

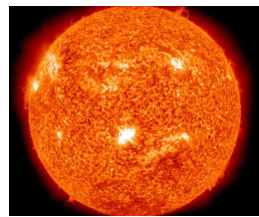
Image-Text Modeling for Multilingual NLP

Simran Khanuja

In this lecture we will talk about ...

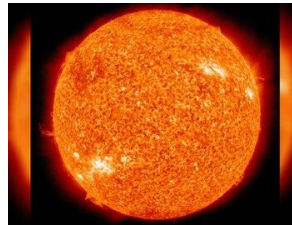
- **Why “*vision*” in multilingual NLP?**
- **Four types of multilingual image-text models**
 - Cross-encoder based (understanding)
 - Dual-encoder based (retrieval)
 - Encoder-decoder based (understanding + text generation)
 - Diffusion based (image generation)
- **For each type we will cover**
 - Downstream task capabilities
 - Model Architecture
 - Pre-training data resources
 - Deep Dive into one model
- **Discussion of biases**
- **Revisit motivation + Open questions**

Some concepts *look* the same across languages and cultures

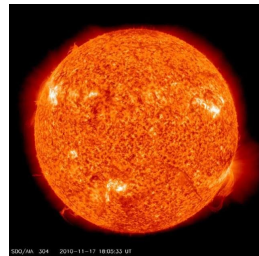


sun

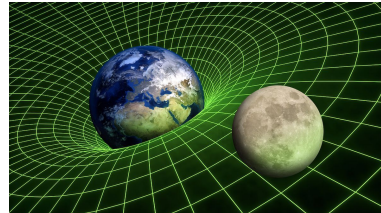
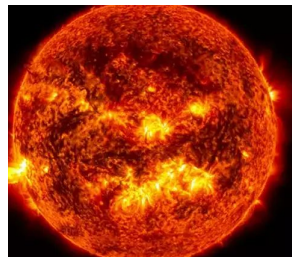
सूरज



太陽

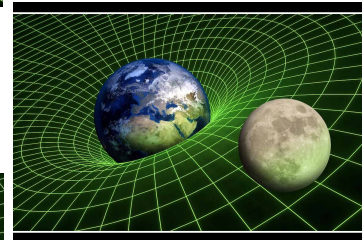


güneş

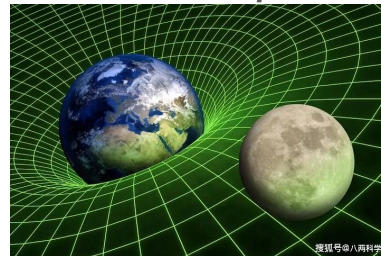


gravity

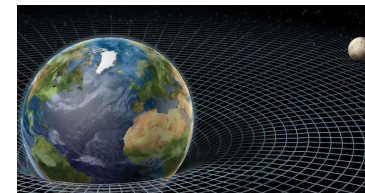
गुरुत्वाकर्षण



重力

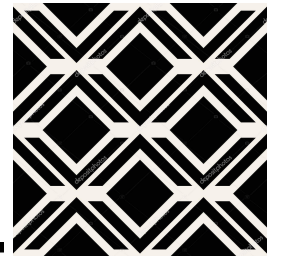


yer çekimi



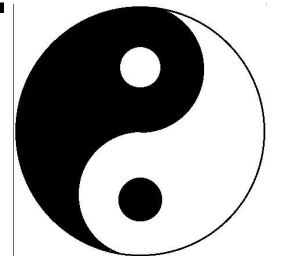
black and white

काला और सफेद



黒と白

siyah ve beyaz



[List of Human Universals \(Donald Brown, 1991\)](#); [Psychological universals: what are they and how can we know?](#)

3 Image Source: Google Search

Some may universally exist but yet *look* different



wedding



music



sports



शादी



結婚式

संगीत



音楽

खेल



スポーツ

düğün



müzik



Spor Dalları



[List of Human Universals \(Donald Brown, 1991\); Psychological universals: what are they and how can we know?](#)

4 Image Source: Google Search

Some may not exist cross-culturally at all ...

Some concepts are only understood within a cultural background

Culture: The way of life of a collective of people that distinguishes them from other people (Mora, 2013; Shweder et al. 2007).



Pilota / Jai-alai



Sanxian / Shamisen

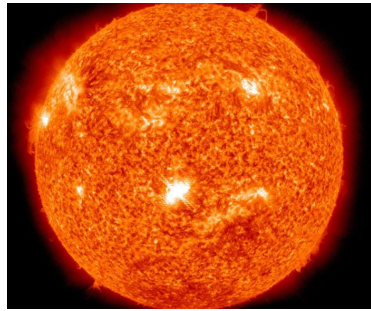


Clavie

Source: [Desmond Elliott's LxMLS Slides](#)

