



Sushma Akoju <sushmaakoju@arizona.edu>

Regarding FOL and

Sushma Akoju <sushmaakoju@arizona.edu>
To: Mihai Surdeanu <surdeanu@gmail.com>
Cc: Mihai Surdeanu <msurdeanu@arizona.edu>

Thu, Sep 8, 2022 at 7:28 PM

Thank you sir, I am looking forward to the meeting.

Best regards,
Sushma Akoju

On Thu, Sep 8, 2022 at 2:36 PM Mihai Surdeanu <surdeanu@gmail.com> wrote:

External Email

It sounds good!
Let's discuss details on Monday.

On September 8, 2022 at 11:55:37 AM, Sushma Akoju (sushmaakoju@arizona.edu) wrote:

Dear Sir,

Thank you so much for the great first two weeks! I am really glad to be part of this group.

As per your guidance from this morning, thank you so much for the encouragement and support towards the NL to FOL problem.

1. To implement encoder decoder model for NL to FOL
2. To see if dataset requires any changes/modifications for FOL statements especially for symbols
3. To explore vastly the limitations of the approach
4. To expand the implementation to include tree LSTMs with symbolism
5. To expand the implementation to include <https://aclanthology.org/Q16-1032/> (to follow Goldberg's tutorial)
6. I understand FOL is not proven to be universal, but I am really keen on finding the best of both worlds from Natural Logic and FOL which also seems to be the intent of <https://github.com/Yale-LILY/FOLIO/tree/main/data/v0.0>

For next week, my tasks are as follows:

1. To implement an encoder decoder model for NL to FOL.
2. Can we use NLI_XY/MoNLI to add chapter 6 from Bill McCartney? What approaches exist? to explore and attempt to analyze.
3. 30 min presentation

Does this sound good?

Best regards,
Sushma Akoju

On Wed, Sep 7, 2022 at 7:35 PM Sushma Akoju <sushmaakoju@arizona.edu> wrote:

Dear Sir,

Thank you, sure will do.

Best regards,

Sushma Akoju

On Wed, Sep 7, 2022 at 6:55 PM Mihai Surdeanu <surdeanu@gmail.com> wrote:

External Email

Yes, this plan sounds good! Let's plan for next week.

On Wed, Sep 7, 2022, 6:52 PM Sushma Akoju <sushmaakoju@arizona.edu> wrote:

Dear Sir,

Sure I can give a 30 min presentation on each of the topics summarizing all of the concepts together. Would this be for just the Natural Logic group ?

I can share a rough powerpoint and some examples for each concept a couple of days before the presentation with you. Do you suggest this is fine?

The presentation would cover:

1. Automated Theorem Provers
2. Coalgebra & algebra for Formal verification
3. Category Theory and Combinatorial Categorical Grammar
4. SAT and SMT solvers

Do you suggest these topics would be fine to summarize and introduce each topic?

Best regards,
Sushma Akoju

On Wed, Sep 7, 2022 at 6:03 PM Mihai Surdeanu <surdeanu@gmail.com> wrote:

External Email

Thanks!

How about a 30 min presentation by you next week on these materials?

On September 7, 2022 at 6:02:31 PM, Sushma Akoju (sushmaakoju@arizona.edu) wrote:

Dear Sir,

Sure, will do.

(I am really sorry my laptop is getting stuck due to some memory issues, so emails are getting sent incomplete. Resending with a complete email.)

Encoder decoder seems more towards machine translation.
I can use RNN and a seq2seq which seem to adapt to FOL. Actually Microsoft had a dataset (symbolic - one hot encoded dataset using RNN for formal natural language proofs). I am looking forward to discussing this further.

