Computationally-aided deep analysis of cancer metaphors in web-based text

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Workshop on Metaphor in Cancer Discourse
April 30, 2016
Road map

- Background: Metaphor computation and Applications to Cancer Discourse

- Objectives of MetaNet project

- Metaphor Identification System

- Cancer Study
Road map

- **Background: Metaphor computation and Applications to Cancer Discourse**

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- Case Study
Background: Metaphor

- How do we define ‘metaphor’?
  - Conceptual Metaphor Theory: not just linguistic trope
  - Not just linguistic, but language points to conceptually active metaphor(s)
  - Embodiment: primary metaphors are assumed universal (easier to formalize)
  - Asymmetric, systematic source to target mapping
Background: Metaphor

- How do we transition to computing metaphoric language?
  - Lexical items and expressions evoke frames
  - Frames populate source and target domains
  - Source and target domain language occur in predictable patterns (Sullivan 2007, 2013, Croft 2002)

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**SOCIAL PROBLEMS ARE PHYSICAL AFFLICTIONS**

- Social Problem
  - Crime
  - Poverty

- Physical Affliction
  - Disease

- Poverty is a Disease
  - poverty
  - impoverishment
  - destitution
  - Indigence ...

- Disease
  - disease
  - illness
  - sickness
  - sick ...

---

Words:
- crime
- felony
- criminal
- perpetrator
- poverty
- impoverishment
- destitution
- Indigence
Methods in researching metaphor

Trade-off between precision and breadth

**Method 1** - Human analyst: high precision, narrow breadth (Pragglejaz Group 2007)

**Method 2** – Current metaphor NLP methods: low precision, wide breadth (Shutova, Sun and Korhonen 2010, Shutova, Teufel & Korhonen 2012)

  - Seed-based systems; statistical metaphor processing; machine learning

**Method 3**: Corpus linguistic approach – a bit more precision AND a bit more breadth (Stefanovich & Gries 2006; Lederer 2015, 2016, forthcoming)

  - Collocational and Metaphor Pattern Analysis methods:
    - Search for target domain terms (*cure, treat, ailment, disease, cancer…*)
    - Search for source domain terms (*fight, beat, journey, win, war…*)
    - Search for target and source domain terms (*kick cancer, cancer journey…*)
Methods in researching metaphor

Method 4 – MetaNet aim:

- build human analyst intuitions into a computational system
- make system semi-automated with carefully-calibrated constraints
- have humans vet the results (keep good, discard bad)
- use human-vetted results to fine-tune the automation for further rounds.

A large-scale data extraction system that detects metaphorical language in a way that increasingly (over multiple iterations) mirrors human-like intuitions about what metaphor is and how it’s used.
Approaches to cancer discourse

Discourse analytic & corpus analyses

- Semino et al. (2015)
  - Hand-annotation (Method 1)
  - Corpus methods, collocations, concordances (Method 3)
  - Focus on Violence (war) and Journey metaphors across corpora
    specialized by author (patients vs. health professionals)

- Discourse analytic
  - Gibbs & Franks (2002)
    - women’s narratives of experience with cancer
    - Metaphors about cancer stem from other shared embodied metaphors from common experiences
    - We blend multiple metaphors within single discourse
  - In the medical (communication) field - Bowker 1996, Byrne et al. 2002, Skott 2002, Camus 2009
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Background: MetaNet Project

- Started in 2012 as part of IARPA’s Metaphor Program

- Initial objectives:
  - Build a multi-lingual metaphor repository
  - Automatically extract metaphors from text
  - Compare conceptual metaphors used by different groups and cultures in order to better understand their different beliefs and worldviews
Background: MetaNet System

- MetaNet metaphor identification system (Dodge, Hong, & Stickles 2015)
- 3 unique contributions of the MetaNet System
  - Repository of frames and metaphors in an ontological network
  - Constructional/syntactic patterns
  - Metaphoricity scoring system
- Processing method for metaphor discovery
- Output
  - Corpus annotated for frame semantic and metaphoric information, automatically rated for...
MetaNet: What can it be used for?

