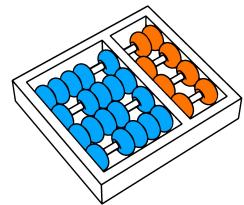


ZéCarioca: A framework for end-to-end chatbots creation

Jader Martins Camboim de Sá

Orientadores: Leandro Villas, Julio C. dos Reis



Agenda

- Introduction
- Motivation
- Proposal
- Methodology
- Results
- Next Steps

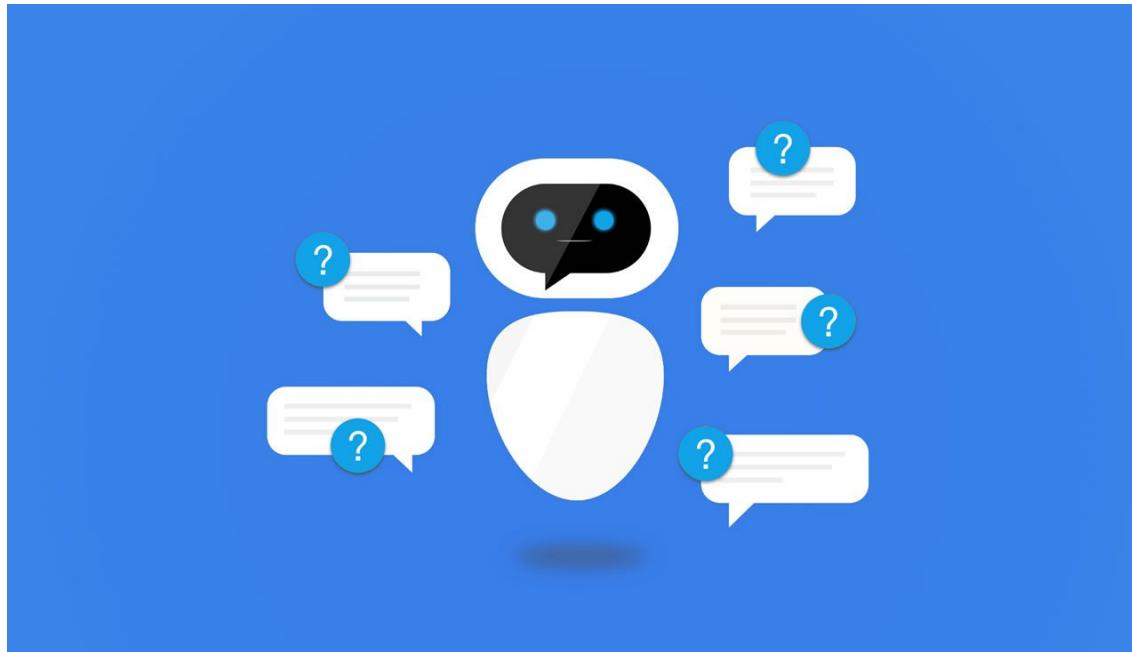


Introduction



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Chatbots (Dialog Systems)



Dialog Problem Structure

- The literature propose to solve task-oriented dialog through recognizing **Intents** and **Entities**:

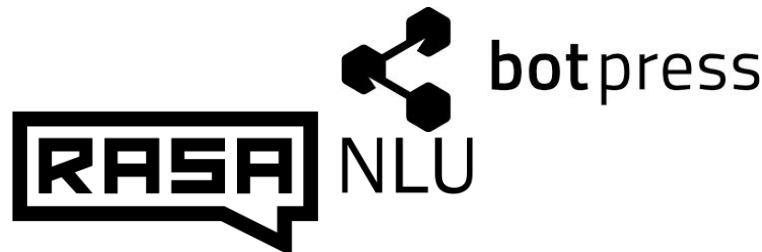
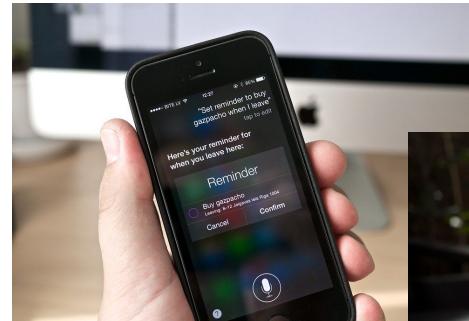
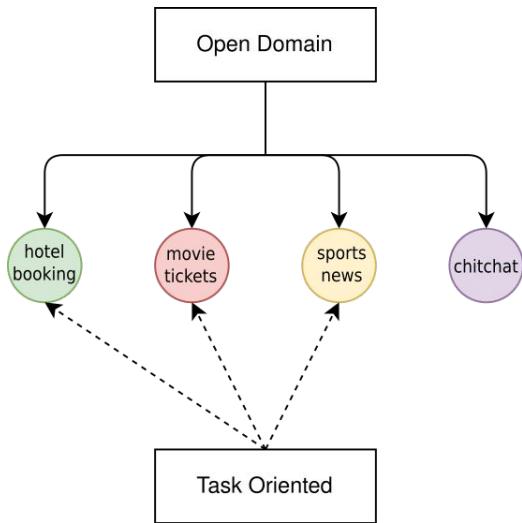
```
USER-utterance: eu preciso de um lugar para jantar no centro que é caro  
find_restaurant  
slot_values: {'restaurant-area': ['centre'], 'restaurant-pricerange': ['expensive']}
```



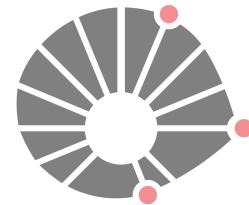
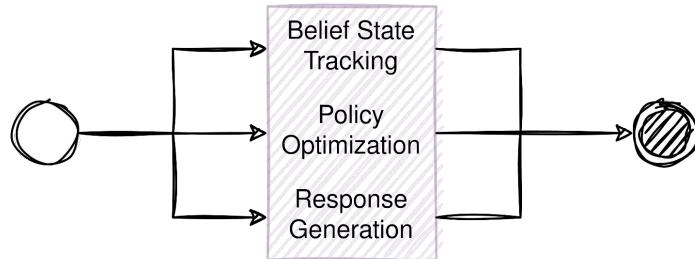
```
SELECT restaurant.name WHERE area='centre'  
AND pricerange='expensive' FROM restaurant;
```

1. BUDZIANOWSKI, Paweł et al. MultiWOZ--A Large-Scale Multi-Domain Wizard-of-Oz Dataset for Task-Oriented Dialogue Modelling. arXiv preprint arXiv:1810.00278, 2018.
2. BYRNE, Bill et al. Taskmaster-1: Toward a realistic and diverse dialog dataset. arXiv preprint arXiv:1909.05358, 2019.

Dialog Systems



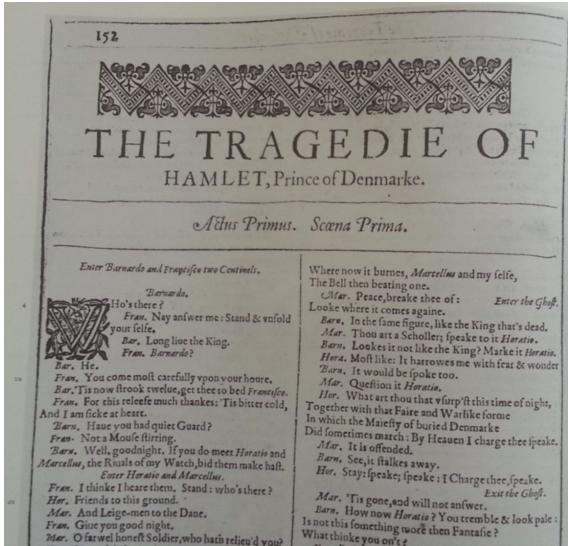
Taxonomy of Task Oriented Dialog Systems



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Differences

Screenplay



Internal Representation (Black Box)



