



# PEMM Paintings End Of Project Recap

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Undergrad Researchers: Ajay, Revanth, Sai, Shravan, Blake



## General Accomplishments

- Clustering ancient Ethiopian manuscript paintings using different AI methods (CLIP, BLIP-2, UMAP, Kmeans/HDBSCAN, IC|TC).
  - Developed a dataset of 1,007 preprocessed images for future model development and training
- Our goal for the summer was to create the best possible model to cluster these images based on stylistic differences.
  - Our work has expanded beyond this point
- This work was completed as a continuation of work of the AAS314 final project



## Organization & Hours

- The team worked for 520 hours total (~10 hrs/week each)
- All code was uploaded to GitHub for repo + issues tracking
- Communication was done mainly through Slack and weekly/ biweekly status meetings were held.



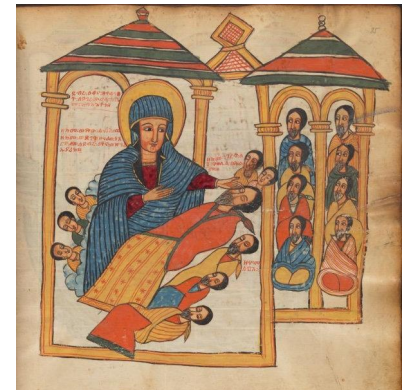
## Technical Progress

- CLIP clustering with UMAP + KMeans (Revanth, Ajay, Blake)
- Hypertuning parameters for all systems (Sai)
- BLIP-2 captioning for representative images
- Enhancing workflow through accessing DELLA superclusters to shorten run time for experiments

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## Processed Dataset

- Filtered out dataset by removing manuscript images of text
- Manually did a 1:1 box crop of each manuscript focusing on the image
- Each image was then resized to 224x224 to be used as model inputs



# Hyperparameter tuning - Grid Search Optimization

# of Epochs	Learning Rate												
	Batch Size=8	5	10	15	20	25	30	35	40	45	50	55	60
	1.00E-05	55.79%	75.10%	53.11%	71.40%	68.56%	54.30%	84.06%	81.71%	56.80%	70.33%	58.46%	55.61%
	3.00E-05	75.62%	85.09%	53.16%	72.60%	59.73%	55.15%	56.23%	81.37%	59.09%	82.93%	73.24%	50.56%
	1.00E-04	71.66%	83.41%	59.17%	79.27%	75.02%	61.44%	85.41%	53.17%	60.00%	63.94%	53.26%	71.90%
	3.00E-04	83.93%	78.61%	64.57%	67.26%	86.01%	62.83%	76.47%	79.56%	55.20%	78.86%	86.21%	62.61%
	1.00E-03	84.79%	52.98%	71.72%	77.37%	63.24%	55.07%	80.07%	84.56%	65.43%	77.18%	53.98%	74.34%
	3.00E-03	70.91%	51.75%	68.34%	55.48%	79.64%	70.27%	85.08%	53.74%	77.70%	82.06%	59.37%	61.04%
	1.00E-02	54.45%	68.09%	59.86%	73.51%	55.97%	81.15%	78.31%	55.12%	58.93%	51.62%	85.50%	71.14%
	3.00E-02	77.18%	83.16%	76.21%	62.16%	57.46%	71.01%	82.83%	64.24%	71.08%	76.86%	57.72%	87.23%
	1.00E-01	85.97%	61.51%	81.06%	82.04%	87.95%	75.08%	83.15%	51.22%	80.33%	62.92%	59.28%	64.53%
# of Epochs	Learning Rate												
	Batch Size=16	5	10	15	20	25	30	35	40	45	50	55	60
	1.00E-05	72.06%	59.19%	80.02%	66.07%	85.63%	61.27%	83.38%	64.13%	73.48%	56.60%	86.34%	73.58%
	3.00E-05	55.51%	85.39%	60.92%	84.87%	63.97%	69.96%	83.03%	58.77%	76.27%	72.04%	52.22%	67.24%
	1.00E-04	71.09%	53.17%	87.46%	77.77%	64.91%	83.55%	51.66%	59.01%	66.89%	52.74%	73.77%	70.91%
	3.00E-04	52.92%	67.49%	63.47%	87.90%	62.49%	70.45%	76.64%	53.57%	55.44%	56.51%	55.94%	79.70%
	1.00E-03	50.24%	69.55%	78.60%	56.57%	52.32%	81.95%	57.61%	80.02%	65.49%	79.24%	68.57%	82.10%
	3.00E-03	84.31%	56.02%	79.87%	82.57%	68.42%	86.97%	84.51%	70.80%	84.56%	66.94%	59.17%	83.01%
	1.00E-02	62.10%	68.29%	81.81%	59.78%	73.55%	70.37%	57.38%	61.86%	85.84%	87.38%	74.39%	55.88%
	3.00E-02	86.32%	61.95%	59.02%	52.03%	70.89%	85.46%	62.38%	74.25%	87.90%	55.93%	74.68%	76.34%
	1.00E-01	64.65%	78.57%	70.06%	50.92%	71.27%	53.35%	60.72%	69.44%	50.06%	63.09%	76.86%	53.55%



