, and was most likely cause for GBS. |                |                     |                  |
# Results of Baseline Study

<table>
<thead>
<tr>
<th>1. Case Name (date); Winner of claim [Althen 1 issue] in Report</th>
<th>2. Vaccine; Alleged Injury; Time-to-Onset</th>
<th>3. Total # cases returned, by query</th>
<th>4. % vaccine comp. cases in top-10, by query</th>
<th>5. Source case in top-10, by query (Y/N)? (rank)</th>
<th>6. % cases in top-10 whose Case Report has all 3 Q1 [4 Q2] items (Y/N)?</th>
<th>7. Source Case Report has all 3 Q1 [4 Q2] items (Y/N)?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cusati (9/22/05) Pet. [Pet.]</strong></td>
<td>MMR; Intractable seizure disorder and death; After about four days</td>
<td>Q1WN: 75</td>
<td>100</td>
<td>YES(2)</td>
<td>30</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q1WA: 5,648,600</td>
<td>100</td>
<td>YES(1)</td>
<td>70</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q2WN: 67</td>
<td>100</td>
<td>YES(4)</td>
<td>10</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q2LA: 7,280,942</td>
<td>100</td>
<td>YES(2)</td>
<td>20</td>
<td>YES</td>
</tr>
<tr>
<td><strong>Roper (12/9/05) Pet. [Pet.]</strong></td>
<td>Tetanus; Chronic gastroparesis; Within four days</td>
<td>Q1WN: 75</td>
<td>100</td>
<td>NO(21)</td>
<td>0</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q1WA: 5,463,833</td>
<td>100</td>
<td>YES(1)</td>
<td>10</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q2WN: 70</td>
<td>100</td>
<td>NO(11)</td>
<td>0</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q2LA: 6,935,432</td>
<td>100</td>
<td>YES(1)</td>
<td>10</td>
<td>YES</td>
</tr>
<tr>
<td><strong>Casey (12/12/05) Pet. [Pet.]</strong></td>
<td>Varicella; Encephalomyeloneuritis; Within four weeks</td>
<td>Q1WN: 56</td>
<td>100</td>
<td>YES(3)</td>
<td>10</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q1WA: 5,455,390</td>
<td>90</td>
<td>YES(1)</td>
<td>10</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q2WN: 60</td>
<td>100</td>
<td>YES(4)</td>
<td>10</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q2LA: 6,484,948</td>
<td>100</td>
<td>YES(1)</td>
<td>10</td>
<td>YES</td>
</tr>
<tr>
<td><strong>Werderitsh (5/26/06) Pet. [Pet.]</strong></td>
<td>Hepatitis B; Multiple sclerosis or MS; After a few days to four weeks</td>
<td>Q1WN: 73</td>
<td>90</td>
<td>YES(1)</td>
<td>50</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q1WA: 399,644</td>
<td>100</td>
<td>NO(na)</td>
<td>100</td>
<td>NO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q2WN: 41</td>
<td>90</td>
<td>YES(1)</td>
<td>50</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q2LA: 11</td>
<td>100</td>
<td>NO(na)</td>
<td>100</td>
<td>NO</td>
</tr>
<tr>
<td><strong>Stewart (3/19/07) Pet. [Pet.]</strong></td>
<td>Hepatitis A; Cerebellar ataxia; On about the fourth day</td>
<td>Q1WN: 61</td>
<td>100</td>
<td>YES(7)</td>
<td>10</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q1WA: 9,437,542</td>
<td>100</td>
<td>YES(1)</td>
<td>10</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q2WN: 49</td>
<td>100</td>
<td>YES(8)</td>
<td>10</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q2LA: 9,639,992</td>
<td>100</td>
<td>YES(1)</td>
<td>10</td>
<td>YES</td>
</tr>
</tbody>
</table>
## Results of Baseline Study (cont.)

