Fill the gap: Machine reading comprehension for medicine

Simon Šuster joint work with Walter Daelemans

NLP Meetup Belgium 23 May 2019 "If I read and memorized two medical journal articles every night, by the end of a year I'd be 400 years behind"

Donald Lindberg, director of US NLM

Machine reading comprehension is fine-grained question answering



How Microsoft is using machine reading comprehension to help create a 'literate machine'

REPORT TECH ARTIFICIAL INTELLIGENCE

No, machines can't read better than humans

Headlines have claimed AIs outperform humans at 'reading comprehension,' but in reality the way to go By James Vincent | Jan 17, 2018, 9:23am EST

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September 18, 2017 | Allison Linn

Google DeepMind **Teaches Artificial** Antelligence Machines to Read

A three-minute guide to how machine reading could make your job easier

GOOL

September 26, 2017 | Microsoft reporter

The best way for AI machines to learn is by feeding them huge data es, and the Daily Mail has unwittingly









Researchers at the Allen Institute for Artificial Intelligence in Seattle. (Stuart Isett for The Washington Post) By Drew Harwell January 16

When computer models designed by tech giants Alibaba and Microsoft this month surpassed humans for the first time in a reading-comprehension test. both companies celebrated the success as a historic milestone

Luo Si, the chief scientist for natural-language processing at Alibaba's AI research unit, struck a poetic note, saying, "Objective questions such as 'what in' ann mans ha annsanad saith high a sunnan he machinas

Machine reading for medicine

Promise for the future of clinical decision making

Physicians seek information from (un)structured clinical records

"Why was the patient prescribed arginine?"

Physicians seek domain knowledge

"Does arginine reduce the length of recovery after surgery?"

Resource bottleneck!

Specialized domains like medicine lack machine reading datasets

Some recently published datasets

CNN / Daily Mail CoQA HotpotQA MS MARCO **MultiRC NewsQA** QAngaroo QuAC RACE SOuAD Story Cloze Test Recipe QA **NarrativeQA** DuoRC DROP Source:

Axes of variation

...

Multi-choice vs. span-based answering Human vs. automatic construction Human-like questions vs. queries Single- vs. multi-hop reasoning Requiring background knowledge Text types

Some recently published datasets

	Domain
<u>CNN / Daily Mail</u>	News
<u>CoQA</u>	Literature, English exams, news, Wikipedia, science,
<u>HotpotQA</u>	Wikipedia
MS MARCO	Web search
<u>MultiRC</u>	Fiction, news, Wikipedia, science textbooks,
<u>NewsQA</u>	News
<u>QAngaroo</u>	Wikipedia, molecular biology
<u>QuAC</u>	Wikipedia
RACE	School exams
<u>SQuAD</u>	Wikipedia
Story Cloze Test	Stories
Recipe QA	Cooking recipes
<u>NarrativeQA</u>	Literature, movie scripts
<u>DuoRC</u>	Movie plots
DROP	Wikipedia
Source:	

Domain

https://github.com/sebastianruder/NLP-progress

What we did

- Created a dataset from clinical case reports
- Automated question construction: gap-filling queries where the answer can be a treatment, a test or a problem
- Analyzed performance of different machine readers
- Examined the required reading skills: in what ways is answering difficult?

Hemorrhagic stroke

CASE REPORT

Intracavitary ultrasound (ICARUS): a neuroendosco adaptation of intravascular ultrasound for intracerebral hemorrhage evacuation

Alexander G Chartrain, Danny Hom, Joshua B Bederson, J Mocco. Christopher Paul Kellner

SUMMARY in view

Neurosurgeons performing intracerebral hemorrhage online evacuation procedures have limited options for

- monitoring hematoma evacuation and assessing
- residual hematoma burden intraoperatively. Here, we

roen report the successful neuroendoscopic adaptation

- of intravascular ultrasound, referred to here as
- NY USA intracavitary ultrasound (ICARUS), in two patients, Pre-
- evacuation ICARUS demonstrated dense hematomas in both patients. Post-evacuation ICARUS in patient 1
- demonstrated significant reduction in clot burden and
- two focal hyperechoic regions consistent with pockets of hematoma not previously seen with the endoscope or
- burr hole ultrasound. These areas were directly taroeted and resected with the endoscope and suction device. Post-evacuation ICARUS in patient 2 showed significant reduction of hematoma volume without indication of residual blood. ICARUS findings were confirmed on intraoperative DynaCT and postoperative CT 24 hours later. ICARUS is feasibly performed in a hematoma cavity both before and after hematoma aspiration. ICARUS may provide additional information to the operating surgeon

and assist in maximizing hematoma removal.

