

Scientific Text Mining and Knowledge Graphs

Chapter 2 Part 2: Knowledge Graph Learning

Presenter: Meng Jiang

University of Notre Dame

mjiang2@nd.edu

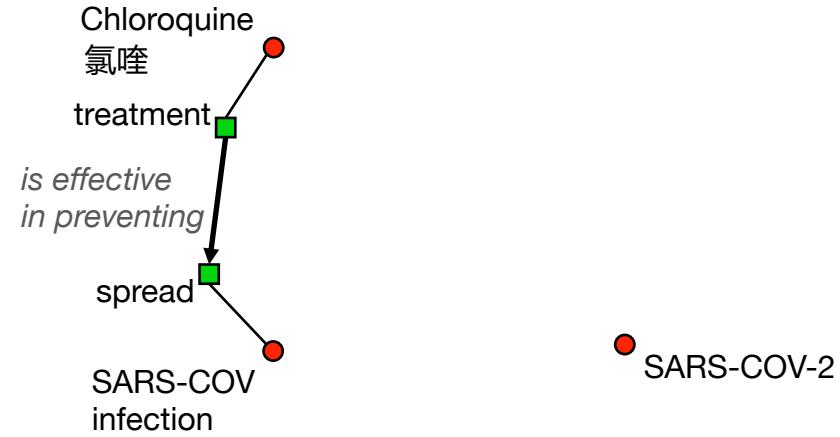
Roadmap

- Scientific KGs of COVID-19 literature
- Learning scientific KG for literature search
- Learning scientific KG for text generation

Roadmap

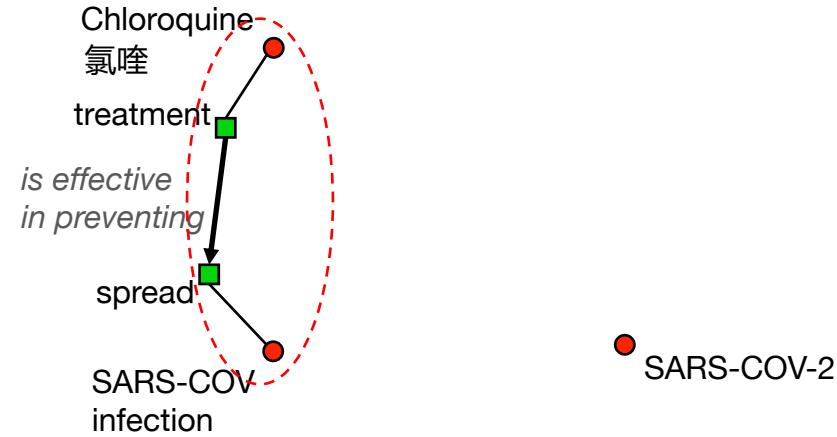
- **Scientific KGs of COVID-19 literature**
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Motivating Examples



Vincent et al. 2005. Chloroquine is a potent inhibitor of SARS coronavirus infection and spread. Virology Journal.

Motivating Examples (cont'd)



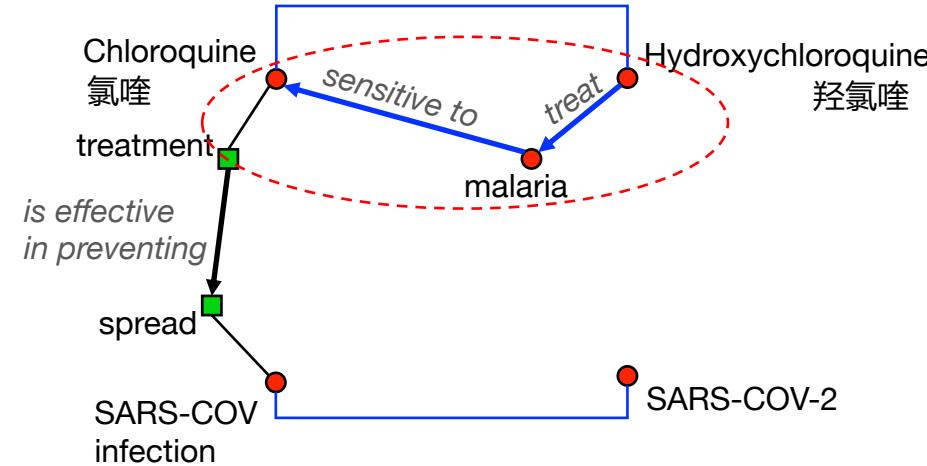
Vincent et al. 2005. Chloroquine is a potent inhibitor of SARS coronavirus infection and spread. Virology Journal.

“... The Chloroquine treatment is effective in preventing the spread of SARS-COV infection. ...”

↓ [1]

Quintuple: ({Chloroquine ::: treatment},
is_effective_in_preventing,
{SARS-COV_infection ::: spread})

Motivating Examples (cont'd)



Vincent et al. 2005. Chloroquine is a potent inhibitor of SARS coronavirus infection and spread. Virology Journal.

The Coronavirus Infectious Disease Ontology (CIDO). The OBO Foundry, Ontobee, and NCBO.

“... Hydroxychloroquine is a medication used to treat malaria in areas where malaria remains sensitive to chloroquine. ...”

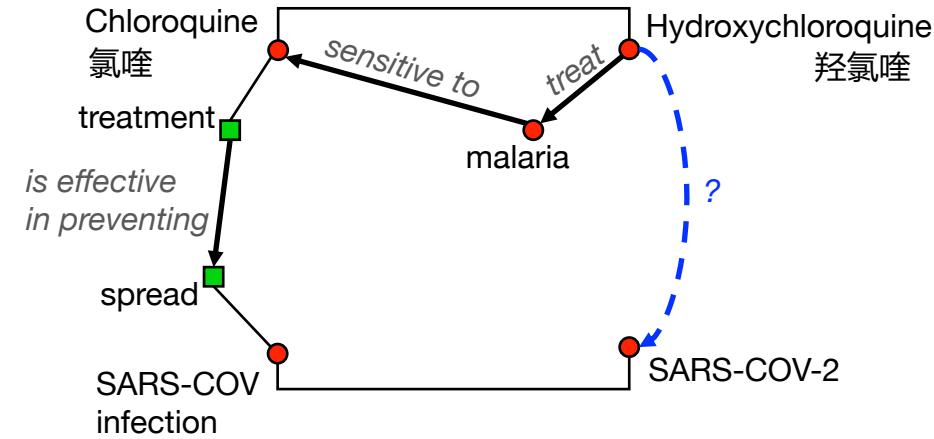
[Wiki]

[1]

Tuples:
(Hydroxychloroquine, *treat*, malaria)
(malaria, *remains_sensitive_to*, chloroquine)

[1] Jiang et al. 2019. The Role of “Condition”: A Novel Scientific Knowledge Graph Representation and Construction Model. SIGKDD.

Motivating Examples (cont'd)



Vincent et al. 2005. Chloroquine is a potent inhibitor of SARS coronavirus infection and spread. Virology Journal.

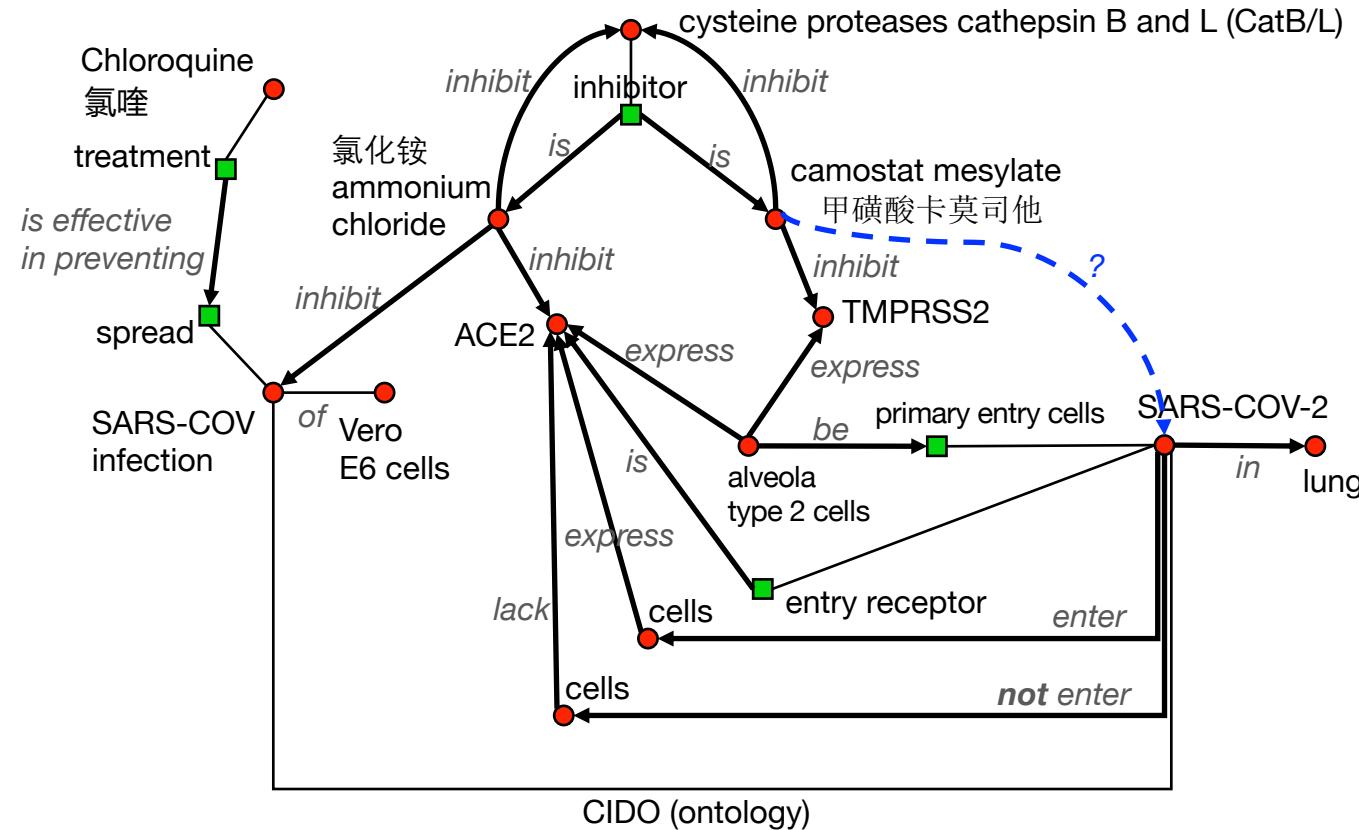
The Coronavirus Infectious Disease Ontology (CIDO). The OBO Foundry, Ontobee, and NCBO.

