

Lensing Machines: Representing Perspective in Machine Learning

Karthik Dinakar ¹
and Henry Lieberman ²

¹ Media Lab ² Computer Science & AI Lab (CSAIL)
Massachusetts Institute of Technology



Point of view is valuable for problem solving

“A perspective is worth 80 IQ points. A change in perspective is worth another 80 IQ points”

~ Alan Kay

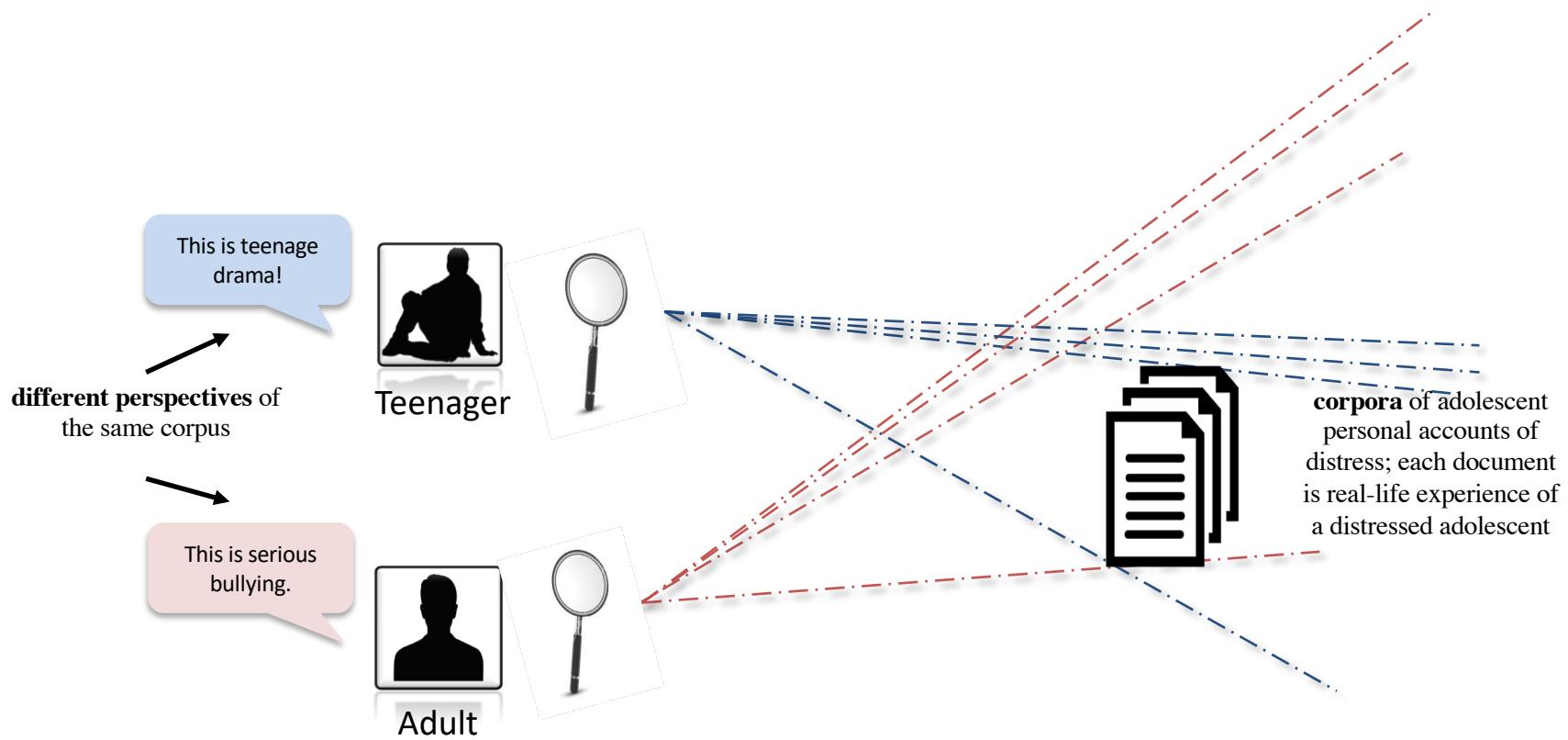


Machine learning is good at
aggregating data

When data comes from people,
you tend to lose the perspective of
individuals or subgroups