I just found this paper on LangPro: they use Fracas and SICK datasets for NLI:
<https://github.com/kovvalsky/LangPro> and the paper
and they used Combinatorial Categorical Grammar using <https://homepages.inf.ed.ac.uk/steedman/papers/ccg/moravcsik2.pdf>

Out of interest in math behind ATPs and algebra, I learnt a couple of ATP courses from youtube videos and as a hobby, to be honest a couple of years ago :
One from Pfenning : <https://www.cs.cmu.edu/~fp/courses/atp/>
One from University of Innsbruck: <http://cl-informatik.uibk.ac.at/teaching/ss20/atp2/content.php>

And one on SMT solvers : <https://people.eecs.berkeley.edu/~sseshia/pubdir/SMT-BookChapter.pdf>
https://resources.mpi-inf.mpg.de/departments/rg1/conferences/vtsa08/slides/barret2_smt.pdf

And the Coalgebra & algebra (which deals with duality in modal logic) is a mapping between functions and vector spaces and is a really interesting math concept used in Category theory for formal verifications in provers.
https://mathsites.unibe.ch/alcop/downloads/Booklet_ALCOP11.pdf

I am really sorry for the too many materials, but I think if it is fine, I can share each of the sub topics on all of the above materials and share some short summaries in 10 days.

Can you please suggest which way might be better to summarize the above materials and share it with you?

Best regards,
 Sushma Akoju

On Wed, Sep 7, 2022 at 3:21 PM Mihai Surdeanu <surdeanu@gmail.com> wrote:

External Email

Let's discuss tomorrow.
 I think the first baseline to implement for NL-to-FOL would be an encoder-decoder architecture.

On Wed, Sep 7, 2022 at 1:55 PM Sushma Akoju <sushmaakoju@arizona.edu> wrote:

Dear Sir,

Thank you so much for the feedback and sharing your thoughts as well.

I see, sure, I was hoping counterfactual and causal reasoning could enhance the uncertainty aspects of the inferences. But it is not clear how this is used in
 About Pearl's and Shafer's books, I already read them.

Sure will do sir, I will keep the goal about publishable work in mind as a short term goal.

I really like PATH 1.
 For PATH 1:
 Converting NL to FOL,
 a) Convert natural language to FOL.

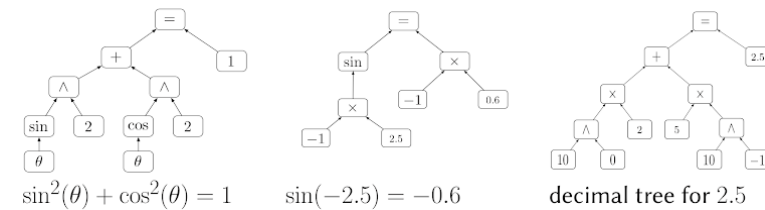
I want to explore this direction vastly to see how this goes.
 I understand this is a hard problem, but below approaches might be one step closer to achieving this goal of converting Natural language to FOL. Do you suggest exploring any direction?
 Can we lend the **below approach from point b)** to build an tree LSTM to equate it to NL or vice versa? I want to try both NL to FOL and FOL to NL. I assume FOL to NL might be easy to start with.
 If it is NL, can we use parts of speech, word compositions to be corresponding FOL statements?
 I want to try to adapt this to tree LSTM and make either Natural Language or FOL as Right Hand Side of equation and analyse. -
 would this be a reasonable direction?

b) Theorem Prover direction:

One direction is to use tree LSTMs to capture the symbolic expression trees.
 They use a one-hot encoding for representing terminal symbols.
<https://github.com/ForoughA/neuralMath/blob/master/lstmTreeNotebook.ipynb>

paper: <https://openreview.net/forum?id=Hksj2WWAW¬elId=Hksj2WWAW>

I can also test the FOL statements with Z3 Prover and Solver, Lean prover solver and Neural Math approach for tree LSTMs with terminal symbols and symbolic expression trees.



Each of these approaches verify the correctness of the given input equation or the FOL statements and its proof.
 The above symbolic expression trees each for mathematical equations for the value on Right Hand Side (RHS).

c) In addition to the a and b directions above, I would also like to attempt the FOL with Neural markov models - for the Epistemic uncertainty as per your suggestion. Do you suggest this is a helpful direction?

These were the approaches I had in mind to try, to be honest, I have been waiting for a dataset like this one that maps NLI premise-hypothesis pairs with corresponding FOL statement pairs.

