A Hard Look at Soft Concepts

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Daniel Gilbert: Psychologists’ Oath

“The human being is the only animal that...”
“The human being is the only animal that...”

- Language?
- Tools?
- Chess/Go?
Here Be Dragons

• Still many areas that are considered outside the reach of CS (soft concepts).
• Such territories define intriguing CS challenges
  – Improvements to HCI + collaboration
Two Approaches

• The *axiomatic* approach:
  – Formalize intuitive concepts
  – Craft an objective function to emulate elusive intuitions

• ... can be difficult.

• The *data-driven* approach:
  – Use data to guide the objective formulation
Axiomatic approach:
Metro Maps of Information
So, you want to understand a complex story...
Search Engines are Great

About 57,500,000 results.

How do they fit together?
Proposed System: Metro Maps

• Input: A set of documents
• Output: A map -- a **set of storylines**
• Each line follows a **coherent** narrative thread
• **Temporal Dynamics + Structure**

**Example: Greek debt crisis Map**

- labor unions
- Merkel
- bailout
- Germany
- protests
- austerity
- strike
- junk status

Deal Appears Forthcoming for Bailout on Greek Debt

LONDON — Euro zone leaders prepared the way on Friday for the approval of a fresh $130 billion bailout for Greece at a meeting of European finance ministers scheduled for Monday.

The bailout is needed to avert a potentially devastating Greek default, which would roil European financial markets and beyond. After a conference call, Chancellor Angela Merkel of Germany, Prime Minister Luke D. Rumford of Greece and Prime Minister Mario Monti of Italy issued a statement on Friday saying they were confident a bailout deal could be reached Monday.
Finding Good Maps

• Hard problem!
• Our (axiomatic) approach:
  • What makes a good map?
  • How to formalize it?
  • How to optimize it?
Properties of a Good Map

1. Coherence
Coherence: Main Idea

- How to measure coherence of a chain of documents?
- Strong transitions
Coherence: Main Idea

• Strong transitions not enough

Incoherent: Each pair shares different words
Coherence: Main Idea

- Coherence is a global property

Coherent: a small number of words captures the story
Coherence\left(d_1, \ldots, d_n\right) =

\max_{\text{activations}} \min_{i=1 \ldots n-1} \sum_{w} \text{Influence}(d_i, d_{i+1} | w) \mathbb{1}(w \text{ active in } d_i, d_{i+1})

\forall w \quad \text{active}_{w,0} = 0

\forall w \quad \sum_{i} \text{init}_{w,i} \leq 1

\forall i \quad \sum_{w} \text{active}_{w,i} \leq k\text{Trans}

\sum_{w,i} \text{init}_{w,i} \leq k\text{Total}

\forall w,i \quad \text{active}_{w,i} \leq \text{active}_{w,i-1} + \text{init}_{w,i}
Properties of a Good Map

1. Coherence

2. Coverage

3. Connectivity
Mathematical Formulation

Optimization Problem: Linear Programming + Rounding

1. Coherence

\[
Coherence(d_1, ..., d_n) = \max_{\text{activations} \ i=1...n-1} \min \sum \text{Influence}(d_i, d_{i+1} \ | \ w) \ 1(w \ \text{active in} \ d_i, d_{i+1})
\]

Algorithm with \textbf{theoretical guarantees}

\[
\sum w \lambda \cdot \left( 1 - \prod_i (1 - \text{cover}_{d_i}(w)) \right)
\]

Encourage Line Intersection

2. Coverage

3. Connectivity

\[
Connectivity(\mathcal{M}) = \sum_{i<j} 1(\pi_i \cap \pi_j \neq \emptyset)
\]
Example Map: Greek Debt

Bottom line:
maps are more useful as **high-level** tools for stories **without a single dominant storyline**

- Greece Struggles to Stay Afloat as Debts Pile On
- E.U. Official Backs Greece's Deficit Cutting Plan
- EU Sets Deadline for Greece to Make Cuts
- Greek economy
- Greek Workers Protest Austerity Plan
- Greeks Take to the Streets, but Lacking Earlier Zeal
- Greek Civil Servants Strike Over Austerity Measures
- Greece Paralyzed by New Strike
- Infighting Adds to Merkel’s Woes
- Deficit Cutting Plan
- Euro Unity? It’s Germany That Matters
- Germany Now Says I.M.F. Should Rescue Greece
- U.K. Backs Germany’s Effort to Support Euro
- I.M.F. More Likely to Lead Efforts for Greek Aid
- I.M.F. Is Urged to Move Forward on Voting Changes

Greek bonds rated 'junk' by Standard & Poor's

Greek economy

- Strikes and Riots
- IMF
- Germany and the EU

I.M.F. More Likely to Lead Efforts for Greek Aid

Bottom line: maps are more useful as high-level tools for stories without a single dominant storyline
So, you want to understand a complex news story...
Application 2: Science

• **Goal:** Understand the *state of the art*
  – What is reinforcement learning up to?