- Sorting out some of the known metaphors used to talk about a particular social domain –
  - Poverty
  - Democracy
  - Gun rights/Gun control
  - **Cancer**
- Finding frequencies of particular metaphors across prohibitively large corpora
- Finding frequencies of particular metaphors across
  - genres of texts (blogs vs. news wire vs. forum conversations vs. Twitter)
  - viewpoints/authors (progressive/conservative, doctor/patient/institutional, etc.)
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MetaNet system diagram
MetaNet system diagram

Linguistic Analysis

Cognitive Linguistic Resources
- Repository of frames and metaphors
- Constructional patterns
- Metaphoric relational patterns

Extraction Process
Text preprocessing
Custom system processing

Text Resources
Gigaword, BNC corpora
Hand-built web corpora
Gold standard

Linguistic Metaphors Database
- Automatically annotated:
  Frame
  Metaphor
  Construction
  Lemma, Wordform

Data Analysis

Data Analysis Toolkit
- Repository viewer
- Visualization tool
- Statistical analysis
Metaphor Repository

• Networks of frames and conceptual metaphors
  • Metaphors represented as mappings between frames (Lakoff & Johnson, 1980; Fillmore, 1976; Ruppenhofer et al., 2010)

• Metaphors for new domains build on frames and metaphors that are already in the repository
Category:Frame

This is the Frame category. This category uses the form Frame.

Create or edit a Frame:

Total number of Frame pages: 656

A
- Ability to act
- Absorption
- Access
- Access to a location
- Access to an object
- Access to education
- Access to knowledge
- Accompany
- Across
- Action
- Activity
- Addiction
- Addressing poverty
- Addressing social problems
- Adoption
- Advocacy

E cont.
- Evil
- Evil creature
- Excess body weight
- Existence
- Experience pain
- Experiencing a negative state
- Experiencing a state
- Experiencing an economic status
- Extinguish

F
- Factory
- Fairness
- Family
- Fierce animal
- Finance
Frame: Cancer

Roles:
- cancer
- patient
- body_part

Lexical Units:
- cancer.n
- cancerous.a
- malignant.cell
- lymphoma.n

Other Frame Info:
- Inferences
- Relations to other frames
- Family: Disease
Frame: Cancer

<table>
<thead>
<tr>
<th>Role Name</th>
<th>Definition/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>cancer</td>
<td></td>
</tr>
<tr>
<td>cancer_patient</td>
<td></td>
</tr>
<tr>
<td>cancerous_body_part</td>
<td></td>
</tr>
</tbody>
</table>

Relevant Lexical Units:
- Lepos cancer.n
- Lepos carcinoma.n
- Lepos cancer cell.n
- Lepos melanoma.n
- Lepos cancerous.a
- Lepos cancerous tumor.n
- Lepos malignant cell.n
- Lepos leukemia.n
- Lepos lymphoma.n
- Lepos breast cancer.n
Frame: Cancer

Related Frames:

<table>
<thead>
<tr>
<th>Current Frame:</th>
<th>Cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relation Type:</td>
<td>is subcase of</td>
</tr>
<tr>
<td>Related Frame:</td>
<td>Disease</td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
</tr>
</tbody>
</table>

Metaphors that use this frame:

<table>
<thead>
<tr>
<th>as Target frame</th>
<th>as Source frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>• CANCER IS A JOURNEY</td>
<td></td>
</tr>
<tr>
<td>• CANCER IS PHYSICAL COMBAT</td>
<td></td>
</tr>
<tr>
<td>• SURVIVING CANCER IS HARMING CANCER</td>
<td></td>
</tr>
<tr>
<td>• SURVIVING CANCER IS WINNING A COMPETITION</td>
<td></td>
</tr>
</tbody>
</table>
Disease frame family
Metaphor: CANCER IS PHYSICAL COMBAT