No easy way to incorporate
outside perspectives

Different points of view on the same data



Informants and Annotators



Annotators (e.g. patient)

Give a *baseline* view of the data
Lots of them provide “big data”
May represent naïve, or mixed, views of data

Informants (e.g. doctor/researcher /subset of patients)

Have unique or valuable perspectives
Know stuff *outside* the system
Not so many of them
They might be able to explain *why*
They *critique* the data and model by example
Amplify their perspective

Cardiac diagnosis guidelines were changed as a result of our work

Journal of the American College of Cardiology

Current Issue Just Accepted Arch

≡ SECTIONS PDF DOWNLOAD CITATION Multimedia References Related Details

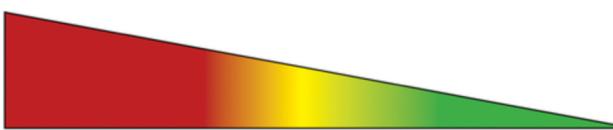
1.3 Defining Chest Pain

Figure 2 presents an index of suspicion that chest "pain" is ischemic in origin based on commonly used descriptors.

Recommendations for Defining Chest Pain

Referenced studies that support the recommendations are summarized in [Online Data Supplements 1 and 2](#).

COR	LOE	Recommendations
1	B-NR	1. An initial assessment of chest pain is recommended to triage patients effectively on the basis of the likelihood that symptoms may be attributable to myocardial ischemia. (9-15)
1	C-LD	2. Chest pain should not be described as atypical, because it is not helpful in determining the cause and can be misinterpreted as benign in nature. Instead, chest pain should be described as cardiac, possibly cardiac, or noncardiac because these terms are more specific to the potential underlying diagnosis.



• Central	• Left-sided	• Stabbing	• Right-sided	• Sharp
• Pressure	• Dull		• Tearing	• Fleeting
• Squeezing	• Aching		• Ripping	• Shifting
• Gripping			• Burning	• Pleuritic
• Heaviness				• Positional
• Tightness				
• Exertional/stress-related				
• Retrosternal				

View Article | Google Scholar

18. Kreatsoulas C., Dinakar D., Mehta S., et al. "Machine learning to evaluate gender differences in typical and atypical angina among patients with obstructive coronary artery disease. ESC Congress 2019. Paris, France". 2019.

[Google Scholar](#)

19. DeFilippis E.M., Collins B.L., Singh A., et al. "Women who experience a myocardial infarction at a young age have worse outcomes compared with men: the Mass General Brigham YOUNG-MI registry". Eur Heart J 2020;41:4127-4137.

[Crossref](#) [Medline](#) [Google Scholar](#)

20. Grosmaire P., Le Vasseur O., Yachouh E., et al. "Significance of atypical symptoms for the diagnosis and management of myocardial infarction in elderly patients admitted to emergency departments". Arch Cardiovasc Dis 2013;106:586-592.

[Crossref](#) [Medline](#) [Google Scholar](#)

21. Leifheit-Limson E.C., D'Onofrio G., Daneshvar M., et al. "Sex differences in cardiac risk factors, perceived risk, and health care provider discussion of risk and risk modification among young patients with acute myocardial infarction: the VIRGO study". J Am Coll Cardiol 2015;66:1949-1957.

[View Article](#) [Google Scholar](#)

Lensing is a form of *knowledge acquisition*

We want to both

- "Learn from the data", *and*
- Leverage expert knowledge / Leverage minority knowledge