• Data: ACM Papers
Example Map: Reinforcement Learning

- **1998**: Elevator Group Control Using Multiple Reinforcement Learning Agents
  Cites, Barto | Mach. Learn.
- **1999**: Partially observable Markov decision processes (POMDPs) extend stochastic games
- **2000**: Reinforcement learning of coordination in cooperative multi-agent systems
  Kapetanakis, Kudenko | AAAI
- **2001**: Efficient reinforcement learning in factored MDPs
  Kearns, Koller | UAI
- **2002**: POMDPs: A policy search method for large MDPs and POMDPs
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Application 3: Legal

- **Goal**: Help lawyers argue a case
- **Data**: Supreme court decisions

Information Cartography [S, Guestrin, Horvitz, Leskovec CACM’15]
Commerce Clause
Application 4: Books

- **Goal:** Structure of a book

- Data: Lord of the Rings
Lord of the Rings Map

At the Shire
Merry
Bilbo
Gandalf
Sam
Frodo
Pippin
Council of Elrond
Aragorn
Legolas
Gimli
Elrond
Gandalf
Frodo
Pippin
Merry
Sam
Frodo
Gollum
Saruman
Sauron
Metro Maps: Recap

• A news-reader, a first-year student, a paralegal ...
  – Used to rely on search
  – Can now get *perspective* on the field
  – See *structure* and *connections*

• *User studies* validate our method
Data-Driven approach:
Inside Jokes: Identifying Humorous Cartoon Captions
Computational Perspective on Humor

- Mysterious aspect of human intellect

Inside Jokes [S, Horvitz, Mankoff KDD’15]
Applications to Data Mining

• An important dimension of **digital content**
  – Human-computer interaction
  – Communication
  – Education
  – Advertising
Tesla Stock Moves on April Fools’ Joke
Algos Fall For An April Fool’s Joke, Send TSLA Surging

Facebook Is Testing A 'Satire' Tag Since Users Think The Onion Articles Are True

NCAA Investigating God For Giving Gifts To Athletes
Problem: Automatically Rank Captions
Properties of a Good Caption

• Funny
  – ???
  – Hard to define axioms: **Data-Driven**!
Constructing a Dataset

It’s a hybrid.
Just don’t kick the tires.

16 cartoons

~5000 pairs with wide agreement
Comparing Captions

• Extract **linguistic features**
  – Length, polarity, joke position, readability, perplexity, parts-of-speech...
Advanced Features

1. We don’t know joke position
   • Joke: Lowest perplexity

   It gets 25 miles per rabbit. And this is our paleo model. It runs entirely on kitchen scraps. And the gas mileage is incredible.

2. Take cartoon into account
Bridging Normal and Odd parts

Background context
- car, salesman

word2vec distances

Caption terms
- goat, miles

Anomalous foreground
- animal, legs
Bridging Normal and Odd parts

Context: office, workplace, secretary, phone
Anomaly: stairway, sky, heaven
Joke Similarity to Context and to Odd Elements of the Cartoon

Yes, you really can buy a stairway to heaven.

I'll have him call you back after the rapture.

Climbing the corporate ladder feels much flatter these days.

The CEO just took the golden parachute...

Our technician is addressing the problem with the cloud.

You just missed him. He stepped up to Accounting.

He's always wanted to be C.E.O. of the world.

I'm sorry, he just stepped out of the office.
What We Learned

• Use simple grammar... but surprising words
  – *It gets 35 miles per goat.*

• Avoid proper nouns
  – *Oh my God, Florenz Ziegfeld has gone to heaven!*
  – Failure mode: *NSA*

• Present the joke later

• Bridge the normal and odd parts of the cartoon

• **Prediction accuracy:** 64%
  (69% for variations of the same joke)
Finding Best Jokes

• Current: read 5000 entries per cartoon
• **Goal**: save intern’s sanity!
• We know how to compare two captions...
• Hold a **tournament**
  – Pair captions against each other
  – Swiss-system tournament (non-eliminate):
    Win, lose, or tie
  – Construct a **ranking**
Ranking (Example)

**Top**
- Just listen to that baby purr.
- ...and it won't cost you arm and a leg.
- Best to not kick the tires.
- Just don't ask for leather.
- You'll save thousands on tires.

**Bottom**
- The previous owner played Frisbee.
- This is the Mordor package.
- Yes, GMM! Genetically Modified Mechanism!
- No gas. No nightly recharging! Just...um...
- We call her a 2015, but technically she's a 14105.
Value of Method

• Evaluation
  – ~10 funniest captions identified for each cartoon
  – When sorted by method, when can I stop going down list to find all 10?
Value of Method

• On average, all appeared in the top **55.8%**
  – Best: 48.9%, worst: 71.4%

• Tradeoff:

*Even better if allowing close matches!*

Read 10%, find 37% of shortlist

Read 50%, find over 80%
Conclusions

- **Soft concepts** offer intriguing CS challenges
- Many applications for HCI + collaboration
- **Axiomatic** approach
  - Metro maps of information
  - Coherence, coverage, connectivity
- **Data-driven** approach
  - Automatically rank humor of captions
- Many other concepts
  - Suggestions?

Thank you!