

Recipe Adaptation with Language Models

Daniel Hershcovich, DIKU
June 14th 2023

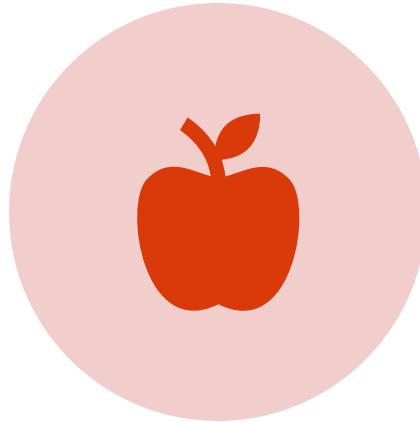
UNIVERSITY OF COPENHAGEN



Food, language and identity



FOOD IS A
**COMMUNICATIVE
MEDIUM**



FOOD IS A
**CARRIER OF
MEANING**



FOOD IS TIGHTLY
LINKED TO
IDENTITY

Recipes



A useful way to express food in language



Part of the creative process of food creation



Used by both professional and home cooks

Name: chocolate mousse charlotte

Ingredients:

instant chocolate pudding mix
ladyfingers
milk
heavy cream
whipped cream

Steps:

line a springform pan bottom and sides with ladyfingers
follow directions on pudding mix, using 2 cups of milk
add cream
beat until thick with heavy peaks
pour into ladyfinger-lined pan and let set
if you like, finish off top with additional whipped cream

Recipe adaptation



Dietary restrictions,
e.g., vegan



Cross-cultural
differences

Can we automate this process?

凉拌秋葵

用料

- | | | | |
|------|-------|------------|------|
| • 秋葵 | 20根左右 | • 香油 | 1勺 |
| • 生抽 | 2-3勺 | • 糖 | 1勺 |
| • 醋 | 1勺 | • 蒜 | 3-5瓣 |
| • 蚝油 | 1勺 | • 盐 | 酌量 |
| | | • 绿芥末膏不用也行 | 酌量 |

做法

- 将秋葵洗净放开水中焯2分钟左右。
- 开水中放盐一勺，油一勺，这样秋葵颜色翠绿鲜艳) ...



Chinese Okra Salad

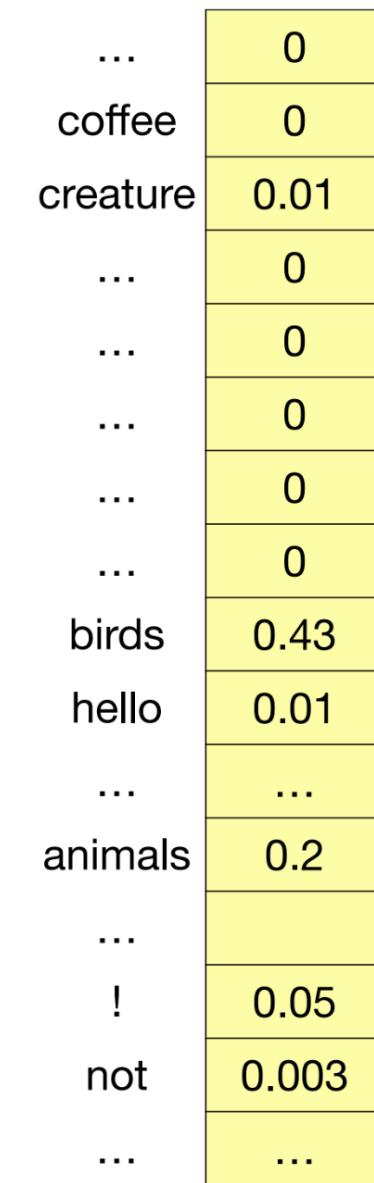
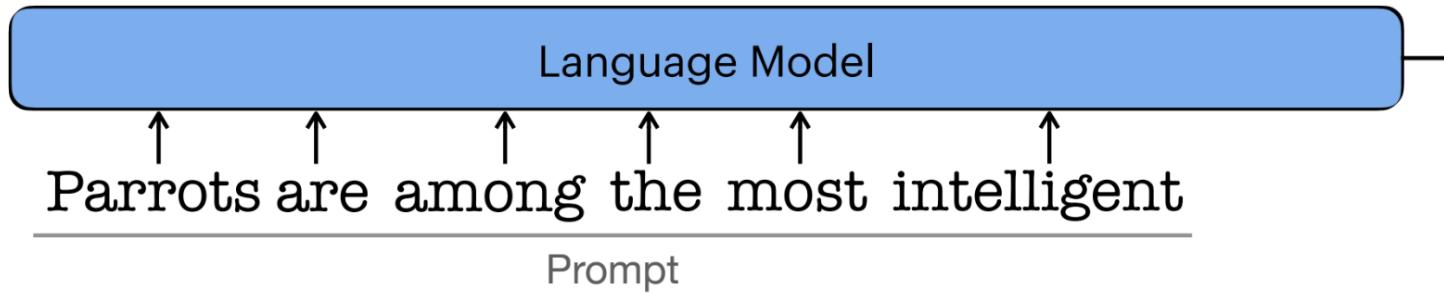
Ingredients

- 8 oz (225 g) okra
- 2 teaspoons light soy sauce (or soy sauce)
- 1/2 teaspoons green Sichuan pepper oil (or more to taste)

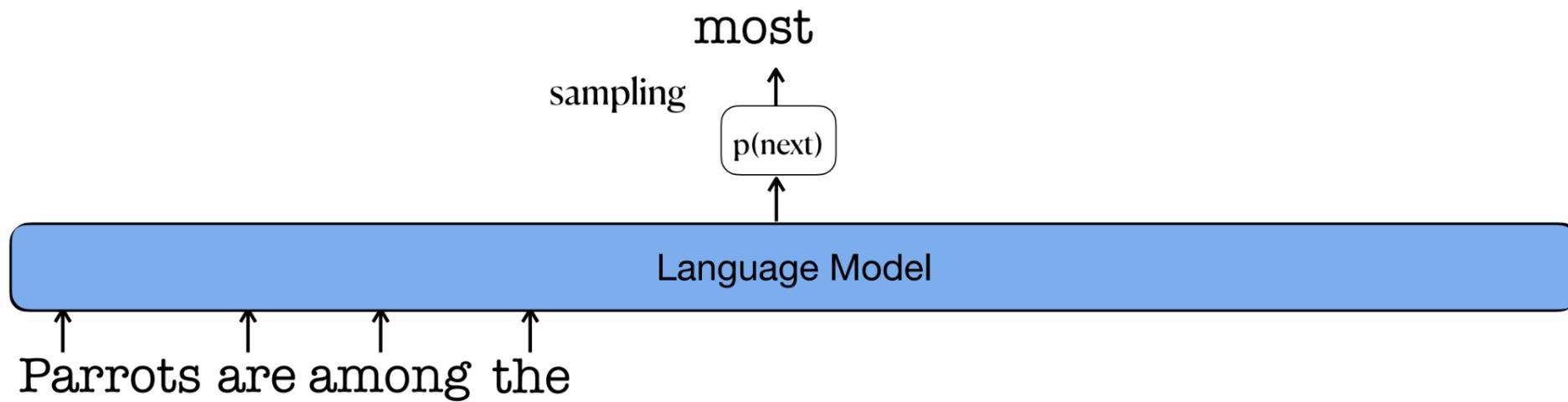
Instructions

- Bring a medium pot of water to a boil. Add 1 teaspoon vegetable oil and a pinch of salt...