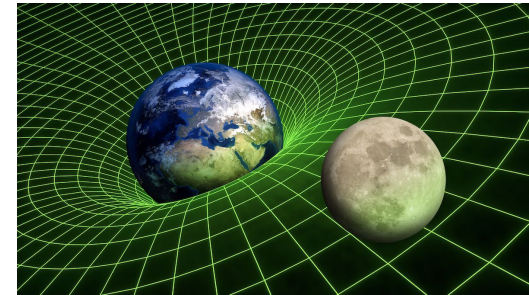
As an anchor point for multiple languages for universal concepts

sun



太陽

gravity



yer çekimi

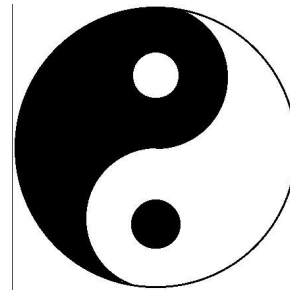
सूरज

güneş

गुरुत्वाकर्षण

重力

black and white



siyah ve beyaz

काला और सफेद

黒と白

As a mechanism to enhance cultural diversity within concepts



wedding
düğün
結婚式
शादी



音樂
müzik
music
संगीत



Spor खेल
Dallari 스포츠
sports

To represent culturally unique objects/events beyond text



Pilota / Jai-alai

sport
racquet
court
actions



Sanxian / Shamisen

musical instrument
strings
action
pose



Clavie

fire
people
night

Status quo

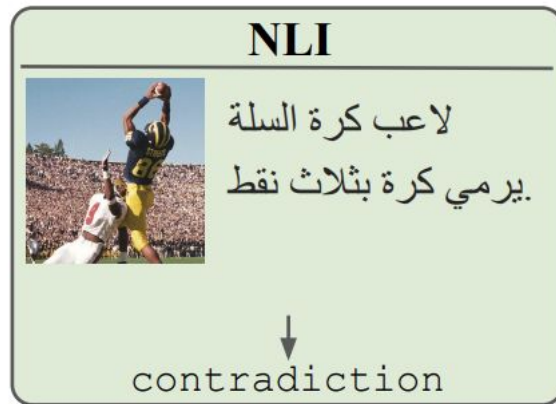
So what progress has been made thus far in the field to support research in image-text multilingual NLP?

We will be looking at **four types** of image-text multilingual models that exist today. For each type of models, we will cover :

- Evaluation Tasks
- Model Architecture
- Data: Pre-training datasets and languages
- Pre-training tasks
 - Deep-dive into a state-of-the-art model
- [Optional] Demo
- [Optional] Bias Discussion

Overview of Downstream Tasks (Understanding)

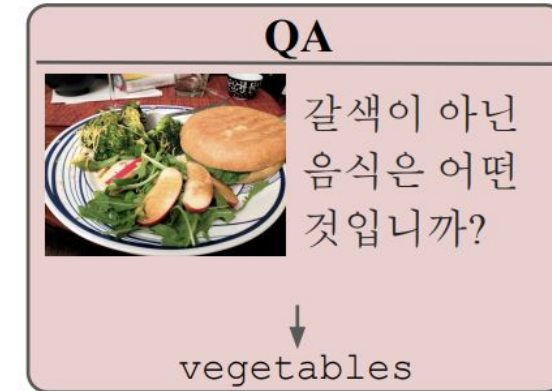
Cross-lingual Visual NLI (XVNLI)



ENG: The basketball player shoots a three pointer

- Infer whether a text-hypothesis *entails*, *contradicts*, or is *neutral* to an image-premise.
- Comprised of: SNLI (Bowman et al., 2015), with its multimodal (Xie et al., 2019) and cross-lingual (Agic & Schluter., 2018) counterparts.
- English, Arabic, French, Russian, Spanish

Cross-lingual Grounded QA (xGQA)



ENG: Which kind of food is not brown?

- Answer several types of structured questions about an image
- xGQA (Pfeiffer et al. 2022) which is translated from GQA (Hudson & Manning, 2019), into 7 languages
- MaXM (Changpinyo et al. 2022), automatically generate QA pairs from XM3600 for 7 langs

Overview of Downstream Tasks (Understanding+Retrieval)

Multicultural V-L Reasoning

Reasoning



两张图加起来总共超过五个人在打鼓, 并且两张图中 的人所打鼓的种类不同。

True

ENG: In total, there are more than five people playing drums in the two images combined and people in the two images are playing different kinds of drums.

- Infer whether statement is true or false about a pair of images.
- MaRVL (Liu et al., 2021): Dataset constructed from scratch by native speakers **[EMNLP Best Paper]**
- Indonesian, Mandarin, Tamil, Turkish, Swahili

Multi-X Retrieval

Retrieval

Мужчины и женщины в черных платьях и костюмах держат ноты в руках и поют хором.



ENG: A group of men and women dressed in formal black dresses and suits holding their music books and singing.

- *xFlickr&CO.*: 1000 from Flickr30K (Young et al., 2014) + COCO (Lin et al., 2014); captions crowdsourced for 7 langs
- *WIT* (Srinivasan et al., 2021): Wikipedia in 108 languages (IGLUE covers 10)
- *XM3600* (Thapliyal et al., 2022): Captions for 3600 geographically diverse images in 36 languages

Overview of Downstream Tasks (Generation)

Image Captioning

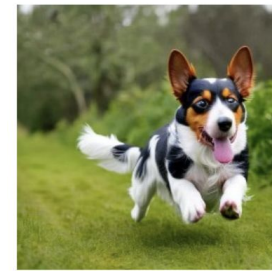


Source: Porsche Museum, Stuttgart by Brian Solis.