<table>
<thead>
<tr>
<th>1. Case Name (date); Winner of claim [Althen 1 issue] in Report</th>
<th>2. Vaccine; Alleged Injury; Time-to-Onset</th>
<th>3. Total # cases returned, by query</th>
<th>4. % vaccine comp. cases in top-10, by query</th>
<th>5. Source case in top-10, by query (Y/N)? (rank)</th>
<th>6. % cases in top-10 whose Case Report has all 3 Q1 [4 Q2] items (Y/N)?</th>
<th>7. Source Case Report has all 3 Q1 [4 Q2] items (Y/N)?</th>
</tr>
</thead>
</table>
| **Meyers (5/22/06)**  
Govt. [Govt.] | DTaP;  
Diabetes;  
At any time | Q1WN: 69  
Q1LA: 5,458,103  
Q2WN: 69  
Q2LA: 6,600,933 | 100 | YES(8) | 10 | YES |
| **Sawyer (6/22/06)**  
Govt. [Govt.] | Tetanus;  
Hand, wrist and arm injuries;  
At any time | Q1WN: 52  
Q1LA: 5,926,913  
Q2WN: 52  
Q2LA: 6,782,277 | 100 | NO(22) | 0 | YES |
| **Wolfe (11/9/06)**  
Govt. [Govt.] | Hepatitis B;  
Intractable seizure disorder;  
After about one day | Q1WN: 74  
Q1LA: 6,785,674  
Q2WN: 75  
Q2LA: 7,896,179 | 100 | YES(5) | 50 | YES |
| **Thomas (1/23/07)**  
Govt. [Govt.] | DPT; Acute encephalopathy and death;  
Within several weeks | Q1WN: 107  
Q1LA: 5,610,041  
Q2WN: 58  
Q2LA: 6,548,798 | 100 | NO (89) | 90 | YES |
| **Walton (4/30/07)**  
Govt. [Govt.] | MMR; Myocarditis;  
After over three weeks | Q1WN: 70  
Q1LA: 5,456,593  
Q2WN: 73  
Q2LA: 6,981,746 | 90 | YES (1) | 10 | YES |
Results: *Rank-Ordered Lists of Cases Retrieved*

- **Goal**: searches should return most relevant cases at top of rank-ordered results list.
  - For all 40 queries, % of returned cases in top-10 cases that were federal vaccine compensation cases always at least 90% (Col.4). ✔

- **Goal**: source case, whose facts formed basis for the query, should be among highly relevant cases.
  - LA: source case in top-10 cases of Results List 75% of time (Col. 5), ✔
    - in top-2 cases 60% of time.
    - For 2 queries, LA returned source case but not in the top-10 cases.
  - WN: returned source case in top-10 50% of time (Col. 5), ✔ –
    - in top-2 15% of time.
    - For remaining 10 queries, WN returned source case, but not in top-10 cases.
Results: *Results-List Case Reports*

- For all 40 queries’ Results Lists:
  - we determined if Case Reports for source case and top-10 cases
  - included all elements sought by query (Col. 6 & 7).

- **Goal:** Source’s Case Report should be Q1- and Q2-complete:
  - Q1-complete: three elements:
    1. a particular vaccine,
    2. a particular alleged injury,
    3. an indication that the vaccine caused the injury.
  - Q2-complete adds:
    4. an indication of time-to-onset between the vaccination and the manifestation of the injury.

- **Goal:** Top-10 cases should include some Q1- and Q2-complete Case Reports.
Policies for determining if Case Report is Q1- and Q2-complete:

Report should include:

1. vaccine by:
   - name (e.g., measles-mumps-rubella),
   - well-known initials (e.g., MMR), or
   - alternative name (e.g., commercial brand name);

2. injury by name (e.g., myocarditis) or alternative names;

3. for Q2, some specific time period;

4. Regarding causation, report should include assertion or direct implication,
   - for Q1, that the vaccine can[not] cause the injury.
   - for Q2, that the vaccine can[not] cause the injury in the specific time period.
Results: *Results-List Case Reports* (cont.)

For 40 queries:

- **Re source case:**
  - On 4 occasions, WN’s Case Report for source case was not Q2-complete even though the query was based on its facts (Col. 7). ✔ –
    - For LA, this occurred twice. ✔ –
    - WN reported *Roper* source case at rank Q1(21) and Q2(11) even though it was only case re gastroparesis in the WN Results List for Q1 or Q2.