FDA Warns Against Using Drugs Promoted By Trump After Reports Of 'Poisoning And Death' [Forbes 04/24/2020]

<https://www.forbes.com/sites/carlieporterfield/2020/04/24/fda-warns-against-using-drugs-promoted-by-trump-after-reports-of-poisoning-and-death>



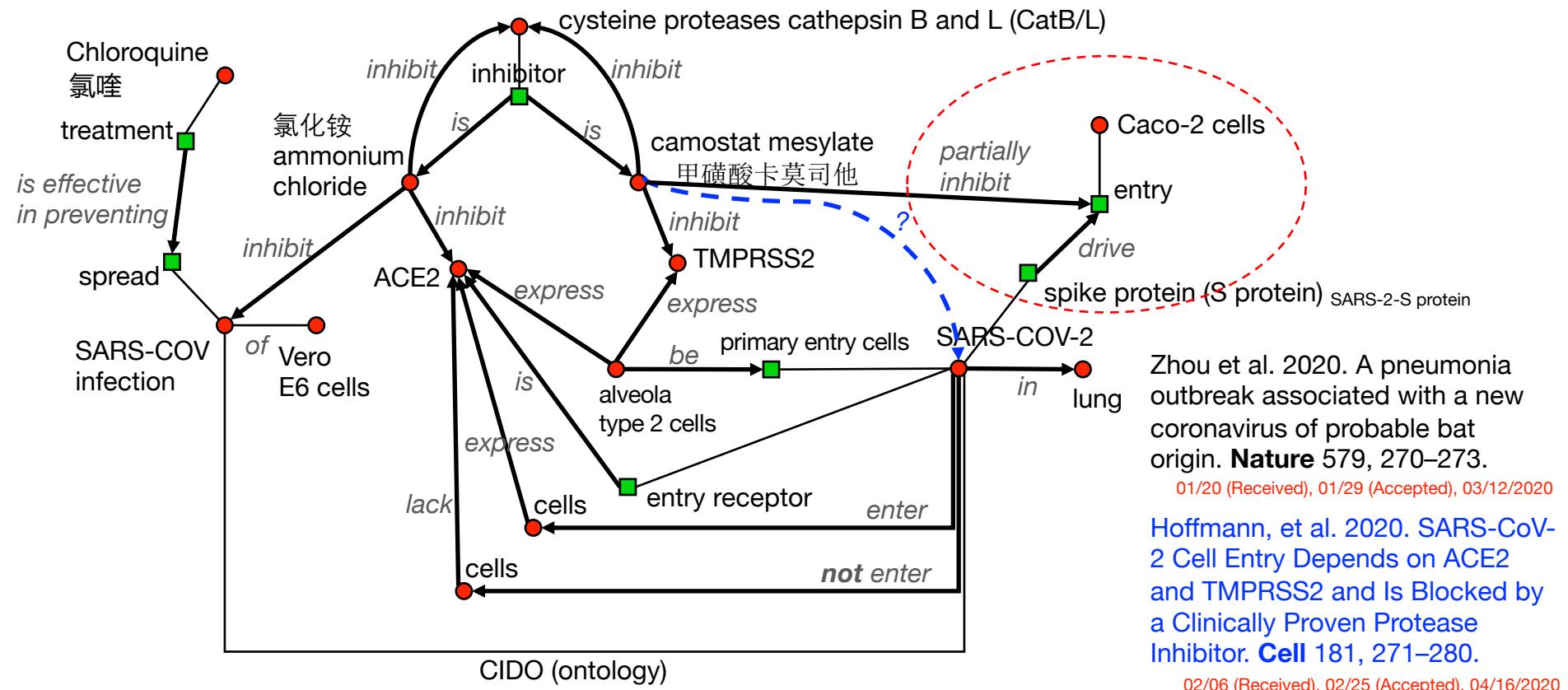
Motivating Examples (cont'd)



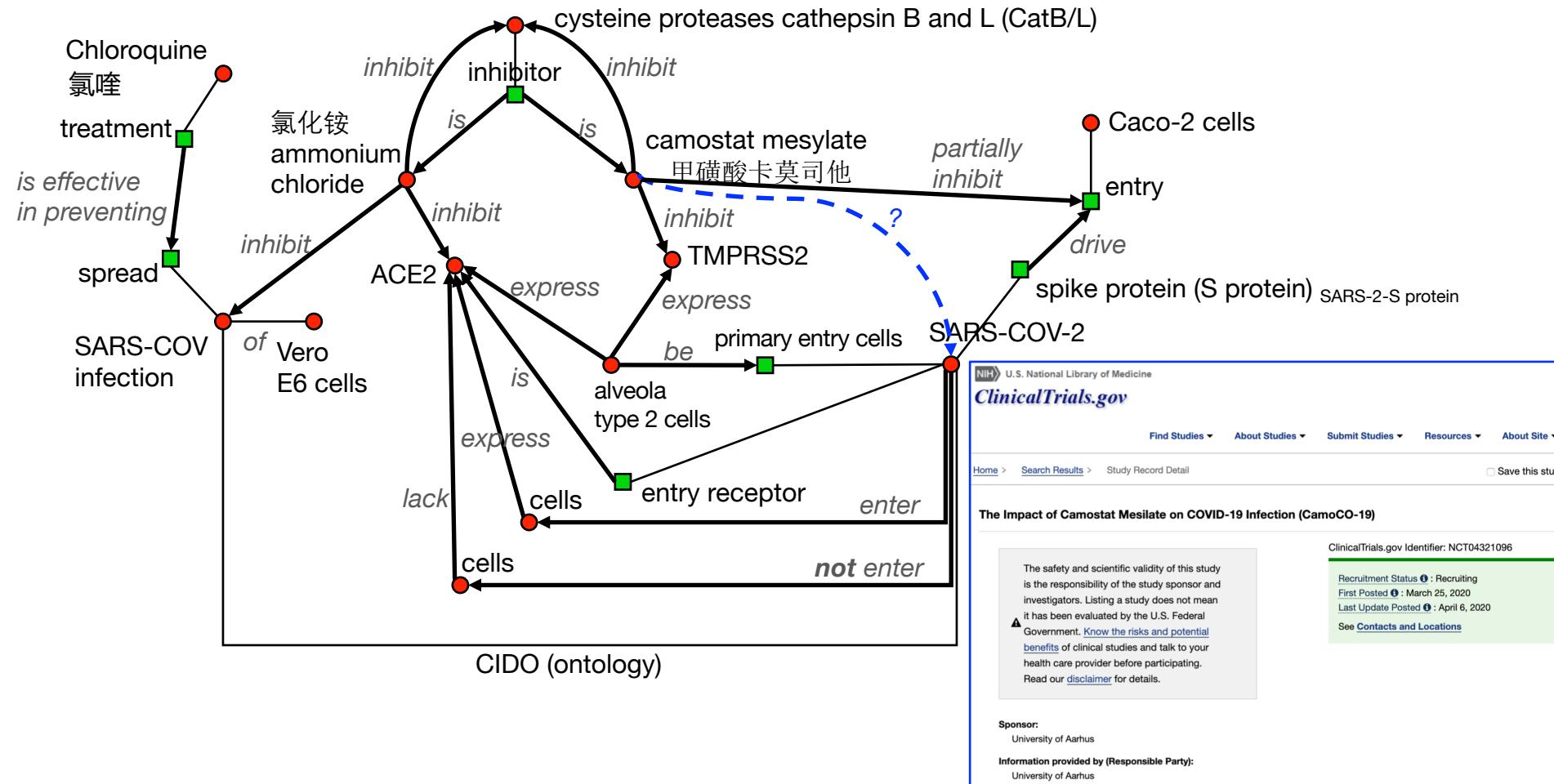
Zhou et al. 2020. A pneumonia outbreak associated with a new coronavirus of probable bat origin. *Nature* 579, 270–273.

01/20 (Received), 01/29 (Accepted), 03/12/2020

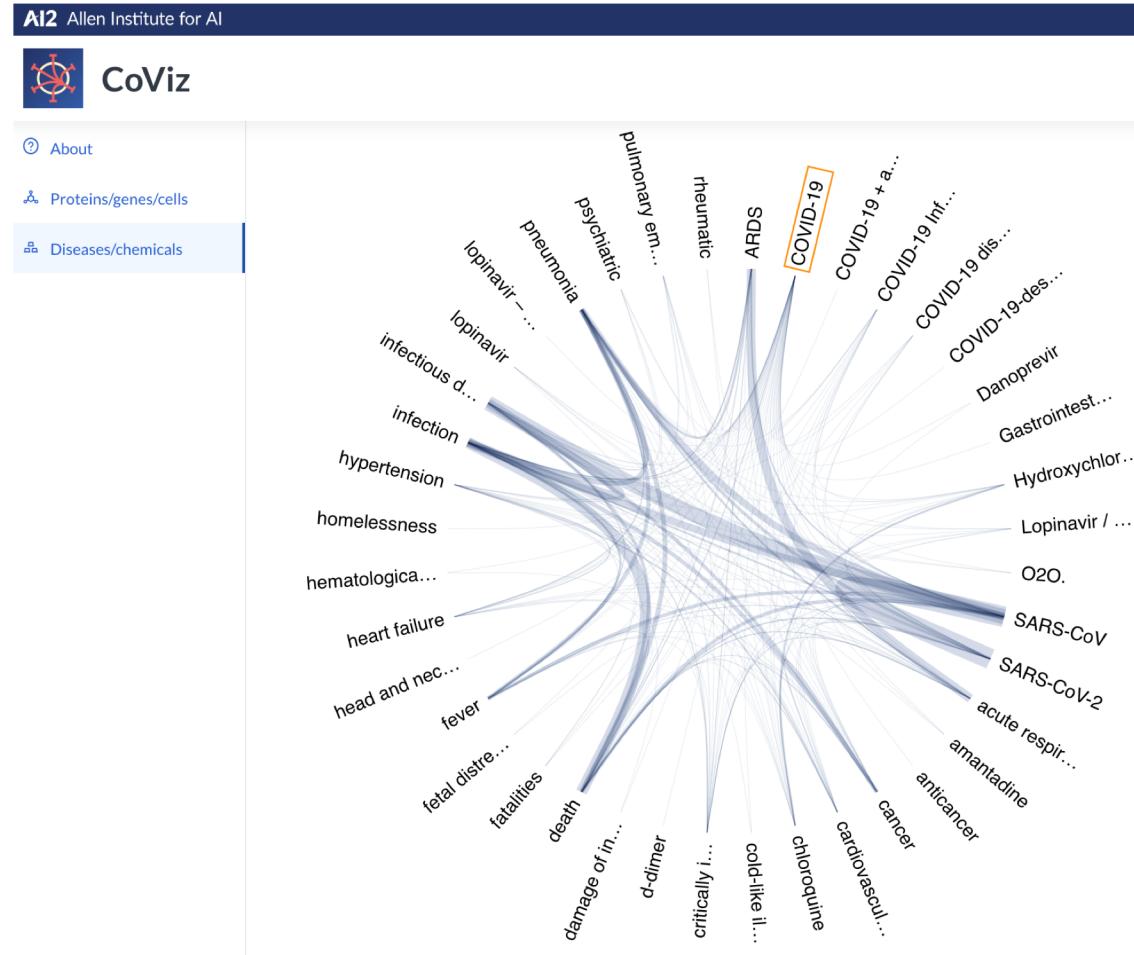
Motivating Examples (cont'd)



Motivating Examples (cont'd)



Knowledge Graph 1: CoViz by AI2



Knowledge Graph 2: SPIKE-CORD

AI2 Allen Institute for AI

SPIKE-CORD: Extractive Search over CORD-19

Type Query

S <>v:virus \$infection \$causes a <>c:condition .