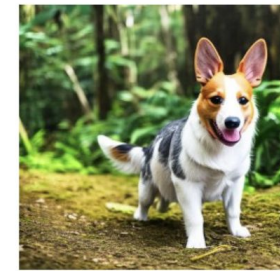
Dutch	nl	klassieke raceauto's op een rij een museum
English	en	The branded classic cars in a row at display.
Persian	fa	تعدادی اتومبیل مسابقه ای اسپرت در یک نمایشگاه سرپوشیده
Filipino	fil	mga klasikong sasakyan na nakadisplay sa tindahan ng kotse
Finnish	fi	Antiikkisia urheiluautoja näyttelyssä
French	fr	Une série de voitures de course vintage exposé dans un musée
German	de	Verschiedenfarbige Rennwagen mit Nummern auf einer Autoausstellung
Greek	el	έκθεση πετρό αγωνιστικών αυτοκινήτων
Hebrew	he	רכב פורשה וינטג' עם גג נפתח בצבע כסוף עומד בתצוגה ליד רכבים נוספים.
Hindi	hi	सफ़ेद फ़र्श पर ठेरी कोरे रंग की गाड़ी और उसके पीछे और भी गाड़ियाँ

- The task is to generate a caption for an image in a language of choice.
- Are image descriptions consistent across cultures? Research shows otherwise (Ye et al. 2023, Vossen et al., 2017).
- **[Open Question]** Beyond BLEU, CIDEr, how do we capture the cultural relevance of a caption?

Text → Image Generation



Chinese:一只柯基犬在丛林中奔跑



French:Un chien corgi court dans la jungle

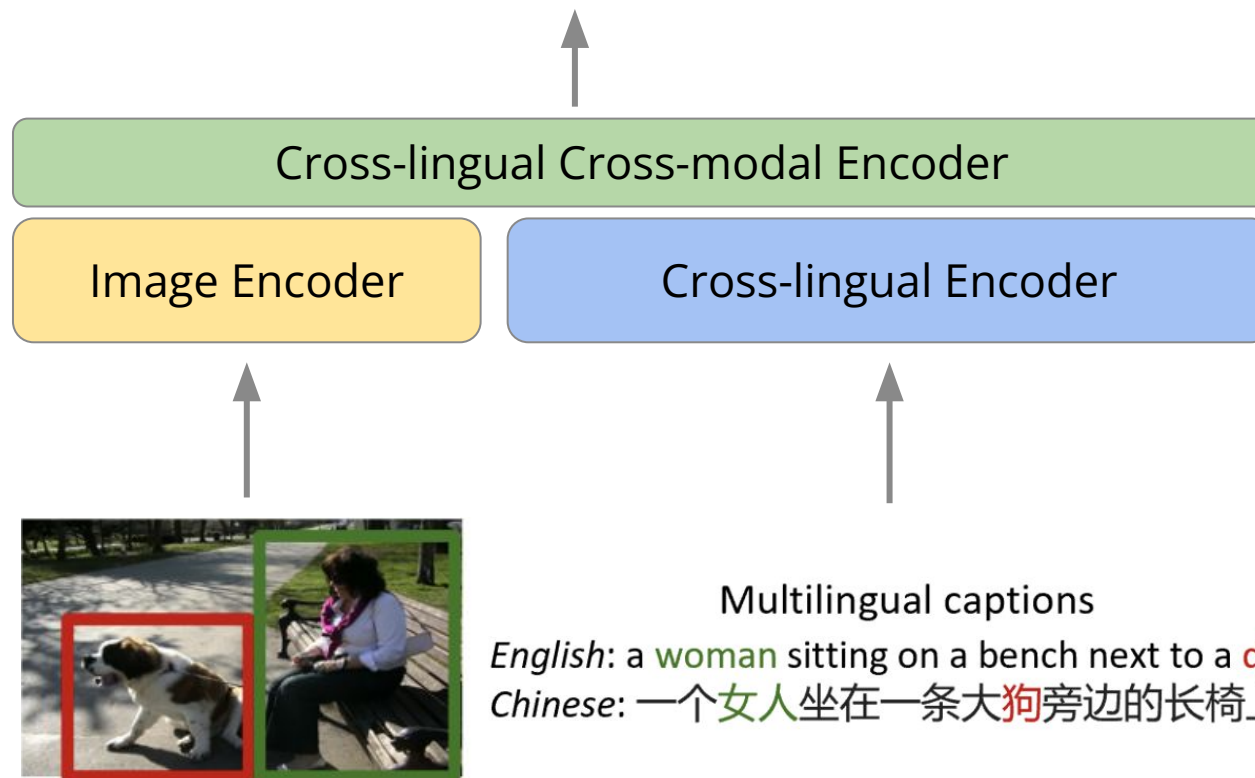


English: A corgi dog runs in the jungle

- The task is to generate an image given a multilingual caption
- Evaluation metrics include FID (can be biased due to training on ImageNet), and image-caption similarity using multilingual CLIP
- **[Open Question]** How do we capture cultural representativeness of output, while making sure the model is not stereotyping/biased?

Category 1: Multi-X Understanding (Cross-Encoding Based Models)

