Social Computing in Online Medical and Healthcare Platforms

CS60017

Introduction

- Online medical platforms are sites on the internet where people post about their health related queries, for them to be answered usually by an expert. Eg: iCliniq, 1mg, WebMD

- Role of online medical and healthcare platforms-
  - **Telemedicine**: Allows for remote consultation.
  - **Healthcare education and information**
  - **Patient support**: Patients can find support groups online in these sites - important for people suffering from chronic, long-term diseases.
  - **Research**: Used to collect data and conduct research

Benefits:

- Convenience
- Affordability
- Increased and (somewhat) instant access to medical opinion
- Enhanced patient satisfaction

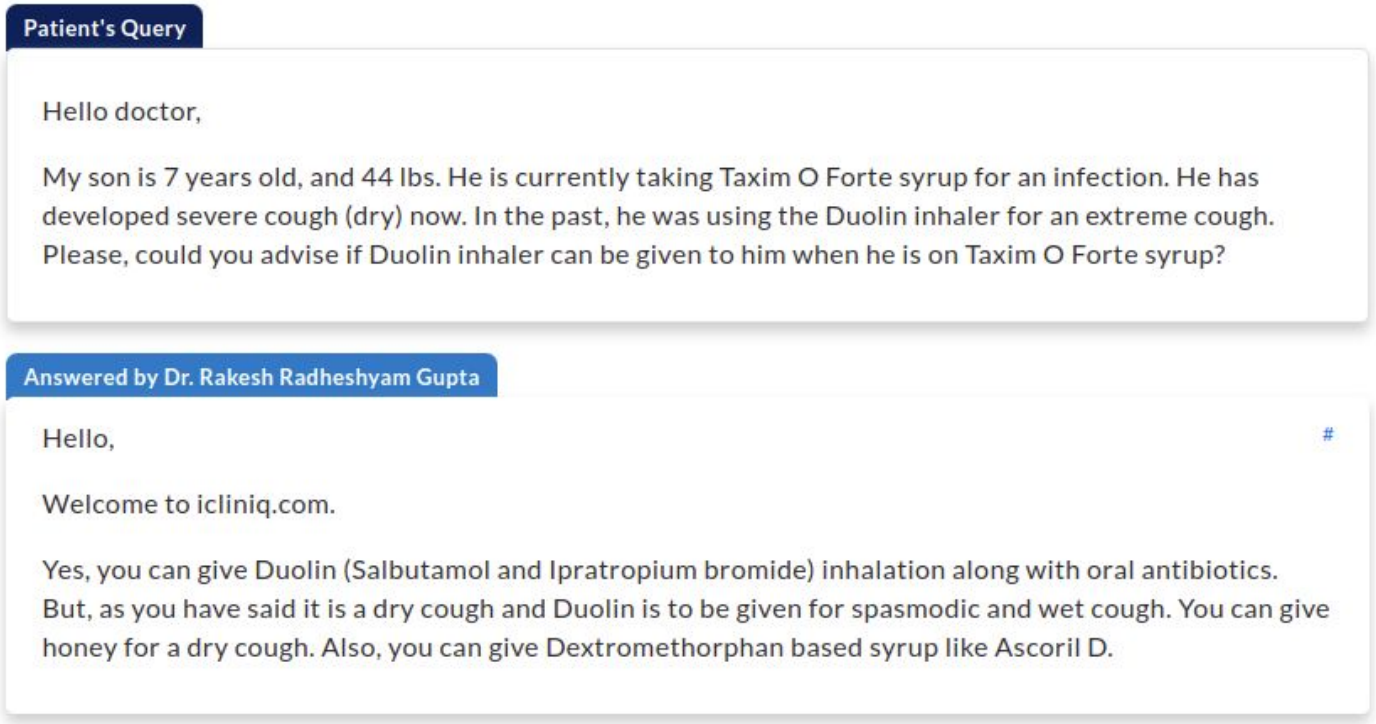
Drawbacks:

- Data security concerns
- Lack of physical exam
- Misdiagnosis
- Lack of proper regulation of users

