How can we use AI Language Models for Personalized Guidance and Nutrition?

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Digital Tech Summit, October 30, 2024

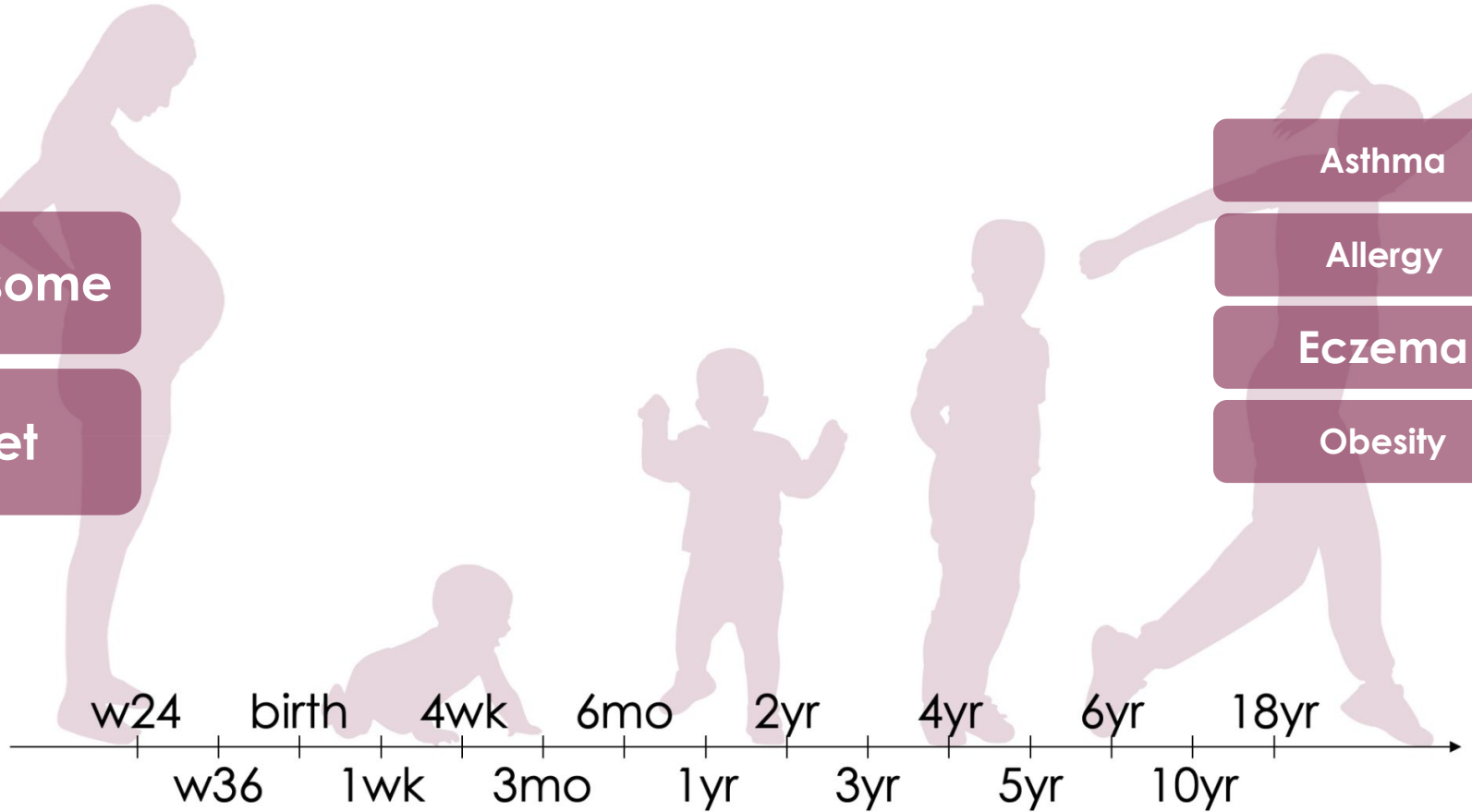
UNIVERSITY OF COPENHAGEN




Why is diet important?