22412

i Because M. haemofelis infection occasionally causes thrombocytopenia , PCR testing for hemoplasmosis is suggested .

31726

i Annexin A2 on lung epithelial cell surface is recognized by severe acute respiratory syndrome-associated coronavirus Severe acute respiratory syndrome-associated coronavirus (SARS-CoV) Annexin A2 Autoantigen Anti-spike domain 2 (S2) a c t Severe acute respiratory syndrome-associated coronavirus (SARS-CoV) infection causes lung failure characterized by hypoxemia and respiratory distress .

based on **SciSpacy**: SpaCy models for biomedical text processing
<https://allenai.github.io/scispacy/>

<https://spike.covid-19.apps.allenai.org/search/covid19>

<https://spike.covid-19.apps.allenai.org/md/covid-usage-examples>

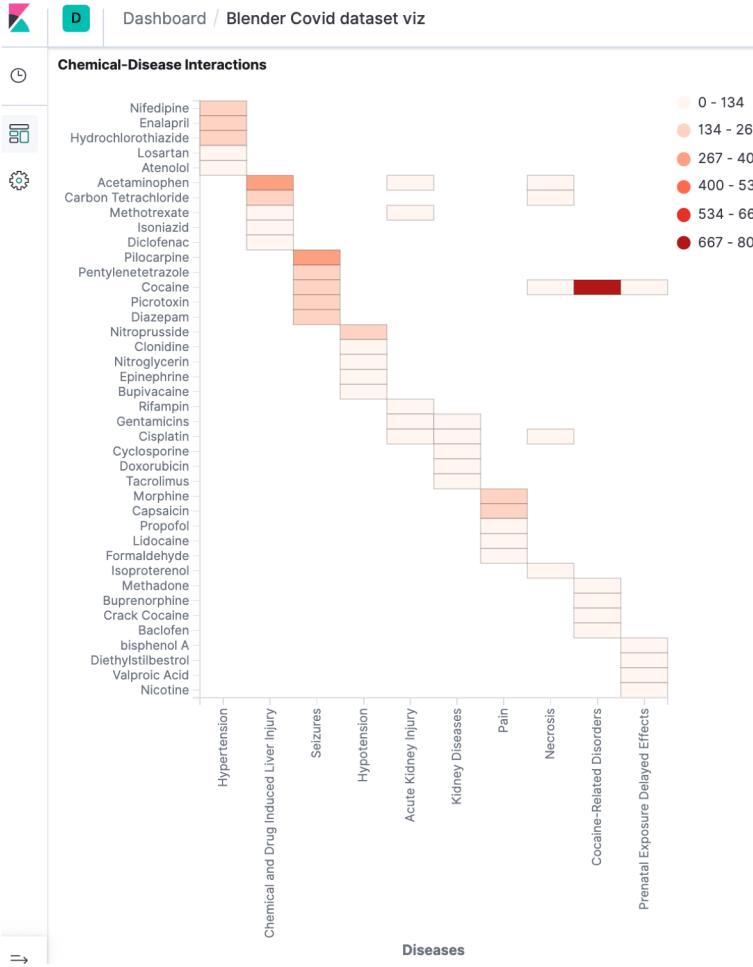
NER

COVID-19
AMINO_ACID
ANATOMICAL_SYSTEM
CANCER
CELLULAR_COMPONENT
CELL_LINE
CELL_TYPE
CHEBI
CHEMICAL
CL
COVID-19
DEVELOPING_ANATOMICAL_STRUCTURE
DISEASE
DNA
ENTITY
GENE_OR_GENE_PRODUCT
GGP
GO
IMMATERIAL_ANATOMICAL_ENTITY
MULTI_TISSUE_STRUCTURE
ORGAN
ORGANISM
ORGANISM_SUBDIVISION
ORGANISM_SUBSTANCE
PATHOLOGICAL_FORMATION
PROTEIN
RNA
SIMPLE_chemical
SO
TAXON
TISSUE

Relation

\$causes
\$treats
\$uses

Knowledge Graph 3: Blender Covid + SemViz@Brendeis



Chemical Word Cloud

Cyclosporine sodium arsenite
Ethynil Estradiol Dexamethasone
pirinixic acid Estradiol Aflatoxin B1
Cisplatin Benzo(a)pyrene
bisphenol A
Valproic Acid
Resveratrol dorsomorphin Ethanol
Acetaminophen Doxorubicin
Lipopolysaccharides



Chemicals - Count

<http://blender.cs.illinois.edu/covid19/?fbclid=IwAR2z0BcjDWScjuilCaWQD-YrdZvtIGGQh3LNjvDi4JzzwU6G1K9HD4owYWE>

<https://www.semviz.org/>

Knowledge Graph 4: Weill Cornell

COVID-19 Literature Search Engine

Query
Popular question...
Submit Reset

Relevant Articles

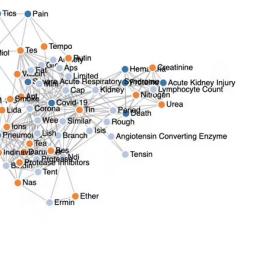
A serological assay to detect SARS-CoV-2 seroconversion in humans
Abstract: Background: Computed tomography (CT) is the preferred imaging method for di...
Authors: Jun Chen; Li...
2020-02-26

A mathematical model for the spatiotemporal epidemic spreading of COVID19
Abstract: Introduction: SARS-CoV-2 (severe acute respiratory disease coronavirus 2), whic...
Authors: Fatima Ama...
2020-03-18

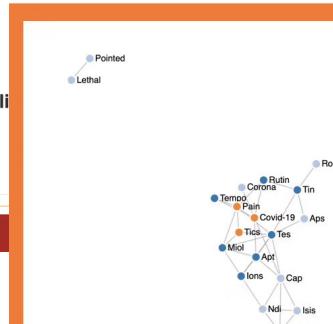
ACE-2 Expression in the Small Airway Epithelia of Smokers and COPD Patients: Implications for COVID-19
Abstract: Introduction: Coronavirus disease 2019 (COVID-19) is a respiratory infection cau...
Authors: Janice M Le...
2020-03-23

The Effectiveness of Social Distancing in Mitigating COVID-19 Spread: a modelling study
Abstract: Background: The novel coronavirus COVID19 has been classified by the World H...
Authors: George J Mil...
2020-03-23

Copyright © Wang's Lab at Weill Cornell Medicine. Developer: Sendong Zhao, Yu Hou and Fei Wang



COVID-19 Literature Search Engine



A mathematical model for the spatiotemporal epidemic spreading of COVID19

2020-03-23

Alex Arenas; Wesley Cota; Jesus Gomez-Gardenes; Sergio Gómez; Clara Granell; Joan T. Matamala; David Soriano-Panos; Benjamin Steinegger

Abstract: An outbreak of a novel coronavirus, named SARS-CoV-2, that provokes the COVID-19 disease, was first reported in Hubei, mainland China on 31 December 2019. As of 20 March 2020, cases have been reported in 166 countries/regions, including cases of human-to-human transmission around the world. The proportions of this epidemics is probably one of the largest challenges faced by our interconnected modern societies. According to the current epidemiological reports, the large basic reproduction number, $R_0 \sim 2.3$, number of secondary cases produced by an infected individual in a population of susceptible individuals, as well as an asymptomatic period (up to 14 days) in which infectious individuals are undetectable without further analysis, pave the way for a major crisis of the national health capacity systems. Recent scientific reports have pointed out that the detected cases of COVID19 at young ages is strikingly short and that lethality is concentrated at large ages. Here we adapt a Microscopic Markov Chain Approach (MMCA) metapopulation mobility model to capture the spread of COVID-19. We propose a model that stratifies the population by ages, and account for the different incidences of the disease at each strata. The model is used to predict the incidence of the epidemics in a spatial population through time, permitting investigation of control measures. The model is applied to the current epidemic in Spain, using the estimates of the epidemiological parameters and the mobility and demographic census data of the national institute of statistics (INE). The results indicate that the peak of incidence will happen in the first half of April 2020 in absence of mobility restrictions. These results can be refined with improved estimates of epidemiological parameters, and can be adapted to precise mobility restrictions at the level of municipalities. The current estimates largely compromises the Spanish health capacity system, in particular that for intensive care units, from the end of March. However, the model allows for the scrutiny of containment measures that can be used for health authorities to forecast with accuracy their impact in prevalence of COVID-19. Here we show by testing different epidemic containment scenarios that we urge to enforce total lockdown to avoid a massive collapse of the Spanish national health

Recommended Principles

- **P1: Relation-schema free:** Open-domain IE with domain-specific pre-training?
- **P2: Attribute-aware:** Quintuple: ($\{E_{subj}:::A_{subj}\}$, R, $\{E_{obj}:::A_{obj}\}$)
 - Entities and noun phrases (attributes, etc.) and verbal phrases (relation), etc.
- **P3: Multi-tuple:** One sentence can make multiple associated tuples
- **P4: Graph-oriented:** Discovering knowledge by link/path prediction

“We showed that extracellular acidic pH reduces the activity of TRPV5/V6 channels, whereas alkaline pH increases the activity of TRPV5/V6 channels in Jurkat T cells.”

