



U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND – ARMY RESEARCH LABORATORY

Automated information extraction to facilitate comprehension across text difficulty levels

Erin Zaroukian

Cognitive Scientist

Content Understanding Branch, Computational and Information Sciences Directorate

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- Information Extraction (IE) pipelines can aid decision making by structuring data and pulling decision-relevant information from large document sets
- Much research focuses on precision/recall of the pipeline
- Little research on how useful the pipeline output is to a user
 - Does text markup from an IE pipeline improve human comprehension of text documents?





EXPERIMENT 1 - RESEARCH QUESTION







Does text markup from an IE pipeline improve human comprehension of text documents?

- ELICIT: Experimental Laboratory for the Investigation of Collaboration, Information Sharing, and Trust [Ruddy 2007]
- Scenario
 - 68 sentences
 - Together provide who/what/where/when of an anticipated adversary attack

Example mini-scenario
The Tetrahedron group is not involved.
There will be a suicide bomb attack at a new hotel.
The Cube and Tetrahedron groups have the capacity to operate in Gibbonland and Lemurland.
The Cube group only attacks on New Year's Day.
A hotel was recently built in Gibbonland.
The attack will be at 11:00 pm.
Time remaining: 19:31 Terrorist plot:
Who? Select group V What? Select target V
Where? Select country \vee When? Select month \vee Select day \vee at Select time \vee Select AM/PM \vee
→ Click here to submit answers for this scenario





- Text/problem difficulty Alston (2010), Morton & Adams (2010)
 - Amount of "noise"
 - Number of sentences required to solve
 - Number of possible solutions





Does text markup from an IE pipeline improve human comprehension of text documents?

- Text/problem difficulty



Logic chains for Scenario 1 "What", as given in Morton & Adams.





Does text markup from an IE pipeline improve human comprehension of text documents?

Text/problem difficulty

	Factoid Set 1	Factoid Set 2	Factoid Set 3	Factoid Set 4
Mixed Logic Streams	7	8	9	4
Factoids per sub-solution	5, 5, 5, 9 (24)	5, 11, 8, 10 (34)	10, 8, 14, 4 (36)	5, 7, 6, 4 (22)
– from Alston				
Who, What, Where, When				
(Sum)				
Factoids per sub-solution	5, 4, 7, 9 (25)	5, 5, 4, 9 (23)	8, 4, 7, 8 (27)	6, 4, 12, 8 (30)
– from Morton & Adams				
solving matrices				
Factoids per sub-solution	5, 5, 8, 9 (27)	5, 6, 5, 9 (25)	11, 5, 8, 9 (32)	6, 6, 11, 9 (32)
– from Morton & Adams				
solution trees				
Number of relationships	25	25	27	17
– from Alston				
Number of factoids	15	15	16	12
- from Alston				
Number of factoids	16	17	16	17
– from Morton & Adams				
solution trees				





- Text/problem difficulty
 - Alston:
 - 4 << 2 < 3
 - 4 << 1
 - Morton & Adams:
 - 1≈2
 - 3 has greater dependence on interim conclusions regarding the answers to *What* and *Where*.
 - 4 is substantially different from the other three scenarios in structure
 - **− 4/8 < 1**, 2 < 3/**7**





- Markup generated by an RPI pipeline [Li, Ji, and Huang 2013; Li and Ji 2014]
 - Events, labeled entities, mouse-over

Plain scenario excerpt	Markup scenario excerpt
All the military bases in Perchland are heavily protected. There is no new information about Raven group operations in Bassland. Perchland is land locked. Locals in Sharkland are being recruited. The Turtle lost his right eye in an accident. The Bronco group does not attack on its Sabbath. Members of the Charger, Titan, Steeler, Raider, and Bronco groups have experience with chemical weapons. The shopping malls in the coalition area are not well defended. Charger and Titan group members have entered Perchland and Salmonland. The Panther, Charger, Titan, and Raven groups prefer to attack in daylight.	All the [osc military] [sc bases] in [cr Perchland] are heavily protected. There is no new information about R Perchland is land locked. [st Locals] in [cr Sharkland] are beavily protected. [st Locals] in [cr Sharkland] are beavily frager: entered The [st Turtle] [st Members] of the [osc Charger], [st Modally: Asserted [st Members] of the [osc Charger], [st Members] Perchland and defended. Charger and Titan [osc group] [st members] have < <i>entered></i> Perchland and [st Salmonland]. The [st Panther], [st Charger], [osc Titan] and Raven [osc groups] prefer to <attack> in daylight.</attack>





Does text markup from an IE pipeline improve human comprehension of text documents?