<table>
<thead>
<tr>
<th>Source Frame</th>
<th>Physical combat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Frame</td>
<td>Cancer</td>
</tr>
</tbody>
</table>

**Mappings:**

<table>
<thead>
<tr>
<th>cancer_patient</th>
<th>&lt;= fighter1</th>
</tr>
</thead>
<tbody>
<tr>
<td>cancer</td>
<td>&lt;= fighter2</td>
</tr>
</tbody>
</table>

**Related Metaphors:**

<table>
<thead>
<tr>
<th>Current Metaphor</th>
<th>CANCER IS PHYSICAL COMBAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relation Type</td>
<td>is related to</td>
</tr>
<tr>
<td>Related Metaphor</td>
<td>CANCER PATIENT IS PHYSICAL COMBATANT</td>
</tr>
<tr>
<td>Description</td>
<td></td>
</tr>
</tbody>
</table>
Cancer metaphor family

- PURPOSEFUL ACTION IS SELF-PROPELLED MOTION TO A DESTINATION
  - is both a source and target subcase of
  - CANCER IS A JOURNEY

- CANCER IS PHYSICAL COMBAT
  - is related to
  - CANCER PATIENT IS PHYSICAL COMBATANT
  - as a mapping within
  - SURVIVING CANCER IS HARMING CANCER

- DISEASE TREATMENT IS WAR
  - as a target subcase of
  - CANCER TREATMENT IS WAR
Extraction Process

Linguistic Analysis

Cognitive Linguistic Resources
- Repository of frames and metaphors
- Constructional patterns
- Metaphoric relational patterns

Extraction Process
- Text pre-processing
- Custom system processing

Text Resources
- Gigaword, BNC corpora
- Hand-built web corpora
- Gold standard

Linguistic Metaphors Database
- Automatically annotated:
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  - Lemma, Wordform

Data Analysis

Data Analysis Toolkit
- Repository viewer
- Visualization tool
- Statistical analysis
Extraction process overview

- Corpus pre-processing using standard NLP methods

  - Text Input and Preprocessing
  - POS Tagging (TreeTagger)
  - Lemmatization (TreeTagger)
  - Dependency parsing

Large corpora
- BNC for English
- Gigaword corpora for English, Spanish, Russian
- SUBTLEX
- GloWbE
- Web corpora

Gold standard
- Hand-annotated examples
Metaphor extraction process

1. Term search
2. Constructional pattern matching
3. Metaphor likelihood estimation
4. Linguistic metaphors

Filter by terms in the corpus:

• Target term(s) for a given semantic domain, e.g. cancer, lymphoma, cancerous, …

OR

• Source term(s) for a given semantic domain, e.g. battle, fight, war, defeat, enemy…

Dodge, Hong, & Stickles NAACL Proceedings 2015
Metaphor extraction process

Conceptual metaphors are typically expressed in particular syntactic patterns

Target and source lexemes reliably occupy certain grammatical slots. (Croft 2002; Sullivan 2013).

E.g.:
• Source is verb, Target is argument: Prices rose
• not Target is verb, Source is argument: ??Higher locations priced
## Metaphoric constructions

<table>
<thead>
<tr>
<th>Constructional pattern</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-subj_S-verb</td>
<td>cancer strikes</td>
</tr>
<tr>
<td>S-verb_T-dobj</td>
<td>battle cancer</td>
</tr>
<tr>
<td>S-verb_Prep_T-noun</td>
<td>move beyond cancer /battle with cancer</td>
</tr>
<tr>
<td>S-noun_of_T-noun</td>
<td>onslaught of disease</td>
</tr>
<tr>
<td>T-noun_poss_S-noun</td>
<td>cancer’s journey</td>
</tr>
<tr>
<td>S-noun_prep_T-noun</td>
<td>war on cancer</td>
</tr>
<tr>
<td>T-noun_mod_S-noun</td>
<td>cancer journey</td>
</tr>
<tr>
<td>S-adj_mod_T-noun</td>
<td>hostile disease</td>
</tr>
<tr>
<td>T-noun_con_S-noun</td>
<td>cancer is a very aggressive</td>
</tr>
</tbody>
</table>
Constructional pattern matching process

