The RTE-3 Extended Task

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History

- **U.S. DTO AQUAINT program**
  - focus on question answering for complex questions
  - long-standing interest in having systems justify their answers
  - RTE-3 provided opportunity to gather data from the community at large to discover what makes a good justification

- **Extended task organization:**
  - Chris Manning, Dan Moldovan, Ellen Voorhees
  - with thanks to the organizers of main RTE-3
Extended Task

• For each entailment pair in RTE-3 main task test set
  – provide 3-way entailment decision
    • Is Entailed (same as main task YES decision)
    • Contradicts (text and hypothesis cannot both be true)
    • Neither (the hypothesis neither is entailed by nor contradicts the text)
  – optionally, provide a justification for each decision where a justification is defined simply as a set of ASCII strings
3-way Entailment Decisions

• Motivation: drive systems to make more precise informational decisions
  • RTE main task conflates “can’t tell” with “contradicts” when intuitively this is a big distinction

• Pragmatic definition for contradiction similar to that used in main task for entailment
  • based on “ordinary understanding”
  • assessors specifically told not to try to invalidate contradiction by constructing some bizarre interpretation where it might happen to be true
Examples

Text: The Communist Party USA was a small Maoist political party which was founded in 1965 by members of the Communist Party around Michael Laski who took the side of China in the Sino-Soviet split.

Hypothesis: *Michael Laski was an opponent of China.*
Decision: Contradicts

Text: Ms. Minton left Australia in 1961 to pursue her studies in London.

Hypothesis: *Ms. Hinton was born in Australia*
Decision: Neither entailed nor contradicts
3-Way Answer Key

- Constructed by NIST assessors
  - all 800 test pairs judged, with each pair judged by two different NIST assessors …
  - … but set of ‘YES’ decisions exactly the same as main task (regardless of NIST assessors’ judgments)
  - disagreements between assessors for contradicts/neither adjudicated by Ellen Voorhees

- Final statistics
  - 410 Entails
  - 72 Contradicts
  - 318 Neither
Evaluation

• **Accuracy**
  - percentage of system responses that match answer key

• \( F = \frac{(1+\beta) \ (P*R)}{\beta \ (P+R)} \)
  - weighted harmonic mean of recall and precision
  - \( \beta = 1/3 \) (emphasize precision over recall)
  - computed only over ‘Is Entailed’ and ‘Contradicts’ entailment pairs
  - this combination selected to allow ‘Neither’ to be a reasonable ‘Don’t know’ response, but highly skewed pair distribution since 410=YES, 72=NO
## Submissions

<table>
<thead>
<tr>
<th>Organization</th>
<th>Country</th>
<th>Run tags</th>
<th>Run type</th>
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<tr>
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<td>Greece</td>
<td>AUEB01, AUEB02</td>
<td>3-way decisions only</td>
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<td>USA</td>
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<td>justifications included</td>
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<td>USA</td>
<td>LCCCOGEX</td>
<td>justifications included</td>
</tr>
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<td>LCC (Groundhog)</td>
<td>USA</td>
<td>LCCH1</td>
<td>justifications included (manual run)</td>
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<td>USA</td>
<td>parc1strict, parc2loose</td>
<td>3-way decisions only</td>
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<td>USA</td>
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<td>justifications included</td>
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<tr>
<td>University of Iasi</td>
<td>Romania</td>
<td>uaic07p01, uaic07p02</td>
<td>justifications included</td>
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<tr>
<td>University of Karlsruhe</td>
<td>Germany</td>
<td>fbRasp, FbMinipar</td>
<td>3-way decisions only</td>
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Effectiveness of 3-way Decisions

- Accuracy
- F

Bars represent different systems:
- LCCH1
- LCCOGEK
- Stanford
- uaic07p01
- AUEB02
- uaic07p02
- fbRasp
- run1
- parc2loose
- parc1strict
- FbMinipar
- AUEB01

NIST
True contradictions are rare and difficult for systems to recognize

Contingency table of responses over all entailment pairs and all runs

<table>
<thead>
<tr>
<th>Systems say ( \rightarrow ) Answer ( \downarrow ) Key</th>
<th>Entails</th>
<th>Neither</th>
<th>Contradicts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entails</td>
<td>2449</td>
<td>2172</td>
<td>299</td>
</tr>
<tr>
<td>Neither</td>
<td>929</td>
<td>2345</td>
<td>542</td>
</tr>
<tr>
<td>Contradicts</td>
<td>348</td>
<td>415</td>
<td>101</td>
</tr>
</tbody>
</table>

Note diagonal entry for ‘Contradicts’ substantially smallest entry in both row and column.
Contradictions are Hard (Take 2)

- No system had the correct response for 22 pairs
  - `Contradicts’ correct for 20 pairs; `Entails’ for other 2

9 (IE) Answer key: Contradicts

Text: Minton’s first major part in England was as Maggie Dempster in the premiere of Nicholas Maw’s One Man Show. Shortly thereafter, she became a regular member of the company of the Royal Opera House Covent Garden.