Exposome

Diet



Asthma

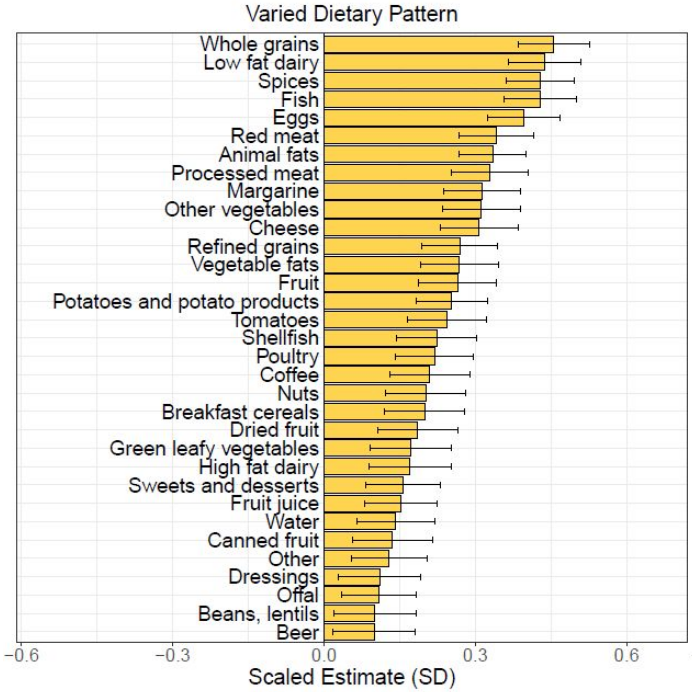
Allergy

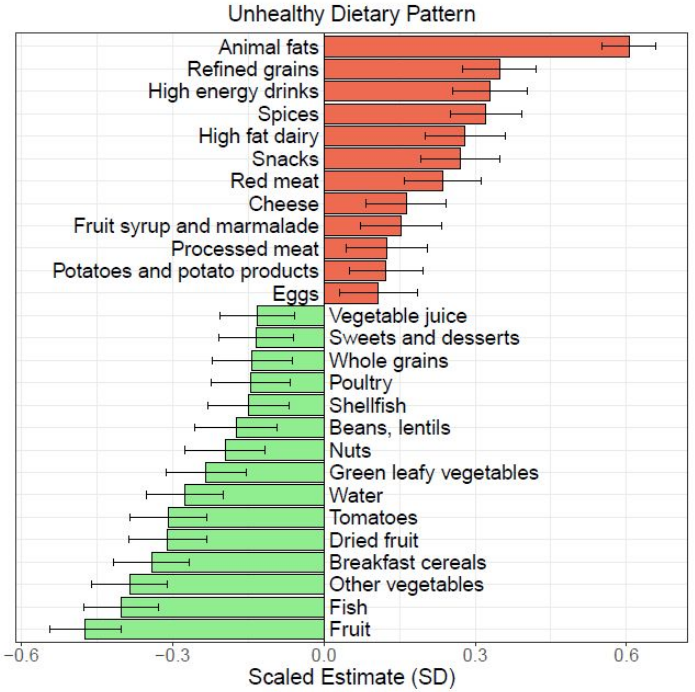
Eczema

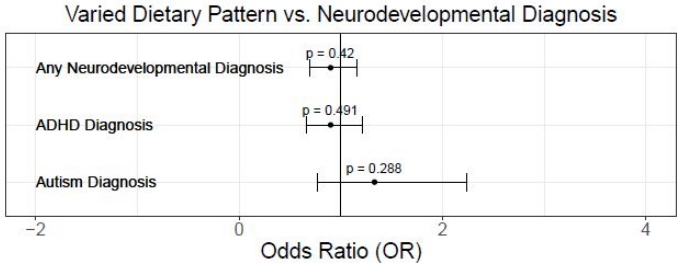
Obesity

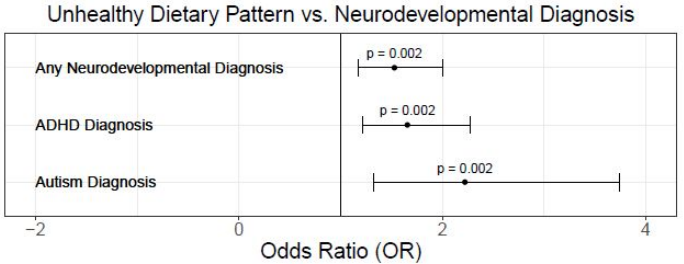
Diet in Pregnancy and offspring health

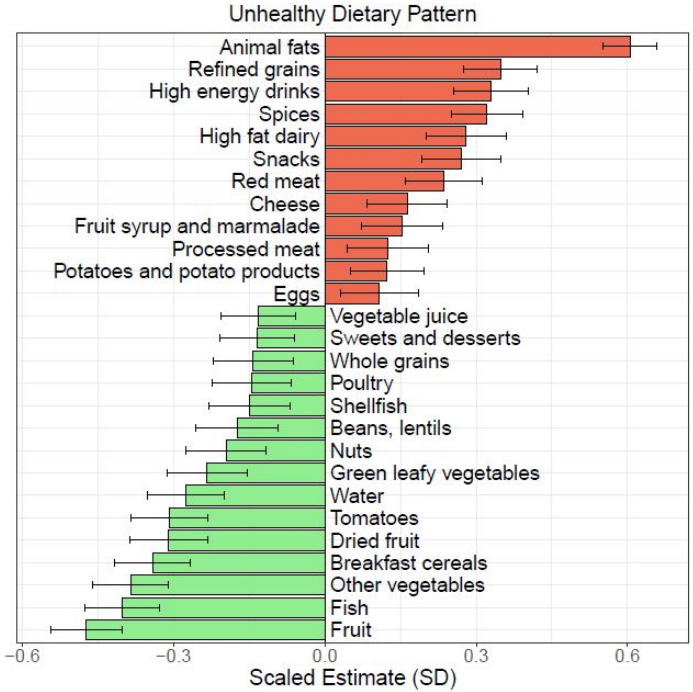
David Horner *et al* (2024) *An Unhealthy Dietary Pattern during Pregnancy is Associated with Neurodevelopmental Disorders in Childhood and Adolescence*. In review