• Identify candidate items which appear in appropriate constructional pattern

• E.g., if Target term is *cancer*:
  Construction: Target(noun) – Source(noun)
  • cancer journey
  • cancer cure
Constructional pattern matching process

• Identify candidate items which appear in appropriate constructional pattern

• E.g., if Target term is cancer:
  Construction: Target(noun) – Source(noun)
  • **cancer** journey
  • **cancer** cure

• Constructional patterns are a necessary constraint on metaphoric expression, but are not sufficient to guarantee metaphoricity
Metaphor extraction process

1. Term search
2. Constructional pattern matching
3. Metaphor likelihood estimation
4. Linguistic metaphors

Assess metaphoricity of candidate expressions:

- Candidate source and target terms are associated with the frames they evoke within repository
- Repository is searched to determine the relational path(s) that connect these two frames
- Expressions are scored 0-1 based on the path
Non-metaphoric pattern: *cancer cure*
Metaphoric pattern: *cancer journey*

**Cancer is a journey**

- **Cancer**
  - cancer.n
- **Journey**
  - journey.v
Metaphor extraction process

1. Term search
2. Constructional pattern matching
3. Metaphor likelihood estimation
4. Linguistic metaphors
**Corpus Database**

<table>
<thead>
<tr>
<th>COLLECTION</th>
<th>glowbe_cancer_4_27_2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>FORM</td>
<td>Search for a target form</td>
</tr>
<tr>
<td>LEMMA</td>
<td>cancer</td>
</tr>
<tr>
<td>FRAME</td>
<td>Search for a target frame</td>
</tr>
<tr>
<td>FRAME FAMILY</td>
<td>Search for a target frame family</td>
</tr>
<tr>
<td>CONCEPT</td>
<td>Search for a target domain</td>
</tr>
<tr>
<td>CONCEPT GROUP / CORENESS ABOVE</td>
<td>Search for a target concept group</td>
</tr>
<tr>
<td>CONSTRUCTION</td>
<td>Specify a construction</td>
</tr>
<tr>
<td>SCORE AT LEAST</td>
<td>Specify a lower limit for LM score</td>
</tr>
<tr>
<td>SEARCH CRITERIA</td>
<td>source lemma: fight target lemma: cancer</td>
</tr>
</tbody>
</table>

**Search Results**

<table>
<thead>
<tr>
<th>SENTENCE</th>
<th>LMS</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>My wife has been <strong>fighting</strong> Sarcoma <strong>cancer</strong> for 2 years now.</td>
<td>1</td>
<td>glowbe_blogs:439</td>
</tr>
<tr>
<td>Everyone needs a little fun and games in life (especially when you’re <strong>fighting</strong> cancer).</td>
<td>1</td>
<td>glowbe_blogs:399</td>
</tr>
<tr>
<td>You can <strong>fight</strong> cancer in many ways.</td>
<td>1</td>
<td>glowbe_blogs:454</td>
</tr>
</tbody>
</table>
The **cancer** that we face is a resilient **enemy**.

The ICR's mission is to make the discoveries that **defeat** **cancer**.

Urologist believes **cancer** is **confined** to the prostate.

Although his **cancer** burden was tremendous, his markers were never out of the normal range.

Not laughing simply because your life isn't going the way you would prefer - gives **cancer** power to have greater control over your life than it deserves.

Putting a Positive **Spin** on **Cancer**.

It's depressing to think that on top of **cancer**, you need to worry about your cat's loyalty too.

**nov/24/13**-sadly but peacefully moms **cancer** journey is at an end, she will start her new spiritual journey together hand in hand with dad.

Finding Peace While **Fighting** **Cancer**.

some of us may live longs lives while **fighting** **cancer**.

**nov/24/13**-sadly but peacefully moms **cancer** journey is at an end, she will start her new spiritual journey together hand in hand with dad.