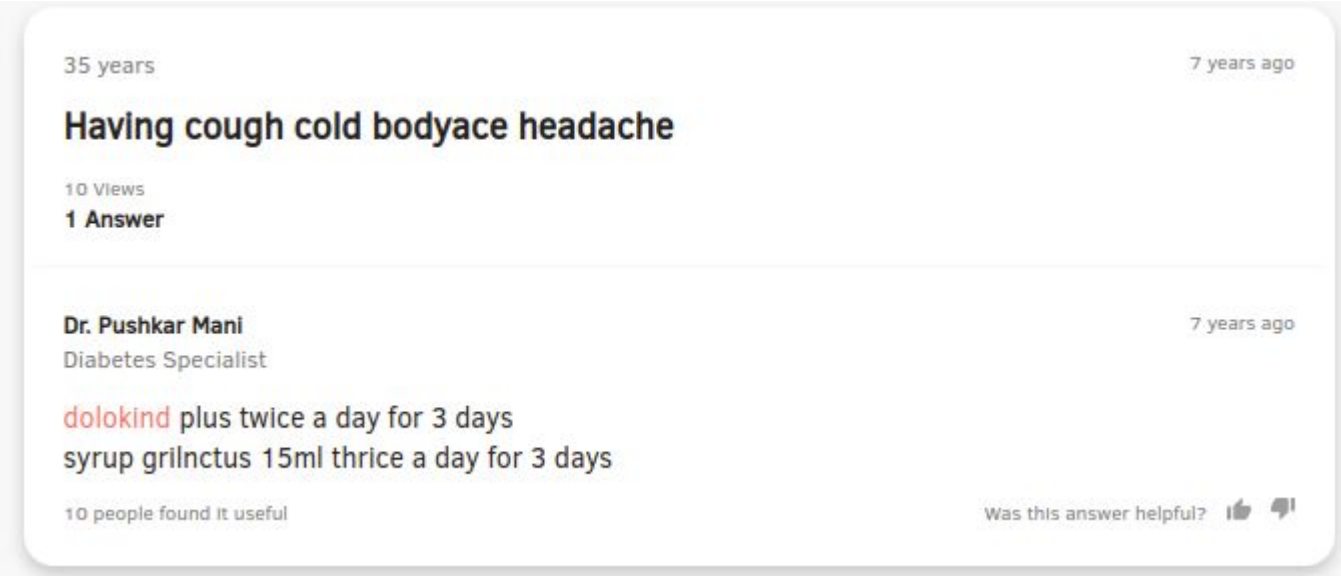
Examples of online medical and healthcare platforms