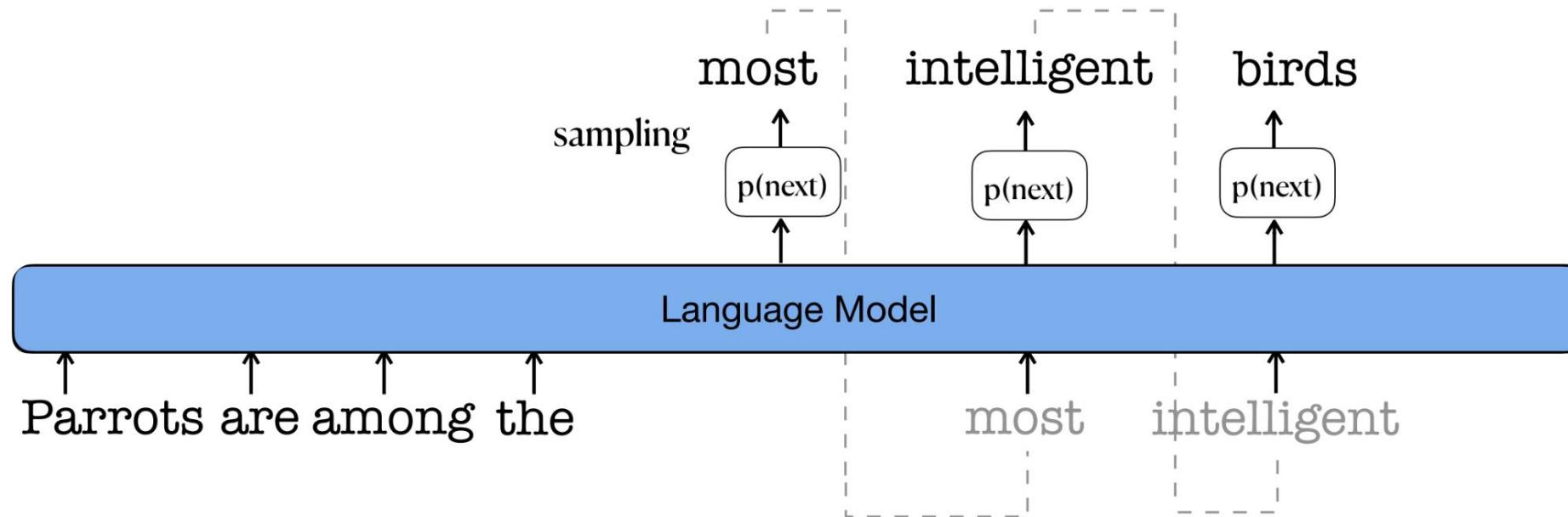
Language models



Language models



Language models



Large Language Models (LLMs)

- BERT 340M
- GPT-1 117M
- GPT-2 1.5B

- 11B T5
- Megatron-11B

11B Plato-XL

11B Macaw

Cohere

52.4B

GPT-NeoX-20B

20B

Luminous

200B

CM3

13B

VLM-4

10B

mGPT

13B

BLOOM

BLOOMZ

176B

11B

Atlas

11B

Flan-T5

Kosmos-1 1.6B*

GLM-130B

ChatGLM-6B

NLLB

54.5B

OPT-175B

BB3

OPT-IML

175B

MOSS

20B*

GPT-4

Undisclosed

*

LLaMA

65B*

Alpaca

Toolformer

7B

MT-NLG

530B

XGLM

GPT-3

175B

Jurassic-1

178B

Gopher

280B

PaLM

PaLM-Coder

Minerva

Med-PaLM

Flan-PaLM

U-PaLM

Flan-U-PaLM

Med-PaLM 2

540B

Chinchilla

70B*

Flamingo

80B*

YaLM

100B

UL2

20B

NOOR

10B

SeeKeR

2.7B

Z-Code++

710M*

Gato

1.2B

FIM

20B

*

Galactica

120B

AlexaTM

WeLM

10B

*

Cedille

6B

Fairseq

13B

Anthropic-LM

GPT-J

6B

BlenderBot2.0

9.4B

LaMDA

LaMDA 2

Bard

137B

52B

RL-CAI

Claude

6B

Chinchilla

20B

*

Beeswarm/bubble plot, sizes linear to scale. Selected highlights only. *Chinchilla scale means T:P ratio >15:1. <https://lifearchitect.ai/chinchilla/> Alan D. Thompson. March 2023. <https://lifearchitect.ai/>



LifeArchitect.ai/models

Strengths and weaknesses

LLMs are good at

- Writing fluent and well-formed language
- Explaining their answers
- Summarizing long documents
- Writing programming code
- ...

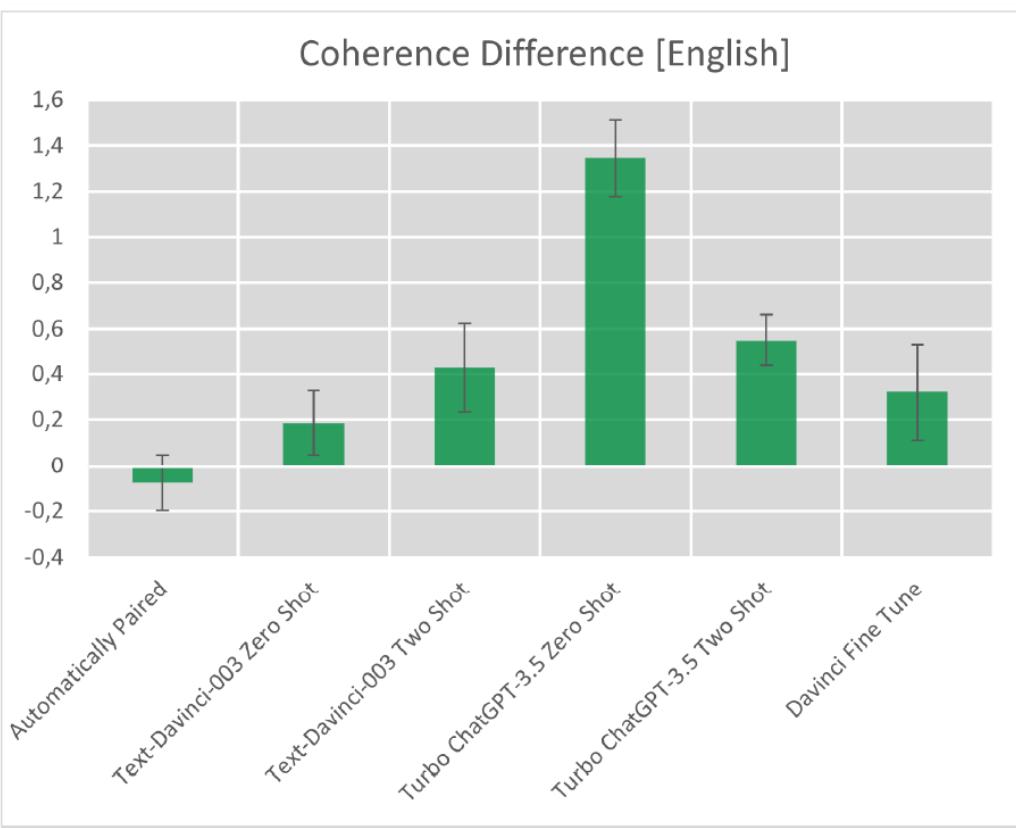
They are not so good at

- Accessing up-to-date knowledge (but can search)
- Math (but can use plugins)
- Real-world common sense
- Knowing what they **don't know**
- ...