Multilingual Image-text Retrieval / VQA / NLI

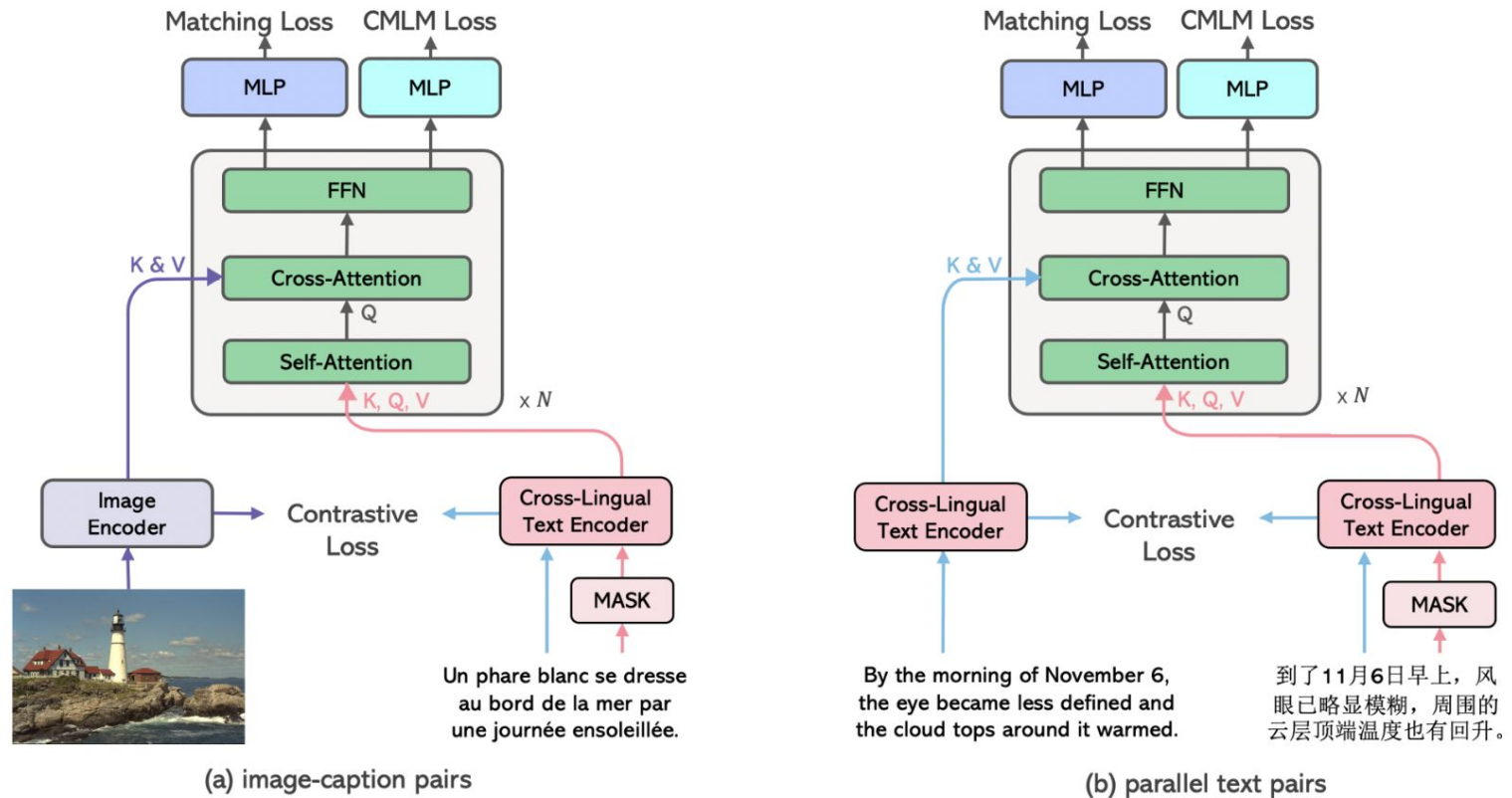


[M3P: Learning Universal Representations via Multitask Multilingual Multimodal Pre-training](#) (Ni et. al, CVPR 2021)

[UC2 : Universal Cross-lingual Cross-modal Vision-and-Language Pre-training](#) (Zhou et. al, CVPR 2021)

[\[CCLM\] Cross-View Language Modeling: Towards Unified Cross-Lingual Cross-Modal Pre-training](#) (Zeng et. al, ACL 2023)

Deep Dive: CCLM (SoTA Encoder-based model)

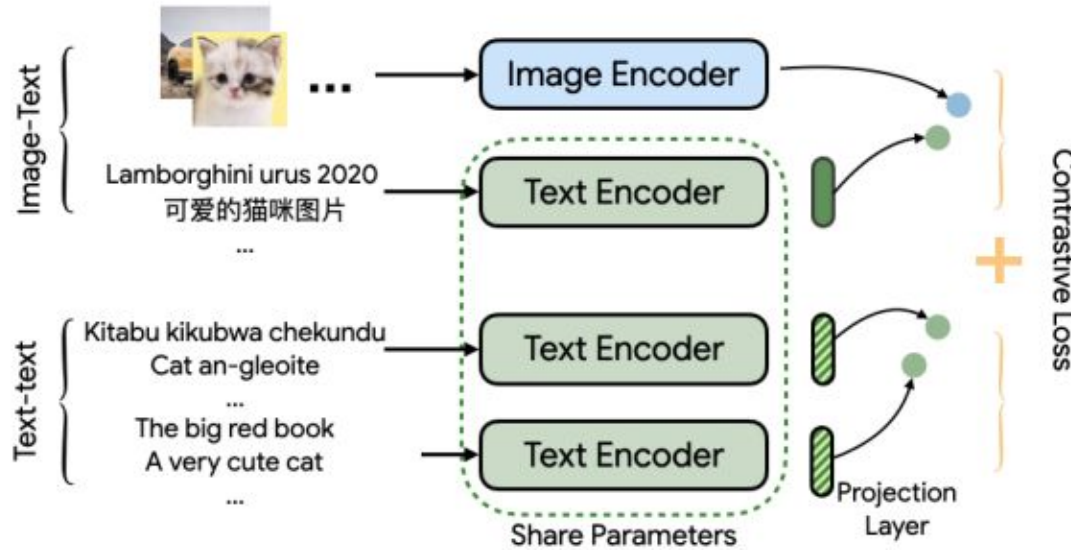


[\[CCLM\] Cross-View Language Modeling: Towards Unified Cross-Lingual Cross-Modal Pre-training](#) (Zeng et. al, ACL 2023)