Surgical removal is the best one can hope for as an initial strategy, if it's staged low enough and the **cancer** burden is small.

Chemo is typically used as clean up, as this **cancer** travels through the lymph, blood system.

You'll find plenty of seemingly healthy people -- some who have never smoked and others who quit smoking decades earlier -- that lung **cancer** attacks.

Live life and breathe it in, stay positive and **defeat** CANCER.

**nov/24/13**-sadly but peacefully moms **cancer** journey is at an end, she will start her new spiritual journey together hand in hand with dad.

It could be paraneoplastic syndrome as a result of the **cancer** burden.
Help me in the **fight** against **cancer**.
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Database and Data Analysis

Linguistic Analysis

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Cancer in online patient discourse

• Goals:
  • Investigate metaphoric construal of cancer in patient discourse
  • Adapt current repository
    • new target domain – cancer
    • new type of corpora – blog/forum data
Cancer in online patient discourse

• Challenges:
  • Prior investigations focused on Disease as a source domain (*cure* poverty, *gun* epidemic, etc.)
• Differences in genre
  • Specialized jargon and slang: *mets* (metastases), *chemo*
  • Casual discourse – increased slang, shorthand; non-standard syntax
Methods

• Corpora
  • Global Web-based English (Davies 2013), American blogs
    • 48,116 websites
    • 106,365 webpages
    • 133,061,093 words
  • Collected data from 3 cancer patient forums
    • 656,171 words

• Repository
  • Increased coverage of Cancer domain
  • Added metaphors based on cancer metaphor literature
Methods

- Global Web-based English (GloWbE)
  - Extracted only metaphors with Cancer, Cancer Treatment, Cancer Patient target domains

- Forum data
  - Extracted metaphors with any Disease-related target domain
  - *Source domain* search focused on Physical Combat and Motion source domains
    - Extracted any metaphors with Physical Combat or Motion source domains, regardless of target domain
Results: Frequent source domains

- Violence: High percentage
- Competition: Moderate percentage
- Journey: High percentage
- Other: Moderate percentage
Violence metaphors

Cancer as an enemy or harmful entity

The cancer that we face is a resilient enemy.

Cancer is such a sneaky monster! You just never know when it's going to rear its ugly head.

Physical combat with cancer

Live life and breathe it in, stay positive and defeat Cancer.

You kick some cancer butt, girl!

Mom battled breast cancer for nearly 12 years from Stage IIIA, to Stage II recurrence, to Stage IV mets.

Cancer as the attacker

You'll find plenty of seemingly healthy people -- some who have never smoked and others who quit smoking decades earlier -- that lung cancer attacks.

Cancer treatment as weaponry

Remember that 'good nourishment' is a crucial weapon in the fight against cancer and any illness.
Journey metaphors

Cancer treatment as a path with recovery as destination

Thanks again to everyone for keeping the newcomers informed of your journeys to recovery.

Share your personal story, diagnosis and treatment path, and stories of survival, hope and success.

It is expensive for the insurance companies to approve, hence, it appears to be the *last* in the list (at least, this was how it went with my sister’s long, long road to diagnosis).

Different treatments are different

I am located in Canada, could have had HIFU here, but would have been required to go biopsy route, so Wheeler and London it was.

Experience of cancer as a path

I think too often, we, the members of this board, try to soften the blow to others who have just started down the cancer road.

nov/24/13-sadly but peacefully moms cancer journey is at an end, she will start her new spiritual journey together hand in hand with dad.
Competition metaphors

I want you to know that cancer will not win.

I am not ready to let this cancer win.

Armstrong's triumph over cancer and his tireless efforts to fund medical research were the contributions in his popularity -- not Jenkins's glowing prose.

Every round we win is worth ringing the bell for.
Some other source domains

Cancer as moving entity

Palliative radiation would only have helped with any pain she was experiencing, but it wouldn’t slow down the cancer as there are micro-metastatic cancer cells traveling via her blood system.