## Four Initial Versions

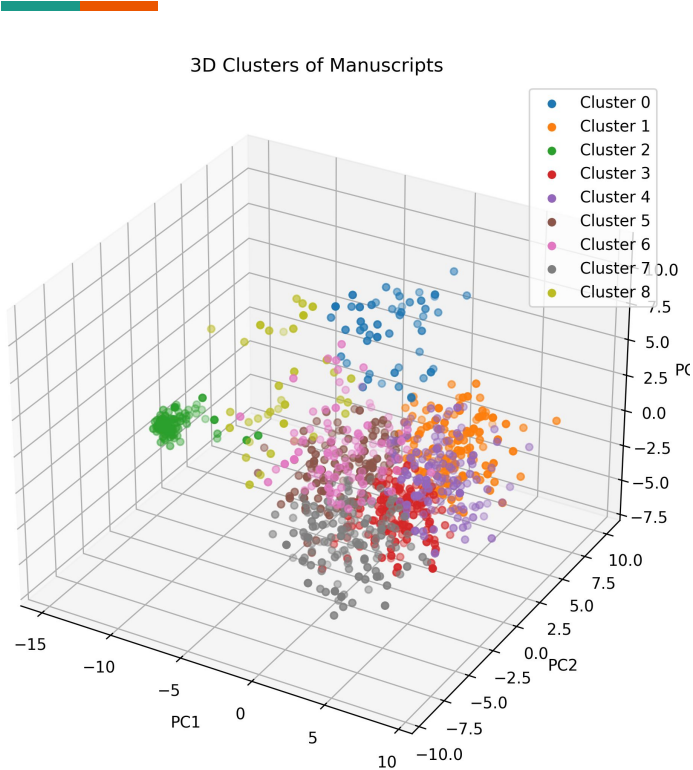
- **og\_hypertuned\_pca:** Uses ResNet feature embeddings with PCA for dimensionality reduction; hyperparameters for PCA and clustering are manually tuned for improved separation.
- **og\_hypertuned\_umap:** Uses ResNet feature embeddings with UMAP for nonlinear dimensionality reduction; UMAP and clustering hyperparameters are tuned for better clustering performance.
- **clip\_umap:** Uses CLIP (Contrastive Language–Image Pretraining) to extract semantically rich image features, followed by UMAP for dimensionality reduction and clustering.
- **blip2\_umap:** Uses BLIP-2 (Bootstrapped Language–Image Pretraining) to extract multimodal-aware visual embeddings, then applies UMAP for dimensionality reduction and clustering.