Introduction

Intravascular ultrasound (IVUS) is an important imaging modality in the diagnosis and treatment of vascular disease.^{1 2} IVUS catheters contain numerous ultrasound transmitters and receivers

is flush with that of the sheath at the distal e the hematoma. The sheath is retracted (exch. a distance equal to the length of the hemo so that the tip of the sheath rests at the proedge of the hematoma. With the ultrasoun vated, the IVUS catheter is slowly retracted in sheath to scan the cavity. The process is reafter evacuation to visualize any residual hem (figure 1). Of note, the use of IVUS for int itary imaging during ICH evacuation is of and not currently cleared by the Food and Administration

The introducer is removed and the IVUS cath

introduced into the sheath until the tip of the

CASE PRESENTATION Patient 1

A 39-year-old man with hypertension, dia and end-stage renal disease presented with s loss of consciousness (LOC), a Glasgow Scale (GCS) of 9, and National Institutes of 1 Stroke Scale (NIHSS) of 16, and was found t a 77 cm3 left-sided ICH (figure 2A). He unde endoscopic evacuation 72 hours after syr onset. Baseline ICARUS prior to evacuation d strated a dense hematoma (figure 3A; see supplementary video 1). At the conclusion evacuation, ICARUS was repeated and ide two residual pockets of hematoma (figure 3 C: see online supplementary video 2). Usi information gathered from ICARUS, these p -int the endoscope and meda, California, US JS not been performe BM Case Reports been terminated w

n it be a diagnostic tool for neurologists?

A Sloan,² Alejandro A Rabinstein¹

inic, Richester, Mimesota, USA scalors, Misso Ginic, Richester, Mimesota, USA

Mittel, dmanokumamitti#@omail.com

ted with acute ischaemic strole with NHSS 13. She had right eve ptosis and missis. She and her husband stares were different than usual. With her consent, we compared her face with her pictures on Facebook. In miosis in her pictures, she was diagnosed with acute Horner syndrome. Facebook may be a useful tool for traing of facial neurological sizes.

ia website with more than 845 users It has been increasingly tient education, sesearch enrolbehaviounl research, and chanost of the residents and fellows

not show any published cases d as a diagnostic tool in neurpatient with acute neurological k played a significant role in her

324 mg and clopidoged 300 mg. She was transferred to neurological intensive case unit for closer monitoring. In the intensive care unit, she was noted to have night ptosis and mild right miosis with pupil 0.6 mm smaller than the left side (figure ID). She and her husband were not sure if her facial features were different than usual. We hecked her driver's licence but her picture was not clear enough to make a comparison. She had no other picture with her. We asked her if she had pictures on her Facebook polile to which she sesponded affirmatively. As our patient was competent to give consent, we asked for her verbal permission to compare her pictures on Facebook with her present facial features to clarify if the syelid droop was

sidual pockets. Subse demonstrated >909 u,2 Gunalp Uzun,2 Hakan Ay2

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roman presented to t gloves for approxi-te felt a burning sen-maemia and blisters implaints aggravato

BMI Case Reports

Other full case

A 12-year-old boy presenting with unilateral proximal interphalangeal joint swelling

itgrowths of buck be delineated fro These are com Michigan, USA

of lamellar bone Correspondence to

bone in larger | Dr Ghasan Bachunn, s can be found + ghachuw20thurleyne.com

for example, ma Accepted 14 December 2014

injury with a peritoneal breach: wisdom

These are com

gh, the actiology l odular growths a

clinicians believ

proposed by Gli

Few cases have

eveloped subsequ

al graft.3-6

CASE REPORT

or absurdity?

S Small, V Murthy, A V Sridhar

Children's Hospital, Leicester Royal Infirmary, University Hospitals of Leicester NHS Trust, Leicester, UK

Correspondence to A V sridbar astal sridbar@ubl.tr.nbs.ul

nearly 12k cases

~112k word types

~590k medical entities

rapidly progressive airway compromise following

recreational huffing. Our patient required intubation and

intensive care unit admission with complete recovery

after 5 days. The aetiology of airway compromise is

postulated to be due to commonly reported frost bit

our knowledge this the second case reporting

angioedema secondary to huffing Air Duster.