Fact tuple 1: (extracellular acidic pH, reduces, {TRPV5/V6 channels: activity})

Fact tuple 2: (alkaline pH, increases, {TRPV5/V6 channels: activity})

Condition tuple: (TRPV5/V6 channels, in, Jurkat T cells)

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Three-Layered Scientific KG

stmt6: We showed that extracellular acidic pH reduces the activity of TRPV5/V6 channels , whereas alkaline pH increases the activity of TRPV5/V6 channels in Jurkat T cells.

fact 1: (extracellular_acidic_pH,
reduces, {TRPV5/V6_channels: activity})

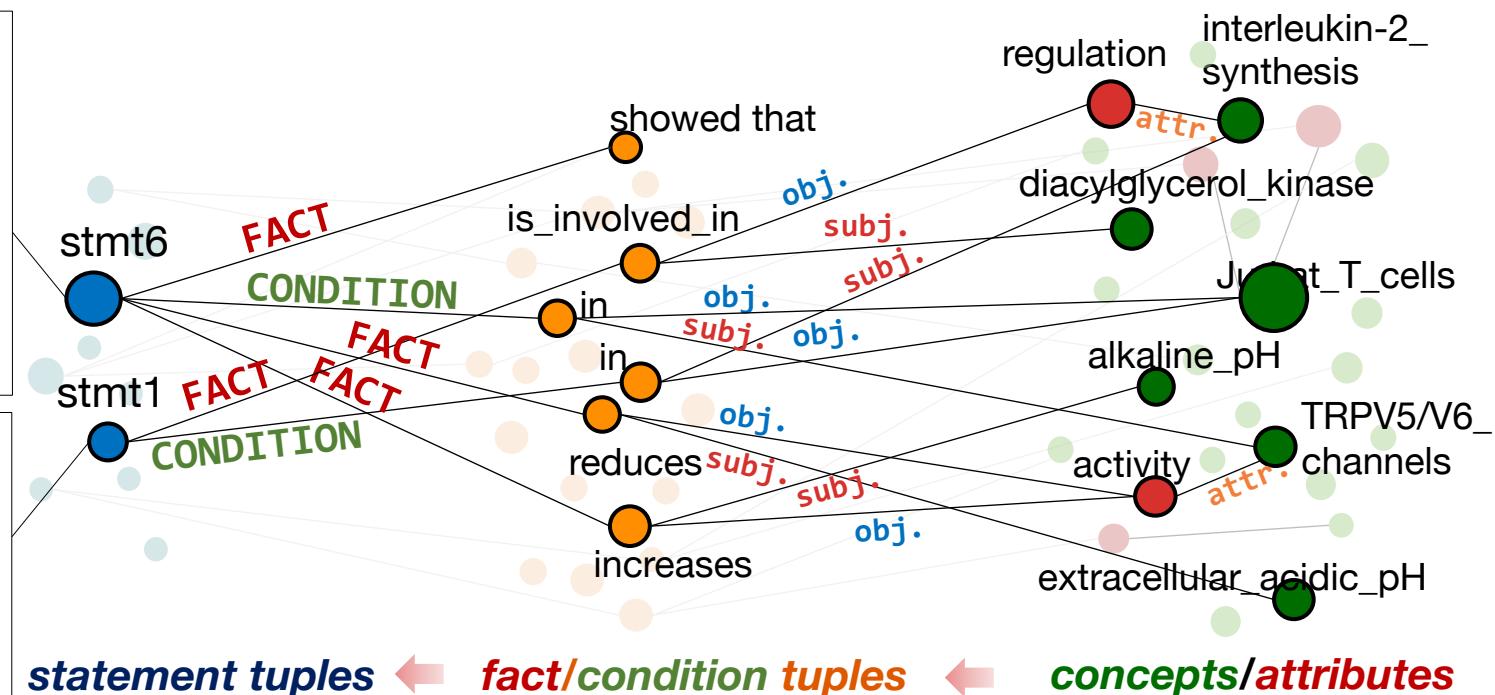
fact 2: (alkaline_pH, increases, {TRPV5/V6_channels: activity})

condition 1: (TRPV5/V6_channels, in, Jurkat_T_cells)

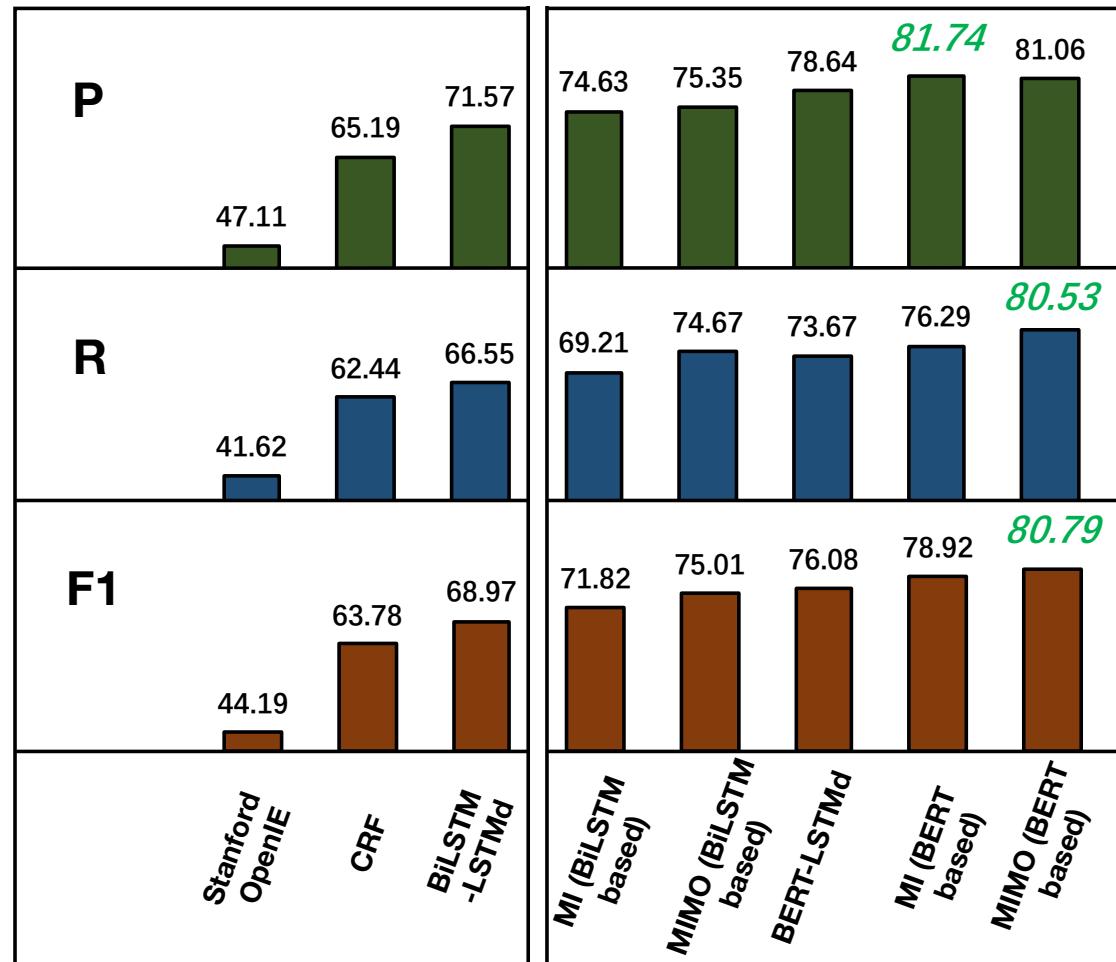
stmt1: A diacylglycerol kinase is involved in the regulation of interleukin-2 synthesis in Jurkat T cells.

fact 1: (diacylglycerol_kinase, is_involved_in,
{interleukin-2_synthesis: regulation})

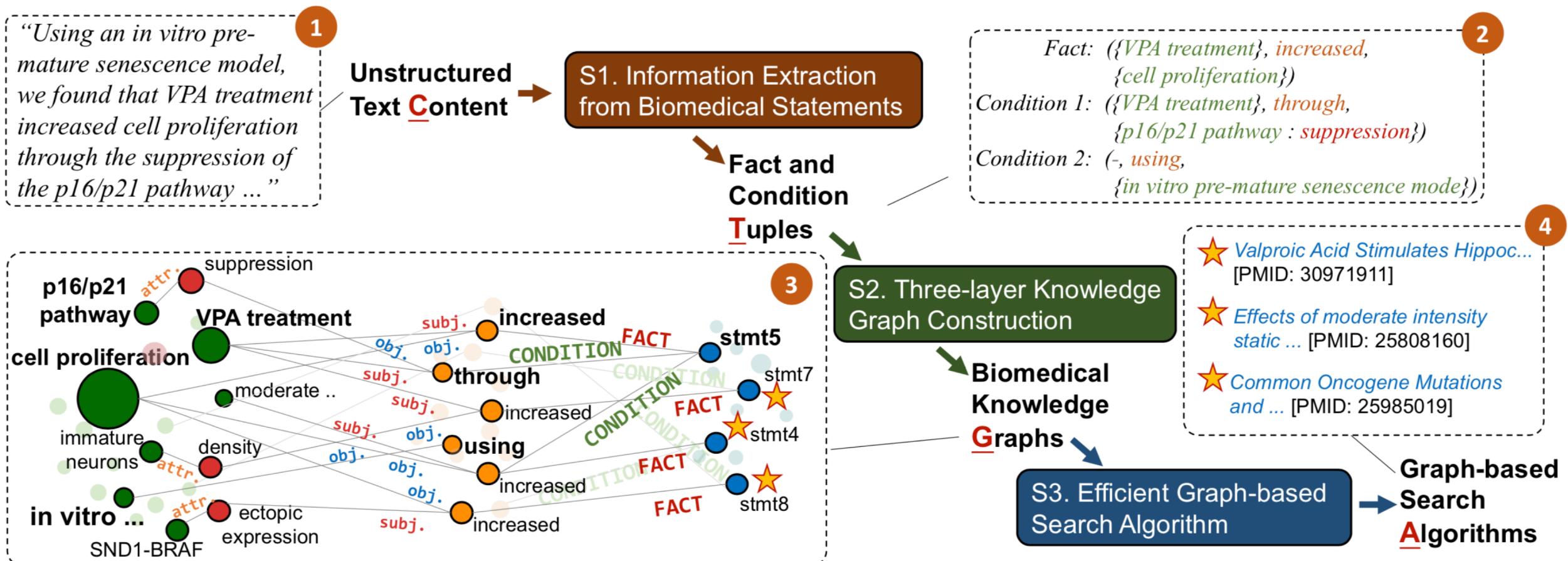
condition 1: (interleukin-2_synthesis, in, Jurkat_T_cells)



MIMO: An Information Extraction Model



Novel Framework: CTGA



- Search and knowledge discovery
- Prediction and inference
- Hypothesis generation
- Hypothesis validation

A Demonstration System

http://www.biokgs.com

CTGA v1.0: Graph-based Biomedical Literature Search

Using an in vitro pre-mature senescence model, we found that VPA treatment increased cell proliferation through the suppression of the p16/p21 pathway.

Search

Example

Statement: Smoking increases the risk of lung cancer .

green: concepts orange: relations red: attributes

subject	relation	object	subject	relation	object	subject	relation	object
checkbox	same	same	checkbox	same	-	checkbox	-	same
checkbox	same	-	checkbox	same	relevant	checkbox	relevant	-
checkbox	-	relevant	checkbox	-	relevant	checkbox	-	relevant

Histone deacetylase inhibitor valproic acid promotes the induction of pluripotency in mouse fibroblasts by suppressing reprogramming-induced senescence stress. [SciKG](#)

Comparison
<https://www.ncbi.nlm.nih.gov/pubmed/?term=26112217> Show Original Tuples
■ (vpa treatment, increased, cell proliferation)

Valproic Acid Stimulates Hippocampal Neurogenesis via Activating the Wnt/β-Catenin Signaling Pathway in the APP/PS1/Nestin-GFP Triple Transgenic Mouse Model of Alzheimer's Disease. [SciKG](#) [Comparison](#)
<https://www.ncbi.nlm.nih.gov/pubmed/?term=30971911> Show Original Tuples
■ (vpa treatment, promoted, cell proliferation)

Effects of moderate intensity static magnetic fields on human bone marrow-derived mesenchymal stem cells. [SciKG](#) [Comparison](#)
<https://www.ncbi.nlm.nih.gov/pubmed/?term=25808160> Show Original Tuples
■ (moderate intensity smfs, increased, cell proliferation)

Estradiol and GPER Activation Differentially Affect Cell Proliferation but Not GPER Expression in the Hippocampus of Adult Female Rats. [SciKG](#) [Comparison](#)
<https://www.ncbi.nlm.nih.gov/pubmed/?term=26075609> Show Original Tuples
● ({gper: activation}, decreased, cell proliferation)

Statement Tagging

Stmt 1: Using an in vitro pre-mature senescence model , we found that VPA treatment increased cell proliferation through the suppression of the p16/p21 pathway .