If you suggest attempting this, I can start working on each one of them and show the results each week. But I don't know what other aspects I am missing for reasonable considerations. Can you please let me know your thoughts and suggestions?

Best regards,
 Sushma Akoju

On Wed, Sep 7, 2022 at 8:58 AM Mihai Surdeanu <surdeanu@gmail.com> wrote:

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Hi Sushma,
 Good comments. I think this needs a longer discussion with the group. But, a few comments:
 - Pearl's causality book is fundamental reading for a computer scientist. However, I would postpone it because he focuses on probabilistic interpretations of causality, which is not exactly what we're doing.
 - Similarly, I would skip Shafer's books because they seem more math-y/philosophical than what we need.
 - The above two points are basically to encourage you to focus on something publishable as quickly as possible. My preferred research style is to learn what I need to solve a research problem, and grow from there. This keeps you focused on a problem while also learning.
 - Epistemic uncertainty is usually discussed in several fields (Bayesian, knowledge representation, and logic). I propose we focus on the latter. In this space, I suspect Markov Logic Networks are still the standard: they focus on FOL, but adding uncertainty to each rule.

- I like the FOLIO paper as well as the other one you found (NeuralLog, attached). Recall that our bigger goal is to address NLI using (a form of) logic proving. There are at least two paths towards this:

PATH 1:

- a) Convert natural language to FOL.
- b) Apply a theorem prover on the FOL. This can be a formal prover or a language model tuned for this. The FOLIO paper is an example of this.

PATH 2:

Apply a (softer) logic prover directly over text. The NeuralLog paper, natural logic, and Zhengzhong's work are example of this.

The advantage of the first direction is modularity. You have different components for each step, which can be developed independently. The big drawback is that in many cases, there is no obvious "translation" from natural language to FOL.

The advantage of the second direction is that it does not require FOL. However, because of this, many approaches such as NeuralLog reduce these proofs to a search problem. Natural Logic and Zhengzhong's work aim to keep the proofs more formal, which I like.

Let's discuss these tomorrow.

On Tue, Sep 6, 2022 at 2:58 PM Sushma Akoju
<sushmaakoju@arizona.edu> wrote:

Dear Sir,

Thank you so much for the guidance.
I forgot to mention the following.

I am also interested in the intersection of uncertain premises and counterfactual reasoning. What directions exist towards the following topics?

1. Julia Pearl's Causality and Book of why.
2. I also read Glenn Shafer's following books which are very interesting: (<http://www.glennshafer.com/cv.html#books>) but all of the following books were from the 1990s so but maybe foundational but I don't know how they apply towards Neural Networks.
 - A Mathematical Theory of Evidence (learning from evidence, more towards epistemic uncertainty that arises from incomplete knowledge)
 - Readings in Uncertain reasoning
 - The Art of Causal Conjecture
 - Algorithmic Learning in a Random World
3. What materials exist towards epistemic uncertainty in NLI?
4. I am glad I got a chance to discuss with you about <https://arxiv.org/pdf/2209.00840.pdf> . FOLIO (NLI with FOL statements) are helpful since according to mathematical theory of evidence, we need evidence to judge or verify if inference or entailments are correct in certain, probabilistic and uncertain cases. FOL provides a concrete base to verify the evidence of inference, which can form explanations from logical reasoning. This is the reason I am keen to work on exploring following:
 1. To test FOLIO dataset on Z3 prover from Microsoft Research

2. **To attempt to build a model that learns both natural language as well as First order logic vocabulary. All verbs in Natural language could be actions in FOL and the symbols for conjunction, XOR, implications etc. Understanding the translation from Natural Language to FOL and vice versa can help to improve logical proof and estimations.**
3. I cannot comment yet on Logical Neural Networks since they take FOL as input. But I am more keen only on the above point since that is a difficult but interesting and helpful problem.

Can you please suggest if I can work towards a problem to build a model that understands natural language and FOL and can translate between each other due to reasons from point 4, hypothetically first from past works?

Best regards,
Sushma Akoju



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