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Motivation

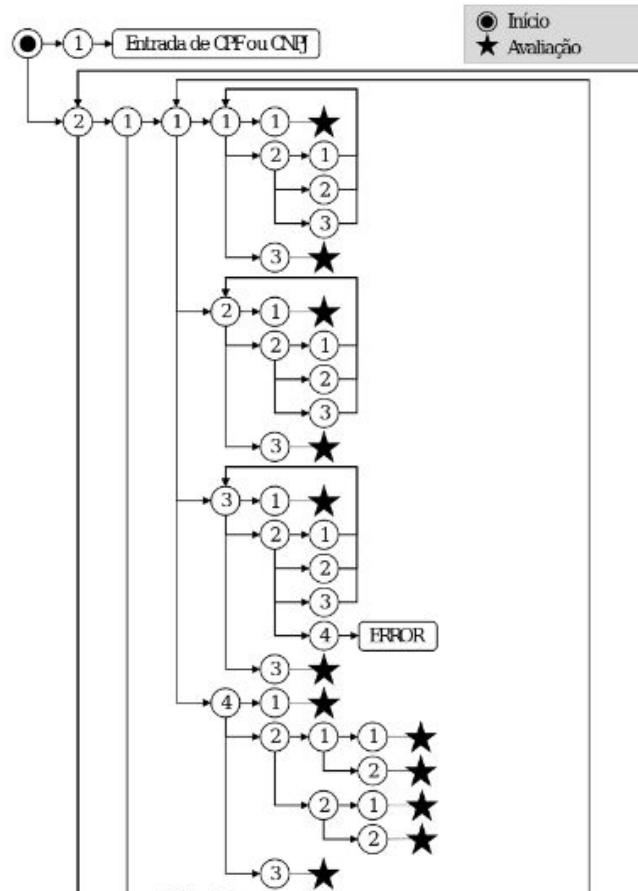


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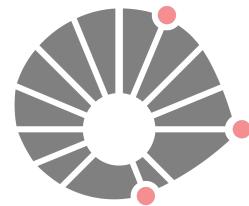
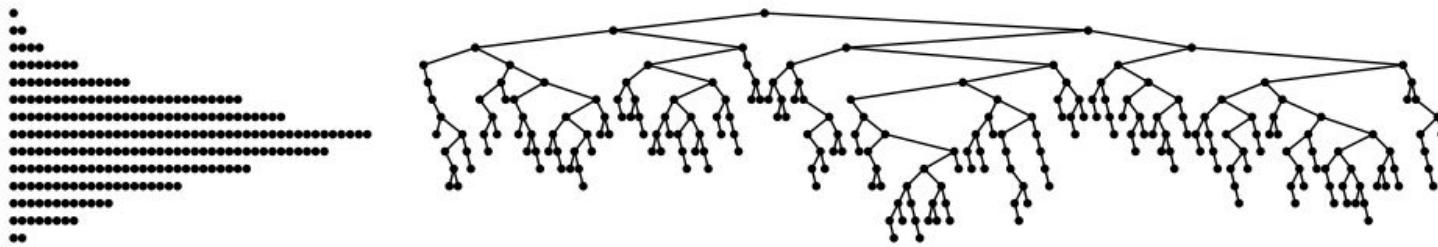
Humanized Chatbot

- olá
- + Olá! Bem vindo(a) a ConectCar! ☐
- + Vamos do inicio: você já é nosso cliente?
 - ☐ 1. Sim
 - ☐ 2. Não
- 2
- + Em que posso te ajudar? ☐
 - ☐1. Quero conhecer mais sobre os planos da ConectCar.
 - ☐2. Quero saber mais sobre promoções
 - ☐3. Quero ser ConectCar.
 - ☐4. Quero comprar um adesivo.
 - ☐5. Quero ativar um adesivo
 - ☐6. Como funciona o Cashback?
 - ☐7. Prefiro escrever o que eu preciso.
- Me informe das promoções <bot não consegue fazer NLU>
- + Escolha uma opção do menu que vamos responder sua dúvida.
Em que posso te ajudar? ☐
 - ☐1. Quero conhecer mais sobre os planos da ConectCar.
 - ☐2. Quero saber mais sobre promoções
 - ☐3. Quero ser ConectCar.
 - ☐4. Quero comprar um adesivo.
 - ☐5. Quero ativar um adesivo
 - ☐6. Como funciona o Cashback?
 - ☐7. Prefiro escrever o que eu preciso.