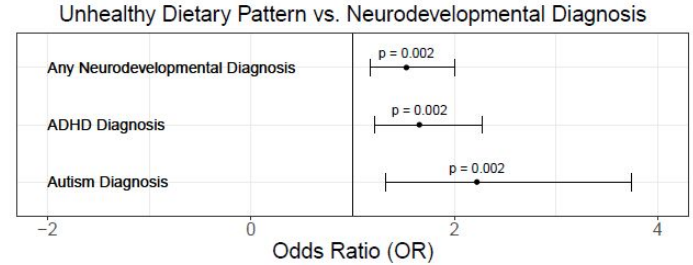


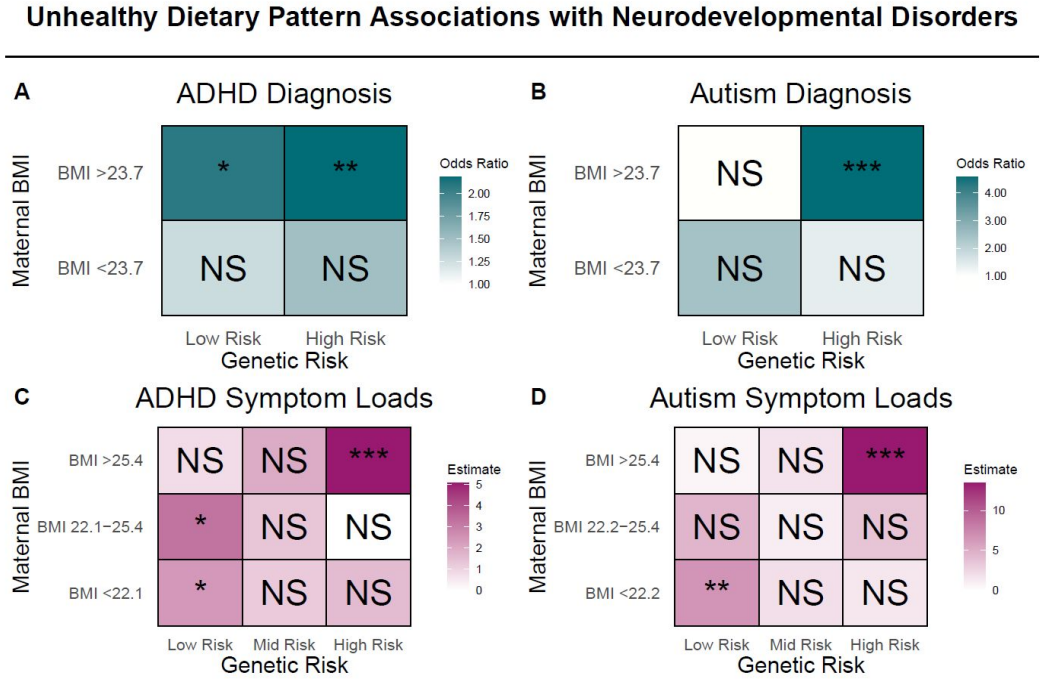












David Horner *et al* (2024) *An Unhealthy Dietary Pattern during Pregnancy is Associated with Neurodevelopmental Disorders in Childhood and Adolescence*. In review

Personalized Nutrition

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But ***knowing*** what is good is one thing

Actually ***doing it*** …. is another challenge

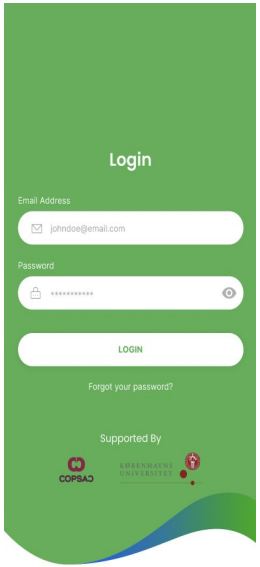
App for improving of health

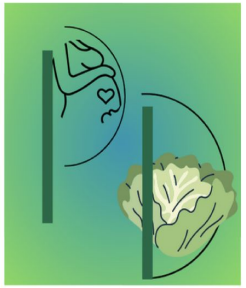
Personalize on
- Contemporary diet
- Diet preferences

Recommendations
- Recipes
- Ingredients

Dailies
- Try a new food/ingredient
- Skip sugar
- …

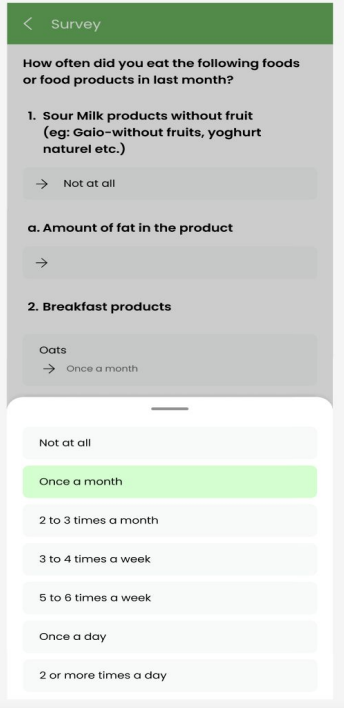
Gamification and Rewards
- Leaderboard
- Achievements / Badges



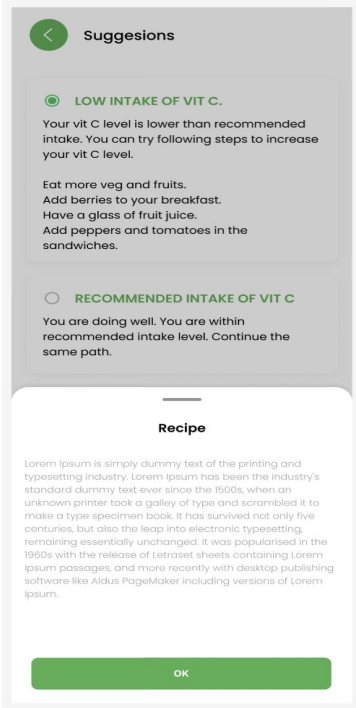


Sangita Sharma Poudel
Dietician and Msc Student

Data on habitual diet



Changes



Performance

Argumentation

Can AI convince consumers of diverse backgrounds to change their habitual behavior?

What characterizes successful arguments for behavior change in public discourse?