Seaweeds such as fucoidan and kombu, eaten in Asia, contain molecules that slow cancers of the breast, prostate, skin and colon cancer.

Ridding the body of colon plaque and buildup is the most effective way to stop cancer of the bowel, digestive issues and to improve kidney and liver function.

While billions, trillions?, of dollars were spent on cancer research, the legal status of cannabis prevented even basic research into what is turning out to be the best hope for cancer prevention or understanding how to stop metastatic cancers from spreading.

If they catch the cancer at its earliest stages, they may be able to forego the terrible stress and strain of lumpectomy and six weeks of radiation or a mastectomy.

My physiotherapist even suggested that I could have paraneoplastic syndrome—basically you get symptoms from your immune system trying to contain the cancer before it’s even detectable.
Some other source domains

Shadow of cancer

I know we will forever live under the cancer shadow, but as the doctor's nurse practitioner told us, healthy people face death in an instant, whether it's an oncoming bus or a plane crash.

If we don't move out of the shadow of cancer ... 

Cancer burden – technical use

One thing I can tell you is that the human body is an amazing work of art and often can continue to thrive even with a heavy cancer burden.
Results: Frequent metaphors

- Physical combat: 45%
- Competition: 10%
- Journey: 20%
- Disease motion: 5%
- Other: 10%
Results: Frequent metaphors
Results: Constructions (Cancer Frame)
Results: lemmas in *verb cancer*

Survivor, I am **fighting** **cancers** for 23 years now.

It's a very emotional song about **battling** **cancer**
Results: lemmas in *cancer* verb

- cancer doesn't seek out people who have
- Cancer didn't beat me
- the cancer progresses

<table>
<thead>
<tr>
<th>Verb</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>run</td>
<td>10</td>
</tr>
<tr>
<td>seek</td>
<td>9</td>
</tr>
<tr>
<td>catch</td>
<td>7</td>
</tr>
<tr>
<td>progress</td>
<td>6</td>
</tr>
<tr>
<td>contain</td>
<td>5</td>
</tr>
<tr>
<td>beat</td>
<td>5</td>
</tr>
<tr>
<td>chase</td>
<td>5</td>
</tr>
<tr>
<td>fight</td>
<td>5</td>
</tr>
<tr>
<td>link</td>
<td>5</td>
</tr>
<tr>
<td>suck</td>
<td>5</td>
</tr>
</tbody>
</table>
Source domain search: No explicit target lemma

Source: Battle

I too realize tiny resistance fighters living in my breast, my own Polish forest, beating away the Nazis inside of me.

We all deserve the metal of honor as we are the soliders on the frontline of a terrible struggle.

Pat is a savior to a lot of us fighting the battle.

At your stage, surgery will give you the absolute best chance of beating this thing for good.

Source: Journey

I just want to help in any way I can since we're all in this mysterious journey searching for the hope of an end of the tunnel! Thanks =).

Not an easy journey for any of us.

This applies also to those traveling the road with us.
Summary

• Existing system, with minimal extensions, was used for large scale, automatic identification of metaphors in text.

• Database of examples includes many examples of previously studied metaphors, as well as some novel metaphors.

• Quantitative analysis expands beyond discourse-analytic approaches.

• Rich annotation, in conjunction with repository of frames and metaphors, supports analysis along different dimensions, at different levels of granularity.

• Future work:
  • Comparing patient vs. doctor discourse
  • Changes in metaphor use over illness time course
Summary

• Linguist-friendly wiki for formally representing conceptual metaphor theory and analyses

• Repository of conceptual metaphors and frames

• System that automatically identifies metaphor in large-scale corpora, producing a database of richly annotated metaphor examples

• Data analysis toolkit that enables semantic analysis and iterative refinement both of the metaphor repository and of conceptual metaphor theory
References


Lederer, J. (Under Review). Triggering metaphorical thought: How corpus methodologies aid in...
References


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Thank you!

- During the lunch break we will be providing laptop stations where you can explore and navigate through the MetaNet Wiki and Metaphor Viewer.