Huxograma Chat Web ConectCar

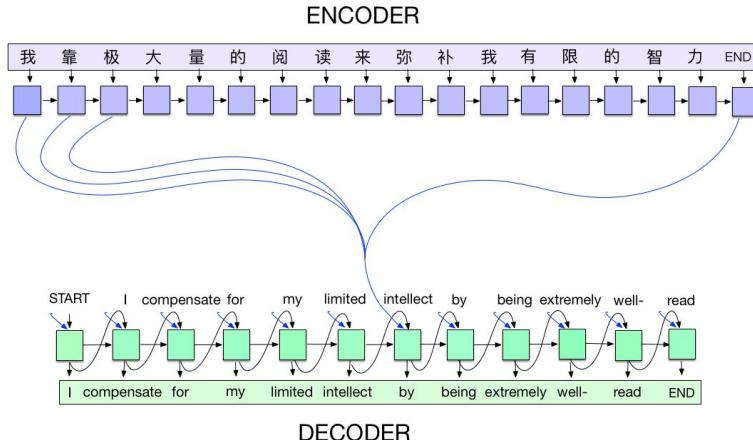


Infinity Possibilities of Dialogues

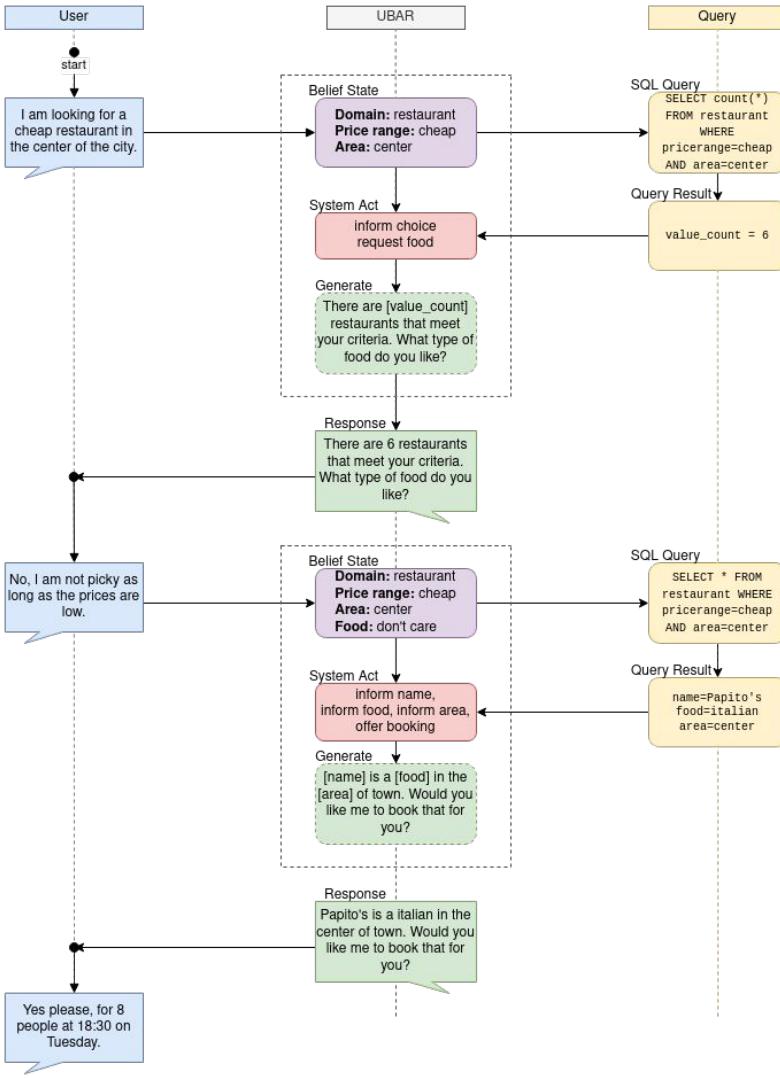


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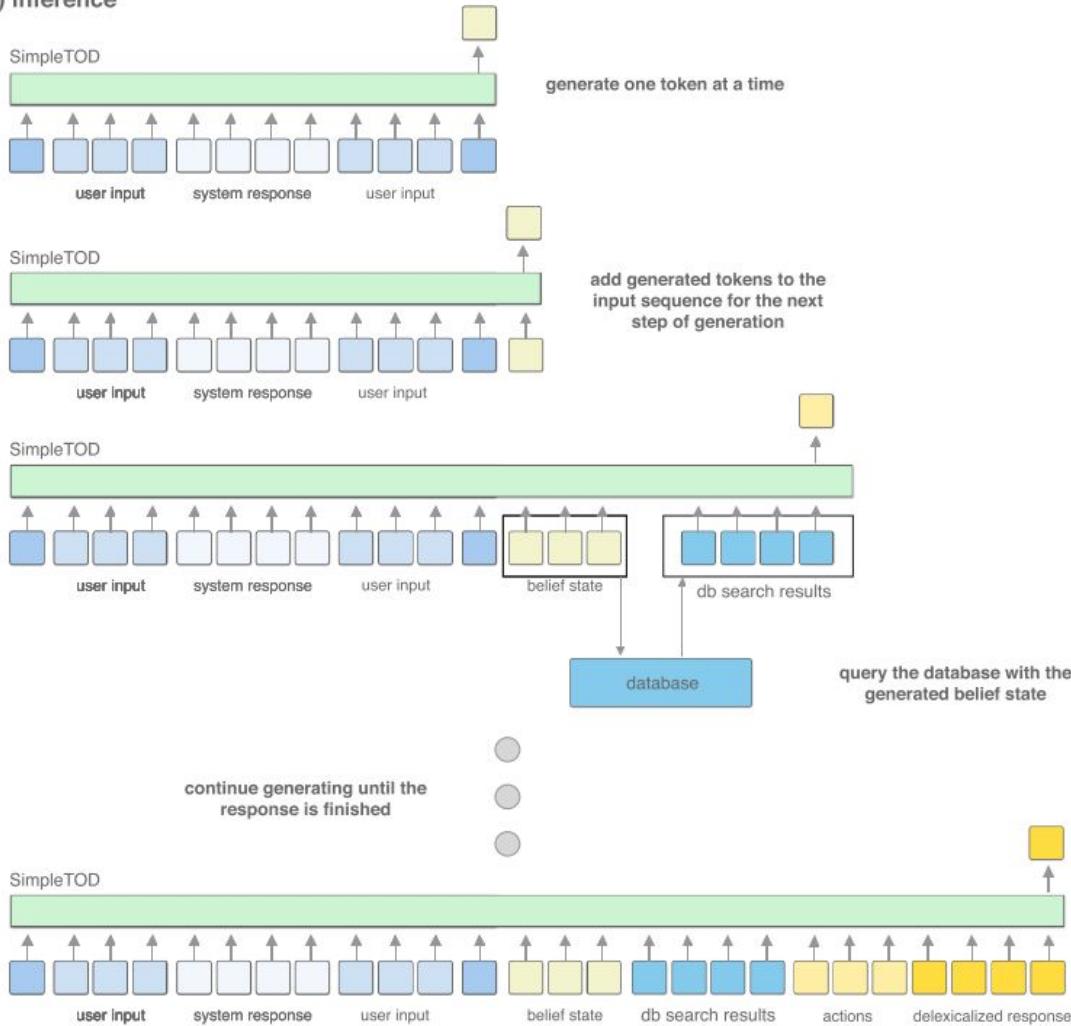
Sequence-to-sequence



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b) inference



	Context	<!context!> <luser!> hello , i need a train to ely on sunday please <!/context!>
Turn 1	Target	<!belief!> train destination ely <!/belief!> <action!> train inform choice, train inform day, train inform dest, train request arrive <!/action!> <response!> we have [value_count] trains traveling to [value_place] on [value_day] . what time would you like to arrive ? <!/response!>
	SimpleTOD	<!belief!> train day sunday, train destination ely <!/belief!> <action!> train inform choice, train inform day, train inform leave, train inform depart, train inform dest, train inform arrive, train inform id, train offerbook none <!/action!> <response!> there are [value_count] trains leaving [value_place] on [value_day]. [train_id] leaves [value_place] at [value_time] and arrives in [value_place] at [value_time]. would you like to book a ticket? <!/response!>
	Context	<!context!> <luser!> hello , i need a train to ely on sunday please <system!> we have 10 trains traveling to ely on sunday . what time would you like to arrive ? <luser> how about 1 arriving by 13:00 departing from cambridge . <!/context!>
Turn 2	Target	<!belief!> train destination ely, train day sunday, train arriveby 13:00, train departure cambridge <!/belief!> <action!> train inform arrive, train inform day, train inform dest, train inform id, train offerbook none <!/action!> <response!> [train_id] will get you to [value_place] by [value_time] on [value_day] . should i book you a ticket ? <!/response!>
	SimpleTOD	<!belief!> train day sunday, train destination ely, train departure cambridge, train arriveby 13:00 <!/belief!> <action!> train inform arrive, train inform leave, train inform id, train offerbook none <!/action!> <response!> [train_id] leaves at [value_time] and arrives at [value_time]. would you like me to book it for you? <!/response!>
	Context	<!context!> <luser!> hello , i need a train to ely on sunday please <system!> we have 10 trains traveling to ely on sunday . what time would you like to arrive ? <luser> how about 1 arriving by 13:00 departing from cambridge . <system!> tr1159 will get you to ely by 12:07 on sunday . should i book you a ticket ? <luser> yes , that would be great . i'll need tickets for 8 people . do you have a reference number ? <!/context!>
Turn 3	Target	<!belief!> train destination ely, train day sunday, train arriveby 13:00, train departure cambridge, train book people 8 <!/belief!> <action!> train offerbooked ref, train offerbooked ticket <!/action!> <response!> booking was successful , the total fee is [value_price] gbp payable at the station . reference number is [train_reference] . <!/response!>
	SimpleTOD	<!belief!> train book people 8, train arriveby 13:00, train day sunday, train departure cambridge, train destination ely <!/belief!> <action!> general reqmore none, train offerbooked ref, train offerbooked ticket <!/action!> <response!> booking was successful, the total fee is [value_price] gbp payable at the station. reference number is [train_reference]. is there anything else i can help you with? <!/response!>



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Proposal

ZéCarioca

Optimal Annotation Tool

Sia Kate Isobelle Furler (/sɪə/ SEE-ə; born 18 December 1975) is an Australian singer, songwriter and music video director.^[1] She started her career as a singer in the acid jazz band Crisp in the mid-1990s in Adelaide. In 1997, when Crisp disbanded, she released her debut studio album titled OnlySee in Australia. She moved to London, England, and provided lead vocals for the British duo Zero 7. In 2000, Sia released her second studio album, Healing Is Difficult, on the Columbia label the following year, and her third studio album, Colour the Small One, in 2004, but all of these struggled to connect with a mainstream audience. Sia relocated to New York City in 2005 and toured in the United States. Her fourth and fifth studio



Multi-task Curriculum Learning



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Methodology

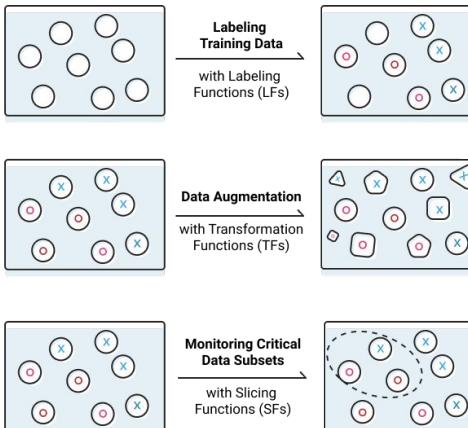
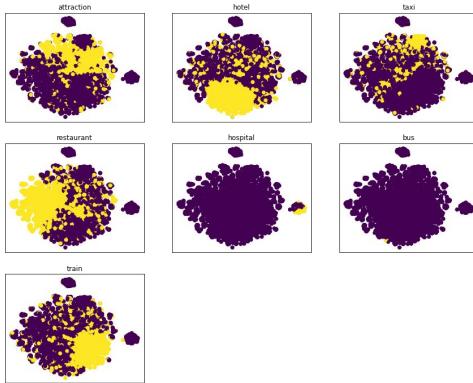
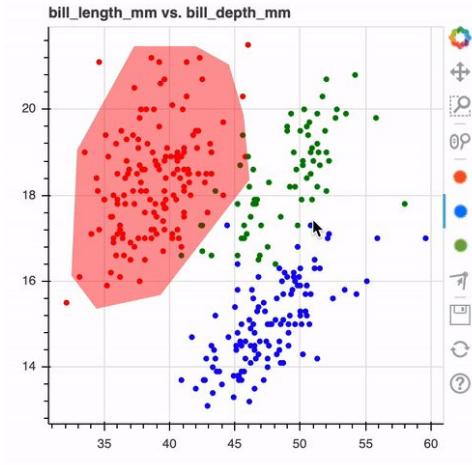


