Supplementary Material: Discourse Representation Structure Parsing

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1 Discourse Representation Graphs

As shown in Figure 1, a DRS or SDRS tree node is represented as a graph node $b_i, i \in \mathbb{N}$, and referents are connected to it by an arc labeled "ref" (e.g., $b_0 \xrightarrow{ref} x_1$). For each condition r in a DRS or SDRS, a dummy node $c_j, j \in \mathbb{N}$ is generated and connected to node b_i by an arc labeled r (e.g., $b_0 \xrightarrow{india} c_0$), and the first referent is connected to c_j by an arc labeled "arg1" (e.g., $c_3 \xrightarrow{arg1} e_1$), the second referent is connected to c_j by an arc labeled "arg2" (e.g. $c_3 \xrightarrow{arg2} \pi_1$), and so on.

For each proposition π_n, a dummy node $c_j, j \in \mathbb{N}$ is created and connected to the direct parent node $b_i, i \in \mathbb{N}$ by a special arc "prop" and its argument is assigned to a new DRS or SDRS node $b_k, k \in \mathbb{N}$. For example, π_1 and its scoped semantics in Figure 1 are converted to $b_0 \xrightarrow{prop} c_4$, $c_4 \xrightarrow{arg1} \pi_1$, and $c_4 \xrightarrow{arg2} b_1$. For each segment k_n a dummy node $c_j, j \in \mathbb{N}$ is produced and connected to node $b_i, i \in \mathbb{N}$ by a special "constituent" arc and its argument is assigned to new DRS or SDRS nodes $b_k, k \in \mathbb{N}$. Similarly, for other scope denoting elements $r \in \{\neg, \square, \diamond, \rightarrow, \vee, ?\}$ in Equation (9) in the paper, a dummy node $c_j, j \in \mathbb{N}$ is produced and connected to node $b_i, i \in \mathbb{N}$ by an arc r, and its argument is assigned to a new DRS or SDRS node $b_k, k \in \mathbb{N}$.

2 Examples of Model Output

We show examples of model output on the GMB test set in Tables 1 and 2. Specifically, we show the output of our best model equiped with a deep structure decoder (see Section 4.4 in the paper).
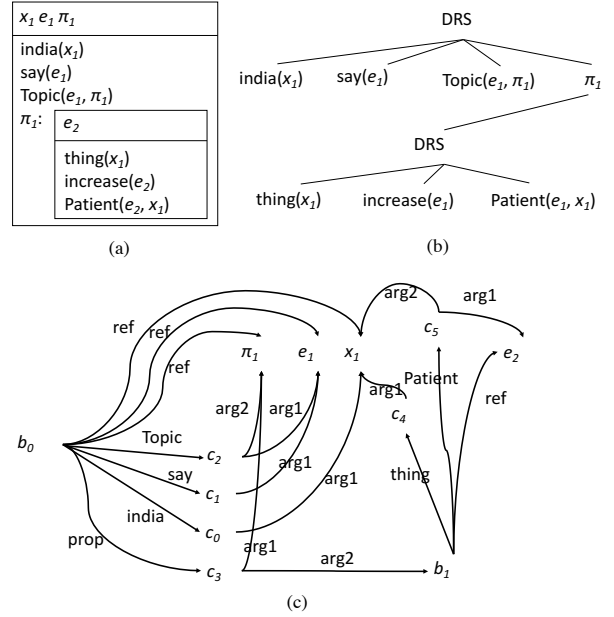

Figure 1: (a) DRS box representing the sentence *India says it is increasing*; (b) DRS represented as a tree; (c) the corresponding discourse representation graph (DRG).