Hypothesis: Maggie Dempster was a member of the company of the Royal Opera House Covent Garden.

303 (IR) Answer key: Entails


Hypothesis: The US Government protected Everglades from further environmental damage.
Diverse Responses from Systems

• All 12 systems agreed on only 2/800 pairs
  • all responded Entails when Entails is correct response

456 (QA)

**Text:** The Hubble is the only large visible-light and ultra-violet space telescope we have in operation.

**Hypothesis:** Hubble is a Space telescope.

501 (QA)

**Text:** Victor Emmanuel III (1869-1947) was king of Italy from 1900 to 1946. His cooperation with Mussolini helped bring an end to the Italian Monarchy.

**Hypothesis:** Victor Emmanuel III was king of Italy from 1900 to 1946.
Annotator Agreement

- Arbitrarily assign one NIST assessor as first assessor for a pair, the other as second
- Contingency tables show raw counts before adjudication
- Conflated agreement is percent of matches when both Neither and Contradict match NO

<table>
<thead>
<tr>
<th>NIST → RTE</th>
<th>Entail</th>
<th>Neither</th>
<th>Contradict</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>378</td>
<td>27</td>
<td>5</td>
</tr>
<tr>
<td>NO</td>
<td>48</td>
<td>242</td>
<td>100</td>
</tr>
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</table>

RTE vs. one NIST meta-assessor; (conflated) agreement = .90

<table>
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<th>Neither</th>
<th>Contradict</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>383</td>
<td>23</td>
<td>4</td>
</tr>
<tr>
<td>NO</td>
<td>46</td>
<td>267</td>
<td>77</td>
</tr>
</tbody>
</table>

RTE vs. other NIST meta-assessor; (conflated) agreement = .91
Example Disagreements

- Official key says Yes, both NIST Assessors said `Contradicts’ (3-way key retains Yes)
  - Granularity of place names

  **Text:** The 52\textsuperscript{nd} Golden Globe Awards, honoring the best in film and television for 1994, were held on January 21, 1995 at the Beverly Hilton Hotel in Beverly Hills, California.

  **Hypothesis:** *Golden Globes for 1994 were awarded in Los Angeles.*

- Tense issues
  (NIST instructions to assessors differed from official)

  **Text:** The head of the Israel Defense Forces, Lt. Gen. Dan Halutz resigned on Tuesday January 16, 2007 after an internal review criticized his military’s leadership during the war in Lebanon last summer.

  **Hypothesis:** *Dan Halutz is the head of the Israel Defense Forces.*
**Annotator Agreement**

- Agreement between two NIST assessors
- Table shows raw counts before adjudication
- Agreement is percentage of matching judgments

<table>
<thead>
<tr>
<th></th>
<th>Entail</th>
<th>Neither</th>
<th>Contradict</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entail</td>
<td>381</td>
<td>43</td>
<td>2</td>
</tr>
<tr>
<td>Neither</td>
<td>39</td>
<td>217</td>
<td>13</td>
</tr>
<tr>
<td>Contradict</td>
<td>9</td>
<td>30</td>
<td>66</td>
</tr>
</tbody>
</table>

NIST assessor vs. NIST assessor; agreement = .83

- Level of agreement is consistent with other RTE challenges, but three-way (rather than binary) match means systems’ accuracy scores can change by significant amount just by changing assessors.
Justifications

• Motivation: explore what constitutes a good explanation of a system response

• Guidelines explicitly noted that target was “ordinary” end user
  • specifically not system builder (not debugging output!)
  • user not necessarily linguist or logician

• Specification of allowable justifications deliberately vague: “a collection of ASCII strings”
  • don’t want to arbitrarily preclude good ideas in pilot
  • but was text-based rather than graphical
  • no size limit imposed; submitted justifications brief
**Example**

**Text:** Muybridge had earlier developed an invention he called the Zoopraxiscope.

**Hypothesis:** *The Zoopraxiscope was invented by Muybridge.*

<table>
<thead>
<tr>
<th>LCCCOGEX</th>
<th>LCCH1</th>
<th>Stanford</th>
</tr>
</thead>
</table>
| The text mentions ‘Muybridge’. We can infer that Muybridge is inventor. From the fact that Muybridge is inventor, we can infer that Muybridge invented. We can conclude that the Zoopraxiscope was invented by Muybridge. | There is a relationship between Zoopraxiscope and Muybridge in both the text and hypothesis. The term “invention” is morphologically similar to “invented”. | 1. The Hypothesis could be precisely matched with content in the Text, with allowance for polarity and embedded context.  
2. Hypothesis words match well with words in the Text.  
3. text adjunct “called” of “invention” dropped on aligned hyp word “invented” |
Example (cont’d)