Annotation Tool

Querying model uncertainty for
optimal annotation



Intentions



1. <https://github.com/koaning/human-learn>
2. <https://github.com/modAL-python/modAL>
3. <https://www.snorkel.org/>



Entities

Document Annotation x +

Hi there stephen! Editing: Amharic Logout

TALEN Home All annotations Dictionary

AMH

'anedenate lademokerasinga lafetehe pareti bakahedawu hulatanawu madabana t'aqelala guba'e doctor nagaso gidadane baliqamanabarenate marat'a'.

doctor nagaso kadoke tawadaderawu ba197 tagalegle .

doctor nagaso gidada negere : deregetac 'anesetawale .

'anedenate lademoker baganezabe dakama lamaserate qale gabewa .

manegesete yaparetiyawcu 'amarare 'abalate yahonu nes'uhane zegocene ba'asabarinate sefane wanegelo salamawi 'eneqeseqase lamafane 'eyadaraga

nagaso gidadane (Google)

PER ORG GPE LOC No label

Save Toggle Dict.

◀ Previous Next ▶

Word	Cnt	%docs	TfIdf
nagaso	4	0.10	9.21
gidadane	1	0.10	2.30

Back to top

Try it live and highlight entities!

PERSON 1 ORG 2 PRODUCT 3 DATE 4

In a March 2014 DATE interview, Apple ORG designer Jonathan Ive PERSON used the iPhone PRODUCT as an example of Apple ORG 's ethos of creating high - quality life - changing products .

✓ ✘ ⚡

VALID_EMAIL_REGEX = /\A[\w+\-\.]+@[a-z\d\-_\.]+\.[a-z]+\z/i

RegEx: \A[\w+\-\.]+@[a-z\d\-_\.]+\.[a-z]+\z

Sample: example@jetbrains.com|

Matches!



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Active Learning

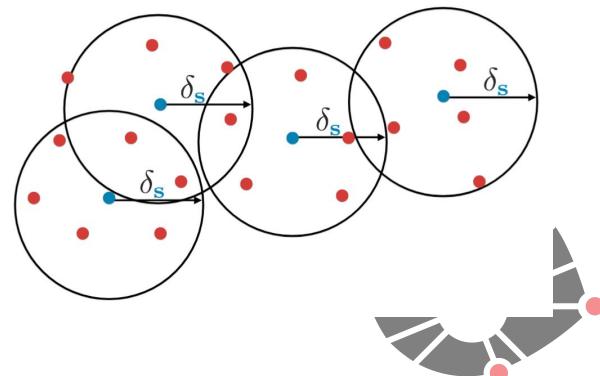
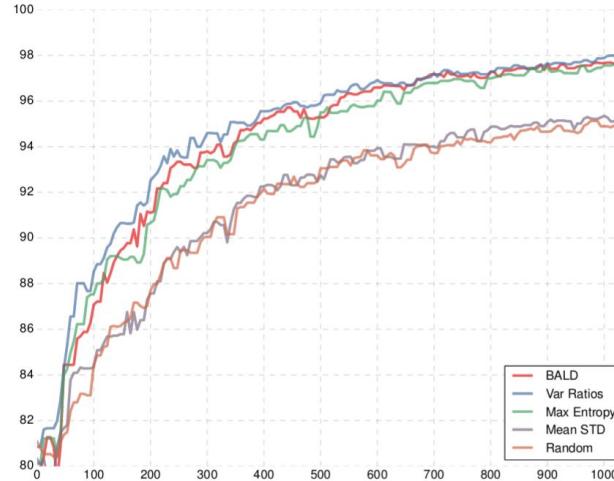
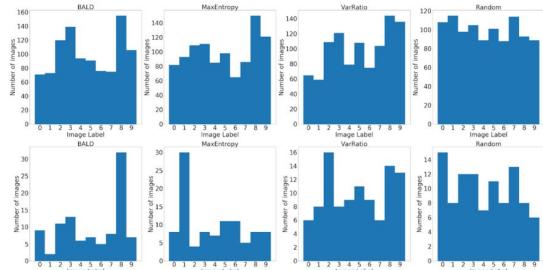
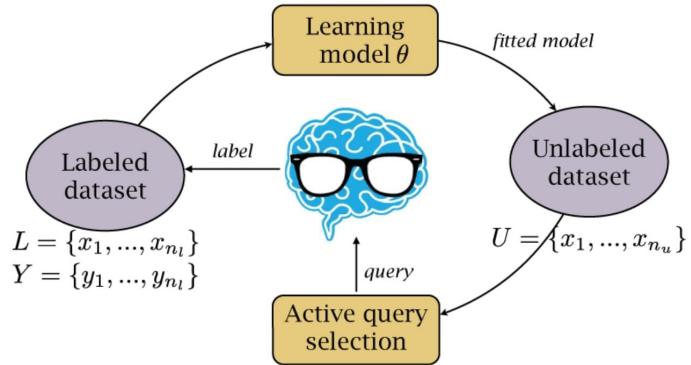
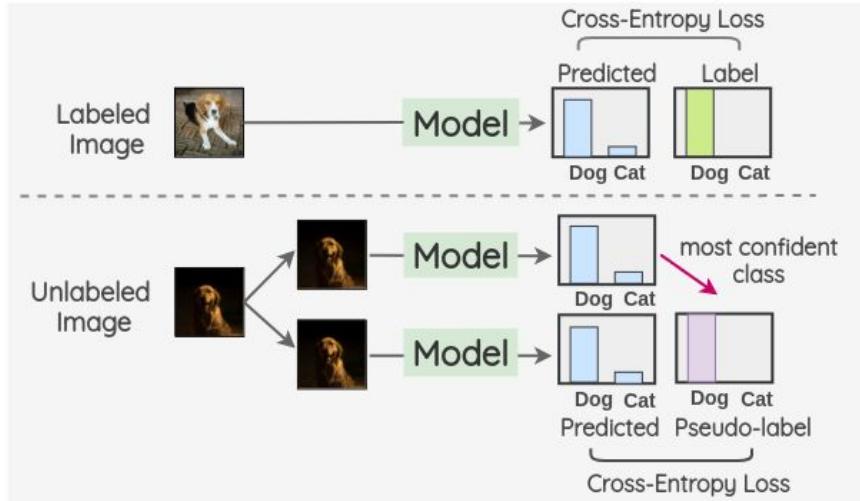


Figure 1: MNIST histograms of true labels in the training set. **Top:** End of AL process. Total number of images in training set: 1,000. **Bottom:** After first 8 acquisition iterations. Total number of images in training set: 100.