BACKGROUND

injury and rarely reported angioedema. To the best of

BM Case Reports

aused by sodium hydroxide tary Medical Academy Haydarpasa Teaching Hospital, Istanbul, Turkey ne, Guitane Military Medical Academy Haydarpasa Teaching Hospital, Istanbul, Turkey

> and she de covered ful and several

Rare disease

A report on a rare case of Klebsiella ozaenae causing atrophic rhinitis in the UK

Yi Jie Lee,1 Luke Stephen Prockter Moore,2 John Almevda

1947 Department, West Middlesex University Hospital, Middlesex, UK; *Microbiology Department, West Middlesex University Hispital, Middlesex, UK

Correspondence to Mr 11 Je Leo, y/kee@doctors.org.uk

Summary

Ozena is a chronic disease of the nasal cavity characterised by atrophy of the mucosa and bone caused by Klebsiella ozenae. It is endemic to subtropical and temperate regions affecting the lower socio-economic group, usually the poor who live in unhygienic conditions. It is a rare disease in the UK. There is usually a delay in diagnosis due to unfamiliarity of the disease. A 25-year-old Nigerian migrant presented with nasal obstruction with purulent nasal discharge. Isolation of the bacterium was found from cultures of nasal discharge, crusting and tissue biopsies. She was treated successfully with oprofloxacin. It is important to consider this rare condition in cases of nasal obstruction even in non-endemic areas especially with the advances of modern travel.

BACKGBOUND

Klebsiella oznenae is associated with chronic inflammation of the upper airways called ozena.1 The incidence of the disease in developed countries has become unco rare progressing chronic rhinitis, forming thick dried scabs due to atrophic changes in the of underlying bone. They

INVESTIGATIONS ringofloyacin CT of the sinuses revealed mucosal thickening in the

and crusting isolated K ozaenae, showing susceptibility to thmoid, sphenoid and maxillary sinuses. The frontal sinuses users clear. The maxillary antrum were obstructed by soft tissue bilaterally. There was bilateral atrophy of the

The septum was not deviated nor were there any nasal

The cultures taken from the pus swabs, tissue biopsies

Haematological and biochemical investigations including HIV were unremarkable

REATMENT nesis of the disease

reatment was initiated with regular saline nasal douching, oral ciprofloxacin for 2 weeks and topical ofloxacin asal spray for 5 days.

OUTCOME AND FOLLOW-UP

al crusting by which PCR findings.

Regular 3 monthly follow-ups for decrusting purposes

treatment (new drug/intervention; established drug/procedure in new sit

CASE REPORT

presence of character

ndicated species.

propical and temper

d hereditary factors

enlargement of nasal

with thick crusts: or

Burning mouth syndrome due to herpes simplex virus type 1

Maria A Nagel,¹ Alexander Choe,¹ Igor Traktinskiy,¹ Don Gilden^{1,2}

SUMMARY

Burning mouth syndrome is characterised by chronic orofacial burning pain. No dental or medical cause has been found. We present a case of burning mouth syndrome of 6 months duration in a healthy 65-year-old woman, which was associated with high copy numbers of herpes simplex virus type 1 (HSV-1) DNA in the saliva. Her pain resolved completely after antiviral treatment with a corresponding absence of salivary HSV-1 DNA 4 weeks and 6 months later.

(HSV-1) and HSV-2 were similar (104 102, respectively), and range of detect

The patient was treated with oral valac three times a day for 10 days, followed clovir, 1 g daily for 1 year.

zoster virus (VZV),* and HSV-1* and F

performed as previously described.⁶ PC

cies for VZV and of herpes simplex vi

The mouth pain resolved completely wi after antiviral treatment, PCR of saliva 4 6 months after starting antiviral treatme no HSV-1, HSV-2 or VZV DNA. The remained pain free for 1.5 years after dir antiviral therapy.