- **Re top-10 cases:**
  - LA always returned at least one case in top-10 whose Case Report was “Q1-complete” or “Q2-complete” (Col. 6). ✔
  - WN did not find any Q1-complete cases in top-10 for 3 queries or any Q2-complete cases in the top-10 for 4 queries. ✔ –
Results: *Case Report Decision Abstracts*

- **Goal:** Case Reports for Top-10 cases should make clear which side won:
  1. ultimate claim for vaccine compensation (i.e., petitioner or the government); and
  2. causation sub-issue under *Althen* Condition 1.

- For all 40 queries, information about winners much less frequent in Case Reports in WN than in LA.
  - WN reported ultimate-claim outcomes about 29% of the time and causation sub-issue outcomes about 47% of the time. ✔️
  - LA reported ultimate-claim outcomes about 88% of the time and causation sub-issue outcomes about 93% of the time. ✔️
From IR Systems to AR Systems

Baseline study shows:

- Legal IR systems return relevant cases with natural language queries and probabilistic criteria.

- Ways IR systems’ performance is not ideal for AR –
  - retrieval precision (e.g., source cases not ranked highly in Results Lists)
  - Case Reports do not focus on retrieved case features relevant to query.
  - Decision Abstracts do not make clear who won what claims or issues.

Hypothesis: AR tasks possible if system can:

- identify / use semantic, presuppositional and DLF information relevant to legal argument (i.e., semantic and pragmatic legal information).
If AR can identify presuppositional info re vaccines: (i.e., Covered-vaccine, Specific-vaccination)

1. Address some co-reference problems. Cases refer to vaccines ito:
   - generic names ("varicella")
   - popular names ("Chickenpox")
   - commercial brand names ("VARIVAX")
   - in composite vaccines (Quadrigen vaccine combines DPT and polio vaccines)
     - In *Thomas* queries ("DPT vaccine can cause acute encephalopathy and death"), cases involving assertions re Quadrigen-caused injuries may be relevant.
If AR can identify presuppositional info re temporal relations: (i.e., Specific-vaccination, Injury-onset, Onset-timing)

2. Perform simple temporal reasoning.
   - In *Wolfe* Q2 queries, neither WN nor LA ranked source case in top-10 cases.
     - Query: “Hepatitis B vaccine can cause intractable seizure disorder after about one day”
     - *Wolfe* does not mention “one day” or “day”, but
       - mentions “12 hours” in the following sentence:
       - “The temporal relationship between the immunization and the chain of seizure activity which followed, starting within the 12 hours after the immunization, compel [sic] one to conclude that there is a causal relationship between the two.”
   - In *Walton* Q2, following seem to have misled LA:
     - Query: “MMR vaccine can cause myocarditis after over three weeks”
     - Cases IR returned:
       - “three test cases”, “all three special masters”, “three theories”,
       - “several weeks of evidentiary hearings”,
       - “after the vaccine (i.e., no time specified)”, “after the designation of this case”, “after determining the evidence”.

Copyright Kevin D. Ashley, Vern Walker. 2013
If AR system can identify presuppositional info re injuries: (i.e., Generic-injury, Injury-onset)

3. Filter sentences / cases not relevant to reasoning about injuries.
   - Sawyer queries sought cases involving injuries to the arm that might have been caused by the tetanus vaccine.
   - Query: “Tetanus can cause hand, wrist and arm injuries at any time”
   - Cases IR returned:
     - Garcia involved vaccinations “in the right and left arms”;
     - Pociask involved a vaccinee with a chronic arm problem; and
     - Hargrove decision referred to “the site that the antigen was introduced [the arm].”
Use logical structure & pragmatic legal context

4. to focus AR on key sentences:
   - Often, few sentences in lengthy opinion capture significant reasoning.
   - User argument goals makes some sentences more relevant than others.
     - For example, purpose behind queries like Q1 or Q2 is fact-oriented.
     - In *Casey* search, Case Reports for cases WN ranked higher than source case contained re-statements of *Althen* rule.
       - They contain search terms, but no info about specific vaccinations, injuries, or durations.