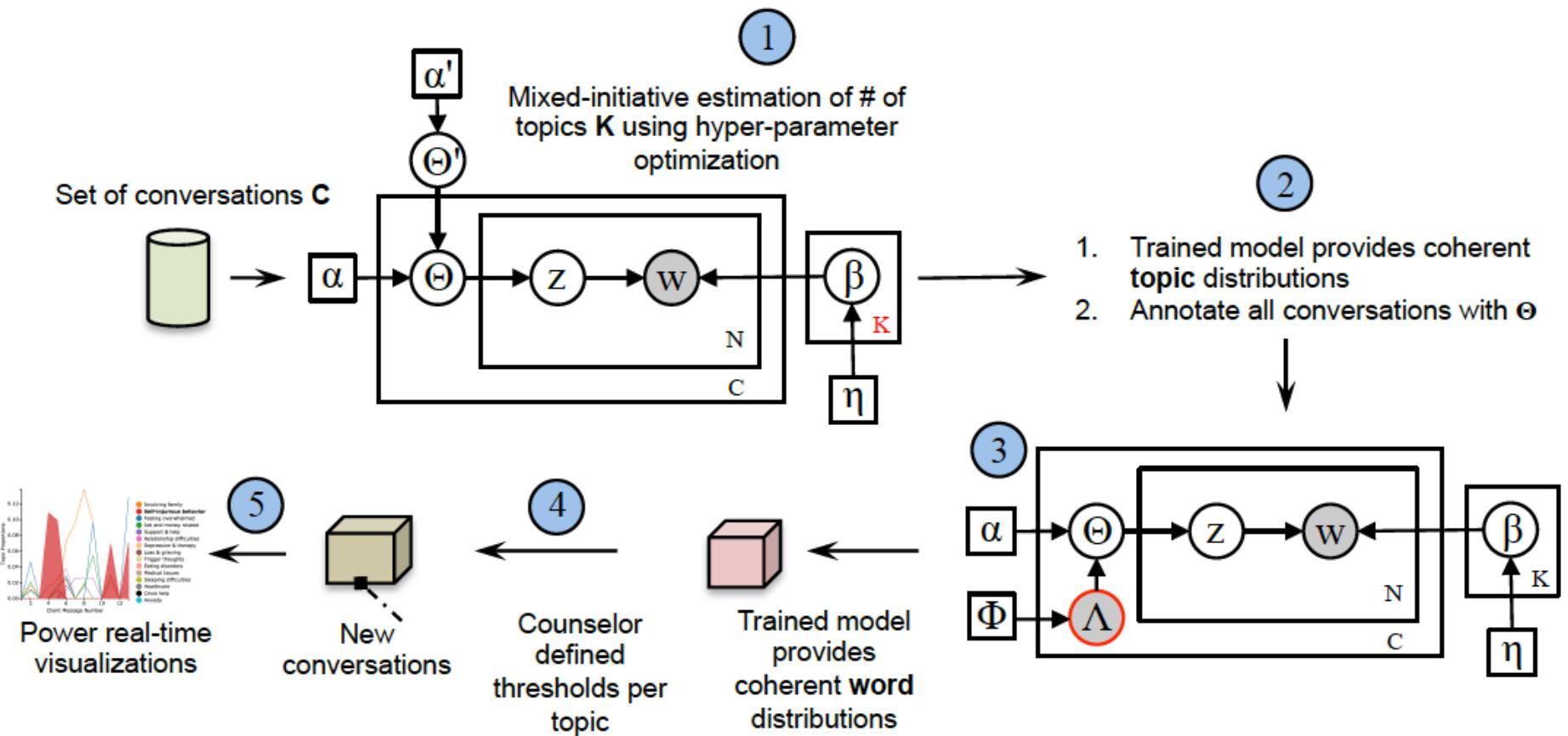
Traditional expert systems methodology had problems:

- Brittleness, expense of acquisition, scale, maintenance, etc.
- Many of those problem addressed by machine learning

We propose a *mixed-initiative* workflow:

- Machine learning analyzes data according to a model
- Informant *critiques* model by example: we extract a *lens*
- The lens is fed back into the next iteration of analysis