iCliniq

Answers given by certified doctors

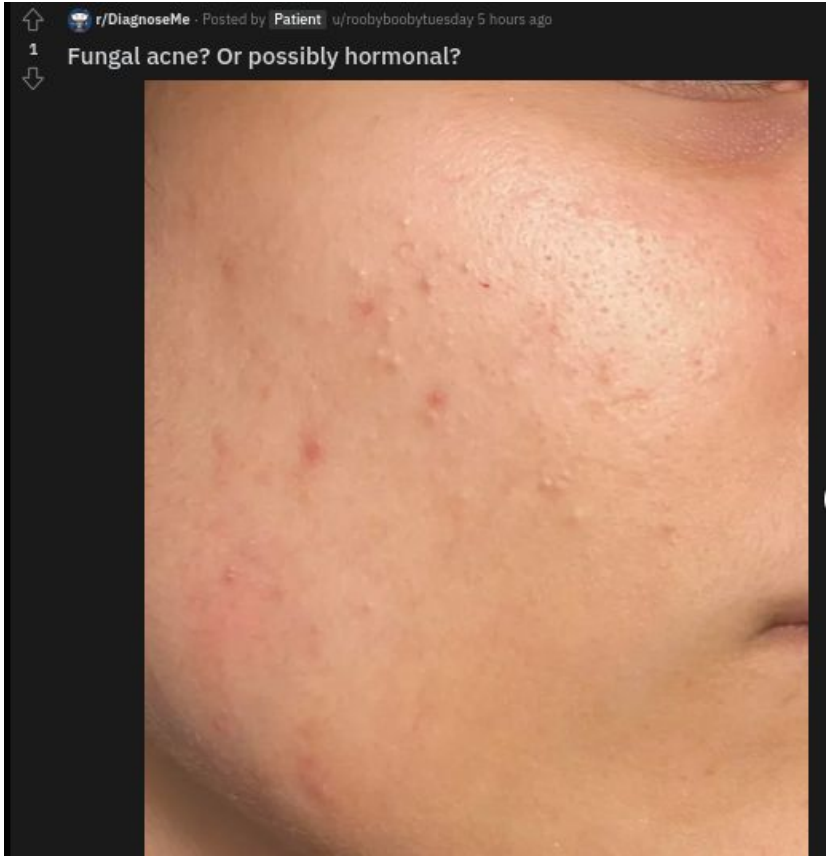


1mg



Questions about specific medicines in the Indian market can be found on 1mg.

Reddit communities: r/DiagnoseMe



Good way to get opinions if problem is visually apparent.

Multimodal data source!

Issue: Diagnosis is not necessarily by a verified doctor.

Motivation of knowledge sharing in such platforms

Extrinsic motivation:

- Reputation in community
- Reciprocity in trust between doctors and potential patients

Intrinsic motivation:

- Knowledge self efficacy - confidence
- Altruism - social responsibility
- Empathy

Xing Zhang, Shan Liu, Zhaohua Deng, Xing Chen, Knowledge sharing motivations in online health communities: A comparative study of health professionals and normal users, Computers in Human Behavior, Volume 75, 2017,Pages 797-810,ISSN 0747-5632

Research methodologies

- Research on such communities require data collection - use web scraping.
- Types of research on medical communities-
  - Quantitative research: using numbers and statistical analysis - Eg: types of information, impact of communities on health outcomes, etc.
  - Qualitative research - textual analysis - Eg: Intent Recognition and entity extraction from queries, understanding qualities of responses, etc.
  - Mixed methods - combines qualitative and quantitative - Eg: frequency of certain behaviour in users + textual analysis to understand reason for such behaviour

Answers to Health Questions: Internet Search Results Versus Online Health Community Responses - A Study

- Search results vs Online health communities:
  - Are the questions actually answered?
  - Are the answers clinically relevant?
  - Are the questions clinically valid?
- Types of questions explored:
  - Fact questions e.g.: Is Byetta a non insulin medication and can it be taken with Metformin?
  - Policy Questions - requires stepwise directions - e.g.: hi i just checked my blood sugar and its 490 how can i get it down my vision is blurry?
  - Value questions - personal experience - e.g.: Have any of you had the Bayer Contour meter just readout “HIGH”? No numeric reading just “HIGH”. I suspect that is a very bad sign [sic].

Kanthawala, Shaheen, Amber L. Vermeesch, Barbara Given and Jina Huh. “Answers to Health Questions: Internet Search Results Versus Online Health Community Responses.” *Journal of Medical Internet Research* 18 (2016): n. pag.

Table 2. Evaluation of all community answers and search results by Clinician A.

Type of question	Answers the question		Is clinically relevant		Is clinically valid	
	No.	%	No.	%	No.	%
Fact						
Search results (n=57)	19	33	28	49	37	65
Community responses (n=66)	35	53	37	56	37	56
Policy						
Search results (n=60)	8	13	8	13	24	40
Community responses (n=49)	30	61	30	61	31	63
Value						
Search results (n=60)	23	38	23	38	29	48
Community responses (n=104)	63	61	51	49	47	45

Qualitative Research Tasks - Why?

It is important to analyse the content of these medical forums, for various uses cases such as -

- Insights from the queries - What kind of questions are asked? How to segregate questions?
- Identify emerging trends in the community.
- Improve the platform design and policies
- Develop online medical decision support systems.
- Develop healthcare related AI in real world scenarios.

Some common tasks:

- Intent Recognition
- Entity Recognition
- Automatic Question Answering

Intent Recognition and Entity Extraction

Intent Identification and Entity Extraction for Healthcare Queries in Indic Languages - A (not very) Deep Dive

Problem Statement: How to perform intent recognition and entity extraction on medical queries in English and Indic (Indian) languages (Hindi, Bengali, Tamil, Telugu, Marathi, Gujarati)?