Selected Facts from Input Text

Fact 1: (vpa treatment, increased, cell proliferation)
Condition

Concept Mapping

cell proliferation
mapping: GO_0008283 | NCIT_C18081 | OMIT_0024131
hypernyms: biological_process | cell function | cell growth processes | cell process | cellular function | cellular process | single organism process | single-organism process
relevant concepts: cell aggregation | cell killing | ...

1

2

3

Case Study

Query
VPA treatment increased cell proliferation.
CTGA
<ol style="list-style-type: none">1. Using an in vitro pre-mature senescence model , we found that VPA treatment increased cell proliferation and inhibited apoptosis through the suppression of the p16/p21 pathway. (Knowledge: {VPA treatment, increase, cell proliferation}, {VPA treatment, inhibit, apoptosis})2. VPA treatment promoted cell proliferation and increased the density of immature neurons in the dentate gyrus (DG) of the hippocampus of 3xTgAD mice. (Knowledge: {VPA treatment, promote, cell proliferation}, {VPA treatment, increase, density of immature neurons})3. VPA treatment increased cathepsin B levels and activities in primary CLL cells. (Knowledge: {VPA treatment, increase, cathepsin B level})4. Moderate intensity SMFs increased cell proliferation, ALP activity, and calcium release. (Knowledge: {Moderate intensity SMF, increase, cell proliferation})5. Ectopic expression of SND1-BRAF in H1299 cells increased phosphorylation levels of MEK/ERK , cell proliferation , and spheroid formation (Knowledge: {Ectopic expression of SND1-BRAF, increase, cell proliferation})
PubMed
<ol style="list-style-type: none">1. These results suggest that VPA increased type-1 stem cells in relation to the activation of SCF-KIT signaling and suppression of BTG2-mediated antiproliferative effect on stem cells.2. Prostate cancer cells , sensitive and resistant to temsirolimus , were exposed to VPA , and tumor cell growth behavior compared.3. VPA treatment promoted cell proliferation and increased the density of immature neurons in the dentate gyrus (DG) of the hippocampus of 3xTgAD mice.4. Cell proliferation had increased to control levels at 30 and 45 d, demonstrating that memory recovery occurs over a period of six weeks after discontinuing VPA treatment.5. To compare the protective effects of suberoylanilide hydroxamic acid (SAHA) and valproic acid (VPA) on human lens epithelial cells (HLECs) following ultraviolet-B exposure. 21

Results

Search Engines	BLEU-1	BLEU-2	BLEU-3	BLEU-4	ROUGE-L	SkipThought	Aver.Embedding	Top@5	Top@1	MRR
PubMed-FullText	17.22	7.01	4.43	3.37	16.34	75.56	68.54	88%	77%	81.5
CTGA-FullText	17.61	7.73	5.07	3.90	17.03	75.91	68.77	93%	92%	92.3
<i>Improvement</i>	2.3%↑	10.3%↑	14.4%↑	15.7%↑	4.2%↑	0.5%↑	0.3%↑	5.7%↑	19.5%↑	13.3%↑
PubMed-BestMatch	28.84	21.46	18.42	16.71	34.91	80.31	81.92	-	-	-
CTGA-BestMatch	32.60	24.67	21.06	18.84	38.26	81.77	82.80	-	-	-
<i>Improvement</i>	13.0%↑	15.0%↑	14.3%↑	12.7%↑	9.6%↑	1.8%↑	1.1%↑	-	-	-

Search Engines	Rate@1	Rate@3	Rate@5	Preference%	Kendall-Tau	SF-Dist	RBO	DCG	NDCG
PubMed	4.60	3.43	2.92	34%	68.95	10.14	87.18	9.61	96.63
CTGA	4.83	3.69	3.31	66%	76.15	8.34	89.31	10.60	99.25

Roadmap

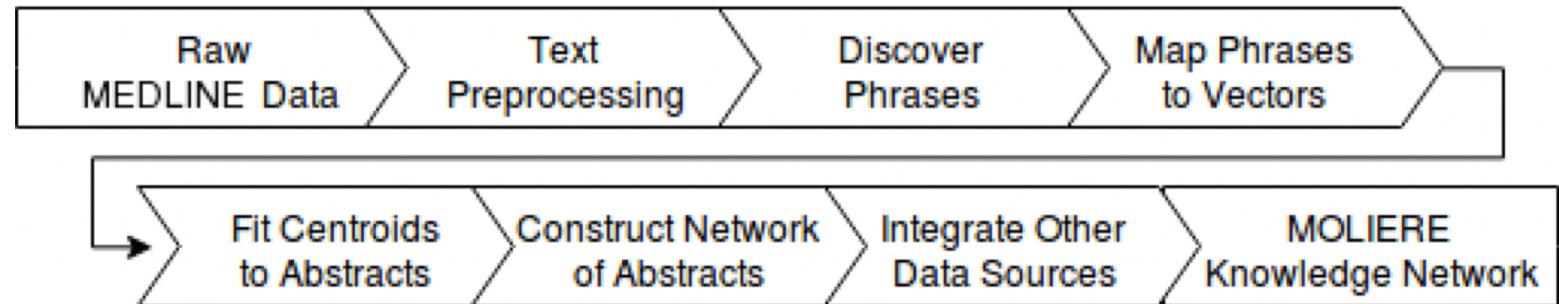
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- **Learning scientific KG for text generation**

Three Interesting Works

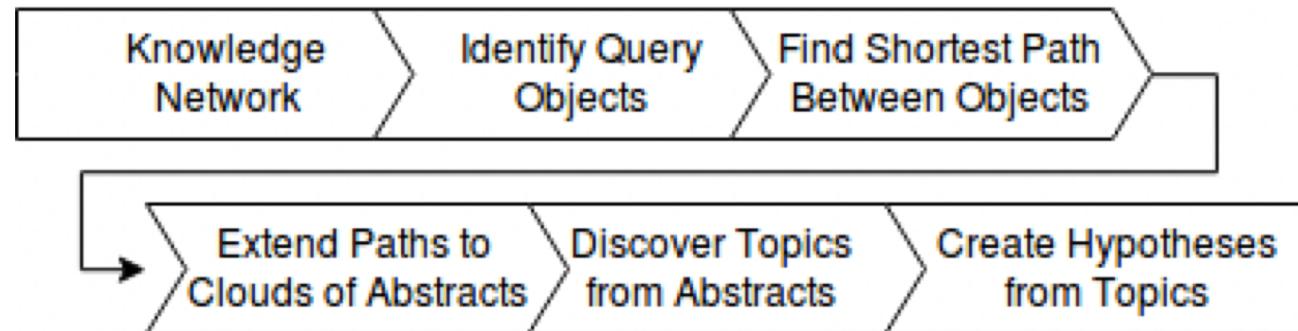
- MOLIERE: Automatic Biomedical Hypothesis Generation System (KDD'17)
- PaperRobot: Incremental Draft Generation of Scientific Ideas (ACL'19)
- Text Generation from Knowledge Graphs with Graph Transformers (NAACL'19)

MOLIERE: Automatic Biomedical Hypothesis Generation System (KDD'17)

Network construction:



Query processing:

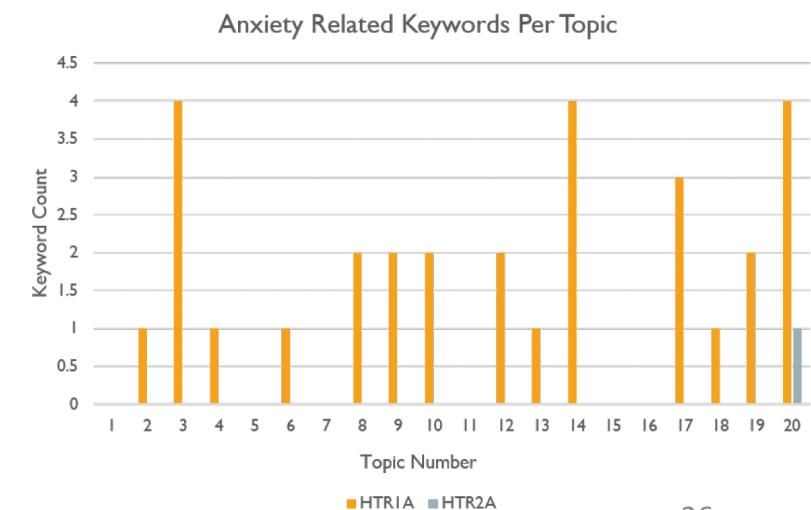
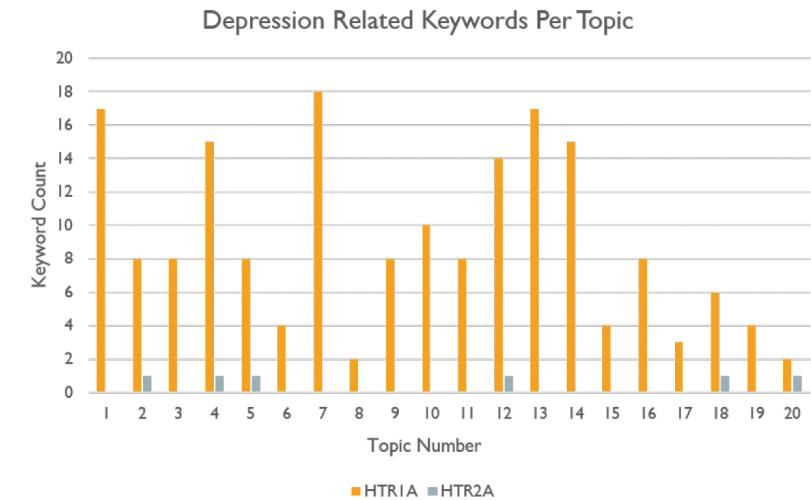


Results

As a result of running two queries, Venlafaxine to HTR1A, and Venlafaxine to HTR2A, we can corroborate the findings of Wang et al. in [49]. We find that neither pair of keywords is directly connected or connected through a single abstract. Nevertheless, **phrases such as “long term antidepressant treatment,” “action antidepressants,” and “antidepressant drugs” are all prominent keywords in the HTR1A query.** Meanwhile, the string “depress” only occurs four times in unrelated phrases with the HTR2A results. The distribution of depression related keywords from both queries can be see in figure 5.