No prior reports have associated th A previously healthy 65-year-old woman developed mouth syndrome with HSV-1 or any c a burning sensation in her mouth, localised to the HSV-1 is a ubiquitous human α-herpe right buccal mucosa and anterolateral two-thirds of becomes latent in most cranial nerve ga the tongue. The burning increased when she to 70% of individuals.5 The trigemina 10 min. Pain resolved spontaneously after 4 weeks. face and mouth, is the most common cr One year later, burning pain in the same distribution ganglion infected.⁸ HSV-1 reactivation recurred and became constant. Dentists, including causes recurrent cold sores (herpes la an oral surgeon, found no mucosal lesions or other ocular disease (herpes keratitis). HSV-1 abnormalities. No relief was provided by facial pain and, rarely, encephalitis, ar

brushed her teeth and usually decreased within mouthworkse mills of mamoria sincer discontinu

three viruses was 10-106 DNA copies p Saliva contained cellular GAPDH and copies of HSV-1 DNA per mL, but r HSV-2 DNA. TREATMENT

DISCUSSION

which provides sensory afferent innerva

9

pack/day the medical literature. In this report we present a case of and hutfied Air Duster, 1 can/day. He denied any alcohol or other substance use. Home medications include fluowetine at 20 mg/day and buspirone at 15 mg twice daily. INVESTIGATIONS Laboratory work was performed on admission to ICU. White cell count was 16 800 cells/µL with a

blood gas performed following intubation were unremarkable. Owing to the significant swelling, which developed over a short period of time, and a rapidly evolving erythema covering a significant portion o the right neck area, a CT of the neck was done which extension soft tissue smalling with codema

for cellulitis versus angioedema (figure 2).

TIAL DIAGNOSIS

Inhaling, or huffing, is common among teenagers and adolescents. However, it can occur in any age group. The side effects can be life-threatening.

njury is a known adverse event from 1 Duster. However, it was thought that progression of airway compromise was he due to froathite injury alone. There is ed case in the literature of angioedema Air Duster inhalation, and this was the ury concern in our patient. Once he was

normal differential and no bands. Electrolytes and

es over the right side of the upper neck

towards the end of the hospitalisation,

RACKGROUND Burning mouth syndrome is a chronic, burning sensation in the mouth, with no underlying dental or medical cause. The burning sensation can be unilat- OUTCOME AND FOLLOW-UP eral or bilateral and is localised to the lips, tongue, hard or soft palate. The prevalence varies from 0.7% to 7% and is seen in up to 18% of postmenopausal women.1 2 Previous treatment has included antidepressants, cognitive behavioural therapy,

analgesics, hormone replacement, α-lipoic acid and anticonvulsants.3

CASE PRESENTATION

Conservative management of an abdominal gunshot

BMJ Case Reports 25 most common medical specialties:



10

CASE REPORT

Conservative management of an abdominal gunshot injury with a peritoneal breach: wisdom or absurdity?

Salma Khan,1 Amyn Pardhan,1 Tufail Bawa,1 Naveed Haroon

partment of Surpers. Aga

with no abnormality found on digital rectal exan Surgical exploration has been the standard of care for ination. The initial management consisted of abdominal gunshot injuries. The authors report a case keeping the patient nothing per oral, catheterisaof a 28-year-old man who sustained a transabdomina tion, intravenous hydration and analgesia. Keeping gunshot injury, which entered the anterior abdominal the bullet trajectory in mind, left colonic and ureteric injury was highly suspected, despite a posteriorly with a tangential trajectory. On presentation, normal abdominal examination and stable haemodynamics.

pertoneal signs. Based on trajectory of the bullet intra-abdominal injury was suspected. Therefore a CT INVESTIGATIONS scan abdomen with intravenous and rectal contrast His complete blood count and serum creatinine was performed. The CT scan revealed no remained normal and his haemoglobin and haemextravasation of the sertal contrast but showed free atocrit did not drop at any point in time air specks behind the descending colon. Delayed renal A CT scan of the abdomen and pelvis was per images of the left uniter years also normal. Resed on formed with intravenous and rectal contrast includthe dinical findings, the patient was managed noning delayed renal films. Images showed specks of operatively with nothing per oral, intravenous free air behind the descending colon with no antibiotics and frequent abdominal assessments. He extravasation of contrast from the rectum and made an uneventful recovery without necessitating ureter (figure 1).