Dataset:

A multilingual dataset has been constructed using queries extracted from **WebMD** and **1mg**. The 1mg queries are taken to obtain questions from the Indian perspective.

Mullick, A., Mondal, I., Ray, S., Raghav, R., Chaitanya, G.S. and Goyal, P., 2023. Intent Identification and Entity Extraction for Healthcare Queries in Indic Languages. *arXiv preprint arXiv:2302.09685*.

Task details:

Given a multilingual query M, classify the query into one of the following intents:

- **Drug related** Eg: What is Itralase 200 Capsule used for?
- **Treatment plan related** Eg: Which lab tests may my child undergo while taking Taxim-O Dry Syrup Delicious Pineapple on a long-term basis?
- **Disease related** Eg: What is the difference between ear pain and ear infection?
- **Other** Eg: Are there any special instructions regarding storage and disposal of this medicine?

Also, identify the spans in the queries which belong to the following entities:

- **Disease** Eg: lyme disease
- **Drug** Eg: Betnesol Tablet
- **Treatment** Eg: chemotherapy

Intent	Language	Query	Entities		
			disease	drug	treatment
treatment	English	can anesthesia during surgery cause memory loss or signs of senility?	memory loss, signs of senility	anesthesia	surgery
	Hindi	क्या सर्जरी के दौरान बेहोशी स्मृति हानि या बुढ़ापा के लक्षण पैदा कर सकता है?	स्मृति हानि, बुढ़ापा के लक्षण	बेहोशी	सर्जरी
	Bengali	অস্ত্রোপচারের সময় অ্যানেস্থেসিয়া কি স্মৃতিভ্রংশ বা বার্ধক্যের লক্ষণ প্রদর্শনের কারণ হতে পারে?	স্মৃতিভ্রংশ, বার্ধক্যের লক্ষণ	অ্যানেস্থেসিয়া	অস্ত্রোপচার

Figure 1: Example of a query of 'treatment' intent category for different languages along with associated entities.

Problems faced while annotating and preparing the dataset-

- Accurate translations are not always available in Indic languages - by default, the translated queries are actually code-mixed (text with multiple languages mixed). Eg: Mujhe *paracetamol* chahiye.
- Spelling mistakes/ Alternate spellings Eg: lepresy (leprosy) - manually corrected
- Abbreviations of diseases/drugs/treatments Eg: UTI (urinary tract infection) - kept the same - does not affect the classification model
- Inter annotator disagreement on intents Eg: How common is syphilis? Intent: disease-related or other? - took mutually agreed intents

Approaches used in the paper

- Back-translation to English and then using
  - Generalised model like RoBERTa
  - Specialised model like BioClinicalBERT
- Zero shot cross-lingual test - training data in English, testing data in Indic languages - multilingual model XLM-RoBERTa used
- Training and testing using multilingual models
- Translation to linguistically similar bridge language -> English - Marathi is similar to Hindi (bridge), which can then be converted to English - ensures better back-translation to English - works best!