 Measured objectively as the <u>accuracy</u> and <u>speed</u> with which participants answer questions about the text

 Measured subjectively through ratings of <u>workload</u> and <u>preference</u>

The Mention [: Entity with relation Chiggery: Event [Fms]: Second [Goc]: organization [GPC]: Geo-political Entity [FMC]: Facility [VMF]: Vehicle [WEA]: Weapon [LOC]: Location [FOO]: Others [TMEK]: Timex [VALUE]: Value The [rest Eagle] is involved. The Grest Eagle] is involved. The antime cruise [FAC terminal] is ocean-based. The <attack-> will be at the end of the second shift. The [rest Circle] [FAC group] is recruiting [FAE locals] - intentions unknown. The [rest attackers] are focusing on a high visibility target. The [rest Heron] was <born> in [GPE Hornetland]. The remaining: 19:54 Terrorist plot: Who? [Select roumty ~ Whar? [Select county ~ Wher? [Select county ~ Wher? [Select county ~</born></attack->	Type Mention]: Entity
Cffigger>: Event [PR]: Fersion: [ORC]: Organization [CPE]: Geo-political Entity [FAC]: Facility [VPI]: Ventice [VPI]: Ven	Type Mention]: Entity with relation
[rex]: Reason [loc]: Corganization [rev]: Geo-political Entity [rev]: Facility [ver]: vehicle [rex]: Weapon [loc]: Location [roo]: Others [rex]: Timex [vulue]: Value The [rex Eagle] is involved. The Eagle does not work in [see Spiderland]. The reading of the second shift. The (rex Circ] [rex group) is recruiting [rex locals] - intentions unknown. The larget lose museum] in [see Spiderland] has a flat roof. The (rex Circ] [rex group) is recruiting [rex locals] - intentions unknown. The larget lose museum] in [see Spiderland] has a flat roof. The [rex Hatckers] are focusing on a high visibility target. The [see Cord] and [see Hexagon] [see groups] want to <atlack> the interests of res Hornetland]. Time remaining: 19:54 Terrorist plot: Who? [select group] ~ What? [select country ~ Wher? [select country ~ Wher? [select month ~ [Select day ~ at [Select tume ~ [Select AMV/PM ~</atlack>	<trigger>: Event</trigger>
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[TIMEX]: TIMEX [VALUE]: Value The [FRE Eagle] is involved. The Eagle does not work in [GR Spiderland]. The northern cruise [rac terminal] is ocean-based. The <attack-will at="" be="" end="" of="" second="" shift.<="" td="" the=""> The [res Circle] [FRE group] is recruiting [FRE locals] - intentions unknown. The largest [one museum] in [GR Spiderland] has a flat roof. The [res attackers] are focusing on a high visibility target. The [res covers] are focusing on a high visibility target. The [res theron] was born> in [GR Hornetland]. Time remaining: 19:54 Terrorist plot: Who? [Select goup] ~ Where? [Select country ~ Where? [Select country ~ Where? [Select month ~ Select time ~ Select time ~ Select time ~</attack-will>	[VEH]: Vehicle [WEA]: Weapon [LOC]: Location [FOO]: Others
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The northern cruise [rac terminal] is ocean-based. The <attack> will be at the end of the second shift. The [rac Circle] [rac group] is recruiting [rac locals] - intentions unknown. The largest [onc museum] in [cre Spiderland] has a flat roof. The [rac attackers] are focusing on a high visibility target. The [onc Oval] and [ras Hexagon] [onc groups] want to <attack> the interests of rea Hornetland]. The [res Heron] was <born> in [cre Hornetland]. Time remaining: 19:54 Terrorist plot: Who?] Select group Wher?[Select country] When?[Select country] at [Select time] [Select AMV/PM]</born></attack></attack>	he Eagle does not work in [GPE Spiderland].
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The [res Circle] [res group] is recruiting [res locals] – intentions unknown. The largest [osc <u>museum</u>] in [cre <u>Spiderland</u>] has a flat roof. The [res attackers] are focusing on a high visibility target. The [osc Oval] and [res <u>Hexagon</u>] [osc groups] want to < <i>attack</i> > the interests of res Hornetland]. The [res Heron] was < <i>born></i> in [cre Hornetland]. Time remaining: 19:54 Terrorist plot: Who? [Select group ~ Whar? [Select country ~ When? [Select country ~] When? [Select country ~]	he <attack> will be at the end of the second shift.</attack>
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rea Hornetland]. The [rea Heron] was < born> in [cre Hornetland]. Time remaining: 19:54 Terrorist plot: Who? [select grup ~~ Who? [select transf ~~ Where? [select county ~~] Where? [select county ~]	he [org Oval] and [PER <u>Hexagon</u>] [org <u>groups</u>] want to < <u>attack</u> > the interests of
The [rex Heron] was < born> in [cre Hornetland]. Time remaining: 19:54 Terrorist plot: Who? [Select group ~ What? [Select arget ~ Where? [Select county ~] Where? [Select county ~] Where? [Select mont ~] [Select day ~] at [Select time ~] [Select AMPM ~]	PER Hornetland].
Time remaining: 19:54 Terrorist plot: Who? Select group What? Select target Where? [Select county] When? Select nonth] [Select day] at [Select time] [Select AM/PM]	The [PER Heron] was < <i>born</i> > in [GPE Hornetland].
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Terrorist plot: Who? [Select group] What? [Select target] Where? [Select country] Wher? [Select country] Wher? [Select nonth] [Select day] at [Select time] [Select AM/PM]	
Who? <u>Select group</u> What? <u>Select target</u> Where? <u>Select country</u> When? <u>Select country</u> When? <u>Select month</u> <u>Select day</u> at <u>Select time</u> <u>Select AM/PM</u>	Terrorist plot:
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Where? [Select country ~] When? [Select month ~] [Select day ~] at [Select time ~] [Select AM/PM ~]	What? Select target ~
When? Select month v Select day v at Select time v Select AM/PM v	
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	Where? Select country \checkmark When? Select month \checkmark Select day \checkmark at Select time \checkmark Select AM/PM \checkmark
\rightarrow Click here to submit your answer and continue	Where? Select county v When? Select month v Select day v at Select time v Select AM/PM v