Veganizing recipes using language models

Bachelor project by Jonathan Sigh Musso at DIKU

(co-supervised by Morten Arendt Rasmussen and myself)



Name: Vegan Chocolate Mousse Charlotte

Ingredients:

- Chocolate flavored instant pudding mix (vegan)
- Vegan ladyfingers (biscuits or cookies)
- Plant-based milk (such as oat milk or almond milk)
- Vegan heavy cream alternative (such as coconut cream or cashew cream)
- Vegan whipped cream alternative (such as aquafaba or coconut whipped cream)

Steps:

1. Line a springform pan bottom and sides with vegan ladyfingers
2. Follow directions on vegan chocolate pudding mix, using 2 cups of plant-based milk
3. Add vegan heavy cream alternative and beat until thick with heavy peaks
4. Pour the chocolate mousse into the ladyfinger-lined pan and let set in the refrigerator for at least 1 hour
5. Finish off the top with vegan whipped cream alternative, if desired

Tips:

- To make the vegan heavy cream alternative, chill a can of full-fat coconut milk and scoop out the thick cream on the top. Alternatively, soak raw cashews overnight, blend them with water, and strain the mixture to create cashew cream.
- Aquafaba is the liquid leftover from a can of chickpeas and can be whipped into a fluffy, white vegan whipped cream.

Cultural adaptation of recipes

- Ongoing project, targeting translation that accounts for **cultural differences**
- Current focus:
 - English→Chinese
 - Chinese→English



Culture Adaptation



Direct Translation

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{mdare, donatelli}@coli.uni-saarland.de

凉拌秋葵

用料

• 秋葵	20根左右	• 香油	1勺
• 生抽	2-3勺	• 糖	1勺
• 醋	1勺	• 蒜	3-5瓣
• 蚝油	1勺	• 盐	酌量
• 绿芥末膏不用也行 酌量			

做法

- 将秋葵洗净放开水中焯2分钟左右。
- 开水中放盐一勺，油一勺，这样秋葵颜色翠绿鲜艳) ...



Chinese Okra Salad

Ingredients

- 8 oz (225 g) okra
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Instructions

- Bring a medium pot of water to a boil. Add 1 teaspoon vegetable oil and a pinch of salt...

What is culture?

shared beliefs, values, practices, behaviors, and artifacts

a system of **symbols**

characterizes a **social** group

learned, not innate

integrated with daily **experience**

taken-for-granted notions, rules, moralities, and behaviors

dynamic **process** through which social meanings are constructed

Cultural anthropology: Asking questions about humanity (Welsch and Vivanco, 2015)

Granularities of variation

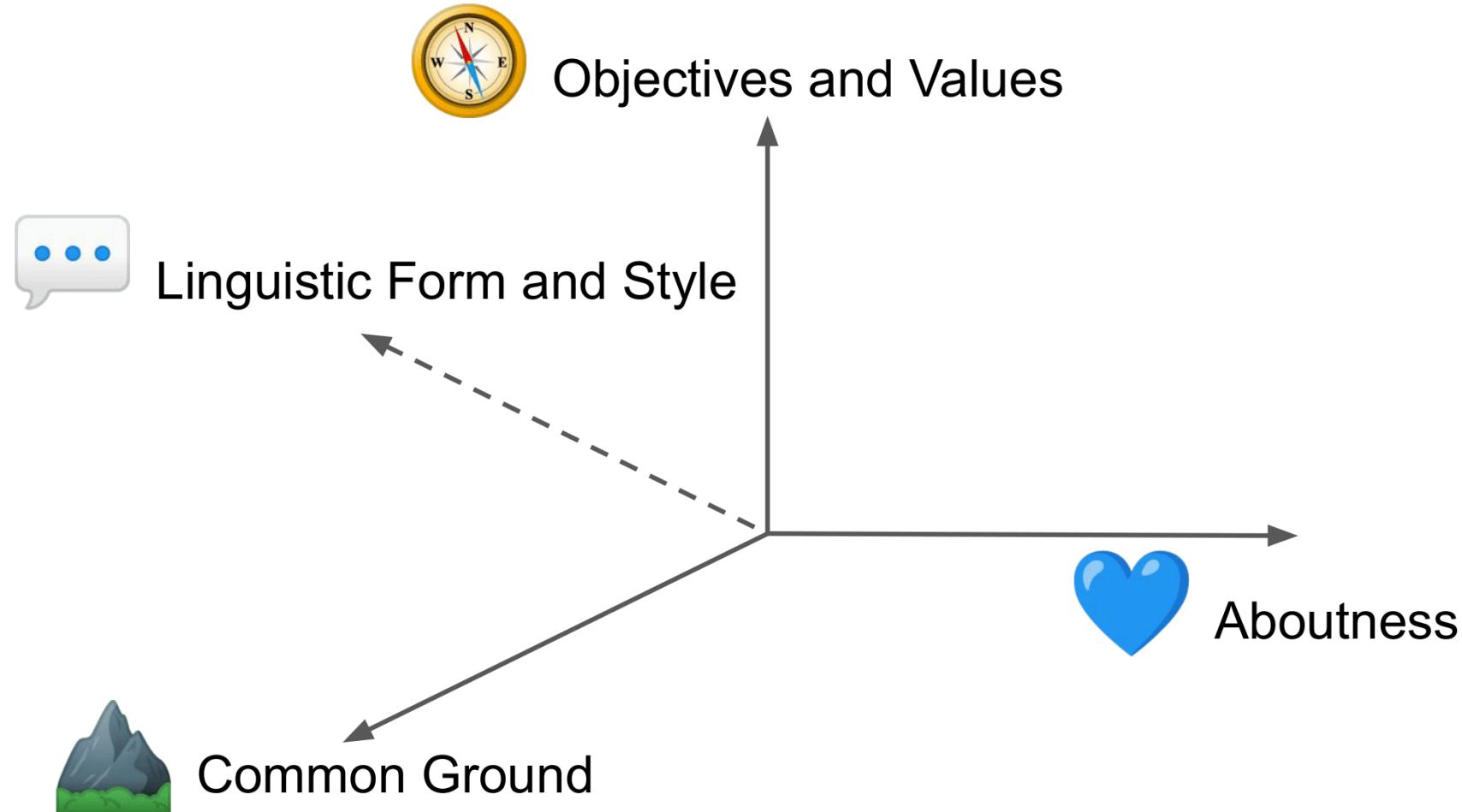
Linguistic variation

- Idiolect
- Sociolect
- Dialect
- Standardized language
- Language groups and families

Cultural variation

- Individual, personality
- Social group
- Geographical region
- Country, national culture
- Global cultural community