laparotomy. BACKGROUND

Gunshot injuries to the abdomen have been traditionally managed by exploratory laparotomy. The

wall and exited adjacent to the T12 vertebra

the patient was haemodynamically stable with no

A decision was made to manage this patient co servatively based on his baemodynamic stability absence of peritoneal signs and no contrast extravasation from the colon, ureter or blood dictum of mandatory surgery of all torsogunshots vessels on CT scan images. Exploration was kept is based on an assumption that only exploration in mind if the patient showed haemodynamic can correctly diagnose all injuries and lower mor- instability or developed peritoneal siens. He was idity and that a clinical examination is usually kept under observation in a high dependency unit unreliable. This results in a negative laparotomy where his vitals were monitored hourly along with rate of 15-25%.1 2 There is recent literature point-strict input/output charting and frequent abdoming towards selective non-operative management in al examinations. He was kept there for 48 h and of isolated anterior or posterior abdominal then shifted to the general ward where he was gunshot injury, but to the best of our knowledge monitored as per ward protocol. He was fully o report is available about conservative treatment ambalated on the second day of admission and of transabdominal gunshot injury with a peritoneal remained stable throughout the hospital course. A breach. A clinical examination and helical CT scan repeat CT scan abdomen with intravenous and are good tools aiding surgeons in the execution of rectal contrast on the fifth postadmission day did non-operative management of a select group of not reveal any abnormality (figure 2), and therefore he was started on oral liquids followed by a progression to soft dict. He remained stable and was later discharged.

TREATMENT

CASE PRESENTATION TrossMark

Sava T. et al. BMI Case Re

A 28-year-old man was brought to the emergency room within 30 min of a ganshot wound to the OUTCOME AND FOLLOW-UP abdomen. On presentation, he was vitally stable On the 10th day postdischarge, he was followed up with no peritoneal signs. On examination, he had in the clinic; he had returned to his normal daily sustained a transabdominal ganshot injury, with the activities and regular diet. entry wound 2 cm above the left anterior superior iliac spine and exit wound just left lateral to the DISCUSSION

ransverse process of T12 vertebra with a tangential Although conservative management of blunt trajectory. His systemic examination was normal abdominal and stab wound injuries is well

REFERENCES ENENCES Web ELA, de Menezes MR, Cerri GG, Abdominal aumhot ucunt multi-detector voi CT findings compared with laparotomy861 a prospective study Temerg Radio 2012; 9:35–41. Como II, Bikhari E, Chiu WC, et al. Practice management guidelines for selective Non-operative management of a transabdominal gunshot wound (GSW) is a safe alternative to mandatory laparotomy perative management of penetrating abdominal trauma. J Tourna 2010;68:721-33 in a select group of patients. Come II. Rokhari F. Chiu WC. et al. Practice management quidelines for set Non-operative management has a role in a resource stricker ent, where geo-political situations result in A clinical abdominal examination and CT scan are use iades D. Toutouzas KG, et al. Uropenitá trauna... Ann tools in mana anagement should be discontinued if the patients develo peritoneal signs and haemodynamic instability anagement of gunshot wounds of the anterior abdomen. An Acknowledgements The authors would like to thank Dr Sadia Raffique for her rav, 132: 178. dimahos GC, Demetriades D, Folarini E, et al. A selective approach to the management of gundhot wounds to the back. Am J Sure 1997: 174-342. Contributors SK - primary physician of potient, involved in treatment, mar writing. AP - involved in patient treatment and follow-up, manuscript revision einahos G. Demetriades D. Toutouzis K. et al. Uropenital trauma . Ann Surp anazzipt writing, literature search. NH - manazzipt writing, literature search, ,234:395–402. ahos GC. Demetrios Demetriades MD, Corrowell III EE, et al. Gunshot wound Vernames GC, Demetration Dimension Inc), Convent III al., P. al. Construct worked to the battacks. *Dis Colon Resture* 1997;40:307–11. Vernahles GC, Demetrations, C. Cennell III E. Teanpalvic gumhet wounds: notine laparoteny or selective management? World J Sagr 1998;22:1034–8. Competing interests Non Patient consent Obtained. Demetriades D, Gomer H, Chahsan S, et al. Gumbot injuries to the liver: the role of selective nonsperative management, J Am Coll Surg 1999; 188:343–8. Provenance and peer review Not commissioned; externally peer reviewed.

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Build gueries from Learning points

Blank out one entity at a time

Identify medical entities

- Blanked-out entities become ground-truth answers
- Extend the ground-truth answers with synonyms in UMLS

query: A clinical abdominal examination and are useful tools in management.

answer: CT scan (CAT scan, computerized tomography, ...)

CASE REPORT

Conservative management of an abdominal gunshot injury with a peritoneal breach: wisdom or absurdity?