Pre-training data for Multi-X understanding models

Data Resource Type →	Multilingual (text)	Multimodal (English-only)	Multi-X (translated)	Multi-X
Datasets	Wikipedia (100L); Wikimatrix (para; 20L);	CC3M (en; 3.3M)	CC3M (5L; 3.3M);	
Models	M3P (Wikipedia)	M3P (CC3M)		
			UC2 (CC3M-translated)	
	CCLM (Wikimatrix)		CCLM (CC3M-trans)	

Category 2: Multi-X Understanding (Dual-encoder Based Models)



[MURAL: Multimodal, Multitask Retrieval Across Languages](#) (Jain et. al, 2021)

[Cross-Lingual and Multilingual CLIP](#) (Carlsson et al., LREC 2022)



Pre-training data for Multi-X understanding models

Data Resource Type →	Multilingual (text)	Multimodal (English-only)	Multi-X (translated)	Multi-X
Datasets	Wikipedia (100L); Wikimatrix (para; 20L); EOBT (wikimatrix+paracrawl+ europarl);	CC3M (en; 3.3M); CC12M (en)	CC3M (5L; 3.3M); MSCOCO; GCC; VizWiz	WIT (101L), Alt-Text
Models	M3P (Wikipedia)	M3P (CC3M)		
			UC2 (CC3M-translated)	
	CCLM (Wikimatrix)		CCLM (CC3M-trans)	
	MURAL (EOBT)	MURAL (CC12M)		MURAL (Alt-Text)
			mCLIP (COCO+GCC+ VizWiz)	

Category 3: Multi-X Understanding + Generation (Text)

一个男人骑着一匹棕色的马 (Text in language L2)

Cross-lingual Cross-modal Decoder

Cross-lingual Cross-modal Encoder

Image Encoder

Cross-lingual Encoder



(Visual tokens)

A man rides a brown horse

(Text in language L1)

Multilingual Image-text
Retrieval / VQA / NLI

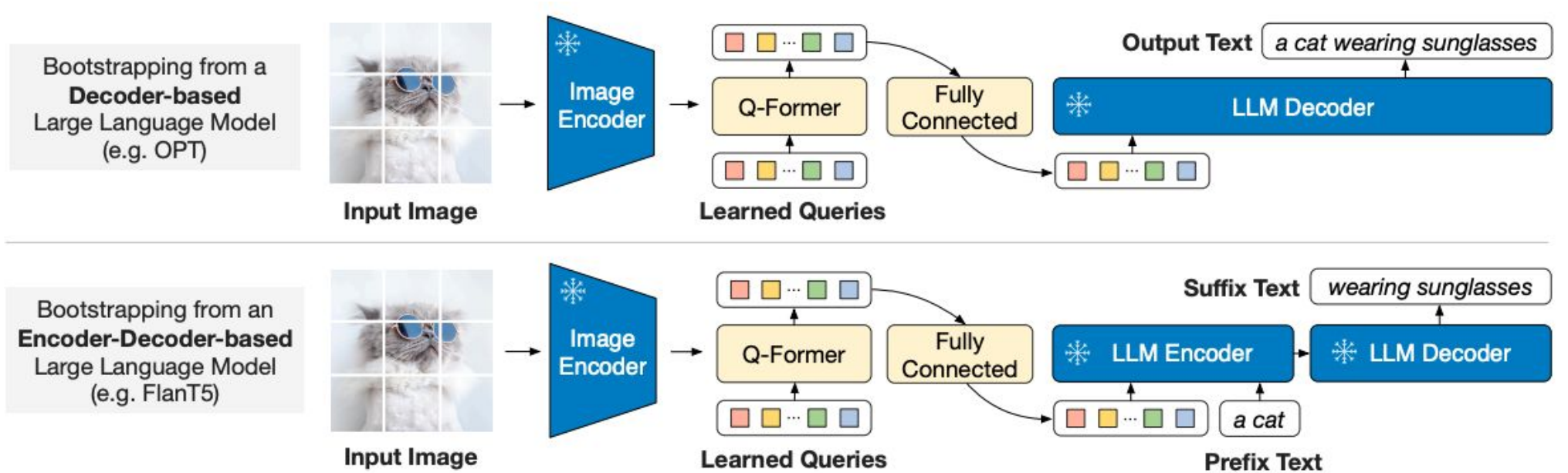
[PALI-X: On Scaling up a Multilingual Vision and Language Model](#) (Chen et al., 2023)

[ERNIE-UniX2: A Unified Cross-lingual Cross-modal Framework for Understanding and Generation](#) (Yin et al, 2022)

[mBLIP: Efficient Bootstrapping of Multilingual Vision-LLMs](#) (Geigle et al., 2023)