#2	They marched from the Houses of Parliament to a rally in Hyde Park .
gold	DRS(Thing(x_1) march(e_1) Theme(e_1 x_1) house(x_2) parliament(x_3) of(x_2 x_3) from(e_1 x_2) rally(x_4) to(e_1 x_4) hyde(x_5) eq(x_6 x_5) park(x_6) in(e_1 x_6))
ours	DRS(Thing(x_1) march(e_1) Theme(e_1 x_1) house(x_2) parliament(x_3) of(x_2 x_3) from(e_1 x_2) rally(x_4) UNK(x_5) of(x_6 x_5) park(x_6) in(x_4 x_6) to(e_1 x_4))

#45	The Pakistani official was giving a background briefing to a small group of reporters in Washington .
gold	DRS(pakistan(x_1) of(x_2 x_1) official(x_2) background(x_3) On(x_4 x_3) briefing(x_4) give(e_1) Agent(e_1 x_2) Theme(e_1 x_4) Topic(s_1 x_5) small(s_1) group(x_5) reporter(x_6) of(x_5 x_6) washington(x_7) in(x_5 x_7) to(e_1 x_5))
ours	DRS(pakistan(x_1) of(x_2 x_1) official(x_2) background(x_3) For(x_4 x_3) briefing(x_4) Topic(s_1 x_5) small(s_1) group(x_5) reporter(x_6) of(x_5 x_6) to(x_4 x_5) give(e_1) Agent(e_1 x_2) Theme(e_1 x_4) washington(x_7) in(e_1 x_7))

#170	Monday , officials reported that a 32-year-old woman from an area just west of Jakarta died of bird flu last week , at her home in the city of Tangerang .
gold	DRS(official(x_1) report(e_1) Agent(e_1 x_1) Theme(e_1 p_1) monday(x_2) On(e_1 x_2) p_1(DRS(Topic(s_1 x_3) 32-year-old(s_1) woman(x_3) area(x_4) Eq(x_4 x_5) west(s_2) Topic(s_2 x_5) just(s_2) jakarta(x_6) of(x_4 x_6) from(x_3 x_4) die(e_2) Patient(e_2 x_3) bird(x_7) in(x_8 x_7) flu(x_8) of(e_2 x_8) week(x_9) On(e_2 x_9) last(e_2) Female(x_3) of(x_{10} x_3) home(x_{10}) at(e_2 x_{10}) city(x_{11}) tangerang(x_{12}) of(x_{11} x_{12}) in(e_2 x_{11}))))
ours	DRS(official(x_1) report(e_1) Agent(e_1 x_1) Theme(e_1 p_1) monday(x_2) in(e_1 x_2) p_1(DRS(Topic(s_1 x_3) 32-year-old(s_1) woman(x_3) area(x_4) Eq(x_4 x_5) west(x_6) of(x_7 x_6) west(x_7) of(x_5 x_7) from(x_4 x_5) just(e_2) from(x_3 x_4) die(e_2) Patient(e_2 x_3) bird(x_8) of(x_9 x_8) flu(x_9) city(x_{10}) tangerang(x_{11}) of(x_{10} x_{11}) in(x_9 x_{10}) from(e_2 x_9) week(x_{12}) On(e_2 x_{12}) last(e_2) just(e_2)))))