**Text:** Muybridge had earlier developed an invention he called the Zoopraxiscope.

**Hypothesis:** *The Zoopraxiscope was invented by Muybridge.*

<table>
<thead>
<tr>
<th>run1</th>
</tr>
</thead>
</table>
| Yes! I have general knowledge that:  
  IF Y is developed by X THEN Y is manufactured by X  
Here: X = Muybridge, Y = the invention 
Thus, here:  
  We are told in t: the invention is developed by Muybridge  
  Thus it follows that: the invention is manufactured by Muybridge  
In addition, I know “manufacture” and “invent” mean roughly the same thing  
Hence: the Zoopraxiscope was invented by Muybridge. |

<table>
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<tr>
<th>uaic07p01</th>
</tr>
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</table>
| The words in the hypothesis are all found, with approximately all the same syntactic dependencies, also in the text. Therefore, I concluded that given hypothesis:  
  *The Zoopraxiscope was invented by Muybridge*  
is entailed by the given text  
  Muybridge had earlier developed an invention he called the Zoopraxiscope. |
Judging Justifications

- Given: an entailment pair, the answer key response, a system’s response & justification
  - assign a score on a scale of 1(low) – 5 (high) for how understandable the justification is
  - if the understandability is at least 3, assign a score on a scale of 1 (low) – 5 (high) for how compelling the argument contained in the justification is; otherwise, no compellingness score is assigned
    - compellingness involves both correctness and pertinence
    - a system reaching the wrong conclusion could get partial credit for a compellingness score, but not a ‘5’
Judging Justifications

• Assessors could skip pairs for which they disagreed with the answer key response

• Assessors judged all justifications for a given entailment pair before moving on to new pair

• Presentation order of different systems’ justifications randomized for a given entailment pair; all assessors who judged that pair saw same order
Judging Justifications

• NIST (Ellen) selected 100 pairs as subset of justifications to be judged
  • various factors in selection: systems generally reached correct response for pair; balance across four application areas (IE, IR, QA, Sum); both ‘long’ and ‘short’ examples; the justification for at least one system was `interesting’ in some way

• All six NIST assessors judged all 100 pairs

• Recall NIST received 6 runs that included justifications from 5 groups; one run was manual
Scores Assigned to Example

**Text:** Muybridge had earlier developed an invention he called the Zoopraxiscope.

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scores:

[4 3] [3 3] [5 4]
[5 1] [5 3] [3 2] |

[4 4] [5 4] [3 2] |
[2 -] [1 -] [2 -] |
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scores:
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Scoring

• **Lots of numbers!**
  - each run: 100 pairs X 6 assessors X 2 5-point scores
  - participants received complete set of 1200 numbers for their run
  - computed mean understandability score and mean compellingness score
    – average computed per assessor over 100 pairs, per entailment pair over 6 assessors, and grand overall mean
    – mean actually a dubious choice since 5-point scale should probably be treated as category rather than interval variable
    – if pair was unjudged, it was skipped in computing means; if understandability was <3, compellingness treated as ‘0’
Distribution of Justification Scores

LCCCOGEX [4.1 2.0]  LCCH1* [4.3 2.8]  run1 [4.1 1.5]

Stanford [2.7 1.2]  uaic07p01 [3.2 1.5]  uaic07p02 [3.1 1.5]
Assessor Agreement

• Differences for both Understandability and Compellingness
  • even with separate score, compellingness score still affected by ease of comprehension
  • the six NIST assessors have different mathematical backgrounds, and it showed
  • differences do affect system rankings
Average System Rank

Understandability

Compellingness

NIST
Common Themes

• Conciseness highly prized
  • “chatty” explanations grew old fast
  • want explanations that focus on specifics
    – “There is a relation”, “there is a match” are unsatisfying
  • but mathematical notation also largely discouraged

• Don’t discuss system internals
  • (uncalibrated) scores from various components do not install confidence
  • jargon (polarity, adjunct, …) unpopular
Extended Pilot Results

• 3-way decisions
  • good task; need more test pairs for evaluation stability
  • recognizing actual contradiction currently difficult
  • contradiction relatively rare in 2007 test set, so constructing future balanced test set may be an issue

• Justifications
  • need better understanding of overall purpose of task
    – having system explain itself at this level is probably counterproductive
    – need to appeal to true task for effective use of assessors
  • systems reaching correct entailment decision by faulty reasoning uncomfortably often