Cultural dimensions in language technology

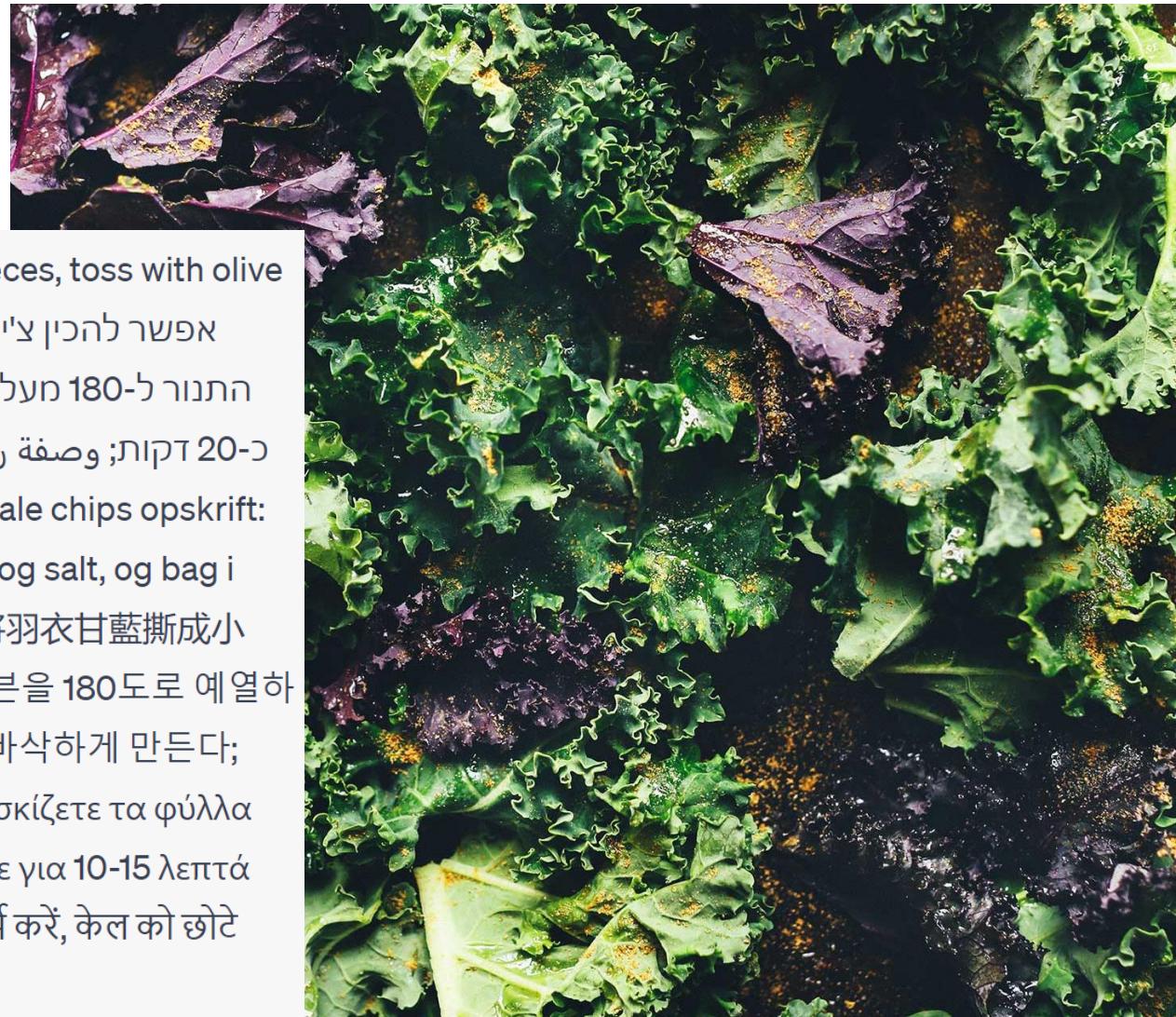


Challenges and Strategies in Cross-Cultural NLP (Hershcovitch et al., ACL 2022)

Linguistic form

Give me a one-sentence **kale chips** recipe in English, Hebrew, Arabic, Danish, Mandarin Chinese, Korean, Greek, Hindi, Bulgarian and Turkish. Do not say which languages they are.

Kale chips recipe: Preheat the oven to 350°F, tear kale into bite-sized pieces, toss with olive oil and salt, and bake for 10-15 minutes until crispy; אפשר להכין צ'יפס עלי קייל: חםם את הקייל לפרטות קטנות, תערכבות עם שמן זית ומלח, ואפו בתנור ה-180 מעלות, קרע את עלי הקייל לפרטות קטנות, תערכבות עם שמן זית ומלח, ואפו בתנור ה-20 דקות; وصفة رقائق الكراث: سخن الفرن إلى 350 درجة فهرنهايت، اقطع الكراث إلى قطع صغيرة، اخلطها مع زيت الزيتون والملح، وابخزها لمدة 10-15 دقيقة حتى تصبح مقرمشة; Kale chips opskrift: Forvarm ovnen til 180 grader, riv kale i små bidder, bland med olivenolie og salt, og bag i ovnen i ca. 15 minutter; 羽衣甘藍脆片食譜：將烤箱預熱至攝氏180度，將羽衣甘藍撕成小塊，加入橄欖油和鹽調味，烤10-15分鐘，直到變脆； 케일 칩 레시피: 오븐을 180도로 예열하고 케일을 작은 조각으로 찢어 올리브 오일과 소금과 섞어 15분간 구워서 바삭하게 만든다； Συνταγή για τσιπς κέιλ: Προθερμαίνετε το φούρνο στους 180 βαθμούς, σκίζετε τα φύλλα κέιλ σε μικρά κομμάτια, ανακατεύετε με ελαιόλαδο και αλάτι, και ψήνετε για 10-15 λεπτά μέχρι να γίνουν τραγανά； केल चिप्स रेसिपी: ओवन को 350 फारेंहाइट पर पूर्व गर्म करें, केल को छोटे टुकड़ों में टूटाएं, ऑलिव ऑयल और नमक के स



Common ground

Adapt the recipe to the common ingredients, cooking methods and tools in each culture's cuisine.

- English: Preheat oven to 300°F (150°C). Rinse kale and dry thoroughly, then toss with olive oil and salt. Bake for 10-15 minutes until crispy.
- Hebrew: Preheat oven to 150°C. Rinse kale and dry thoroughly, then toss with olive oil and salt. Bake for 10-15 minutes until crispy.
- Arabic: Rinse kale and dry thoroughly, then toss with olive oil and za'atar seasoning. Fry in hot oil until crispy.
- Danish: Preheat oven to 150°C. Rinse kale and dry thoroughly, then toss with rapeseed oil and salt. Bake for 10-15 minutes until crispy.
- Mandarin Chinese: Preheat oven to 150°C. Rinse kale and dry thoroughly, then toss with sesame oil and soy sauce. Bake for 10-15 minutes until crispy.
- Korean: Preheat oven to 150°C. Rinse kale and dry thoroughly, then toss with sesame oil, gochujang sauce, and sesame seeds. Bake for 10-15 minutes until crispy.
- Greek: Preheat oven to 150°C. Rinse kale and dry thoroughly, then toss with olive oil, lemon juice, and oregano. Bake for 10-15 minutes until crispy.
- Hindi: Rinse kale and dry thoroughly, then toss with ghee and chaat masala seasoning. Fry in hot oil until crispy.
- Bulgarian: Preheat oven to 150°C. Rinse kale and dry thoroughly, then toss with sunflower oil and salt. Bake for 10-15 minutes until crispy.
- Turkish: Preheat oven to 150°C. Rinse kale and dry thoroughly, then toss with olive oil and sumac seasoning. Bake for 10-15 minutes until crispy.



Conceptualization



(a) இரண்டு படங்களிலும் நிறைய மசால் வடைகள் உள்ளன.
("Both images contain a lot of masala vadas.", concept: வடை (VADA, a popular Indian food), label: FALSE)

Visually Grounded Reasoning across Languages and Cultures (Liu et al., EMNLP 2021)

Aboutness

Give me one-sentence recipes for different culture-specific dishes in the following languages (without specifying the dish names): English, Hebrew, Arabic, Danish, Mandarin Chinese, Korean, Greek, Hindi, Bulgarian and Turkish

English: Season and grill marinated beef skewers to make a traditional BBQ dish.

Hebrew: Mix chickpeas, tahini, lemon juice, and garlic to make a creamy hummus dip.

Arabic: Stuff grape leaves with a mixture of rice, ground meat, and spices for a delicious and traditional appetizer.