#5363	Security officials say the explosion , Monday , at a busy market in Pulwama , south of Srinagar , also wounded more than 70 others and damaged a school , a police station and several shops .
gold	DRS(security(x_1) With(x_2 x_1) official(x_2) say(e_1) Cause(e_1 x_2) Topic(e_1 p_1) p_1(SDRS(k_1(DRS(explosion(x_3) monday(x_4) Rel(x_3 x_4) Person(x_5) Person(x_6) more(s_1) Topic(s_1 x_5) Card(x_7 CARD_NUMBER) than(s_1 x_7) wound(e_2) Stimulus(e_2 x_3) Experiencer(e_2 x_5) also(e_2) Topic(s_2 x_8) busy(s_2) market(x_8) pulwama(x_9) south(x_{10}) srinagar(x_{11}) of(x_{10} x_{11}) Rel(x_9 x_{10}) in(x_8 x_9) at(e_2 x_8) Not(DRS(Eq(x_5 x_6)))))) k_2(DRS(explosion(x_{12}) monday(x_{13}) Rel(x_{12} x_{13}) school(x_{14}) police(x_{15}) By(x_{16} x_{15}) station(x_{16}) Subset_of(x_{16} x_{17}) Topic(s_3 x_{18}) several(s_3) shop(x_{18}) Subset_of(x_{18} x_{17}) Rel(x_{14} x_{17}) damage(e_3) Agent(e_3 x_{12}) Patient(e_3 x_{14}) also(e_3) Topic(s_4 x_{19}) busy(s_4) market(x_{19}) pulwama(x_{20}) south(x_{21}) srinagar(x_{22}) of(x_{21} x_{22}) Rel(x_{20} x_{21}) in(x_{19} x_{20}) at(e_3 x_{19}))) Continuation(k_1 k_2) Parallel(k_1 k_2)))))
ours	DRS(security(x_1) of(x_2 x_1) official(x_2) say(e_1) Cause(e_1 x_2) Topic(e_1 p_1) p_1(SDRS(k_1(DRS(explosion(s_1) monday(s_1 x_3) On(s_2 x_4) Topic(s_2) busy(x_4) market(x_5) pulwama(x_6 x_5) in(x_6) at(x_6 x_7) south(x_8) srinagar(x_7 x_8) of(x_6 x_7) Rel(e_2) wound(e_2 x_4) Experiencer(e_2 x_6) Stimulus(x_9) also(x_{10} x_9) Not(DRS(Eq(x_{10}))))) k_2(DRS(explosion(x_{11}) police(x_{12} x_{11}) of(x_{12}) station(x_{12}) Subset_of(s_3 x_{11}) Topic(s_3) several(x_{11}) shop(x_{12} x_{11}) Subset_of(x_{12}) Rel(x_{10} x_{12}) in(x_8 x_{10}) school(s_3) more(s_3 x_8) Topic(x_8) Card(x_9 CARD_NUMBER) than(s_4 x_9) Rel(x_8))) Continuation(k_1 k_2) Parallel(k_1 k_2)))))

#5298	Local authorities say four women and two crew members managed to swim to safety , but that eight women are still missing .
gold	DRS(Topic(s_1 x_1) local(s_1) authority(x_1) Card(x_2 CARD_NUMBER) woman(x_2) Subset_of(x_2 x_3) Card(x_4 CARD_NUMBER) crew(x_4) that(x_4 p_1) Subset_of(x_4 x_3) Card(x_5 CARD_NUMBER) crew(x_5) Card(x_6 CARD_NUMBER) woman(x_6) Eq(x_5 x_7) miss(e_1) Experiencer(e_1 x_6) Stimulus(e_1 x_7) still(e_1) Subset_of(x_5 x_3) say(e_2) Cause(e_2 x_1) Topic(e_2 x_3) p_1(DRS(member(x_8) manage(e_3) Agent(e_3 x_8) Theme(e_3 p_2) p_2(DRS(swim(e_4) Theme(e_4 x_8) safety(x_9) to(e_4 x_9)))))))
ours	DRS(that(x_1 p_1) Topic(x_1) local(x_1) authority(x_1) say(e_1) Cause(e_1 x_1) Topic(e_1 p_1) p_1(SDRS(Continuation(k_1 k_2) Parallel(k_1 k_2) k_1(DRS(Card(e_2 CARD_NUMBER) woman(e_2) Subset_of(e_2 x_2) Card(x_3 CARD_NUMBER) crew(x_3) Of(e_2 x_3) member(x_4) Subset_of(x_4) to(e_2) member(e_2 x_4) manage(e_2 p_2) Agent(e_3) Theme(e_3 x_4) p_2(DRS(Card(e_4 CARD_NUMBER) woman(e_4) miss(e_4 x_2) Patient(e_4))))) k_2(DRS(Card(e_4 CARD_NUMBER) woman(e_4) miss(e_4 p_3) Patient(e_4) still(e_4) p_3(DRS(Card(e_4 CARD_NUMBER) woman(e_4) miss(e_4 x_5) Patient(e_4)))))))))

Table 1: Examples of model output on the GMB test set.