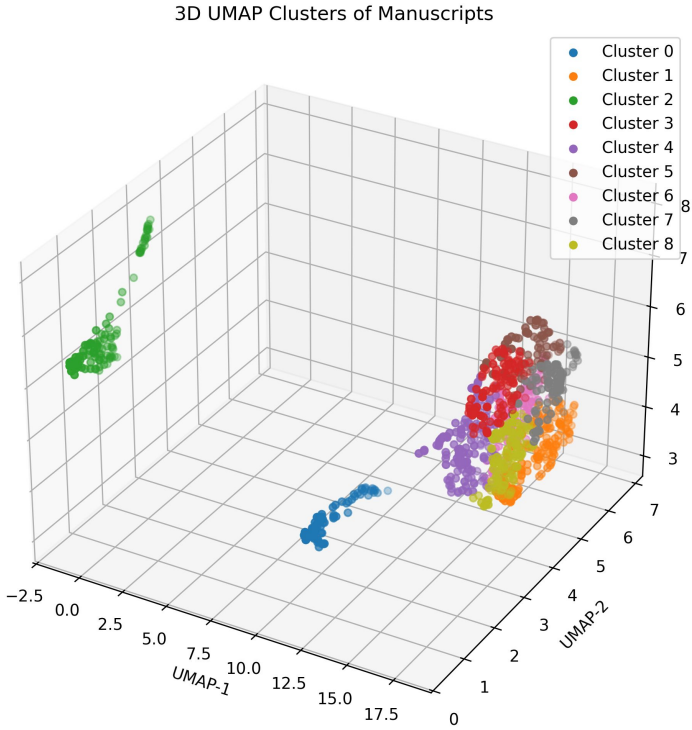
## ResNet + PCA/UMAP

- **ResNet feature extraction:** leverages pretrained ResNet to obtain high-quality visual embeddings from manuscript images.
- **PCA (linear reduction):** projects embeddings into a lower-dimensional space; captures variance efficiently but may miss nonlinear structures.
- **UMAP (nonlinear reduction):** preserves local and global structure in the embedding space, often improving cluster separation compared to PCA.
- **Hyperparameter tuning:** manual adjustment of dimensionality and clustering parameters enhances separation between stylistic groups.
- **Strengths:** stable, interpretable, and computationally efficient; ResNet features are well-established in image analysis.
- **Limitations:** may capture only visual style, without semantic or contextual understanding of manuscripts.

# ResNet + PCA (9 Categories)



# ResNet + UMAP (9 Categories)





## Clip + UMAP

- **CLIP feature extraction:** uses pretrained CLIP to generate semantically rich embeddings aligned across image and text.
- **Multimodal awareness:** embeddings capture both visual style and higher-level semantic meaning (e.g., subject matter).
- **UMAP dimensionality reduction:** preserves local neighborhood structures, enabling more meaningful clustering of manuscript styles.
- **Improved clustering:** better separates groups based on both appearance and semantic content.
- **Strengths:** captures richer features than ResNet alone; useful for stylistic + contextual clustering.
- **Limitations:** computationally heavier; may overemphasize semantic similarities over purely visual ones.



## BLIP2 + UMAP

- **BLIP-2 feature extraction:** generates multimodal-aware embeddings by combining vision and language pretraining.
- **Contextual understanding:** embeddings incorporate both fine-grained visual details and broader textual/semantic associations.
- **UMAP dimensionality reduction:** projects high-dimensional BLIP-2 embeddings into a low-dimensional space while preserving local/global structures.
- **Enhanced clustering:** captures nuanced manuscript similarities that go beyond style (e.g., theme, context, or symbolic meaning).
- **Strengths:** most semantically informed approach; powerful for tasks requiring multimodal interpretation.
- **Limitations:** high computational cost; risk of clustering more by semantic meaning than by visual authorship cues.