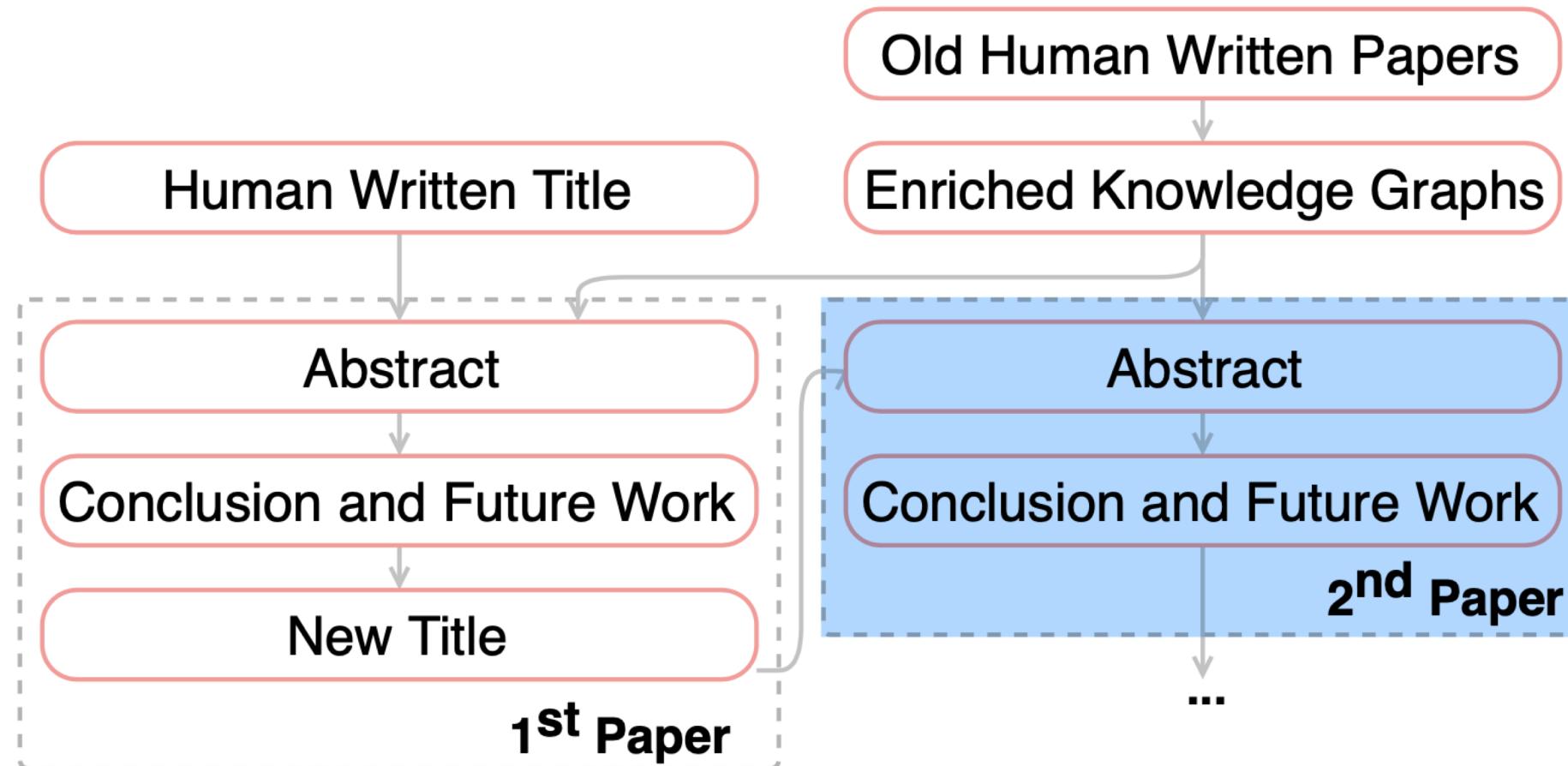
Similarly, our results for **HTR1A contain a single topic holding the phrases “anxiogenic,” “anxiety disorders,” “depression anxiety disorders,” and “anxiolytic response.”** In contrast, our HTR2A results do not contain any phrases related to anxiety. The distribution of anxiety related keywords from both queries can be see in figure 6.

Our findings agree with those of Wang et al. which were that **a small association score of 0.34 between Venlafaxine and HTR1A indicates a connection which is likely related to depressive disorder and anxiety.** The association score between Venlafaxine and HTR2A, in contrast, is a much higher 4.0. This indicates that the connection between these two keywords is much weaker.

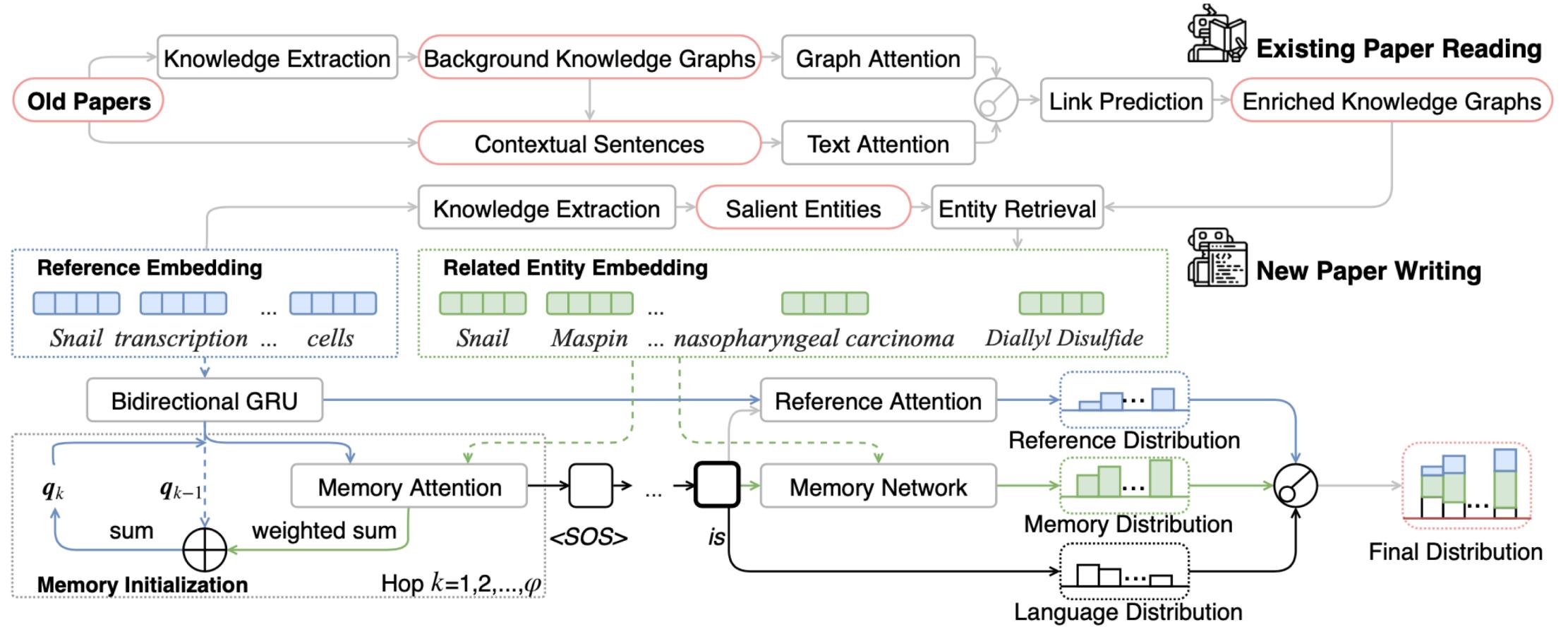


PaperRobot: Incremental Draft Generation of Scientific Ideas (ACL'19)

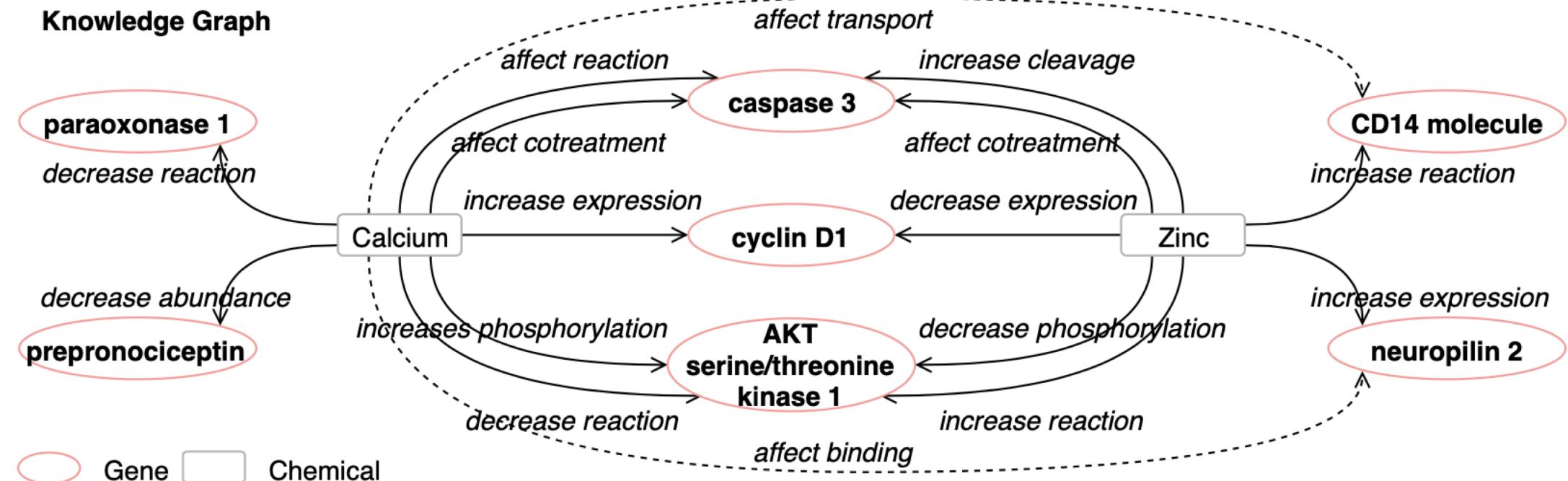
- Incremental writing



Architecture Overview



Biomedical Knowledge Extraction and Link Prediction



Contextual Sentence: So, Ca^{2+} possibly **promoted caspases** activation upstream of **cytochrome c** release, but inactivated **caspase** activity by calpain and/or fast depletion of ATP; whereas Zn^{2+} blocked the **activation of procaspase-3** with no visible change in the level of **cytochrome c**, and the block possibly resulted from its direct inhibition on **caspase-3** enzyme.