AR could distinguish sentences that re-state the law from those that apply the law to facts using:
   - DLF (Default Logic Framework) rule tree showing *Althen* rule
   - presence / absence of presuppositional entities/events (e.g., Covered-vaccine, Generic-injury, and Onset-timing)
   - citation text analyzer identifying appellate courts (rule-setters)
Use logical structure & pragmatic legal context...

... so that AR can

5. rank cases more effectively and improve precision.
   - Some knowledge of pragmatic legal context (e.g., which presuppositional info fulfilled or not) may improve precision where
   - source case is only Q1- or Q2-complete case returned, but source is still not ranked at top of Results List (i.e., *Roper, Casey, Stewart, Meyers*, and *Walton*, Table 2, Col. 5).

6. generate more informative summary of case decisions.
   - determine issues addressed from DLF structure & presuppositional info,
   - conclusion reached (the finding of fact) on each decided issue (i.e., which party won or lost).
Challenges: Attributing (Embedded) Assertions:

- “Attribution problem”: determining participant to whom AR system should attribute the assertion.
  - Sentence that expresses causal assertion may be:
    - recounting of allegations in the case,
    - entry in a medical record,
    - testimony of an expert witness,
    - finding of the factfinder.
  - E.g., in Walton Q2 search, LA ranked source case first:
    - Sentence recounted causal testimony of witness.
    - But, Special Master discounted testimony, held against petitioner.

- Analyze “Dr. Smith testified that the vaccine can cause the injury”:
  a) embedded assertion (“the vaccine can cause the injury”) and
  b) the person to whom the assertion should be attributed (e.g., Dr. Smith).
Challenges: presuppositional info phrased differently:

- If user’s goal seeks arguments relevant to proving or disproving *Althen* Condition 1, then
  - assertions about general causation (Medical-theory-assertions) and specific causation (Specific-causation-assertions) are important.

- Presents lexical challenges:
  - recognizing alternative ways to express causal relations, such as “results in” and “brings about”.

- Pragmatic challenges:
  - recognizing successful / unsuccessful ways of reasoning to causal conclusions.
Integrated pipeline of open-source UIMA software components that:

1. takes full-text legal decisions re scientific evidence of causation,
2. extracts syntactic and argument-related semantic and pragmatic (contextual/discourse) information, and
3. uses it to improve IR precision, report extracted arguments, and suggest new evidence and arguments.
References: re automatic semantic processing of case decision texts for legal IR:

- SPIRE retrieved cases and highlighted passages relevant to bankruptcy law factors (Daniels, Rissland 1997).
- SMILE+IBP classified case texts in terms of factors and predicted outcomes (Ashley, Brüninghaus 2009).
- Assigned rhetorical roles to case sentences based on 200 manually annotated Indian decisions (Saravanan, Ravindran 2010).
- Categorized legal cases by Westlaw categories (e.g., bankruptcy, banking) (Thompson 2001) or general topics (e.g., exceptional services pension, retirement) (Gonçalves, Quaresma 2005).
- Extracted treatment history (e.g., “affirmed”, “reversed in part”, or “overruled”) (Jackson, et al. 2003).
- Classified sentences as argumentative based on manually classified sentences from court reports and generated argument tree structures (Mochales, Moens 2011).
- Determined role of sentence in legal case (e.g., as describing the applicable law or the facts) (Hachey, Grover 2006).
- Extracted from criminal cases, offenses raised and legal principles applied to generate summaries (Uyttendaele 1998).
- Extracted holdings of legal cases (McCarty 2007).
Conclusions

- Baseline study suggests:
  - current legal IR systems are effective at returning relevant cases, but
  - do not support AR.

- Module added to full-text legal IR system could:
  - extract semantic / pragmatic legal information from top $n$ cases returned and
  - analyze them to improve retrieval precision and
  - construct better Case Reports and Decision Abstracts.

- Future work:
  - Using V/IP corpus as training data and test bed,
  - program could learn to extract semantic / pragmatic legal information from new case texts with UIMA-based multi-level annotation approach
  - similar to DeepQA architecture of IBM Watson question-answering system (Ashley & Walker, ICAIL 2013).