An autonomous debating system
Slonim et al. (Nature 2021)

A Dataset of Sustainable Diet Arguments on Twitter

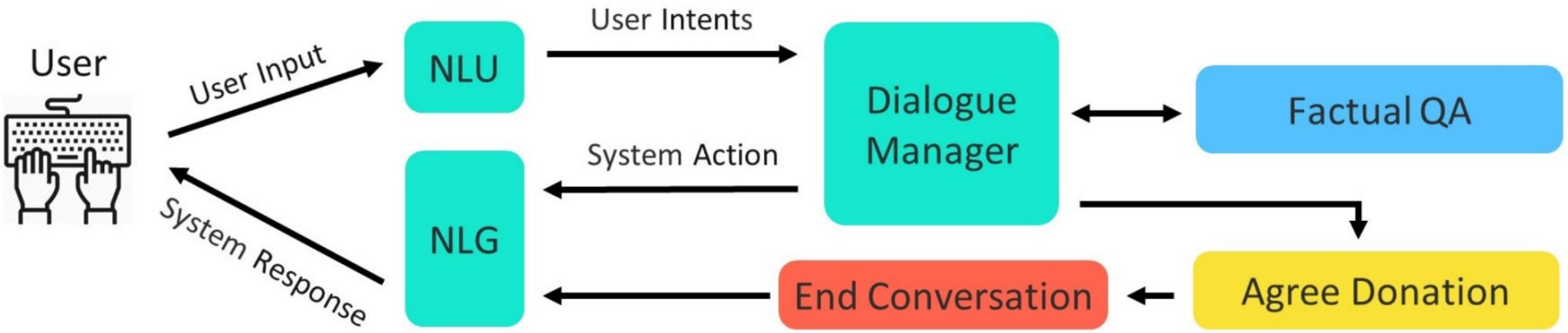
1. Corpus of 32840 English tweets
2. 600 arguments annotated for 5 topics
3. Trained NLP models with strong performance

- We should reduce the consumption of meat
- Plant based food should be encouraged
- Meat alternatives should be encouraged
- Vegan and vegetarian diets should be encouraged
- We should pursue policies that promote sustainable foods

Argument mining for green nutrition. M. Hansen (MSc thesis, 2022)

AI Influences Human Behavior

Whether through explicit persuasion or implicit priming, user behavior changes as a result of interaction with AI



How to ask for donations? learning user-specific persuasive dialogue policies through online interactions (Tran et al., *UMAP* 2022)

Can we harness this for positive behavior change?

Risks of AI Influence

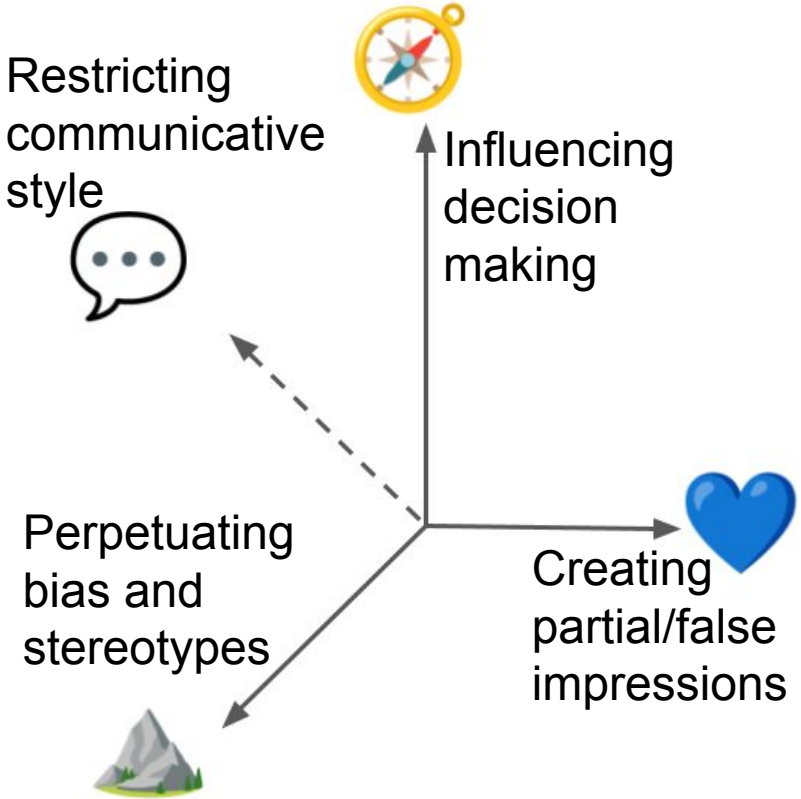
10 July 2023

ChatGPT promotes American norms and values

TECHNOLOGY ARTIFICIAL INTELLIGENCE

ARTIFICIAL INTELLIGENCE ChatGPT, the revolutionary new AI chatbot, reflects American norms and values – even when queried about other countries and cultures. The mismatch has been demonstrated in research from the University of Copenhagen. The AI spun web of cultural bias is a major problem according to the study's researchers.

Assessing Cross-Cultural Alignment between ChatGPT and Human Societies: An Empirical Study (Cao et al., C3NLP 2023)



Challenges and Strategies in Cross-Cultural NLP (Hershcovich et al., ACL 2022)

AI Alignment

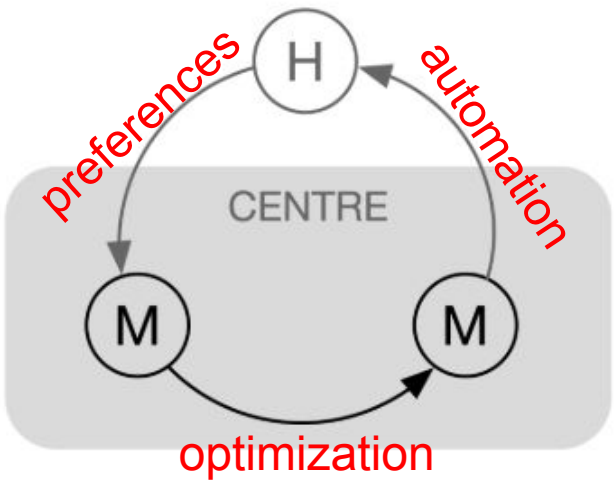
"our AI systems must do what we **want them to do**" (Russel et al., 2015)