Semi-supervised Learning

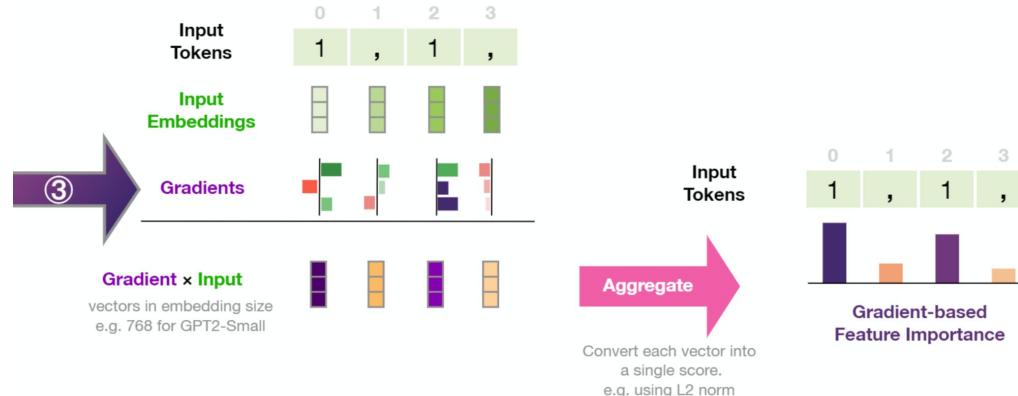
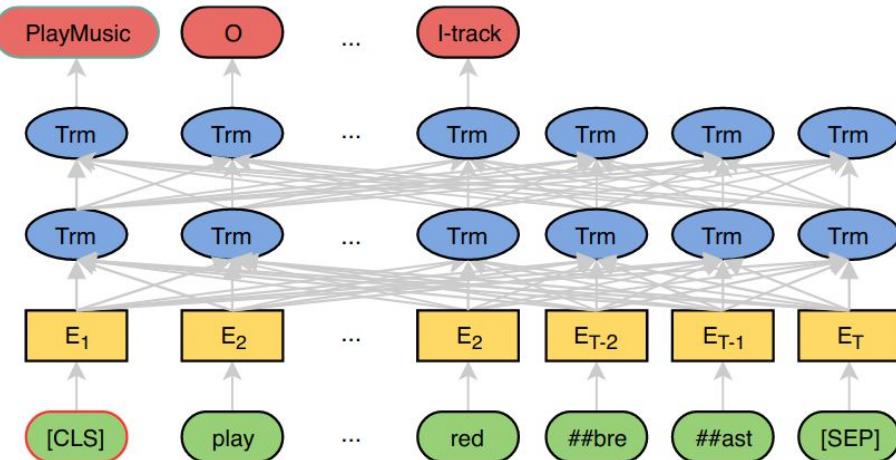
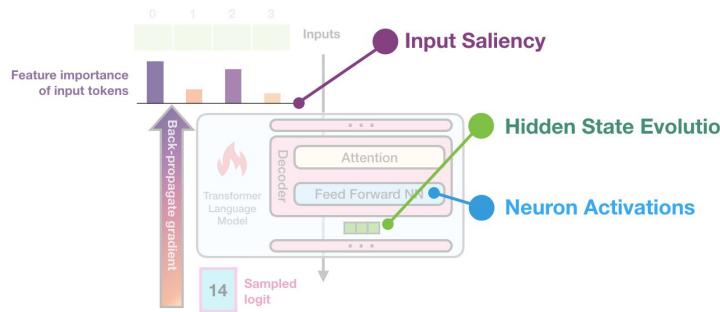


Algorithm 1 Self-training

```
1: repeat
2:    $m \leftarrow \text{train\_model}(L)$ 
3:   for  $x \in U$  do
4:     if  $\max m(x) > \tau$  then
5:        $L \leftarrow L \cup \{(x, p(x))\}$ 
6: until no more predictions are confident
```

1. RUDER, Sebastian; PLANK, Barbara. Strong baselines for neural semi-supervised learning under domain shift. arXiv preprint arXiv:1804.09530, 2018.
2. OLIVER, Avital et al. Realistic evaluation of deep semi-supervised learning algorithms. arXiv preprint arXiv:1804.09170, 2018.

Querying BERT



Differential

	denoise	clustering	active-learning	multi-label	NER	Free
WebAnno	-	-	-	x	x	x
Doccano	-	-	-	x	x	x
Brat	-	-	-	x	x	x
Prodigy	-	-	x	x	x	-
Ours	x	x	x	x	x	x

Table 1: Comparative table between existing annotation tools and the proposed annotator.



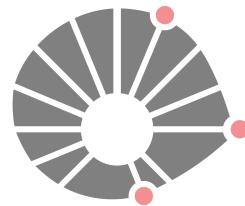
Multi-task Curriculum Learning

Selecting and ordering tasks
addressing the final objective.



Learning Objective

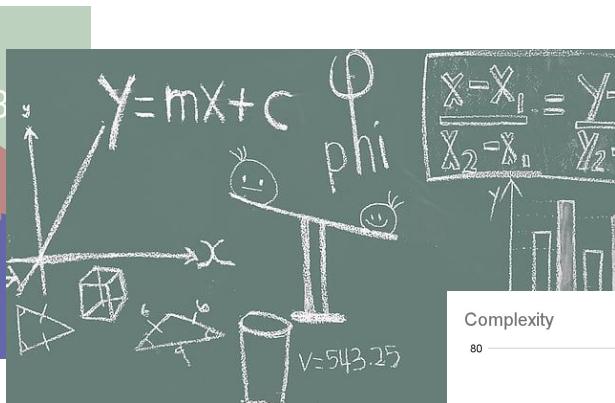
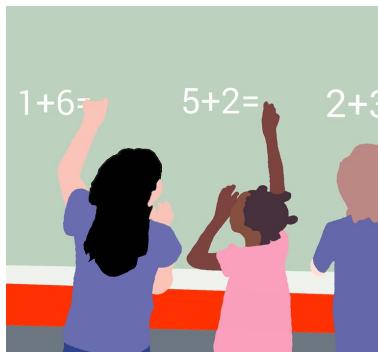
```
USER-utterance: eu preciso de um lugar para jantar no centro que é caro  
find_restaurant  
slot_values: {'restaurant-area': ['centre'], 'restaurant-pricerange': ['expensive']}
```



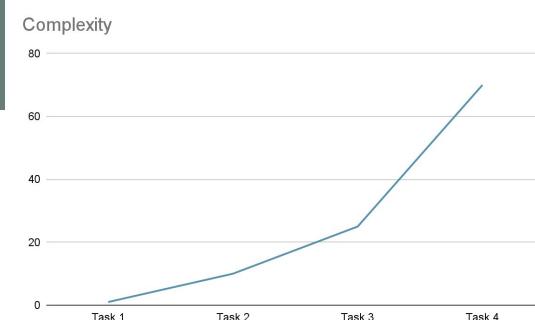
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Curriculum Learning

Aritmética



Algebra



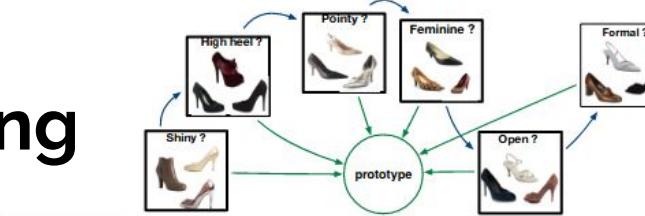
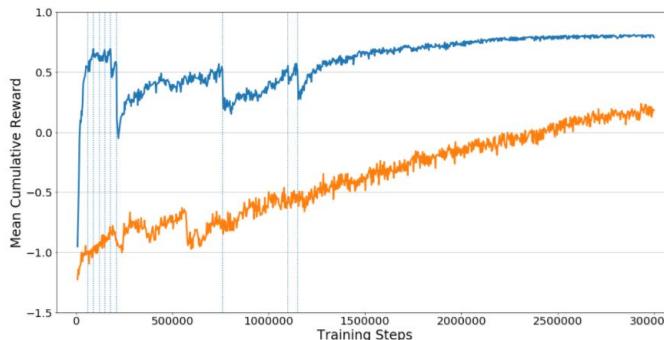
Cálculo

$$\begin{aligned}f(t) &= a_0 + \sum_{n=1}^{\infty} \left[a_n \cdot \cos\left(\frac{n\pi t}{L}\right) + b_n \cdot \sin\left(\frac{n\pi t}{L}\right) \right] \\&= a_0 + a_1 \cdot \cos\left(\frac{\pi t}{L}\right) + b_1 \cdot \sin\left(\frac{\pi t}{L}\right) + a_2 \cdot \cos\left(\frac{2\pi t}{L}\right) + b_2 \cdot \dots \\a_0 &= \frac{1}{L} \int_{-L}^{L} f(k) dk = \frac{4}{\pi} \int_0^{\pi} f(k) dk \\&= \frac{2}{\pi} \int_0^{\pi} f(k) dk + \frac{2}{\pi} \int_0^{\pi} f(k) dk \\&= \frac{2}{\pi} \int_0^{\pi} f(k) dk + \frac{2}{\pi} \int_0^{\pi} f(k) dk \\a_n &\rightarrow a(\omega) \\b_n &\rightarrow b(\omega)\end{aligned}$$