Results

Title	Snail transcription factor negatively regulates maspin tumor suppressor in human prostate cancer cells		
Entities	Related: nasopharyngeal carcinoma; diallyl disulfide		
Output	Human (Neal et al., 2012)	System	Post-edited by Human
Abstract	<p>Background: Maspin, a putative tumor suppressor that is down-regulated in breast and prostate cancer, has been associated with decreased cell motility. Snail transcription factor is a zinc finger protein that is increased in breast cancer and is associated with increased tumor motility and invasion by induction of epithelial-mesenchymal transition (EMT). We investigated the molecular mechanisms by which Snail increases tumor motility and invasion utilizing prostate cancer cells. Methods: Expression levels were analyzed by RT-PCR and western blot analyses. Cell motility and invasion assays were performed , while Snail regulation and binding to maspin promoter was analyzed by luciferase reporter and chromatin immunoprecipitation (ChIP) assays. Results: Snail protein expression was higher in different prostate cancer cells lines as compared to normal prostate epithelial cells.</p>	<p>Background: Snail is a multi-functional protein that plays an important role in the pathogenesis of prostate cancer. However, it has been shown <i>to be</i> associated with poor prognosis. The purpose of this study <i>was</i> to investigate the effect of <i>negatively</i> on the expression of maspin in human nasopharyngeal carcinoma cell lines. Methods: <i>Quantitative real-time PCR</i> and western blot analysis were used to determine <i>whether the demethylating agent was investigated by quantitative RT-PCR (qRT-PCR) and Western blotting</i>. Results showed that the binding protein plays a significant role in the regulation of tumor growth and progression.</p>	<p>Background: Snail is a multifunctional protein that plays an important role in the pathogenesis of prostate cancer. It has been shown associated with poor prognosis. The purpose of this study is to investigate the negative effect of on the expression of Maspin in human nasopharyngeal carcinoma cell lines. Methods: Quantitative RT-PCR (qRT-PCR) and western blot analyses were used to determine <i>correlation of the two proteins expressions</i>. Results showed that the binding protein plays a significant role in the regulation of tumor growth and progression.</p>
Conclusion and Future work	<p>Collectively, our results indicate for the first time that Snail can negatively regulate maspin through direct promoter repression resulting in increased migration and invasion in prostate cancer cells. This study reveals a novel mechanism of how Snail may function and show the importance of therapeutic targeting of Snail signaling in future.</p>	<p>In summary, our study demonstrates that Snail negatively <i>inhibited</i> the expression of Maspin in human nasopharyngeal carcinoma cell lines <i>and in vitro</i>. Our results indicate that <i>the combination of the demethylating agent</i> might be a potential therapeutic target for the treatment of prostate cancer.</p>	<p>In summary, our study <i>in vitro</i> demonstrates that Snail negatively <i>inhibits</i> the expression of Maspin in human nasopharyngeal carcinoma cell lines. Our results <i>further</i> indicate that Maspin might be a potential therapeutic target for the treatment of prostate cancer.</p>
New Title	Role of maspin in cancer (Berardi et al., 2013)	The role of nasopharyngeal carcinoma in the rat model of prostate cancer cells	The role of Maspin in the rat model of nasopharyngeal carcinoma cells

Results (cont'd)

Model	Title-to-Abstract		Abstract-to-Conclusion and Future Work		Conclusion and Future Work-to-Title	
	Perplexity	METEOR	Perplexity	METEOR	Perplexity	METEOR
Seq2seq (Bahdanau et al., 2015)	19.6	9.1	44.4	8.6	49.7	6.0
Editing Network (Wang et al., 2018b)	18.8	9.2	30.5	8.7	55.7	5.5
Pointer Network (See et al., 2017)	146.7	8.5	74.0	8.1	47.1	6.6
Our Approach (-Repetition Removal)	13.4	12.4	24.9	12.3	31.8	7.4
Our Approach	11.5	13.0	18.3	11.2	14.8	8.9

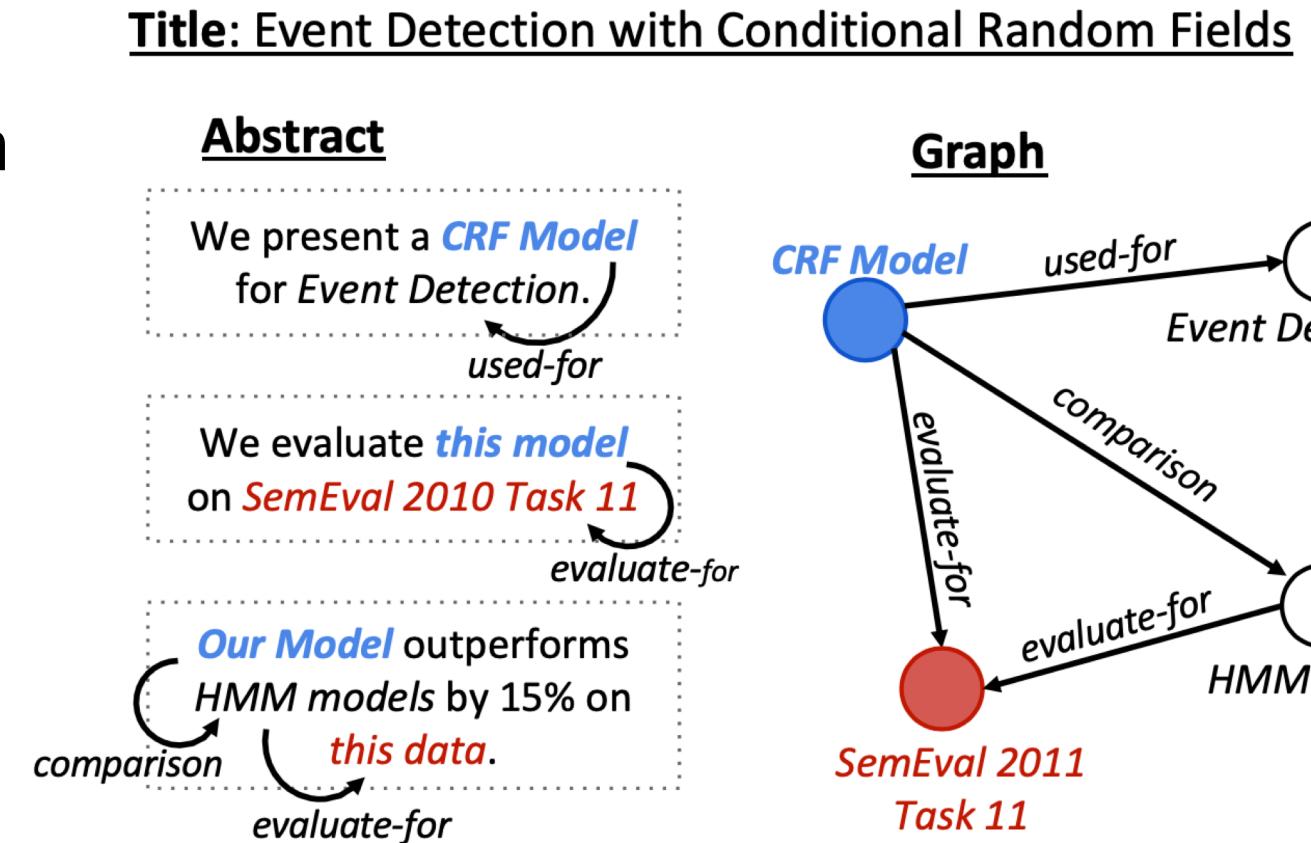
Task	Input		Output	Domain Expert	Non-expert
End-to-End	Human Title	Different	Abstract (1st)	10	30
		Same		30	16
	System Abstract	Different	Conclusion and Future work	12	0
		Same		8	8
	System Conclusion and Future work	Different	Title	12	2
		Same		12	25
Diagnostic	System Title	Different	Abstract (2nd)	14	4
	Human Abstract	Different	Conclusion and Future work	12	14
		Same		24	20
	Human Conclusion and Future work	Different	Title	8	12
		Same		2	10

Results (cont'd)

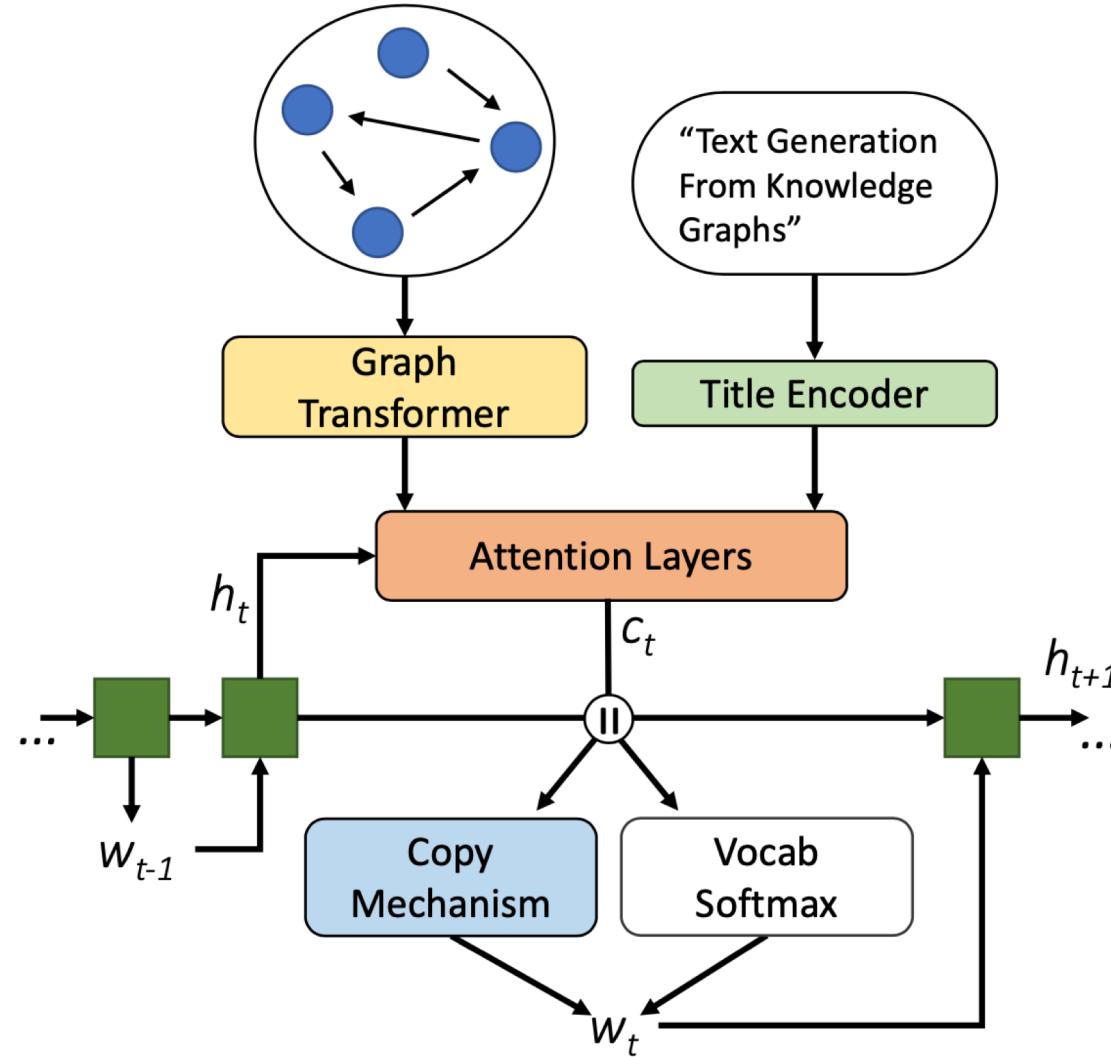
Output	Without Memory Networks	Without Link Prediction	Without Repetition Removal
Abstract	Background: Snail has been reported to exhibit a variety of biological functions. In this study, we investigated the effect of negatively on maspin demethylation in human prostate cancer cells. Methods: Quantitative real-time PCR and western blot analysis were used to investigate the effects of the demethylating agent on the expression of the protein kinase (TF) gene promoter. Results: The results showed that the presence of a single dose of $50 \mu M$ in a dose-dependent manner, whereas the level of the BMP imipramine was significantly higher than that of the control group.	Background: Snail has been shown to be associated with poor prognosis. In this study, we investigated the effect of negatively on the expression of maspin in human prostate cancer cells. Methods: Cells were treated with a single dose of radiotherapy for 24 h, and was used to investigate the significance of a quantitative factor for the treatment of the disease. Results: The remaining controls showed a significant increase in the G2/M phase of the tumor suppressor protein ($p<0.05$).	Background: Snail is a major health problem in human malignancies. However, the role of Snail on the expression of maspin in human prostate cancer cells is not well understood. The aim of this study was to investigate the effect of Snail on the expression of maspin in human prostate cancer cells. Methods: The expression of the expression of Snail and maspin was investigated using quantitative RT-PCR and western blot analysis. Results: The remaining overall survival (OS) and overall survival (OS) were analyzed.
Conclusion and Future work	In summary, our study demonstrated that negatively inhibited the expression of the BMP imipramine in human prostate cancer cells. Our findings suggest that the inhibition of maspin may be a promising therapeutic strategy for the treatment.	In summary, our results demonstrate that negatively inhibited the expression of maspin in human prostate cancer cells. Our findings suggest that the combination of radiotherapy may be a potential therapeutic target for the treatment of disease.	In summary, our results demonstrate that snail inhibited the expression of maspin in human prostatic cells. The expression of snail in PC-3 cells by snail , and the expression of maspin was observed in the presence of the expression of maspin .
New Title	Protective effects of homolog on human breast cancer cells by inhibiting the Endoplasmic Reticulum Stress	The role of prostate cancer in human breast cancer cells	The role of maspin and maspin in human breast cancer cells