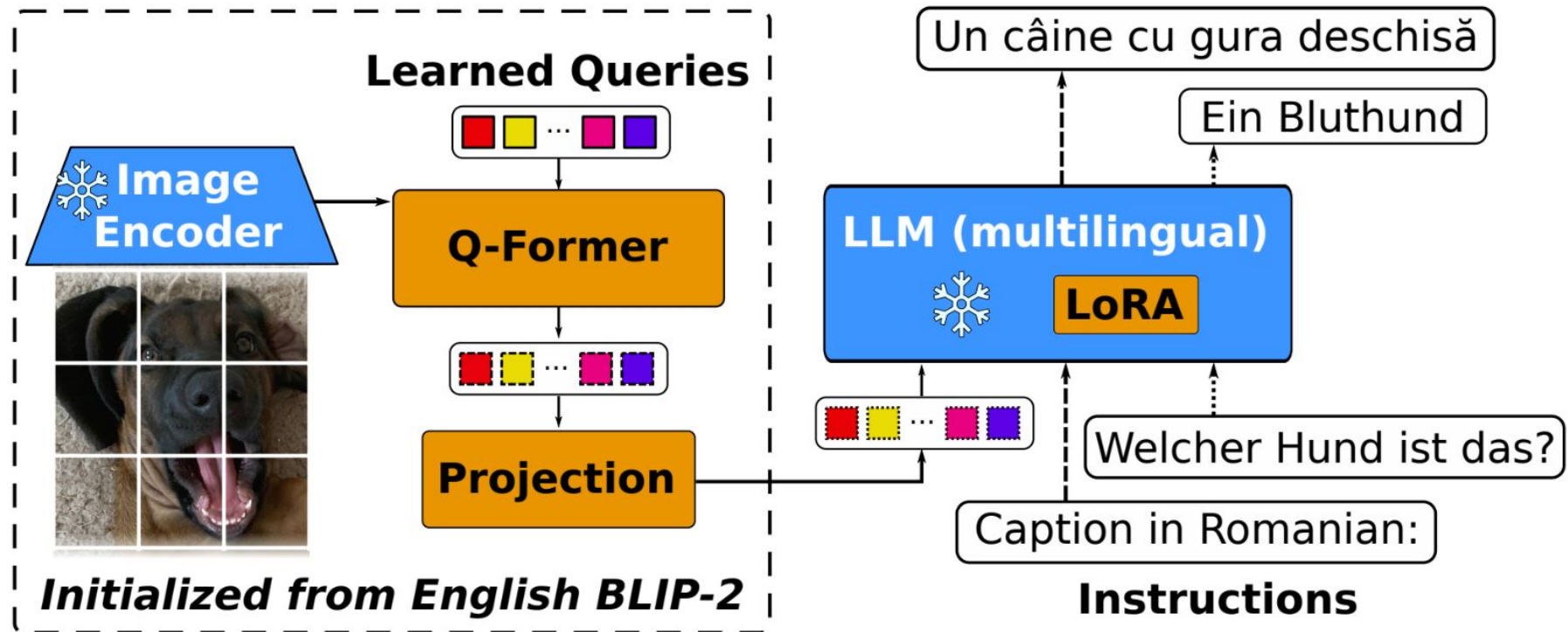
Deep Dive: mBLIP (Encoder-Decoder)

Background: BLIP-2 Architecture



[BLIP-2: Bootstrapping Language-Image Pre-training with Frozen Image Encoders and Large Language Models](#) (Li et al., CVPR 2023)

Deep Dive: mBLIP (Encoder-Decoder)



[mBLIP: Efficient Bootstrapping of Multilingual Vision-LLMs](#) (Geigle et al., 2023)



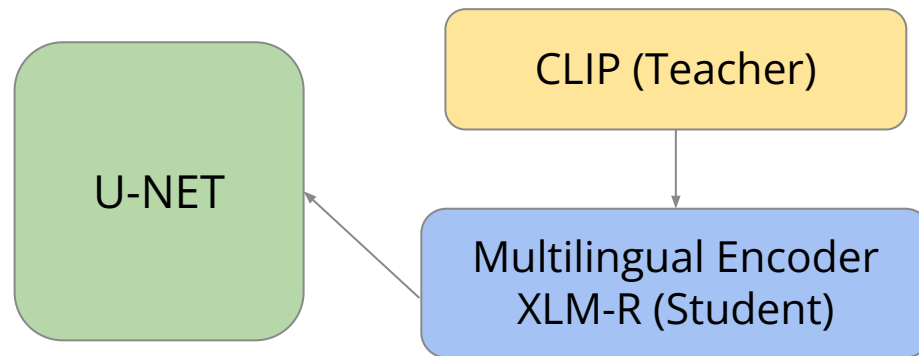
Deep Dive: mBLIP (Demo)

<https://4c2e12edc5350ddb9f.gradio.live>

Pre-training data for Multi-X understanding models

Data Resource Type →	Multilingual (text)	Multimodal (English-only)	Multi-X (translated)	Multi-X
Datasets	Wikipedia (100L); Wikimatrix (para; 20L); EOBT (wikimatrix+paracrawl+ europarl);	CC3M (en; 3.3M); CC12M (en)	CC3M (5L; 3.3M); MSCOCO; GCC; VizWiz	WIT (101L), Alt-Text
Models	M3P (Wikipedia)	M3P (CC3M)		
			UC2 (CC3M-translated)	
	CCLM (Wikimatrix)		CCLM (CC3M-trans)	
	MURAL (EOBT)	MURAL (CC12M)		MURAL (Alt-Text)
			mCLIP (COCO+GCC+ VizWiz)	
			mBLIP (MSCOCO+WebCapFilt+ LLaVa (IFT))	

Category 4: Multi-X Generation (Image): diffusion-based models



[ERNIE-ViLG 2.0: Improving Text-to-Image Diffusion Model with Knowledge-Enhanced Mixture-of-Denoising-Experts](#) (Feng et al, CVPR 2023)

[AltDiffusion: A Multilingual Text-to-Image Diffusion Model](#) (Ye et al, 2023)



Hindi
पहाड़ी महिलाएँ, अमृता शेरगिल
(Pahari Women, Amrita Sher-Gil)



Spanish
Retrato de mujer, estilo Picasso
(Portrait of a woman, Picasso style)



Italian
Pittura ad acquerello di spaghetti
(Watercolor painting of spaghetti)