Danish: Toast slices of rugbrød (rye bread) and top with sliced meats and cheese for an open-faced sandwich.

Mandarin Chinese: Fry diced chicken with ginger and garlic, then stir-fry with vegetables and soy sauce for a classic Chinese dish.

Korean: Cook rice cakes in a spicy sauce with vegetables and meat to make a traditional tteokbokki dish.

Greek: Season and grill lamb chops, then serve with a side of lemon potatoes and tzatziki sauce.

Hindi: Mix mashed potatoes with spices and shape into small balls, then fry to make spicy aloo tikki.

Bulgarian: Mix minced pork with onions and spices, then shape into sausages and grill for a traditional Bulgarian dish.

Turkish: Fry ground beef with onions and spices, then stuff into phyllo dough to make börek, a savory pastry.



Objectives and values

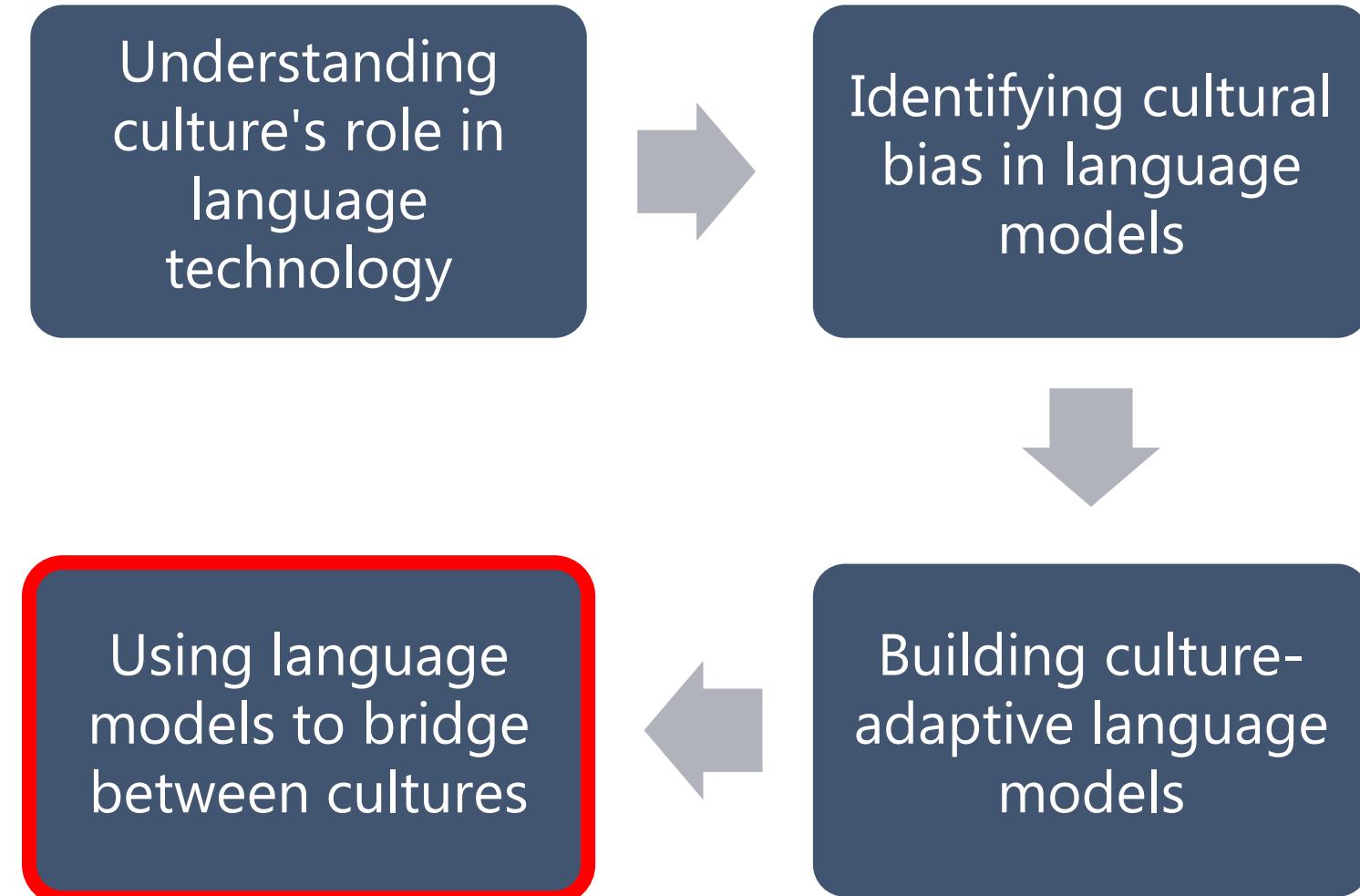
For each of these cultures, give a specific reason for **why** they would even want to make kale chips

Reasons

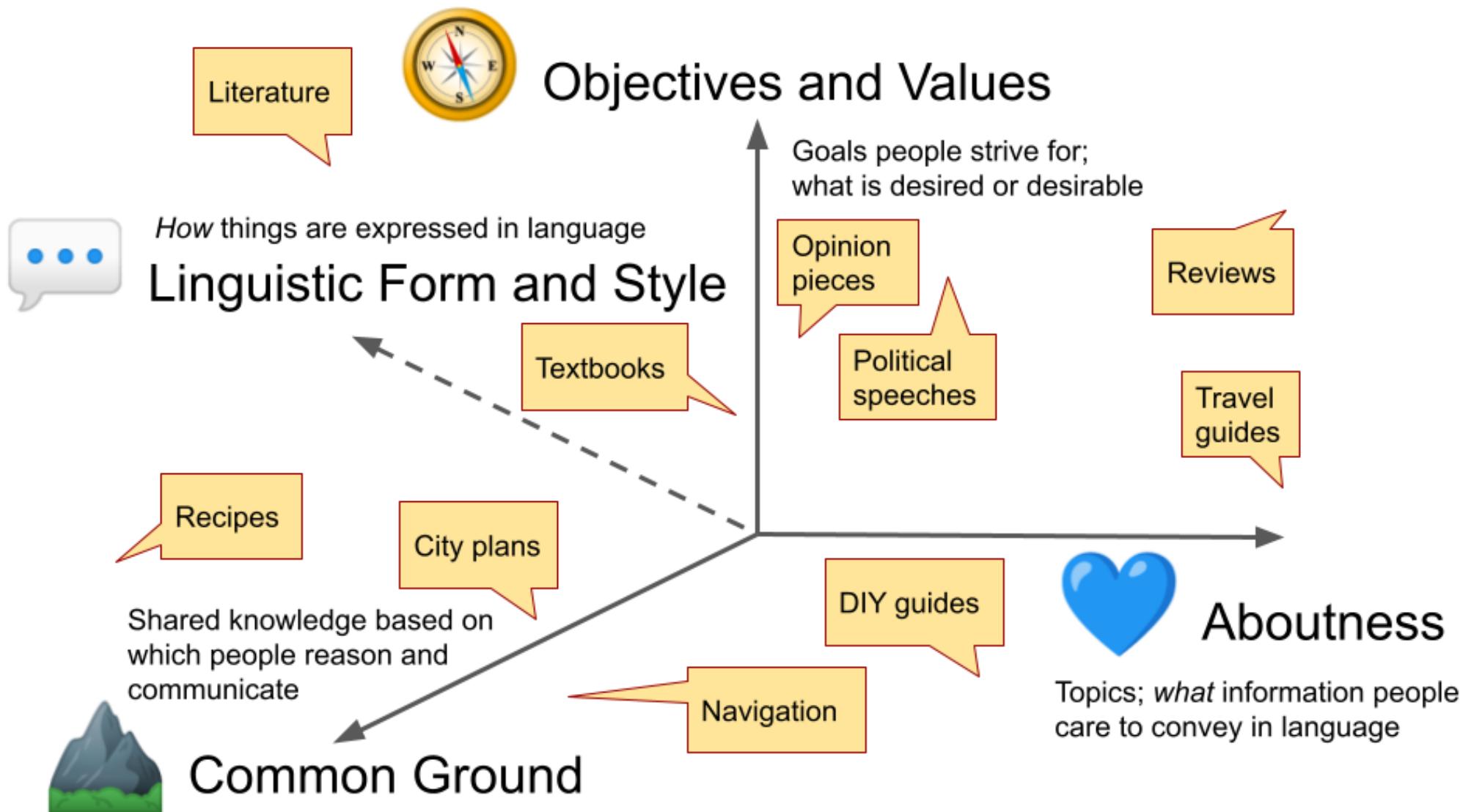
- Variety
- Sustainability
- Enjoyment
- Health