#6	The International Atomic Energy Agency is to hold second day of talks in Vienna Wednesday on how to respond to Iran 's resumption of low-level uranium conversion .
gold	DRS(international(x_1) For(x_2 x_1) atomic(x_3) For(x_2 x_3) energy(x_4) For(x_2 x_4) agency(x_2) be(e_1) Agent(e_1 x_2) Theme(e_1 p_1) p_1(SDRS(k_1(DRS(Topic(s_1 x_5) second(s_1) day(x_5) talk(x_6) of(x_5 x_6) hold(e_2) Agent(e_2 x_2) Theme(e_2 x_5) vienna(x_7) in(e_2 x_7) wednesday(x_8) on(e_2 x_8))) k_2(DRS(Manner(p_2) p_2(DRS(respond(e_3) Agent(e_3 x_9) iran(x_{10}) of(x_{11} x_{10}) resumption(x_{11}) Topic(s_2 x_{12}) low-level(s_2) uranium(x_{13}) of(x_{12} x_{13}) conversion(x_{12}) of(x_{11} x_{12}) to(e_3 x_{11}))))) on(k_1 k_2))))
ours	DRS(international(x_1) For(x_2 x_1) atomic(x_3) For(x_2 x_3) energy(x_4) For(x_2 x_4) agency(x_2) be(e_1) Agent(e_1 x_2) Theme(e_1 p_1) p_1(DRS(Topic(s_1 x_5) second(s_1) day(x_5) talk(x_6) vienna(x_7) in(x_6 x_7) of(x_5 x_6) hold(e_2) Agent(e_2 x_2) Theme(e_2 x_5) wednesday(x_8) on(e_2 x_8) p_2(DRS(eq(x_9 x_{10}) respond(e_3) Agent(e_3 x_{10}) iran(x_{11}) of(x_{12} x_{11}) resumption(x_{12}) Topic(s_2 x_{13}) low-level(s_2) uranium(x_{14}) of(x_{13} x_{14}) conversion(x_{13}) of(x_{12} x_{13}) conversion(x_{15}) on(x_{12} x_{15}) of(e_3 x_{12}))))))

#3337	The German man works for the company Bilfinger Berger .
gold	DRS(germany(x_1) Of(x_2 x_1) man(x_2) work(e_1) Patient(e_1 x_2) company(x_3) On(x_4 x_3) bilfinger(x_5) Eq(x_4 x_5) berger(x_4) for(e_1 x_4))
ours	DRS(germany(x_1) Of(x_2 x_1) man(x_2) work(e_1) Agent(e_1 x_2) company(x_3) Of(x_4 x_3) bilfinger(x_5) Eq(x_4 x_5) berger(x_4) for(e_1 x_4))

#3338	Police have not named any suspects in the case .
gold	DRS(police(x_1) Not(DRS(Imp(DRS(suspect(x_2)) DRS(name(e_1) Agent(e_1 x_1) Theme(e_1 x_2) case(x_3) in(e_1 x_3))))))
ours	DRS(police(x_1) Not(DRS(Imp(DRS(suspect(x_2)) DRS(case(x_3) in(x_2 x_3) name(e_1) Agent(e_1 x_1) Theme(e_1 x_2))))))

#3339	Kidnappings are common in the delta region .
gold	DRS(kidnapping(x_1) common(s_1) Topic(s_1 x_1) delta(x_2) Of(x_3 x_2) region(x_3) in(s_1 x_3))
ours	DRS(kidnapping(x_1) common(s_1) Topic(s_1 x_1) delta(x_2) On(x_3 x_2) region(x_3) in(s_1 x_3))