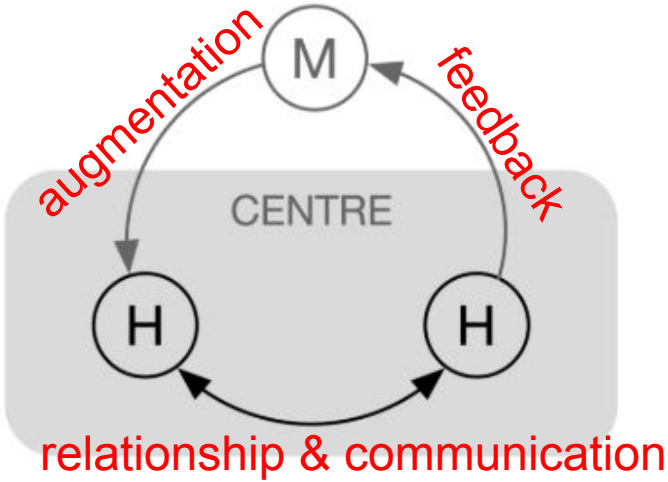
"prevent [autonomous systems] from causing **unintended harm**" (Amodei et al., 2016)

Towards Bidirectional Human-AI Alignment: A Systematic Review for Clarifications, Framework, and Future Directions (Shen et al., 2024), adapted from Gabriel (2020)

Our Goal: Reframing Alignment

from Aligning AI ↦ Humans to Aligning Humans + AI ↦ a goal





Adapted from Centering the Speech Community (Bird & Yibarbuk, EACL 2024)

Food, language and identity

FOOD IS A **COMMUNICATIVE MEDIUM**

FOOD IS A **CARRIER OF MEANING**

FOOD IS TIGHTLY LINKED TO **IDENTITY**

Recipe adaptation

Dietary restrictions, e.g., vegan

Cross-cultural differences

Can we automate this process?

红豆汤
Red Bean Soup

Sweet Red Bean Soup

Ingredients

1. 适量红豆
   Moderate amount of red bean
2. 适量米酒
   Moderate amount of rice wine
3. 适量带皮老姜
   Moderate amount of ginger with skin

1. 2 cups dried adzuki beans
2. 1/2 cup sugar
3. 1 inch fresh ginger

Cooking Steps

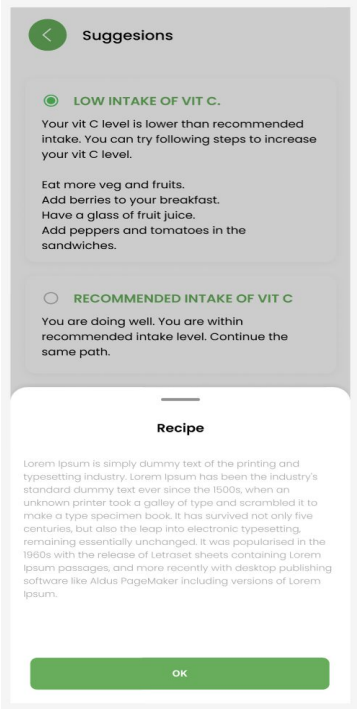
1. 姜切成丝
   Shred ginger.
2. 将和红豆放入米酒中，搅匀浸泡8小时
   Put the red beans into the rice wine, stir well and soak for 8 hours.
3. 浸泡好的红豆放入锅内，大火煮沸，搅拌一下
   Put the soaked red beans into the pot, boil on high heat, stir well.
4. 调成小火熬制30分钟。
   Turn to low heat and simmer for 30 minutes.

1. Soak the beans in water for 8 hours.
2. Drain the beans and put in a medium-sized pot.
3. Peel and julienne the ginger, and add it to the pot.
4. Add 6 cups of water and sugar. Bring to a boil over high heat, stir, lower the heat and let simmer for 30 minutes.

Cultural Adaptation of Recipes (Cao et al., TACL 2024)

Aligning Humans + AI for Positive Behavior Change

Vision:
Combining **adapted recipes** with **tailored diverse argumentation** in a personal AI assistant



Structured Argument Mining in Persuasive Online Articles on Sustainable Diets

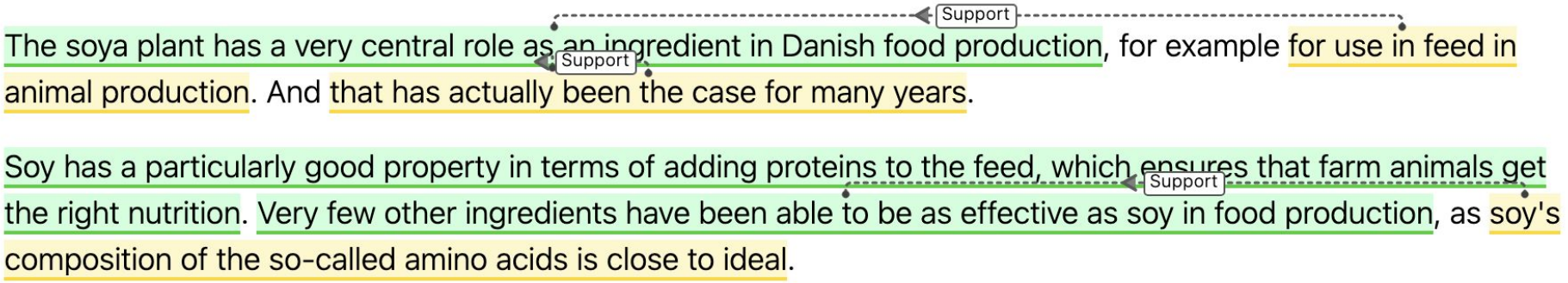
MSc thesis project by Lukas Mikelionis

Supervised by Daniel Hershcovich

2023

Structured Argument Mining in Persuasive Online Articles on Sustainable Diets

1. Structured Argument Mining: extraction of arguments and their relations
2. Persuasive Online Articles: opinionated and influential content for the public
3. Sustainable Diets: relevant topic in the modern society