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Which version of the task felt more mentally demanding?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	С
Which version of the task felt more physically demanding?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	С
Which version of the task felt more hurried or rushed?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C
On which version of the task do you think you performed better?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C
On which version of the task did you feel you had to work harder?	0	0	0		0	0		0	0		0	0	0	0	0	0		0	0		0
Which version of the task lead you to feel more insecure, discouraged, irritated, stressed, or annoyed?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C
Overall, which version of the task do you prefer?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C





- Participants
 - 100 Turkers
 - \$2
- Procedure
 - Demographic questionnaire
 - Instructions



- Plain: Practice scenario, test scenario, answers
- Markup: Practice scenario, test scenario, answers
- Workload and preference questionnaire







- Accuracy ٠
 - Plain >_∗ Markup
- Speed
 - Plain <, Markup</p>
- Workload •
 - Plain <, Markup</p>
- Preference ٠
 - Plain >_∗ Markup







Scenario difficulty

- Did not affect accuracy, response time



EXPERIMENT 2 – RESEARCH QUESTION



Does text markup from an IE pipeline improve human comprehension of text documents?

Experiment 1 - comprehension *worsened* with markup, no effect of difficulty

Experiment 2 – will comprehension improve with "ideal" markup?





Does text markup from an IE pipeline improve human comprehension of text documents?