Thai
ชีวิตชนบทไทย อรรถพล เมฆพจน์
(Thai Countryside Life, Akaphol Mekpoth)



English
The Hay Wain, John Constable



Chinese
小桥流水人家
(Small bridge, flowing water and household)



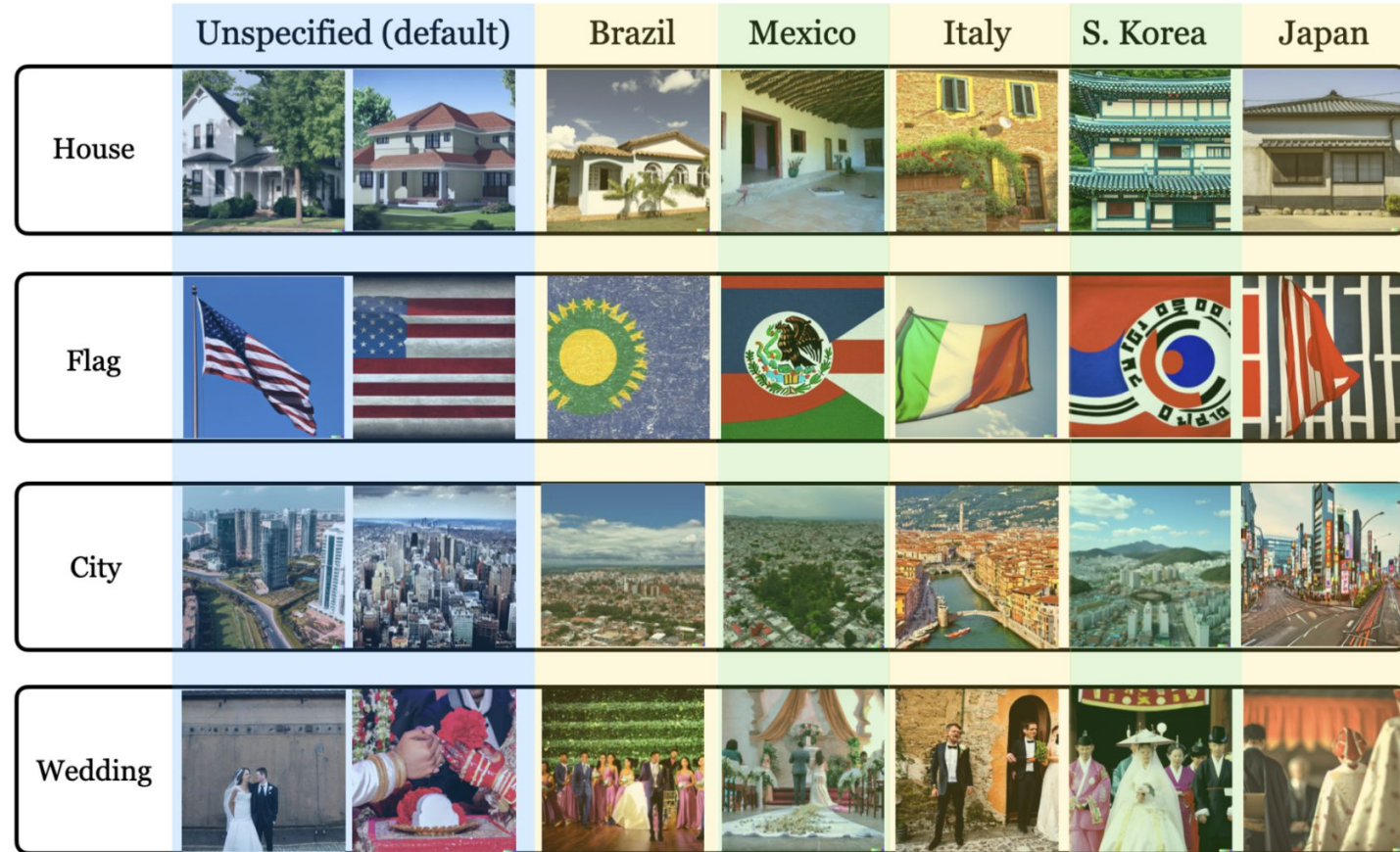
Russian
Вид на Байкал, картина алекс
(View of Baikal, oil painting)

AltDiffusion (Outputs)