Curating a Dataset and Choosing a ML Model

Articles:

- (10) Altinget
- (5) The Guardian
- (5) Plant Based News (PBN)

Prevalent sub-topics:

- Innovation in food industry
- Meat alternatives
- Cooking education
- Social and cultural challenges regarding dietary preferences

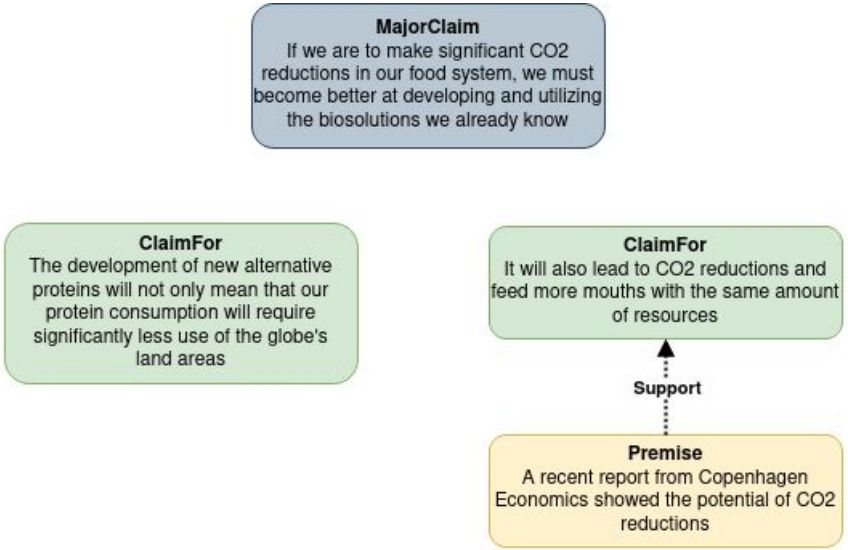
Annotation:

- Amazon's Mechanical Turk crowdsourcing platform
- Funded by Green Solutions Centre

ML model:

- Architecture: End-to-End Structured AM (Morio et. al., 2022)
- Base embedding layer: Longformer (Beltagy et al., 2020)

Structuring Arguments and an Example AI Output



Fødevarer Artikler Debat Job & Navne Podcast

11. april 2023 kl. 05.00

Debat

DI Fødevarer og Bio: Vi skal udnytte alternative proteiner, hvis vi skal skabe en CO2-reduktion i fødevaresystemet

Hvis vi skal lave markante CO2-reduktioner i vores fødevaresystem, skal vi blive bedre til at udvikle og udnytte de biosolutions, vi allerede kender, skriver branchedirektør i DI Fødevarer og chef i DI Bio, Leif Nielsen og Mikkel Valsted.

Observations and Possible Applications of Argument Mining

Observations:

- AM is a challenging task
- Impressive result by ML model
- Future potential of AM

Applications:

- Summarizing content
- Debate support
- Writing support
- Analysis of actors
- Decision making

Veganizing Recipes using Language Models

BSc project by Jonathan Sigh Musso

Supervised by Daniel Hershcovich &
Morten Arendt Rasmussen

2023

Project Goal and Motivation

- Many benefits of a vegan diet
- Widespread adaptation hindered due to a lack of familiarity with vegan ingredients/methods
- Solution: Apply language models to adapt recipes into vegan alternatives, while preserving dish essence

Approach & Methodology

- GPT Models from OpenAI API
- Recipes adapted across both English and Danish
- Crowdsourcing used for evaluations due to lack of automatic metric
- Crowdsourcing Humanly Written Adaptations

Models and Setups:

- Text-Davinci-003 Zero Shot Prompting
- Text-Davinci-003 Two Shot Prompting
- Turbo GPT-3.5 Zero Shot Prompting
- Turbo GPT-3.5 Two Shot Prompting
- GPT-3 Davinci Fine-Tuning

Adaptations and Crowdsourcing

- English recipes sourced from Food.com dataset (~133k nonvegan and ~7k vegan recipes).
- Danish recipes scraped from popular Danish cooking sites, followed by data cleaning and annotation. (~6500 nonvegan and ~2000 vegan recipes)

Crowdsourcing

- Prolific online crowdsourcing
- In-Person Food and Meal Consumer Research Course
- 1096 english responses
- 704 danish responses

Example 1 - Turbo GPT-3.5 Two Shot

Name: chicken stir fry with cashews

Ingredients:

oyster sauce
fish sauce
brown sugar
cornstarch
water
boneless skinless chicken breast halves
cooking oil
onion
red chili peppers
garlic
unsalted cashews
cooked rice

Name: cashew and vegetable stir fry

Ingredients:

vegetable broth
soy sauce
maple syrup
cornstarch
water
extra-firm tofu
vegetable oil
onion
red bell pepper
garlic
ginger
unsalted cashews
cooked rice

Example 2 - Turbo GPT-3.5 Two Shot

Name: simple pancakes

Ingredients:

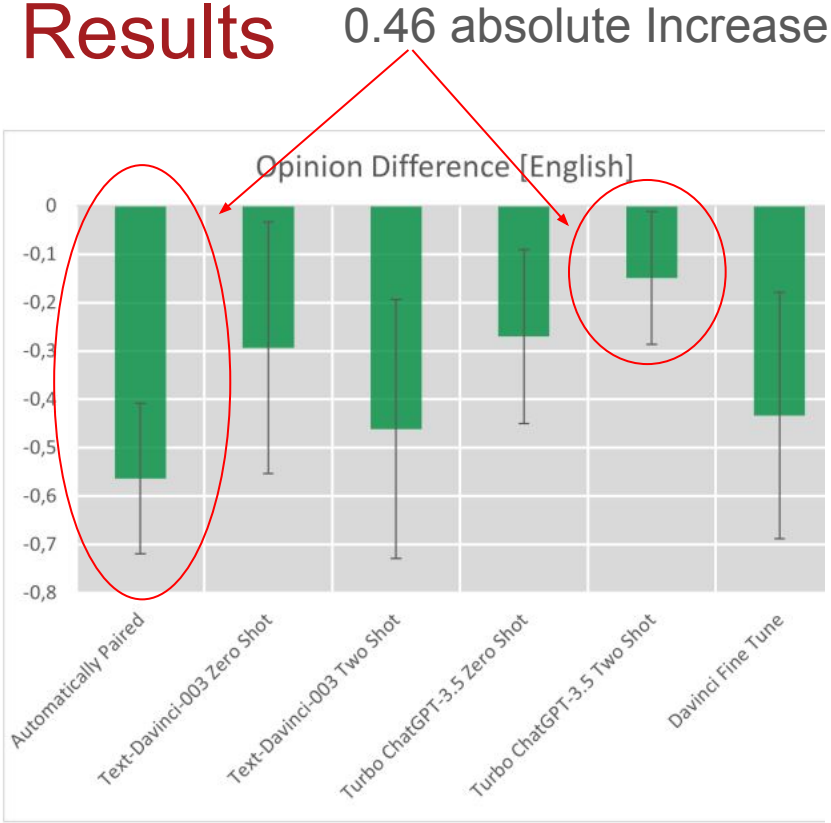
egg
sugar
vanilla
milk
flour
baking powder

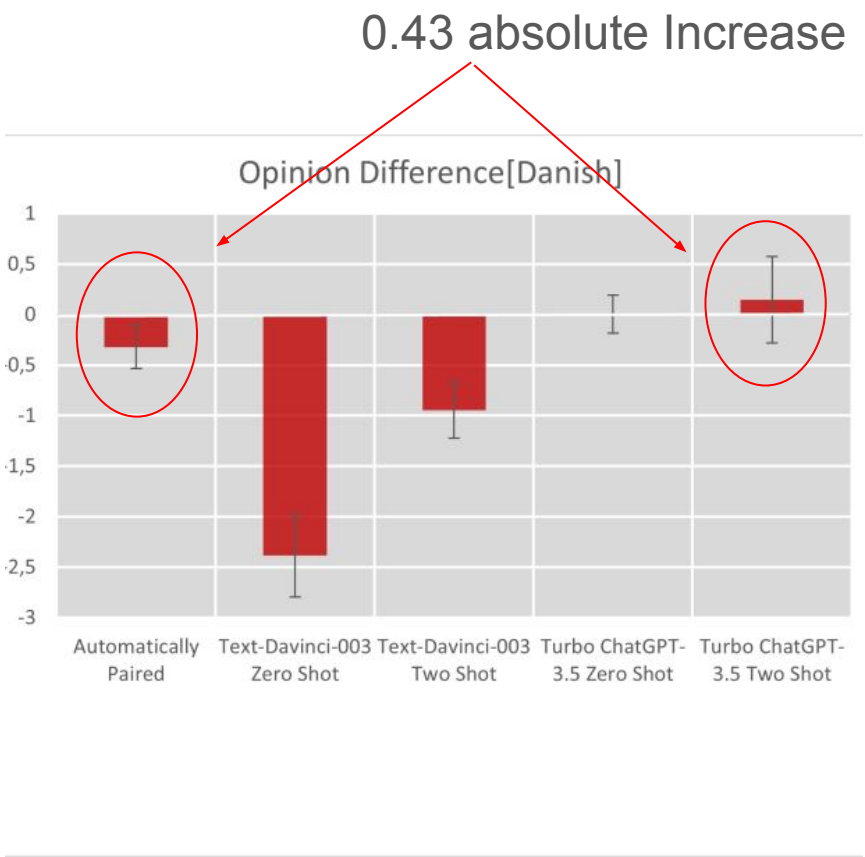
Name: Fluffy Vegan Pancakes

Ingredients:

flaxseed meal
water
agave syrup
vanilla extract
unsweetened almond milk
all-purpose flour
baking powder
salt
coconut oil for frying