Salma Khan,1 Amyn Pardhan,1 Tufail Bawa,1 Naveed Haroon

abdominal gunshot injuries. The authors report a case of a 28-year-old man who sustained a transabdomina ourshot injury, which entered the anterior abdominal wall and exited adjacent to the T12 vertebra posteriorly with a tangential trajectory. On presentation, the patient was haemodynamically stable with no eritoneal signs. Based on trajectory of the bullet

Surgical exploration has been the standard of care for ination. The initial management consisted of keeping the patient nothing per oral, catheterisation, intravenous hydration and analgesia. Keeping the bullet trajectory in mind, left colonic and ureteric injury was highly suspected, despite a normal abdominal examination and stable haemodynamics.

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TREATMENT

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CASE PRESENTATION rossMark

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Comoe ting Patient con A 28-year-old man was brought to the emergency room within 30 min of a ganshot wound to the OUTCOME AND FOLLOW-UP abdomen. On presentation, he was vitally stable On the 10th day postdischarge, he was followed up with no peritoneal signs. On examination, he had in the clinic; he had returned to his normal daily sustained a transabdominal ganshot injury, with the activities and regular diet. ntry wound 2 cm above the left anterior superior

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Provenance and peer review Not commissioned: externally peer reviewed

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with no abnormality found on digital rectal exar

INVESTIGATION His complete blood count and serum creatinine remained normal and his haemoglobin and haematocrit did not drop at any point in time. A CI scan of the abdomen and pelvis was per ing delayed renal films. Images showed specks of free air behind the descending colon with no extravasation of contrast from the rectum and

A decision was made to manage this patient co

Build gueries from Learning points

- Identify medical entities
- Blank out one entity at a time
 - Blanked-out entities become ground-truth

> 100k instances (queries)

~56k different answers

avg. passage length: 1.5k tokens

answers with

examination and

are useful tools in management.

answer: CT scan (CAT scan, computerized tomography, ...)

Passage:	A 22-year-old woman presented to the emergency room with headache and confusion. The symptoms had woken her in the morning and progressively worsened through the day. Neurological examination demonstrated left lower facial paralysis with aphasia, dyscalculia, dyslexia and fingeragnosia, clinically Gerstmann syndrome. Further examination showed no abnormalities. A non-contrast head CT was performed and showed a left parietotemporal venous infarction and a small juxtacortical haemorrhage. An additional MR angiography showed occlusion of the left transverse sinus and a T2-weighted MRI showed a venous infarction with a juxtacortical haemorrhage just beneath the sulcus.
Query:	Upon performing an MRI, an accompanying was found near the bottom of the sulcus.
Answer:	juxtacortical haemorrhage

Source: BMJ Case Reports

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Baselines

Random and frequency-based selection

Language model

• Kneser-Ney LM to predict the most likely word/concept based on 3 preceding words in the query

Embedding-based

• Pick the concept whose context representation is maximally similar to the context of the query

A simple neural approach

Answer

palpation

... abdominal examination and ____ Query

... decision was made ...

Passage



Neural readers

Stanford attentive reader (Chen et al. 2016) (see previous slide)

Gated-attention reader (Dhingra et al. 2017)

- Adds iterative refinement of attention
- Answer prediction with a pointer

Key-value memory network (Miller et al. 2016)

- Memory keys: passage windows
- Memory values: entities from the windows
- Encoding word and entities as vector averages

pretrained biomedical word embeddings

answer candidates = passage entities

random search for hyperparameter selection

Human estimate

Answered 100 random instances from the development set

One person with medical background

One person without medical background

Comprehension skills

We annotated those 100 instances with all required skills

A set of 13 skills

Machine vs. human results



Additional observations

Human performance tops at 54 F1: Some queries may be unanswerable

Both MemNet and Stanford reader suffer from having a classifier on top with a huge output space

MemNet additionally lacks good encoding of input

Comprehension skills



Conclusion

A new dataset for clinical machine reading

- exploiting the structure of case report articles
- large and challenging
- varied skill requirements

We should be incorporating domain knowledge, object tracking, coreference resolution, temporal reasoning...

More information

Original paper:

Simon Šuster and Walter Daelemans (2018) CliCR: A Dataset of Clinical Case Reports for Machine Reading Comprehension. In NAACL.

Agreement with the publisher to freely distribute the dataset for research purposes (send me an e-mail)

Clinical NLP efforts at our lab: <u>https://clips.github.io/</u>

Our clinical NLP software: https://github.com/clips/accumulate

University of Antwerp's AI center: <u>https://antwerp.ai/</u>