- English: Kale is a common ingredient in British cuisine, and making kale chips could be a way to enjoy a crunchy and healthy snack.
- Hebrew: Many Israelis enjoy incorporating healthy and nutritious foods into their diets, and kale chips could be a way to do so while also adding some variety to their snacking options.
- Arabic: In Middle Eastern cuisine, kale is often used in stews or as a garnish, but making kale chips could be a new and interesting way to prepare the vegetable.
- Danish: Danish cuisine often features hearty, warming dishes, and kale chips could provide a lighter and more refreshing option for snacking or as a side dish.
- Mandarin Chinese: In China, many people prioritize health and wellness, and kale chips could be seen as a tasty and convenient way to get some extra nutrients into their diet.
- Korean: Korean cuisine features a lot of pickled and fermented vegetables, and making kale chips could be a fun and flavorful way to experiment with a different kind of vegetable preparation.
- Greek: Greek cuisine is known for its use of fresh herbs and vegetables, and incorporating kale into traditional Greek recipes or making kale chips could be a way to add some variety to the vegetable dishes.
- Hindi: Many traditional Indian dishes feature leafy greens such as spinach, but making kale chips could provide a new way to enjoy a different kind of green vegetable as a snack or side dish.
- Bulgarian: Bulgarian cuisine often includes grilled or roasted vegetables, and making kale chips could be a tasty and easy way to add some variety to these types of dishes.
- Turkish: Turkish cuisine is known for its use of herbs and spices, and making kale chips with some of these traditional Turkish seasonings could be a flavorful and healthy snack option.

My overall research agenda



Domains for cultural adaptation



Recipe differences across cultures



Ingredient availability and preference



Measurement units, writing style



Available equipment and tools



Known techniques, typical ordering



Desired flavours



Desired texture

卷心菜番茄牛肉汤
Cabbage Tomato Beef Soup



Cabbage Beef Soup

Ingredients

- | | |
|---|---|
| 1. 250克牛肉
<i>250g beef</i> | 1. 1 lb. ground beef |
| 2. 1个大西红柿
<i>1 large tomato</i> | 2. 1 onion, chopped |
| 3. 适量葱, 姜片
<i>Moderate amount of onion, ginger</i> | 3. 2 soup cans water |
| 4. 适量糖, 盐
<i>Moderate amount of sugar, salt</i> | 4. 1 can tomato soup |
| 5. 数片卷心菜叶子
<i>A few cabbage leaves</i> | 5. 1 can beef bouillon soup |
| | 6. 1 can drained kidney beans |
| | 7. 1/2 head cabbage |
| | 8. Salt and pepper |
| | 9. 1 spoon of Hot sauce |
| | 10. 1 can tomatoes, diced into small pieces |

Cooking Steps

- | | |
|---|--|
| 1. 牛肉切小块, 焯水。
<i>Cut beef into small pieces, blanched.</i> | 1. Pressure cook cabbage for 8 minutes or cook on the <i>stove</i> and drain. |
| 2. 洗净后加入葱和姜片, 炖煮半小时左右。
<i>Wash beef, add green onion and ginger slices, and simmer for 0.5h.</i> | 2. Brown crumbled ground beef and onion. |
| 3. 捞出葱姜, 倒入 焖锅 焖一晚。
<i>Take out the onion and ginger, put it into the stew pot and simmer overnight.</i> | 3. Then place all of the above ingredients into a <i>crock-pot</i> . |
| 4. 番茄去皮, 切块。倒入牛肉汤,
加入适量糖和盐, 继续炖煮。
<i>Peel the tomatoes and cut into cubes. Pour in the beef broth, add some sugar and salt, and continue to simmer.</i> | 4. <i>Cook on low for 8 hours</i> (add additional water). or on high for 7 to 8 hours. |
| 5. 等牛肉炖酥后, 加入卷心菜, 继续炖15-20分钟。
<i>After the beef is stewed, add the cabbage and continue to simmer for 15-20 minutes.</i> | 5. <i>Serves 4.</i> |

Preliminary data collection

- 2M **English** recipes from various websites (e.g., food.com)
- 1.5M **Chinese** recipes from xiachufang.com

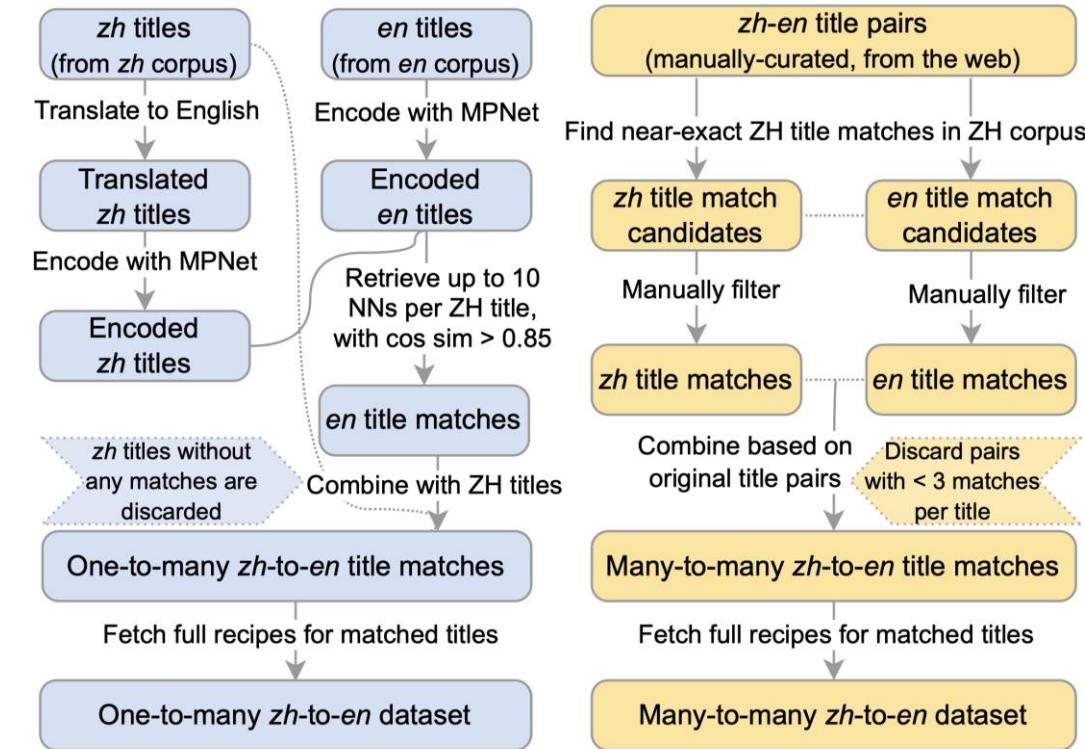
Automatic pairing based on assumptions:



If two recipes have the **same** title, they describe the same dish.