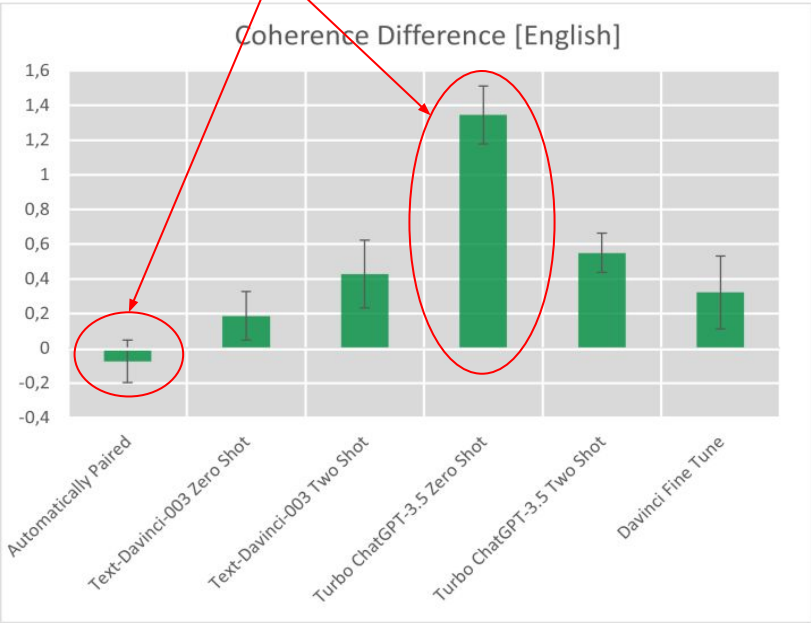
Results


0.46 absolute Increase
Opinion Difference [English]
0
-0,1
-0,2
-0,3
-0,4
-0,5
-0,6
-0,7
-0,8
Automatically Paired
Text-Davinci-003 Zero Shot
Text-Davinci-003 Two Shot
Turbo ChatGPT-3.5 Zero Shot
Turbo ChatGPT-3.5 Two Shot
Davinci Fine Tune

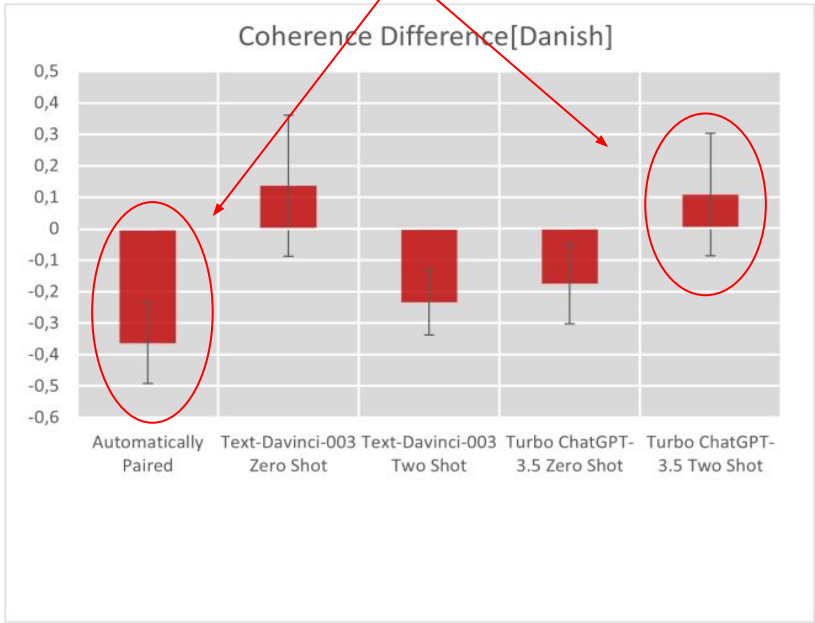

0.43 absolute Increase
Opinion Difference[Danish]
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
-3
Automatically Paired
Text-Davinci-003 Zero Shot
Text-Davinci-003 Two Shot
Turbo ChatGPT-3.5 Zero Shot
Turbo ChatGPT-3.5 Two Shot

Results

1.79 absolute Increase



0.46 absolute Increase



Recap and what's next?

- Results look better than automatically assigned – Is this good enough?
- Lack of benchmark
- GPT-4
- How much can be read from recipes ? - Cooking the dish

Summary

Adapting recipes and advice to personal preferences and values

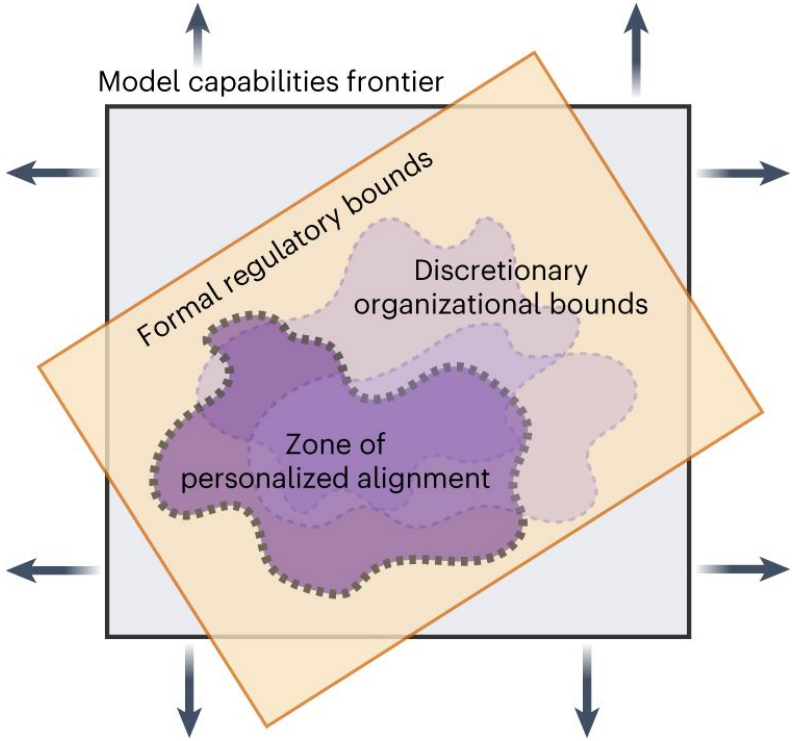
Combining with persuasive tailored stories and argumentation

Personal dietary AI to assist behavior change to personal/societal goals

Contact:
dh@di.ku.dk
mortenr@food.ku.dk

Who Decides?

- Researchers
- Practitioners
- End-users
- Affected communities
- Regulators



The benefits, risks and bounds of personalizing the alignment of large language models to individuals (Kirk et al., *Nature Machine Intelligence* 2024)