Medical Question Answering

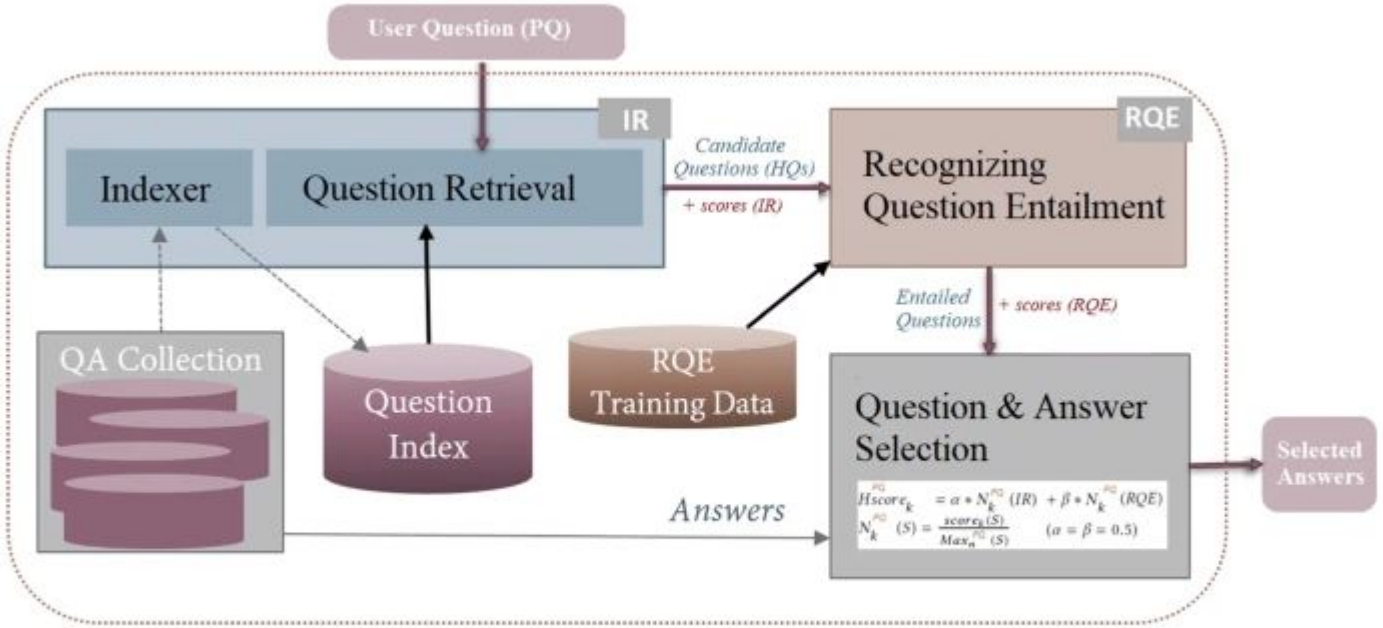
A question-entailment approach to question answering

Research Question: In a medical question answering system , can we map the questions to previously answered *similar* questions? - Recognizing Question Entailment (RQE) task

Dataset: Built the **MedQuAD dataset** consisting of QA pairs from various trusted sources like publicly shared consumer health questions from the US National Library of Medicine and FAQs from US National Institutes of Health websites.

Ben Abacha, A. and Demner-Fushman, D., 2019. A question-entailment approach to question answering. *BMC bioinformatics*, *20*(1), pp.1-23.

Approach used to solve the RQE task



Overview of the RQE-based Question Answering System

Approach (Contd.)

To help with the question retrieval process:

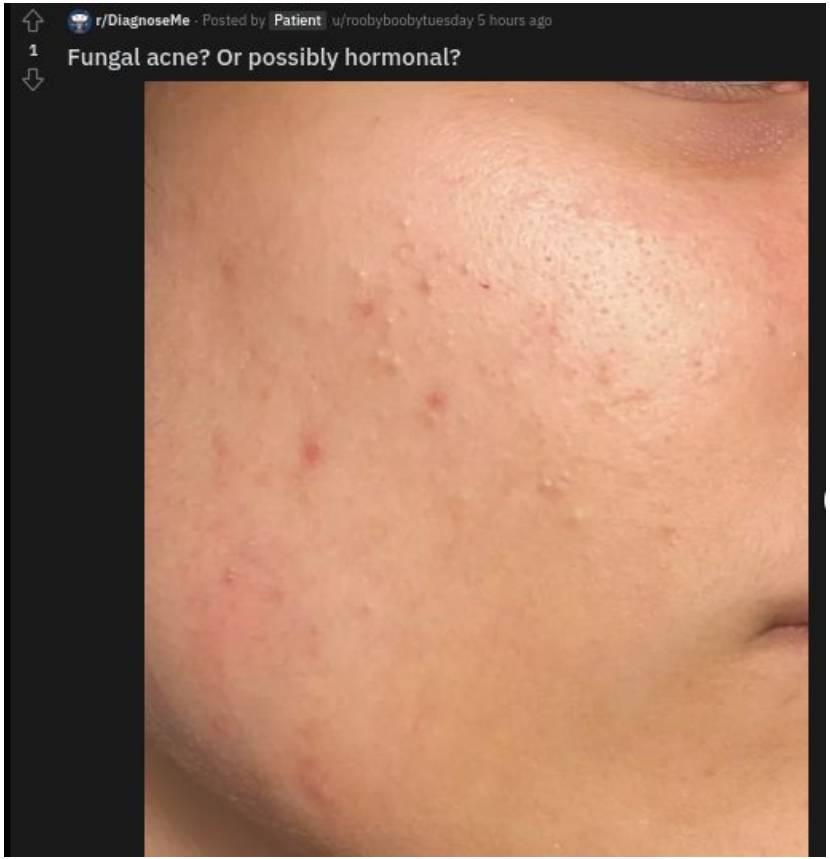
- Focus word was identified
- Synonyms of focus word were added added from the QA collection
- Question type triggers (intent of sorts) were added

Eg: What are the treatments for Torticollis?