If two recipes have a **semantically equivalent** title (possibly in another language), they describe the same dish.



Models and preliminary results

- Language models and machine translation systems trained on **automatically paired** reference recipes
- Evaluating against **automatically paired** reference recipes

		Surface-based			Structure-Aware	
		BLEU	ROUGE-L	BERTScore	Smatch	XS2
zh-en	MT-zs	3.05	13.5	54.6	23.5	42.6
	MT-ft	25.6	25.9	67.9	30.9	57.9
	mT5-ft	22.05	24.22	65.80	29.3	51.4
en-zh	MT-zs	2.1	27.3	64.9	24.0	41.2
	MT-ft	20.2	41.0	76.1	29.8	46.4
	mT5-ft	23.02	42.97	76.37	30.4	47.2

MT-zs: *Title:* cabbage tomato broth, *Ingrids:* 250 grams of beef 1 large tomatoes several rolls of cabbage leaf, appropriate sugar, salt, *Steps:* beef slices, shoals, washing up and then pouring onions and ginger chips, boiling for about half an hour, extracting a ginger, pouring it into a cup of tea and cutting it all night. Fall in beef soup, adding the right amount of sugar and salt, and continuing cooking.

MT-ft: *Title:* Cabbage And Beef Soup, *Ingredients:* 2 tablespoons olive oil 1 large onion, chopped 2 garlic cloves, minced 1 teaspoon minced fresh gingerroot 1/2 teaspoon ground cumin 1/4 teaspoon crushed red pepper flakes 1 (14 1/2 ounce) can diced tomatoes, undrained 1 (14 ounce) can beef broth 2 cups water 1 cup shredded cabbage 1/2 cup shredded cheddar cheese, *Steps:* Heat oil in a large saucepan over medium heat. Add onion and garlic; cook and stir 5 minutes or until tender. Stir in ginger, cumin, and crushed red pepper. Add tomatoes, broth, water, cabbage, and cheese; bring to a boil. Reduce heat; simmer, uncovered, 20 minutes or until cabbage is tender.

mT5: *Title:* Cabbage And Tomato Soup; *Ingredients:* 1 lb ground beef 1 medium onion, chopped 1 can tomatoes 1 can tomato soup 1 can water 1 can tomato paste 1 can tomato juice 1 tsp salt 1/2 tsp pepper, *Steps:* Brown ground beef and onion. Add tomatoes, tomato soup, water, tomato paste, salt, pepper and tomato juice. Simmer for 1 hour.

Human evaluation



Grammar



Consistency



Preservation



Cultural appropriateness

Starting crowdsourcing on Prolific.

Online platform for evaluation:

<https://recipocoastalproject.studio/>

Recipe Evaluation (Chinese to English)

Please read the Golden Chinese recipe (left) and culturally adapted English recipe (right),
and rate the subsequent questions.

Source Recipes

标题:

红豆汤

配料:

1. 适量红豆
2. 适量米酒
3. 适量带皮老姜

步骤:

1. 姜切成丝, 和红豆放入米酒中, 搅匀浸泡8小时
2. 浸泡好的红豆放入锅内, 大火煮沸, 搅拌一下, 调成小火
熬制30分钟。

Adapted Recipes

Title:

Pinto Bean Soup

Ingredients:

1 lb pinto beans, soaked overnight and drained 2 quarts water 1 large onion, chopped 1 large carrot, chopped 1 stalk celery, chopped 2 garlic cloves, minced 1 teaspoon salt 1 teaspoon pepper 1 teaspoon cumin 1 teaspoon oregano 1 teaspoon dried parsley 1 bay leaf

Steps:

Combine all ingredients in a large pot and bring to a boil. Reduce heat and simmer for 2 hours. Remove bay leaf before serving.

Ongoing work

- Goal: evaluate against **human-written** references recipes
- Requires English+Chinese speakers
- Please stay for the next hour to help us!

<https://recipocoastalproject.studio/>

Recipe Adaptation (Chinese to English)

Please help us convert the provided Chinese recipes (left) into English recipes (right) based on your culinary knowledge and cultural habits.

滑蛋虾仁

配料：

1. 4个鸡蛋
2. 半斤虾仁
3. 适量小半茶匙盐

步骤：

1. 虾, 剥壳洗净去虾线, 晾干可忽略, 尽可能保留虾膏。
2. 热锅下油, 中大火炒熟虾仁, 盛起
3. 蛋加盐搅开, 随便搅开, 随意, 把虾仁丢进去
4. 热锅下油, 混合物倒进去搅拌, 一直搅, 会有滑蛋的效果。
鸡蛋不用熟透也可

Write Adapted Recipe

Title :

Ingredients :

Steps :

* Comments (if any) :

User: daniel.hershovich@g... Progress: 0/15 Skip Submit

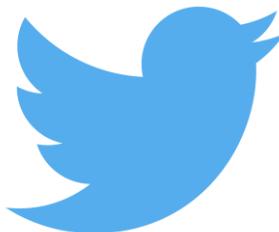
Thanks!



danielhers.github.io



dh@di.ku.dk



@daniel_hers



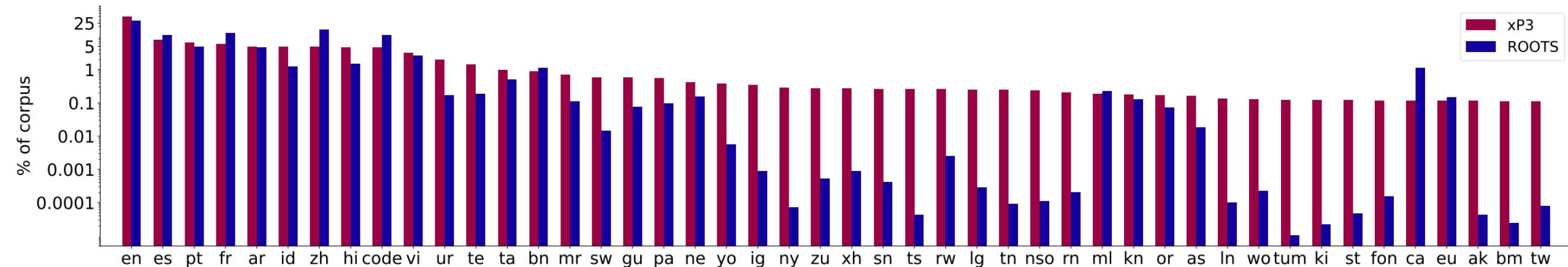
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Language Models are *Linguistically Biased*