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Curriculum Learning



Easy cases:

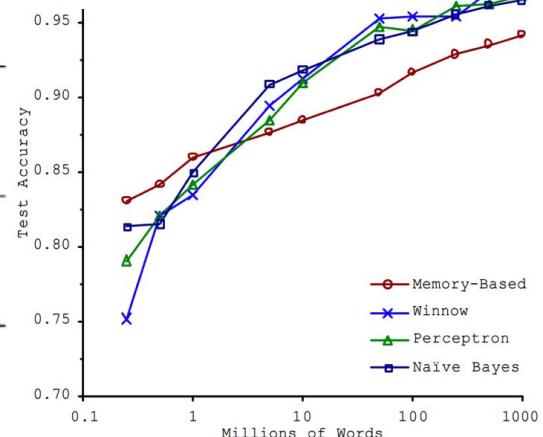
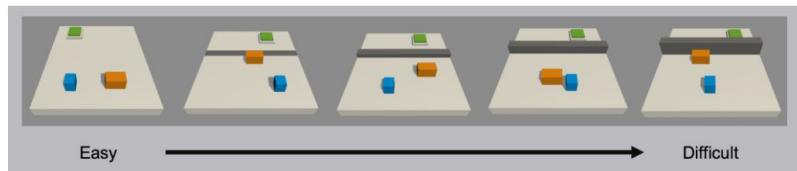
easy, comfortable
most purely enjoyable
most plain, unimaginative
badly edited

positive
positive
negative
negative

Hard cases:

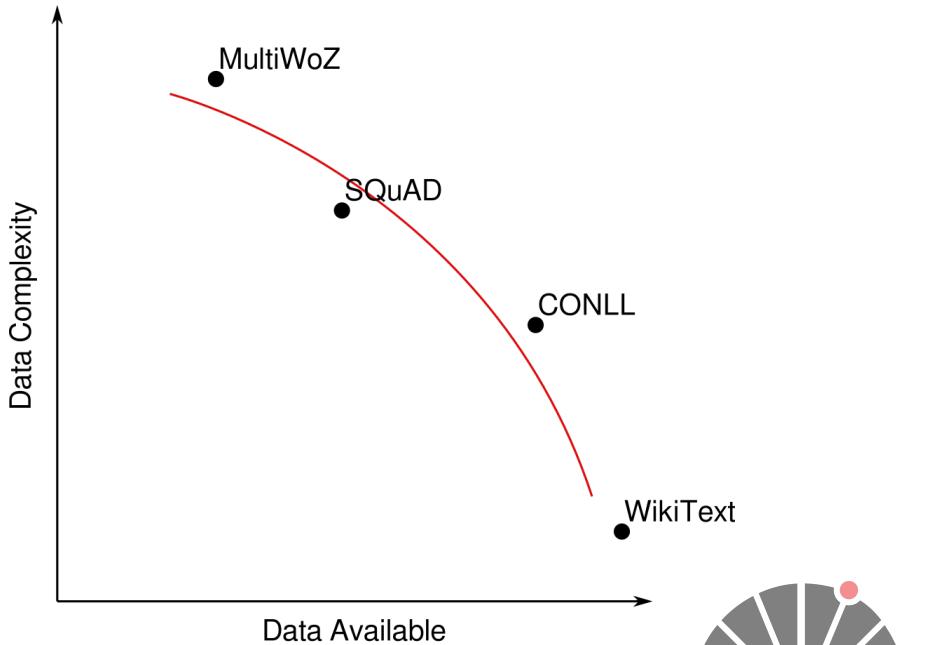
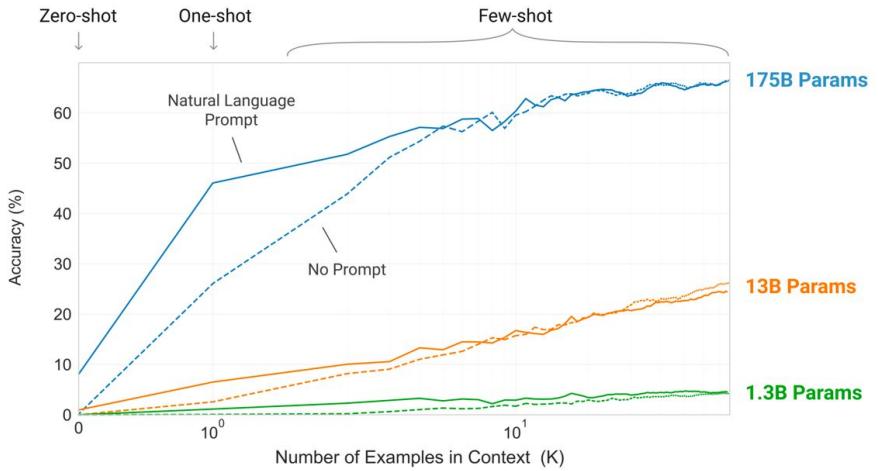
why didn't Hollywood think of this sooner
I simply can't recommend it enough
supposedly funny movie
occasionally interesting

positive
positive
negative
negative



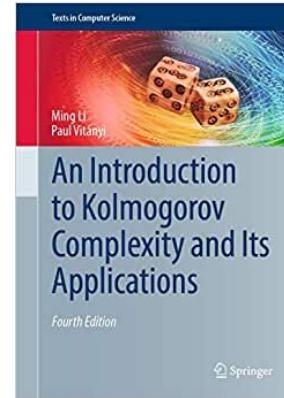
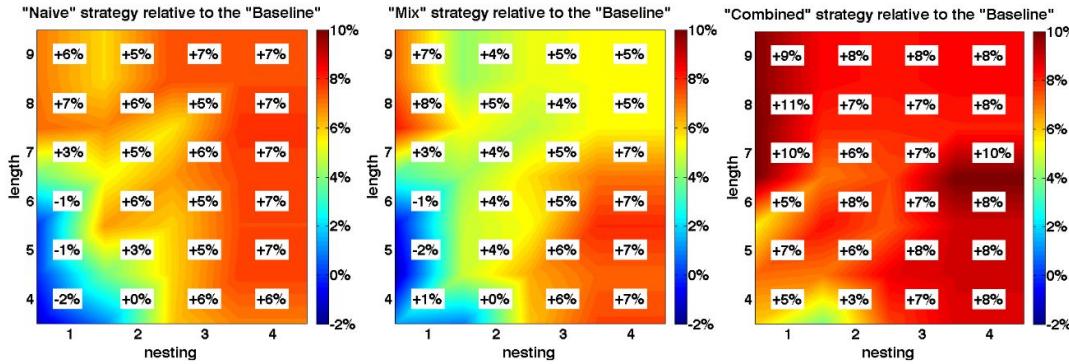
1. HALEVY, Alon; NORVIG, Peter; PEREIRA, Fernando. The unreasonable effectiveness of data. *IEEE Intelligent Systems*, v. 24, n. 2, p. 8-12, 2009.
2. XU, Benfeng et al. Curriculum learning for natural language understanding. In: Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics. 2020. p. 6095-6104.
3. PENTINA, Anastasia; SHARMANSKA, Viktoriia; LAMPERT, Christoph H. Curriculum learning of multiple tasks. In: Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. 2015. p. 5492-5500.

Available Data



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Data Complexity



$$H = - \sum_{i=1}^N p_i \log(p_i)$$

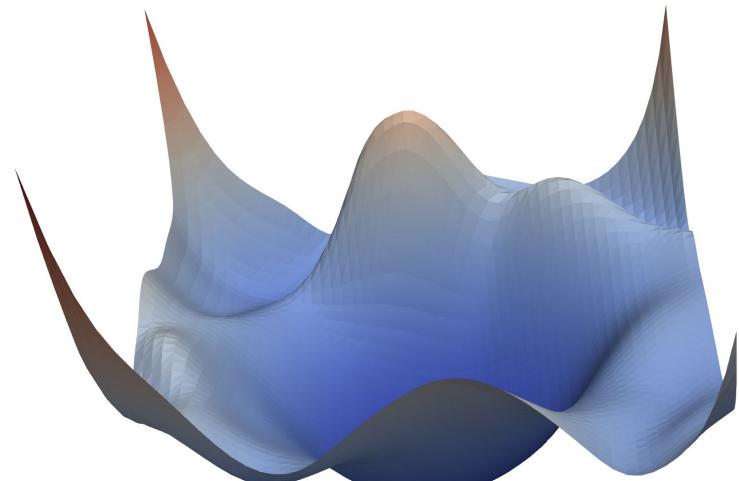
1. ZAREMBA, Wojciech; SUTSKEVER, Ilya. Learning to execute. arXiv preprint arXiv:1410.4615, 2014.