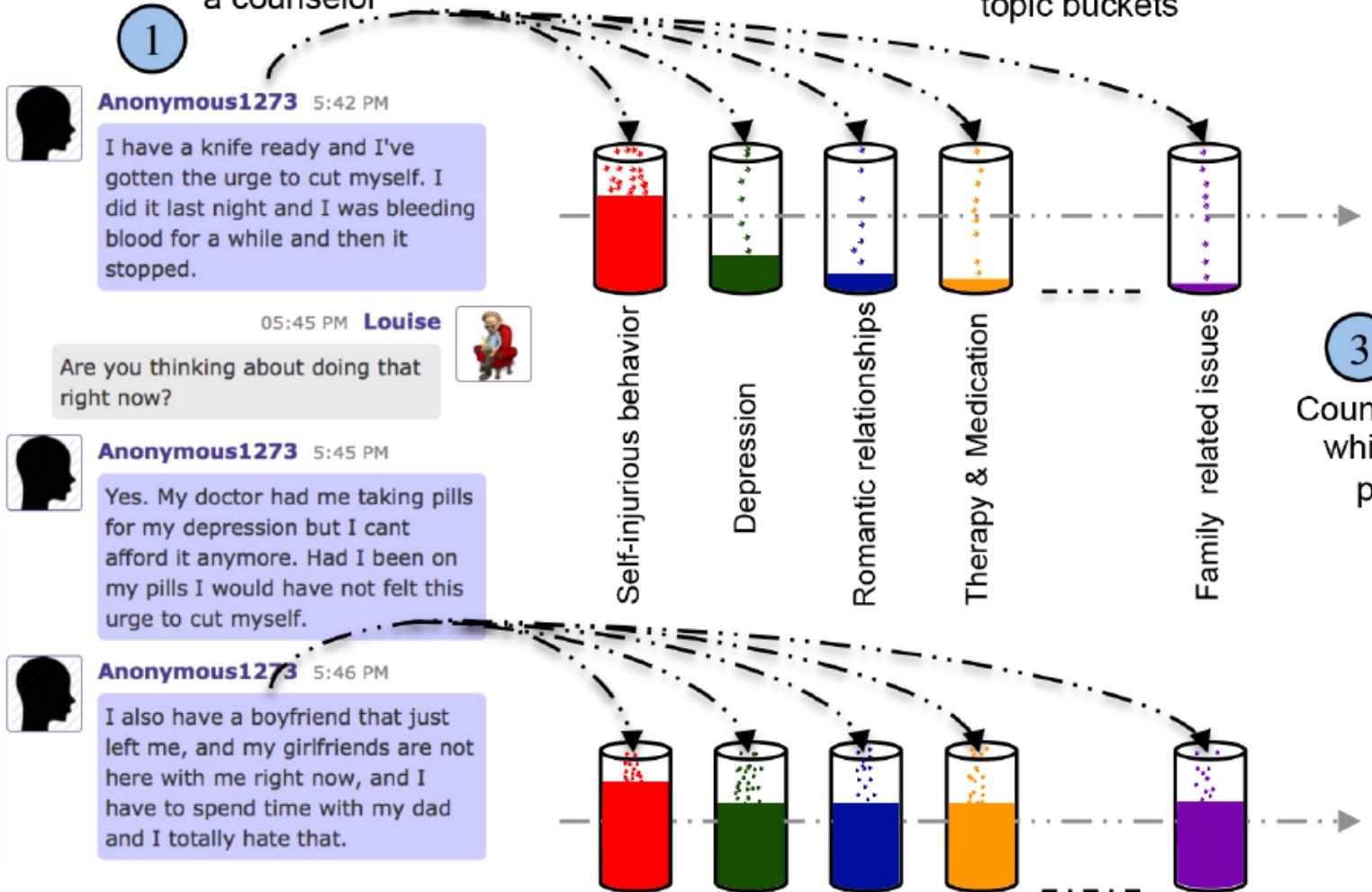
Parameter Space Lensing



[Dinakar et.al 2015]

Lensing for Crisis Counseling

An ongoing live chat interaction between an anonymous client and a counselor



[Dinakar et.al 2015]

Fathom interface for Crisis Text Line



Contributions

We introduced **Lensing**

- A first-class representation for *perspective* or *point of view* in machine learning

We showed how to use lensing in a ***mixed-initiative workflow***

- Machine learning analyzes data
- Informants contribute their perspective *by example*
- Improves next round of analysis
- Works with many ML methodologies
- Works at various stages: parameter, data, configuration spaces

We implemented impactful ***real-world applications*** in

- Cardiology
- Crisis counseling
- Other mental and physical health applications (in papers)