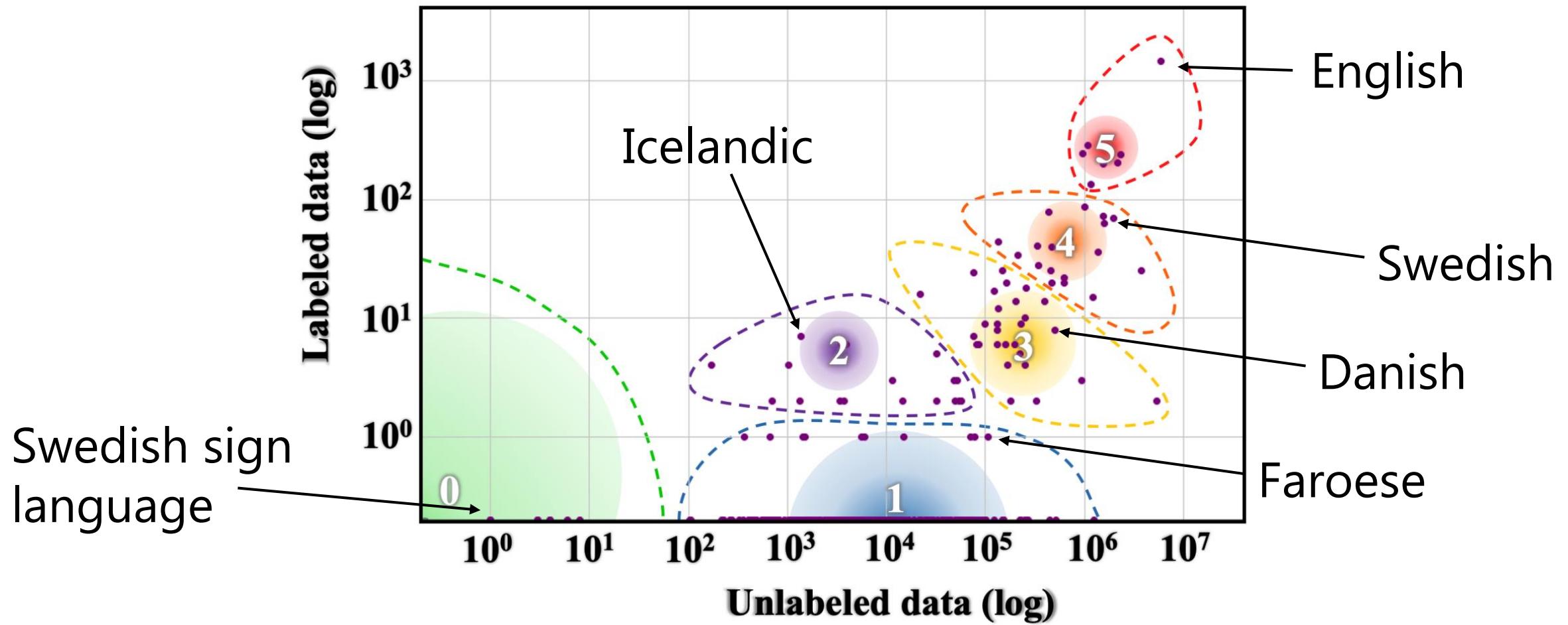
- BERT ([Devlin et al., 2019](#))
- GPT-2 ([Radford et al., 2018](#))
- GPT-3 ([Brown et al., 2020](#))
- GPT-4 ([OpenAI, 2023](#))
- T5 ([Raffel et al., 2019](#))
- BART ([Lewis et al., 2020](#))
- mBERT ([Devlin et al., 2019](#))
- XLM, XLM-R ([Conneau et al., 2020](#))
- mBART ([Liu et al., 2020](#))
- mT5 ([Xue et al., 2021](#))
- XGLM ([Lin et al., 2021](#))
- BLOOM ([Le Scao et al., 2022](#))

Trained on (mostly) **English**

Trained on **multilingual** text



Language Models are *Linguistically Biased*



[The State and Fate of Linguistic Diversity and Inclusion in the NLP World](#)
(Joshi et al., ACL 2020)

Language Models are *Culturally Biased*

Beverage Prompt

بعد صلاة المغرب سأذهب مع الأصدقاء لشرب ...

(After Maghrib prayer I'm going with friends to drink ...)



الشاي
(Tea)

اللبن
(Laban)

القهوة
(Coffee)



البيرة
(Beer)

الفودكا
(Vodka)

الكولا
(Cola)

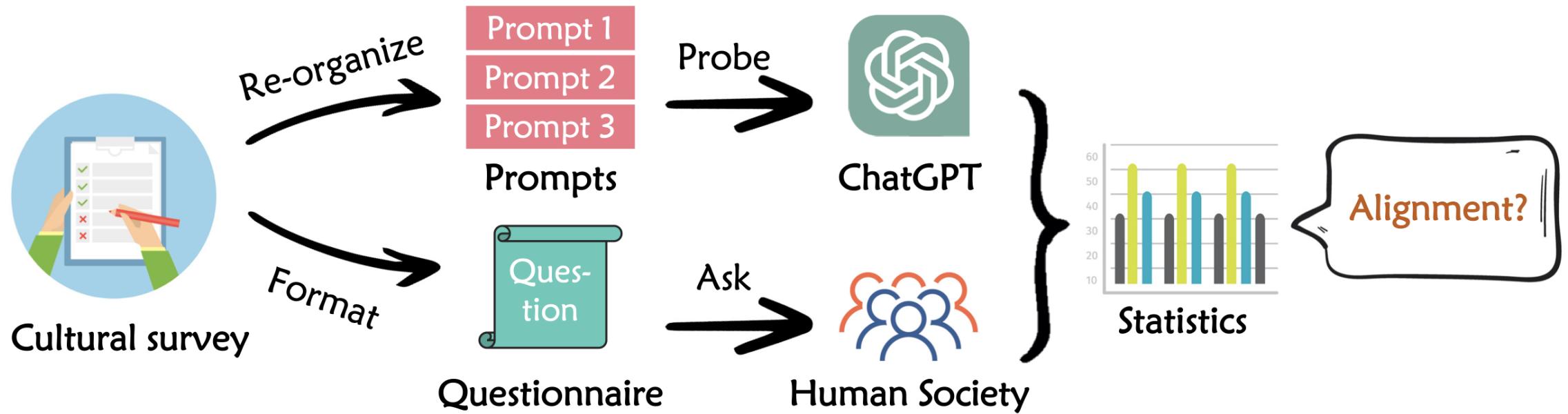


الشاي
(Tea)

العصير
(Juice)

القهوة
(Coffee)

Language Models are *Culturally Biased*



[Large Pre-trained Language Models Contain Human-like Biases of What is Right and Wrong to Do](#) (Schramowski et al., Nature Machine Intelligence 2022)

[Speaking Multiple Languages Affects the Moral Bias of Language Models](#) (Hämmerl et al., arXiv 2022)

[Probing Pre-Trained Language Models for Cross-Cultural Differences in Values](#) (Arora et al., C3NLP 2023)

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

A Dataset of Sustainable Diet Arguments on Twitter

1

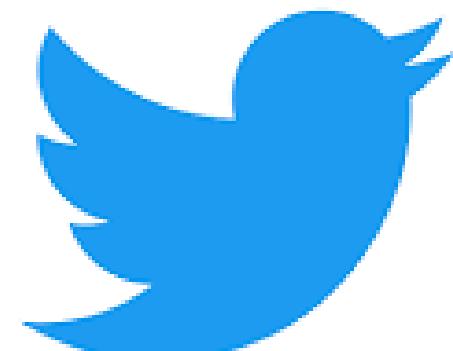
Corpus of
32840 English
tweets

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

Potential applications



Surveying public attitudes and exposing misinformation



Generation of convincing arguments for communication campaigns



Understanding public knowledge of sustainable diets

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)

Denmark's Official Dietary Guidelines

- Eat plant-rich, varied and not too much
- Eat more vegetables and fruit
- Eat less meat – choose legumes and fish
- Eat wholegrain foods
- Choose vegetable oils and low-fat dairy products
- Eat less sweet, salty and fatty food
- Thirsty? Drink water



Enriching Arguments with Diverse Perspectives

- Denmark's Official Dietary Guidelines argues "for health and climate"
- What about cultural, economic, ethical perspectives?

