Qualitative analysis of Semantic Parsing Models

In the logical form supervised setting, logical forms are provided for each question and are directly used to supervise the model outputs. In latent variable model, we only use question and answer (denotation) pairs. Here, many logical forms are possible that give rise to the denotation. Both the models perform generally well with identification of correct variables, pointing correct predicates, and getting the unary predicate variables right in almost all cases. The latent variable model having a lesser accuracy as it is weakly supervised. While the general trend in errors for logical form supervised model was due to swapping of variable where the variables are copied in wrong order in the output, the errors are more complex for the weakly supervised model. In addition to exhibiting the variable swapping error, in most other erroneous cases, the model confuses the predicates for similar words and swaps/omits them, especially in cases such as "west virginia" in the question where both west and virginia are part of other predicates, but not all the time. This seems like a direct consequence of not being trained on specific logical forms where the mapping would be more explicitly learned by the model. As expected, the logical form supervised setting does not lead to these errors. Few examples below -

Example 39

Logical form supervised

dev question: is there a national park in west virginia ?
dev true LF: (lambda $w (exists $x (and (park $w) (in-rel $w $x) (kb-westvirginia $x))))
dev pred LF: (lambda $w (exists $x (and (park $w) (in-rel $w $x) (kb-westvirginia $x))))
dev true denotation: 'monongahelanationalforest'
dev pred denotation: 'monongahelanationalforest'
dev denotation match: True

Latent variable

dev question: is there a national park in west virginia ?
dev true LF: (lambda $w (exists $x (and (park $w) (in-rel $w $x) (kb-westvirginia $x))))
dev pred LF: (lambda $w (exists $x (and (west-rel $w $x) (kb-westvirginia $x))))
dev true denotation: 'monongahelanationalforest'
dev pred denotation: set()
dev denotation match: False

The latent variable model does not accurately predict in-rel and instead predicts west-rel, probably 'copying' the west from 'west virginia'. These types of errors can be reasoned as the model is trained on direct question-answer pairs using latent logical forms. As expected, similar errors are not seen in the logical form supervised model that uses logical forms explicitly where the representations for west-virginia and west-rel would not have the same ambiguity.

Example 41

Logical form supervised

dev question: is virginia east of west virginia ?
dev true LF: (lambda $w (exists $x (and (kb-virginia $w) (east-rel $w $x) (kb-west virginia $x))))
dev pred LF: (lambda $w (exists $x (and (kb-west virginia $w) (east-rel $w $x) (kb-virginia $x))))
dev true denotation: 'virginia'
dev pred denotation: set()
dev denotation match: False

Latent variable

dev question: is virginia east of west virginia ?
dev true LF: (lambda $w (exists $x (and (kb-virginia $w) (east-rel $w $x) (kb-west virginia $x))))
dev pred LF: (lambda $w (exists $x (and (east-rel $w $x) (kb-west virginia $x))))
dev true denotation: 'virginia'
dev pred denotation: 'richmond', 'virginia'
dev denotation match: False

The error here is the predicates for $x and $w being swapped for the logical form supervised model, and the absence of kb-virginia for the latent variable that seems to have missed the state and only considered west virginia. While the variable swapping seems like a consequence of being trained on logical forms and erroneous pointing/copying, missing virginia in-lieu of west-virginia may be because the model was not specifically trained on these terms as predicates and neither was it trained on explicit mappings.

Example 16

Logical form supervised

dev question: what state is south of west virginia ?
dev true LF: (lambda $w (exists $x (and (state $w) (south-rel $w $x) (kb-west virginia $x))))
dev pred LF: (lambda $w (exists $x (and (state $w) (south-rel $w $x) (kb-west virginia $x))))
dev true denotation: 'virginia'
dev pred denotation: 'virginia'
dev denotation match: True

Latent variable

dev question: what state is south of west virginia ?
dev true LF: (lambda $w (exists $x (and (state $w) (south-rel $w $x) (kb-west virginia $x))))
dev pred LF: (lambda $w (exists $x (and (state $w) (west-rel $w $x) (kb-west virginia $x))))
dev true denotation: 'virginia'
dev pred denotation: set()
dev denotation match: False

The latent variable model confuses south and west (from west virginia) again as seen in example 39, probably due to the same reason. However, it is curious to note that dev example 9 "what state is east of west virginia ?" was answered correctly by the latent variable

model. Perhaps, this can be improved with more examples?

Example 25

Logical form supervised

dev question: is virginia inside of west virginia ?
dev true LF: (lambda $w (exists $x (and (kb-virginia $w) (inside-rel $w $x) (kb-west virginia $x))))
dev pred LF: (lambda $w (exists $x (and (kb-west virginia $w) (inside-rel $w $x) (kb-west virginia $x))))
dev true denotation: set()
dev pred denotation: set()
dev denotation match: True

Latent variable

dev question: is virginia inside of west virginia ?
dev true LF: (lambda $w (exists $x (and (kb-virginia $w) (inside-rel $w $x) (kb-west virginia $x))))
dev pred LF: (lambda $w (exists $x (and (kb-west virginia $w) (west-rel $w $x) (kb-virginia $x))))
dev true denotation: set()
dev pred denotation: 'west virginia'
dev denotation match: False

Yet, again the latent variable model is confused by repeated virginias and misassigns them to wrong variables. The logical form supervised model does not make the same error as it is trained on explicit logical forms.

Example 35

Logical form supervised

dev question: what 's the capital of virginia ?
dev true LF: (lambda $w (exists $x (and (capital-rel $w $x) (kb-virginia $x))))
dev pred LF: (lambda $w (exists $x (and (capital $w) (capital-rel $w $x) (kb-virginia $x))))
dev true denotation: 'richmond'
dev pred denotation: set()
dev denotation match: False

Latent variable

dev question: what 's the capital of virginia ?
dev true LF: (lambda $w (exists $x (and (capital-rel $w $x) (kb-virginia $x))))
dev pred LF: (lambda $w (exists $x (and (capital-rel $w $x) (kb-virginia $x))))
dev true denotation: 'richmond'
dev pred denotation: 'richmond'
dev denotation match: True

This is probably an error in the database instead of our model, as the only difference is (capital $w) in the prediction, which should be true (even if redundant) anyway. However, the latent variable model does not include (capital $w) in its prediction and gets it right according to the dataset. Conversely, it's interesting to think about whether there could be any incorrect logical forms accidentally leading to correct denotations in latent models.