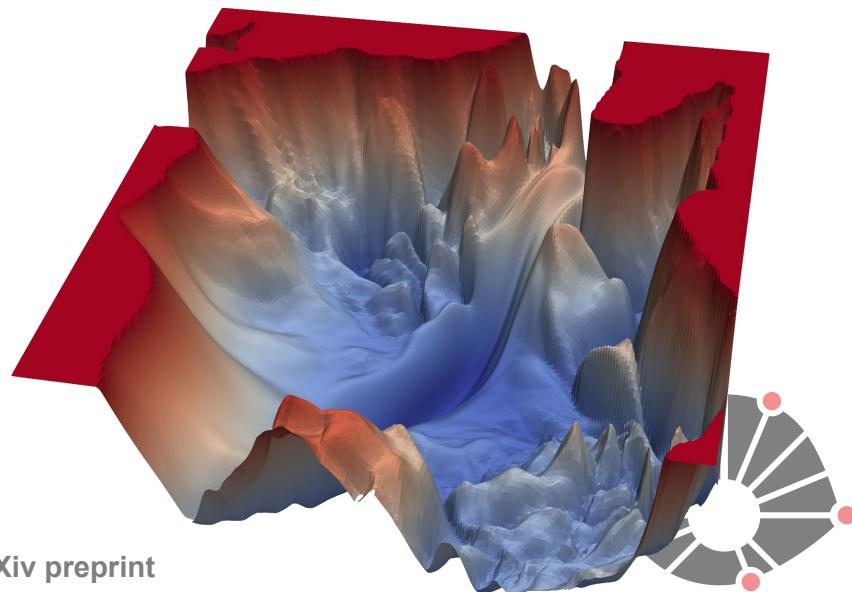
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Loss Complexity

Predict next word



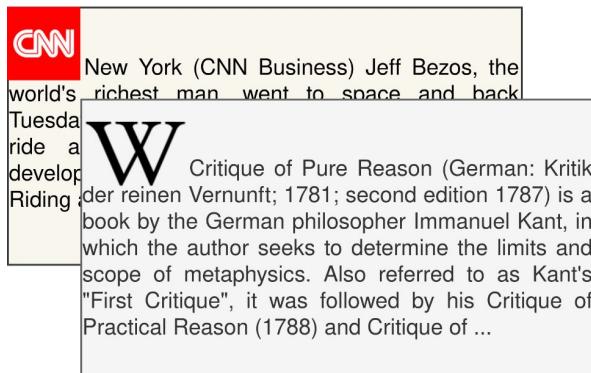
Predict next response



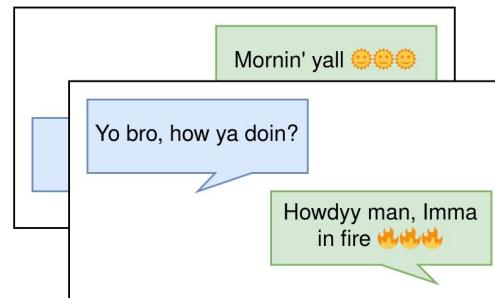
1. LI, Hao et al. Visualizing the loss landscape of neural nets. *arXiv preprint arXiv:1712.09913*, 2017.
2. BENGIO, Yoshua. Evolving culture versus local minima. In: *Growing Adaptive Machines*. Springer, Berlin, Heidelberg, 2014. p. 109-138.

Concept Drift

Formal Sources



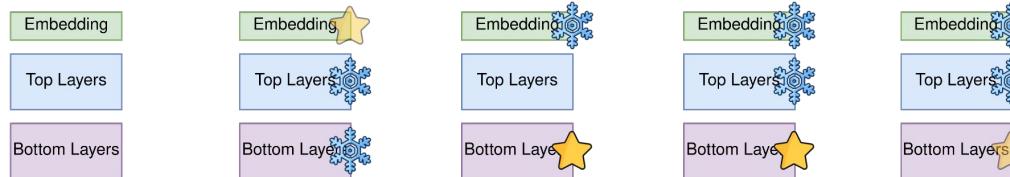
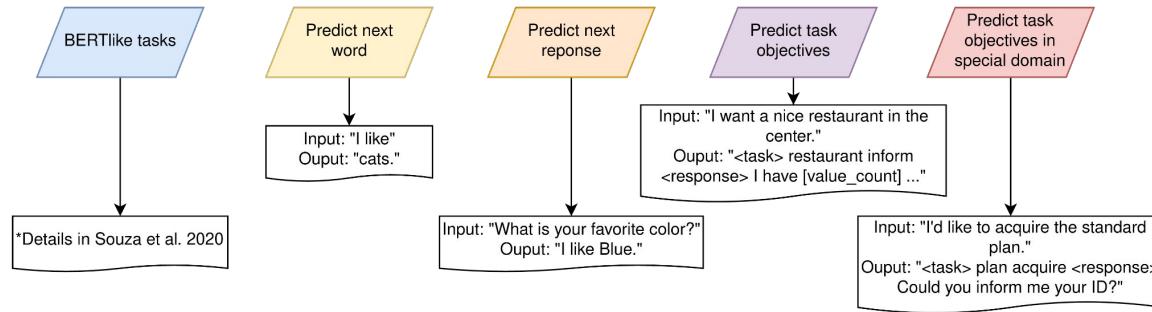
Informal Sources



1. ZHANG, Yizhe et al. Dialogpt: Large-scale generative pre-training for conversational response generation. arXiv preprint arXiv:1911.00536, 2019.
2. WU, Chien-Sheng et al. TOD-BERT: pre-trained natural language understanding for task-oriented dialogue. arXiv preprint arXiv:2004.06871, 2020.



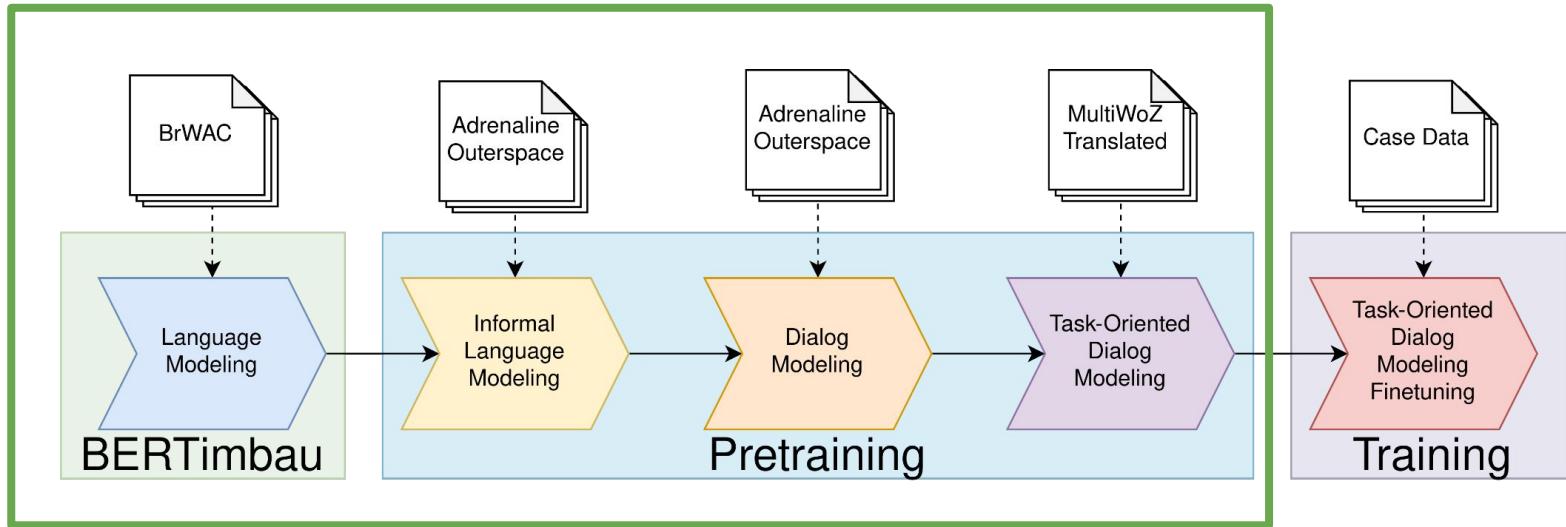
Multi-task Curriculum Learning



1. DEVLIN, Jacob et al. Bert: Pre-training of deep bidirectional transformers for language understanding. arXiv preprint arXiv:1810.04805, 2018.
2. XU, Benfeng et al. Curriculum learning for natural language understanding. In: Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics. 2020. p. 6095-6104.
3. NARVEKAR, Sanmit et al. Curriculum learning for reinforcement learning domains: A framework and survey. arXiv preprint arXiv:2003.04960, 2020.