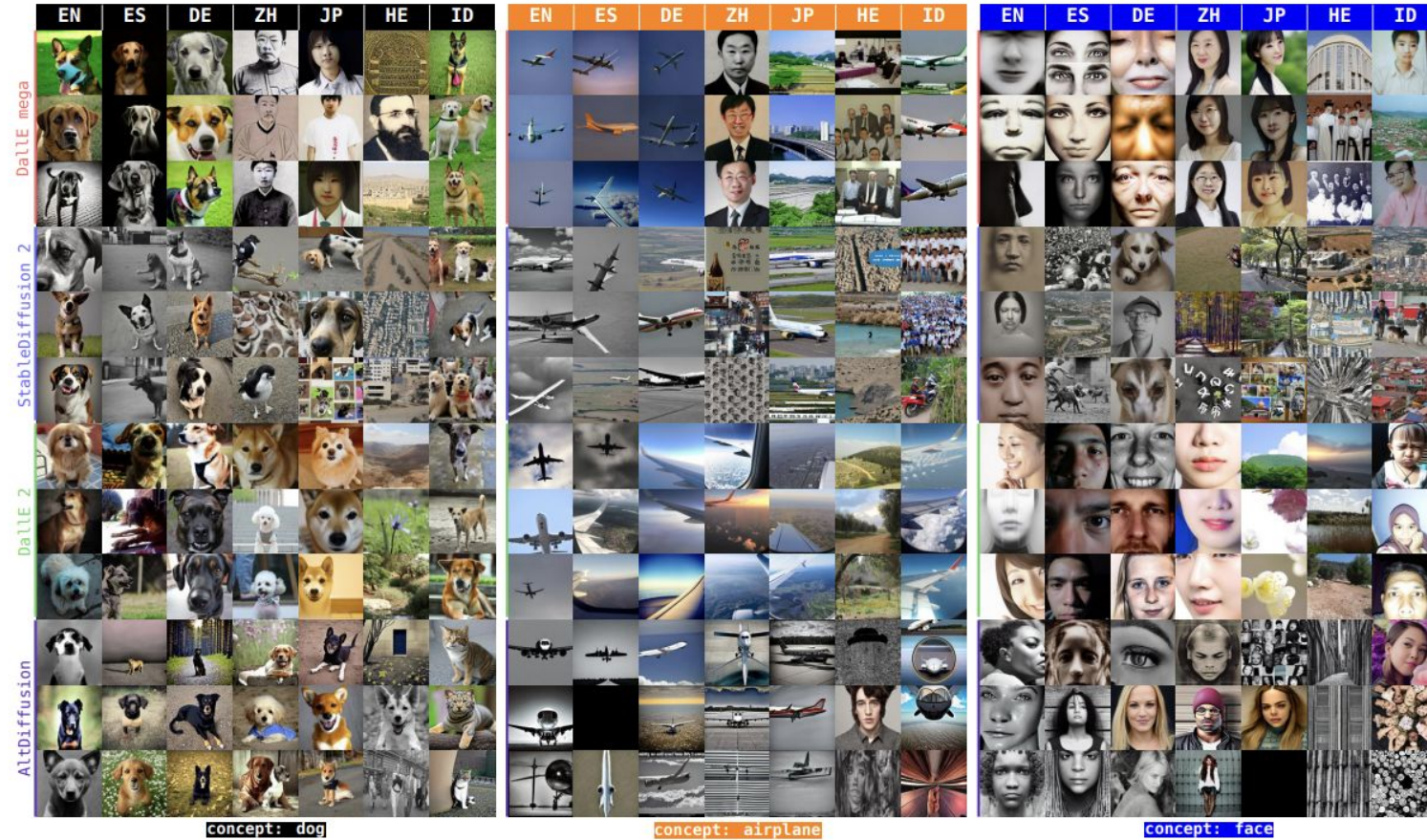
Figure 14: Images generated by AltDiffusion with prompt “boy portrait with sunglasses” in various languages and a fixed seed. Note that the model demonstrates proficiency in capturing distinct facial features of young males from various cultural backgrounds, including a European-American style for English and an Asian style for Chinese.

Biases in image generation models



[Inspecting the Geographical Representativeness of Images from Text-to-Image Models](#) (Basu et. al, ACL 2023)

Biases in image generation models



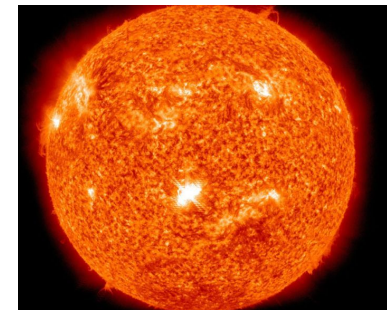
[Multilingual Conceptual Coverage in Text-to-Image Models](#) (Saxon et. al, ACL 2023)

Let's revisit our motivation in context of the prior work

Do models leverage the universality of concepts to learn better representations for multiple languages in text?

- a. [Open] Hard to define *universality*
 - i. [Proposal] Study similarities and differences in naturally occurring data from different countries/cultures?
- b. [Open] How do we measure cross-lingual alignment in an embedding space?
- c. [Open] How can we piece out contributions of the textual and visual modality in learning a cross-lingual representation?
- d. [Open] Hard to evaluate with high confidence

sun



太陽

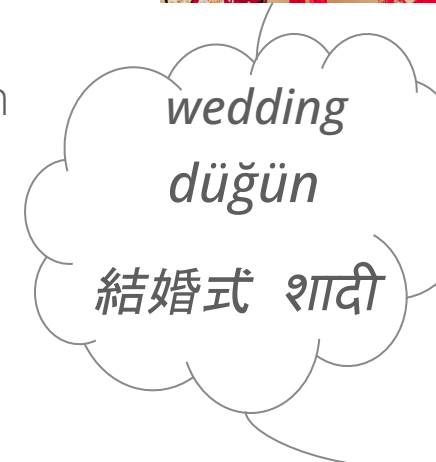
सूरज

güneş

Let's revisit our motivation in context of the prior work

Do models incorporate diversity in representation?

- a. Initial explorations suggest otherwise
- b. **[Open]** How do you evaluate diversity?
 - i. Can you account for individual preferences?
 - ii. What is the tradeoff between diversity v/s stereotyping/bias?
- c. **[Open]** Is it right to discern culture based on language input?
 - i. English is ubiquitous
BUT also
 - ii. Language has evolved within a culture and holds key information about it



Let's revisit our motivation in context of the prior work

Do models have a world view of concepts specific to every culture?

- a. Probably not and may never will
 - i. Not everything is present digitally
 - ii. Cultures and concepts are constantly changing
- b. **[Open]** How can we make models adept at keeping up with evolving concepts and cultures?
- c. **[Open]** How can we incorporate cultures of communities that are not present digitally, into our models?



Sanxian / Shamisen

musical instrument
strings
action
pose



Thanks!

Questions?