Text Generation from Knowledge Graphs with Graph Transformers (NAACL'19)

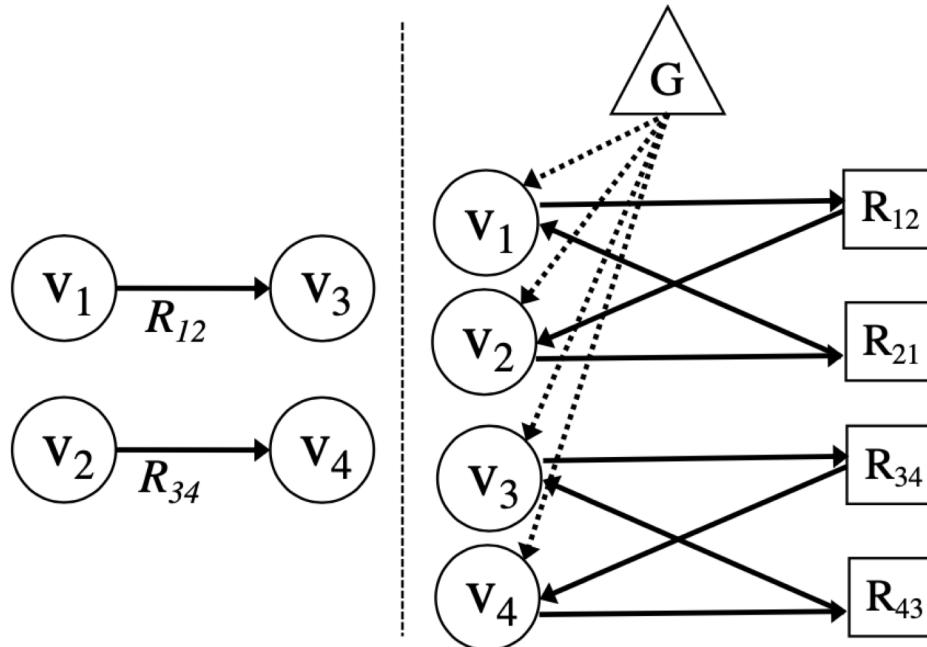
- Text-to-graph extraction
- Graph-to-text generation



Graph Writer Model

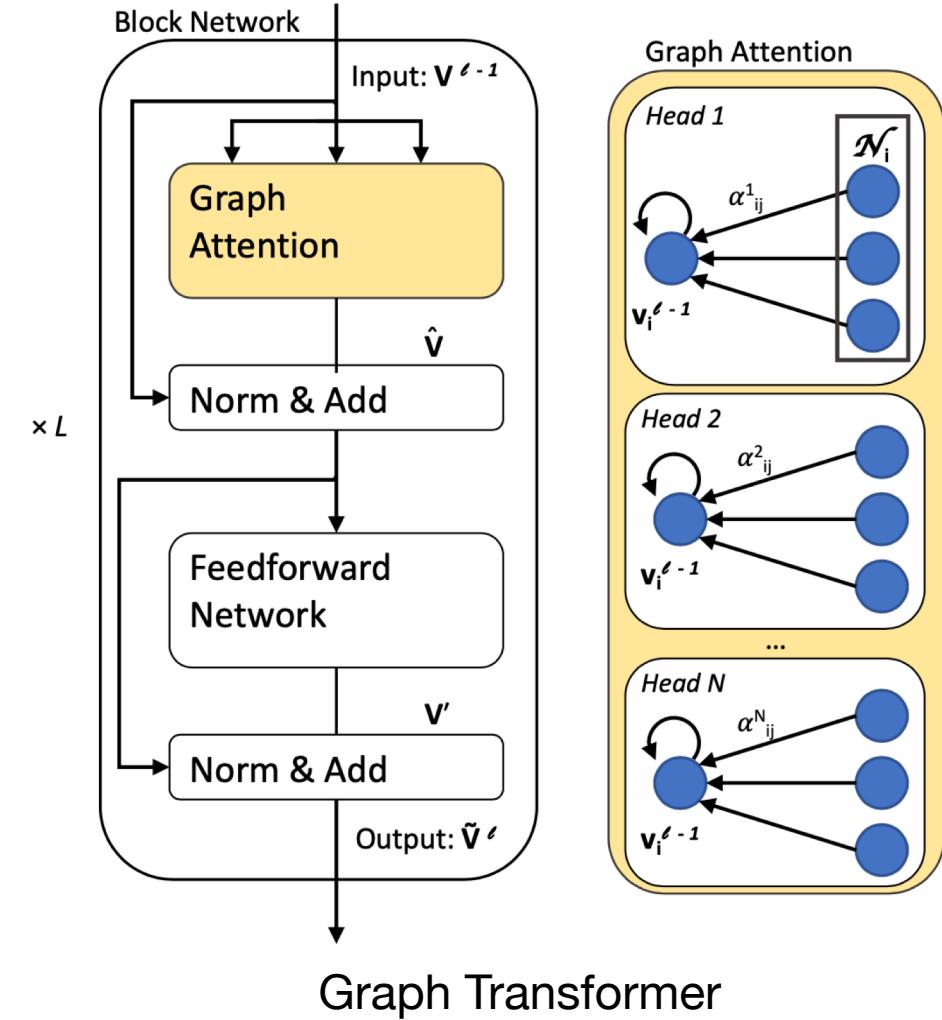


Graph Attention and Graph Transformer



Converting disconnected labeled graph to connected unlabeled graph for use in attention-based encoder.

v_i refer to vertices, R_{ij} to relations, and G is a global context node.



Results

Title	Block and Group Regularized Sparse Modeling for Dictionary Learning
Knowledge	(dictionary learning, CONJUNCTION, sparse coding) ; (optimization problems, USED-FOR, dictionary learning) ; (optimization problems, USED-FOR, sparse coding)...
GraphWriter	Sparse representations have recently been shown to be effective in many optimization problems. However, existing dictionary learning methods are limited in the number of dictionary blocks, which can be expensive to obtain. In this paper, we propose a novel approach to dictionary learning based on sparse coding ...
GAT	In this paper, we consider the problem of dictionary learning in well-known datasets. In particular, we consider the problem of dictionary learning, where the goal is to find a set of dictionary blocks that maximize the likelihood of a given set of dictionary blocks ...
EntityWriter	We propose a novel dictionary learning framework for reconstructed block/group sparse coding schemes. The dictionary learning framework is based on the descent, which is a block structure of the group structure ...
Rewriter	This paper presents a new approach to the k-means of the algorithm. The proposed approach is based on the basis of the stationarity algorithm. The algorithm is based on the fact that the number of bits is a constant of the base of the base of the input ...
<i>Gold</i>	This paper proposes a dictionary learning framework that combines the proposed block/group (BGSC) or reconstructed block/group (R-BGSC) sparse coding schemes with the novel Intra-block Coherence Suppression Dictionary Learning algorithm. An important and distinguishing feature of the proposed framework is that all dictionary blocks are trained simultaneously ...

Results (cont'd)

Title	Image Interpolation with Directionlets
Knowledge	(directionally adaptive image interpolation USED-FOR edge information) ; (numeric and visual quality, HYPONYM-OF, directionally adaptive image interpolation) ; (directionlets, EVALUATE-FOR, multiple-direction wavelet transform) ...
GraphWriter	In this paper, we propose a novel directionally adaptive image interpolation based on the multiple-direction wavelet transform, called directionlets, which can be used as a directionlets to improve the numeric and visual quality of the directionally adaptive image interpolation ...
GAT	In this paper, we propose a novel directionally adaptive image interpolation, called directionally adaptive image interpolation, for directionally adaptive image interpolation , which is based on the multiple-direction wavelet transform ...
EntityWriter	We present a novel directionally adaptive image interpolation for numeric and visual quality. The wavelet transform is based on the wavelet transform between the low-resolution image and the interpolated image. The high-resolution image is represented by a wavelet transform ...
Rewriter	We present a new method for finding topic-specific data sets. The key technical contributions of our approach is to be a function of the terrestrial distributed memory. The key idea is to be a function of the page that seeks to be ranked the buckets of the data. The basic idea is a new tool for the embedded space ...
<i>Gold</i>	We present a novel directionally adaptive image interpolation based on a multiple-direction wavelet transform, called directionlets. The directionally adaptive image interpolation uses directionlets to efficiently capture directional features and to extract edge information along different directions from the low-resolution image ...