#1735	Officials in the Somali capital of Mogadishu say a bomb explosion near the mayor 's convoy Sunday has killed two people and wounded several others .
gold	DRS(official(x_1) somalia(x_2) of(x_3 x_2) capital(x_3) mogadishu(x_4) of(x_3 x_4) in(x_1 x_3) say(e_1) Cause(e_1 x_1) Topic(e_1 p_1) p_1(SDRS(k_1(DRS(bomb(x_5) of(x_6 x_5) explosion(x_6) mayor(x_7) of(x_8 x_7) convoy(x_9) of(x_8 x_9) sunday(x_8) near(x_6 x_8) Card(x_{10} c_{ARD_NUMBER}) people(x_{10}) kill(e_2) Instrument(e_2 x_6) Patient(e_2 x_{10}))) k_2(DRS(bomb(x_{11}) of(x_{12} x_{11}) explosion(x_{12}) mayor(x_{13}) of(x_{14} x_{13}) convoy(x_{15}) of(x_{14} x_{15}) sunday(x_{14}) near(x_{12} x_{14}) Topic(s_1 x_{16}) several(s_1) Person(x_{16}) Person(x_2) wound(e_3) Stimulus(e_3 x_{12}) Experiencer(e_3 x_{16}) Not(DRS(Eq(x_{16} x_2)))))) Continuation(k_1 k_2) Parallel(k_1 k_2))))
ours	DRS(official(x_1) somalia(x_2) of(x_3 x_2) capital(x_3) mogadishu(x_4) of(x_5 x_4) in(x_3 x_5) say(e_1) Cause(e_1 x_3) Topic(e_1 p_1) p_1(SDRS(Continuation(k_1 k_2) Parallel(k_1 k_2) k_1(DRS(bomb(x_6) With(x_7 x_6) explosion(x_7) mayor(x_7 x_8) of(x_9) convoy(x_{10} x_9) near(x_{10}) sunday(x_{11} x_{10}) near(x_{11}) Card(x_{11} c_{ARD_NUMBER}) people(x_{11}) kill(x_{12} x_{11}) Instrument(x_{12}) Patient(x_{11} x_{12}))) k_2(DRS(bomb(x_{11}) Patient(x_{12} x_{11}) explosion(x_{12}) mayor(x_7 x_{12}) of(x_7) sunday(e_2) near(e_2 x_6) Not(DRS(Eq(x_7)))))))))

#2389	Meanwhile , Japan 's Kyodo news agency reports Pyongyang has agreed to talks with Japan in October on a range of issues , including Pyongyang 's nuclear weapons program .
gold	DRS(japan(x_1) of(x_2 x_1) kyodo(x_3) For(x_2 x_3) news(x_4) From(x_2 x_4) agency(x_2) report(e_1) Agent(e_1 x_2) Theme(e_1 p_1) meanwhile(e_1) p_1(DRS(pyongyang(x_5) agree(e_2) Agent(e_2 x_5) talk(x_6) japan(x_1) with(x_6 x_1) to(e_2 x_6) october(x_7) in(e_2 x_7) range(x_8) issue(x_9) of(x_8 x_9) pyongyang(x_5) of(x_{10} x_5) Topic(s_1 x_{10}) nuclear(s_1) weapon(x_{11}) of(x_{10} x_{11}) program(x_{10}) include(x_8 x_{10}) on(e_2 x_8))))
ours	DRS(japan(x_1) of(x_2 x_1) kyodo(x_3) For(x_2 x_3) news(x_4) From(x_2 x_4) agency(x_2) report(e_1) Agent(e_1 x_2) Theme(e_1 p_1) meanwhile(e_1) p_1(DRS(pyongyang(x_5) agree(e_2) Agent(e_2 x_5) Theme(e_2 x_6))))

Table 2: Examples of model output on the GMB test set.