Focus: Torticollis. Question type: Treatment.

Added focus synonyms: “Spasmodic torticollis, Wry neck, Loxia, Cervical dystonia”. Added question type triggers: “relieve, manage, cure, remedy, therapy”.

Related research problem: Multimodal Question Answering



Build a corpus from multimodal queries from sites like Reddit.

Related:

- Multimodal answer retrieval
- Multimodal intent and entity recognition (does the image modality help?)

Can Large Vision Language models like GPT-4 or LLAVA be used? Fine-tuned models like Med-LLAVA?

Some problems in Online Medical Communities

- **Health Misinformation** - discussing the paper “Detecting health misinformation in online health communities: Incorporating behavioral features into machine learning based approaches”
- **Behavioural Influence** - discussing the paper “Online health communities influence people’s health behaviors in the context of COVID-19”
- **Ethical issues**

Health Misinformation

Detecting health misinformation in online health communities: Incorporating behavioral features into machine learning based approaches

- Dataset collected from the autism forum on Baidu Tieba, a Chinese site.
- Identified the types of misinformation-
    - **Advertisements** Eg: “I am an autism special education teacher. I just want to bring the light to the autistic children. Contact me via phone or WeChat 159********”
    - **Propaganda for websites, products** Eg: I found a good lesson about how to cure autistic babies. Scan the QR code I sent. You can listen to it.”
    - **Misleading Information** Eg: “Copy the scriptures! Tested useful! Thank the Buddha with a sincere heart. Copy the scriptures with ease. Try it. I copy the scriptures every day. The condition of my son has been much better.”
    - **Unrelated Information** Eg: “Watch movie here”

Zhao, Y., Da, J. and Yan, J., 2021. Detecting health misinformation in online health communities: Incorporating behavioral features into machine learning based approaches. *Information Processing & Management*, *58*(1), p.102390.

Description of behavioural features

Behavioral feature	Measurement	Description
Discussion initiation	#Thread a user created	To reflect the activity of a user in terms of initiating new discussions
Interaction engagement	#Reply and #reply to reply a user created	To reflect the activity of a user in terms of interacting with other users
Influential scope	Degree centrality	To reflect the potential communication ability of a user
Relational mediation	Betweenness centrality	To assess the potential of a user for control of communication in the community
Informational independence	Closeness centrality	To assess the ability a user to instantly communicate with others without going through many intermediaries

Numeric features

Graphical features

Which features to extract?

Table 13. The important score of each feature in the best model.

Scope	Feature	Importance sco
Linguistic	Length	0.0455
	Whether contains a picture	0.0046
	Whether contains a URL	0.0013
	Content similarity	0.0703
Topic	Topics	0.0064
Sentiment	Sentiment intensity	0.0540
	Sentiment polarity	0.0106
Behavioral	Discussion initiation	0.0517
	Interaction engagement	0.0538
	Influential scope	0.0477
	Relational mediation	0.0474
	Informational independence	0.0792

Importance score is calculated by measuring relative performance of best classification model (in this case, Random Forest) after removing feature

Behavioural features are on an average, have more importance (based on score) than linguistic and topical features!

$$S(f) = F1 - score_{complete\ set} - F1 - score_{leave\ f\ out\ set}$$

Behavioral Influence

Online health communities influence people's health behaviors in the context of COVID-19

Research problem: Analysis of development and importance of domestic online health communities by sorting of behavioral types and patterns.