Transfer-Learning

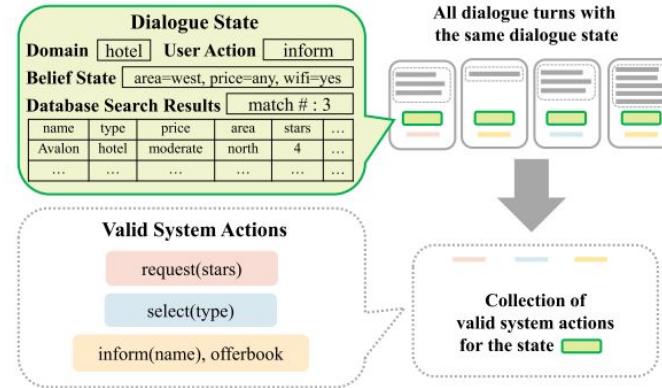
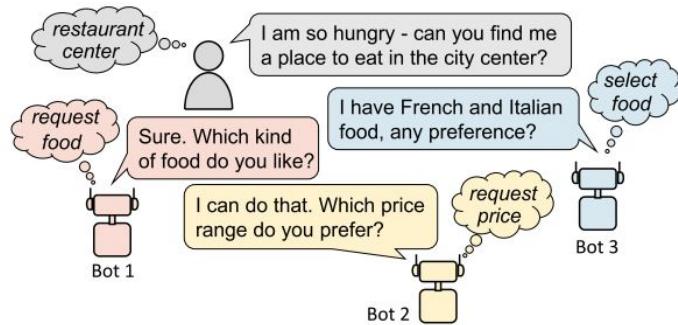


1. LIN, Zhaojiang et al. Mintl: Minimalist transfer learning for task-oriented dialogue systems. arXiv preprint arXiv:2009.12005, 2020.



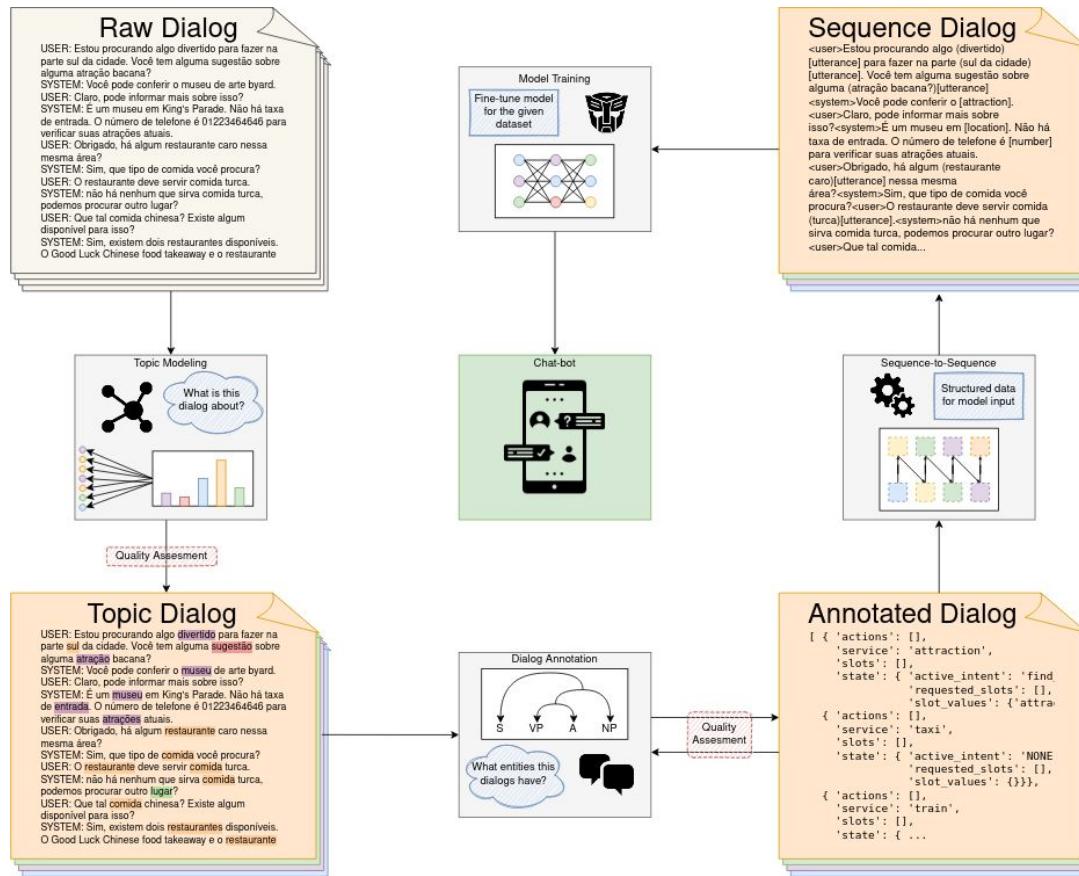
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Data Augmentation



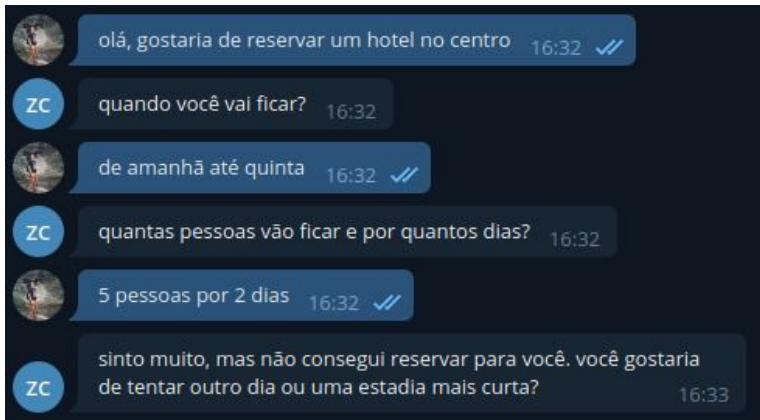
1. ZHANG, Yichi; OU, Zhijian; YU, Zhou. Task-oriented dialog systems that consider multiple appropriate responses under the same context. In: Proceedings of the AAAI Conference on Artificial Intelligence. 2020. p. 9604-9611.

ZéCarioca



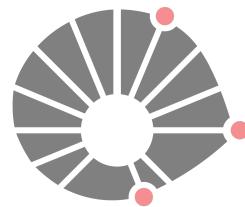
Results

Results (Preview)



Validation Loss EN: 57.43

Validation Loss PT: 40.26



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Issues

Delexicalization:

```
{ utterance: "I recommend you the University Arms Hotel",  
utterance_delex: "I recommend you the [value_type]",  
slot_value: [value_name: "University Arms Hotel"]}
```

Possible translations:

'hotel de armas universitárias'

'hotel de armas da universidade'

'hotel universitário de armas'



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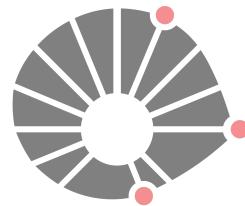
Next Steps



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Improvements

- Fix MultiWOZ translation
 - Annotate case dataset
 - Incorporate NER task through encoder decoder architecture (BART)
 - Classification task
-
- Scalability (Model Compression, Efficient Transformers)
 - Interaction with services and databases (Semantic Parsing)



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