- ELICIT: Experimental Laboratory for the Investigation of Collaboration, Information Sharing, and Trust [Ruddy 2007]
- Scenario
 - 68 sentences
 - Together provide who/what/where/when of an anticipated adversary attack

Example mini-scenario
The Tetrahedron group is not involved.
There will be a suicide bomb attack at a new hotel.
The Cube and Tetrahedron groups have the capacity to operate in Gibbonland and Lemurland.
The Cube group only attacks on New Year's Day.
A hotel was recently built in Gibbonland.
The attack will be at 11:00 pm.
Time remaining: 19:31 Terrorist plot: Who? Select group What? Select country Wher? Select country Wher? Select country Wher? Select country
→ Click here to submit answers for this scenario





- Hand-generated "ideal" markup
 - Potential Who, What, Where, When highlighted

Plain scenario excerpt	Markup scenario excerpt
The Lion is involved.	The Lion is involved.
Word has it that an unprotected target is preferred to ensure the likelihood of success.	Word has it that an unprotected target is preferred to ensure the likelihood of success.
The Lion doesn't operate in Chiland.	The Lion doesn't operate in Chiland.
The Lion attacks in daylight.	The Lion attacks in daylight.
All of the members of the Azure group are now in custody.	All of the members of the Azure group are now in custody.
Security forces are providing highly visible, around the clock protection to all visiting dignitaries in the region.	Security forces are providing highly visible, around the clock protection to all visiting dignitaries in the region.
The Lion is planning something in April on the anniversary of his father's death.	The Lion is planning something in April on the anniversary of his father's death
The Brown group is recruiting locals - intentions unknown.	The Brown group is recruiting locals - intentions unknown.
The Lion is planning something in April on the anniversary of his father's death. The Brown group is recruiting locals - intentions unknown.	The Lion is planning something in April on the anniversary of his father's death. The Brown group is recruiting locals - intentions unknown.





- Measured objectively as the <u>accuracy</u> and <u>speed</u> with which participants answer questions about the text
- Measured subjectively through ratings of <u>workload</u> and <u>preference</u>

	The Lion is involved.						- 1	
2	Word has it that an unpr	otected targ	et is preferre	d to ensure the	e likelihood o	f success.	- 1	
5	The Lion doesn't operat	e in Chiland					- 1	
1	The Lion attacks in day	light					- 1	
<u>/</u>	All of the members of <mark>t</mark>	he Azure gro	oup are now i	in custody.			- 1	
	Security forces are prov the region.	iding highly	visible, arou	and the clock j	protection to	all visiting di	gnitaries in	
	The Lion is planning so	mething in <mark>/</mark>	April on the a	nniversary of	his father's d	eath.	- 1	
Ī	The Brown group is rec	ruiting local	s - intentions	unknown.			- 1	
-	Time remaining: 19:51							
	Terrorist plot: Who? Select group What? Select target	involving						
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- Participants
 - 200 Turkers
 - \$2
- Procedure
 - Demographic questionnaire
 - Instructions
 - Plain practice scenario, Markup practice scenario
 - Trust in automation survey
 - Plain or Markup: Test scenario, answers, text scenario, answers
 - Trust in automation survey
 - Workload and preference questionnaire







- Accuracy
 - Plain ≈ Markup
- Speed
 - Plain ≈ Markup
- Workload
 - Plain ≈ Markup, except Overall Performance favored Markup
- Preference
 - Plain <_∗ Markup







- Scenario difficulty
 - Did not affect accuracy, response time





Experimental framework

- Twice failed to show accuracy/speed advantage for markup
- Showed lower workload, preference for "ideal" markup
- Can be used to explore further manipulations, lead to a better understanding of how various features of tasks and text presentation affect various aspects of performance.
 - E.g., task difficulty multidimensional!
- Specific use cases to be tested as IE pipelines are developed or as the end user's task changes → IE development loop that includes user testing and user-directed IE development guidelines, promoting systems that succeed not only on intrinsic measures, but on extrinsic measures as well.





• Sue Kase, Michelle Vanni, Justine Caylor, Stephen Tratz, Claire Bonial, Jeffrey Micher, Clare Voss, Lucia Donatelli, Jon Bakdash of ARL





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