- Data collected from "Lilac Garden Forum" - a Chinese medical social networking site.
- Queries/posts were taken, and the emotion was determined, on the basis of participation behaviour type- interactive participation preference.
- Emotion classes:
  - Pejorative - expressing disapproval
  - Compliment - encouraging
  - Neutral

Chen, X., 2023. Online health communities influence people's health behaviors in the context of COVID-19. *Plos one*, *18*(4), p.e0282368.

The pandemic gave rise to more user participation in online medical platforms

Statistics table of "Dr. Clove" WeChat public account before and after the pandemic.

Research variables	Data	
Years	2019	2020
Cumulative readings	290 million	470 million
Cumulative count	2.75 million	3.95 million
Number of articles published	3183 articles	4825 articles
COVID-19 themed articles	126 articles	1756 articles
Read 10w+ articles	2235 articles	3146 articles
Accumulated likes	11093 times	59106 times
Total word count	4.925 million words	6.78 million words
Reading time	10260 minutes	40159 minutes

The participation behaviour types explored were:

- Help seeking participation behaviour - health queries mainly - less specific than questioning
- Questioning participation behaviour - more specific queries
- Emotional expression behaviour
- Experiential participation behaviour - describes experiences first hand or second hand
- Knowledge sharing
- Social engagement
- Irrelevant engagement

Cases of user participation in asking questions in the "Lilac Forum" during the pandemic.

Serial number	Title	Emotion
19	Under the new crown pandemic, how to strengthen the prevention and treatment of osteoporosis in the elderly?	Neutral
36	Remember those classic pneumonia during the pandemic?	Neutral
72	How did the pandemic in Zhengzhou fall?	Pejorative
85	What is the pandemic and what has it brought?	Neutral
141	Can fenugreek cure the new crown and is better than western medicine?	Pejorative
…	……	……

Statistical tests on the data was used to prove the following hypothesis:

H1: *Perceived information support* (how much information is received?) *significantly affects online users' health information adoption behavioral intentions.*

H2: *Health self-efficacy significantly affects online users' intention to adopt health information.* Self efficacy means a person's confidence in their ability to perform a behaviour - related to information integrity and credibility.

H3: T*he stronger the homogeneity, the more significant the influence of perceived information support on online users' health information adoption behavior intention.* Homogeneity means that people of the same nature are more likely to form social connections - gender homogeneity, age homogeneity, regional homogeneity.

Ethical Issues

- **Privacy and Confidentiality** issues of participants - the information extracted from these platforms should be void of any personal information that can be misused.

- **Security of the data** posted on these platforms - If personal data is being shared, there should be proper security measures.

- **Bias** problems in the AI algorithms used for content analysis and filtering - both in image and text data.

Interesting Research Directions

- **Weaving clinical expertise** - discussing the paper “Weaving Clinical Expertise in Online Health Communities”
- **Designing peer support chats** - discussing the paper ““Suddenly, we got to become therapists for each other”: Designing Peer Support Chats for Mental Health”
- **Utilizing Health Vlogs** - discussing the paper “Health Vlogger-Viewer Interaction in Chronic Illness Management”

Weaving Clinical Expertise

Weaving Clinical Expertise in Online Health Communities

Research problem: How to integrate clinical expertise in semi-automatic system for online health communities?

Insights gained from 14 clinicians analysing peer-patient conversation threads.

Main points of the study-

- When peer-patients were providing appropriate support?
- What kinds of clinical help can they give online?
- When to defer to patients' healthcare providers?

Huh, J. and Pratt, W., 2014, April. Weaving clinical expertise in online health communities. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 1355-1364).

What kind of clinical practices can be moved online?

- Triaging - how to prioritize treatments in cases where there are multiple patients or a single patient requiring multiple treatments - how serious is a problem?

- Clinical questioning
  - Getting to know more about patient history Eg: How long has she been a diabetic?
  - Gaining objective data Eg: “ I would like to run a lab test again on her. I want to get more objective data from her.”
  - Gaining context Eg: “ Does it change what you do during the day? How has it changed your quality of life?”

- Partnering with patients: Building connection and trust
  - Translating patient posts into what makes sense to the clinicians - using better medical terms to get an exact idea of the problem - “hesitant urination” -> “urinary retention”
  - Increased back and forth interaction - asking relevant follow up questions
  - Being transparent with patients

- Deciding what to tell patients
  - Explain problems in terms of bigger picture, individual differences and what to expect - what exactly to say and how to say it? “What you see in X’s case might not be applicable to you do to YZ reasons”.
  - Clarification of medical information - what kind of clarifications would be required?

Not crossing the line - Rules around “Go see your doctor”

- Online medical communities should act as an assistant to traditional medical resources - **human in the loop**.
- However, telling patients to go see a doctor can be a conversation stopper. Rather, addressing the implications built around why one would suggest to ‘go see your doctor’ better tackle potential needs of the patients.
- Possible tasks for agents would include
  - finding key terms relating to diet, medication, emotions , triggers and critical events .
  - provide related online health resources
  - add words of support
  - attempt further evaluation, going back to gaining more history of the patient.
- Key medical decisions should ultimately be made by doctors!

Designing peer support chats

“Suddenly, we got to become therapists for each other”: Designing Peer Support Chats for Mental Health

- Problem Statement: Design a guided and unguided chat tool for peer support chats for people suffering from mental health problems
- Guided chats (prompt based guiding) useful for providing new perspectives
- Unguided chats offered personal connection on shared experiences.

O'Leary, K., Schueller, S.M., Wobbrock, J.O. and Pratt, W., 2018, April. “Suddenly, we got to become therapists for each other” Designing Peer Support Chats for Mental Health. In *Proceedings of the 2018 CHI conference on human factors in computing systems* (pp. 1-14).

	EXPRESSIVE PROMPTS	EXAMPLE SKILLS FOR IDENTIFYING TYPES OF THOUGHTS & FEELINGS	REFLECTIVE PROMPTS
1.	Share a **concern** that is causing stress, anxiety, or low mood. Then, use the skills page to find your main concern and paste it.	I have an esteem concern that... I have a love/belonging concern that… I have a safety/security concern that…	Read their concern, and reply: **"You're concerned about…"**
2.	Open up about how you **want** things to be different. Then, use the skills page to find a desired feeling and paste it.	I want to feel peaceful… I want to feel powerful... I want to feel joyful…	Read their wants, and reply: "**You want…**"
3.	Share your **thoughts** about the situation. Then, use the skills page to find a distressing thought you're having, and paste it.	I have a personalizing thought... I have a worst-case scenario thought… I have an overgeneralizing thought...	Read their thoughts, and reply: "**I hear…**"
4.	Describe your **feelings** related to your distressing thoughts. Then, use the skills page to find the troubling feeling you're experiencing and paste it.	I'm feeling scared... I'm feeling mad… I'm feeling sad…	Read their feelings, and reply: "You're **feeling**…"
5.	Suggest one thing the other person **can try**: "I'd try [in your situation]..."	N/A	Read their **suggestion**. Underline ideas.
6.	Use the skills page to find a type of **strategy** that can help you, and say what you'll try next.	I'll try a mindful strategy of... I'll try a physical strategy of... I'll try a social strategy of...	Read their **strategy**. Thank your chat partner.

Table 1. Prompts based on established psychotherapeutic techniques contained in the guided chat tool.

Interesting Idea: Might be cool to explore building a LLM based chat tool inspired by such prompts.

Utilizing Health Vlogs

Health Vlogger-Viewer Interaction in Chronic Illness Management

- Problem Statement: Perform a qualitative study examining health vlogs.
- Data collected from Youtube for HIV, diabetes and cancer.
- Qualitative task:
  - Health vlogging genre classification
    - Teaching
    - Personal Journal - personal perspectives
    - Self Documentaries - personal experiences

Personal Journal

Figure 3

Blake (HIV10a) wiped away tears as he shared his experience about being newly diagnosed with HIV.

Self Documentary

Figure 4

Paul (CAN9) showed viewers what his IV insertion looked like.

Papers to read:

- Detecting health misinformation in online health communities: Incorporating behavioral features into machine learning based approaches https://www.sciencedirect.com/science/article/pii/S030645732030885 2
- Intent Identification and Entity Extraction for Healthcare Queries in Indic Languages https://arxiv.org/abs/2302.09685
- A question-entailment approach to question answering https://bmcbioinformatics.biomedcentral.com/articles/10.1186/s12859-019-3119-4