# BLIP-2 Markov Code Snippet

```
markov_chain = build_markov_chain(rep_captions,
args.guidelines)
refined_keywords = refine_keywords(markov_chain,
args.guidelines)
print(f"[+] Refined keywords via Markov chain:
{refined_keywords}")

cluster_id_to_caption = {i: cap for i, cap in
enumerate(rep_captions)}
for cid, cap in cluster_id_to_caption.items():
print(f"Cluster {cid}: {cap}")
```

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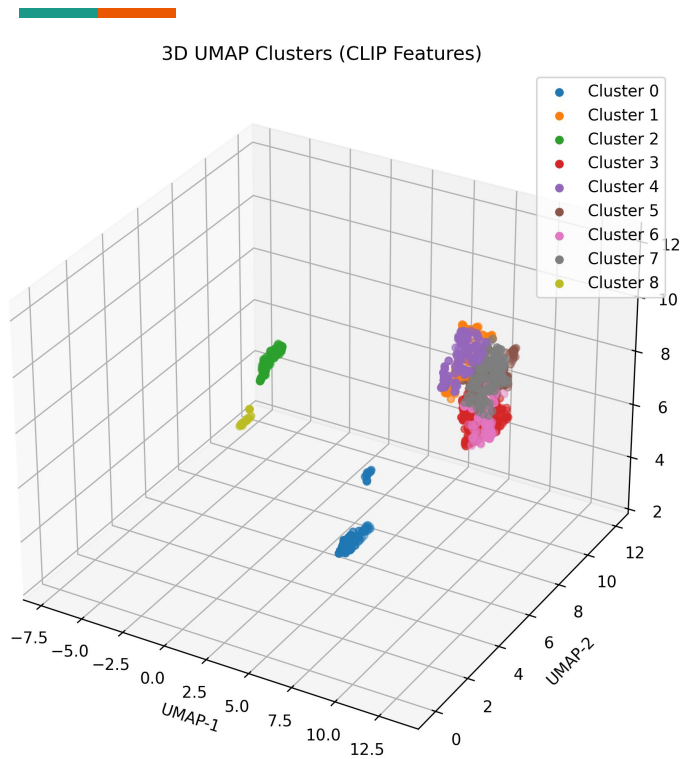
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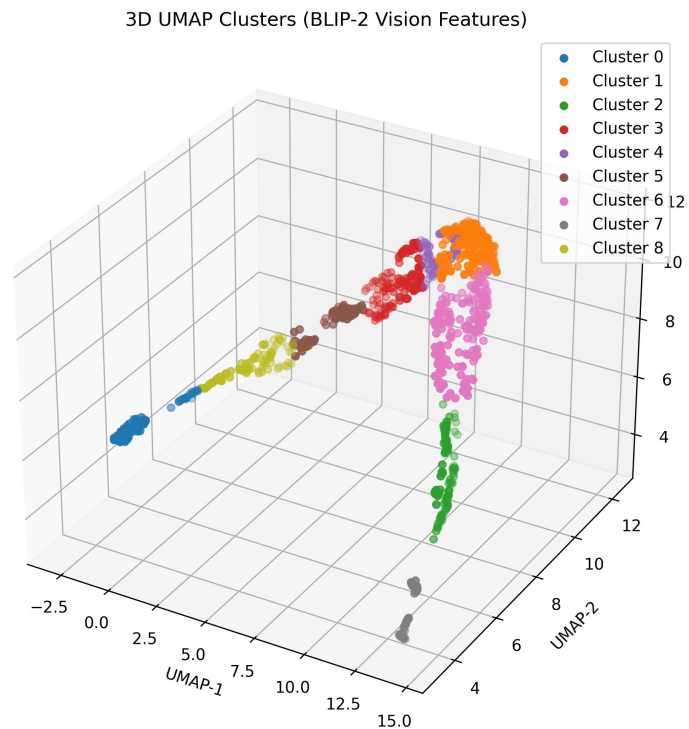
Multi-scale graph-based clustering of  
images using Markov theory

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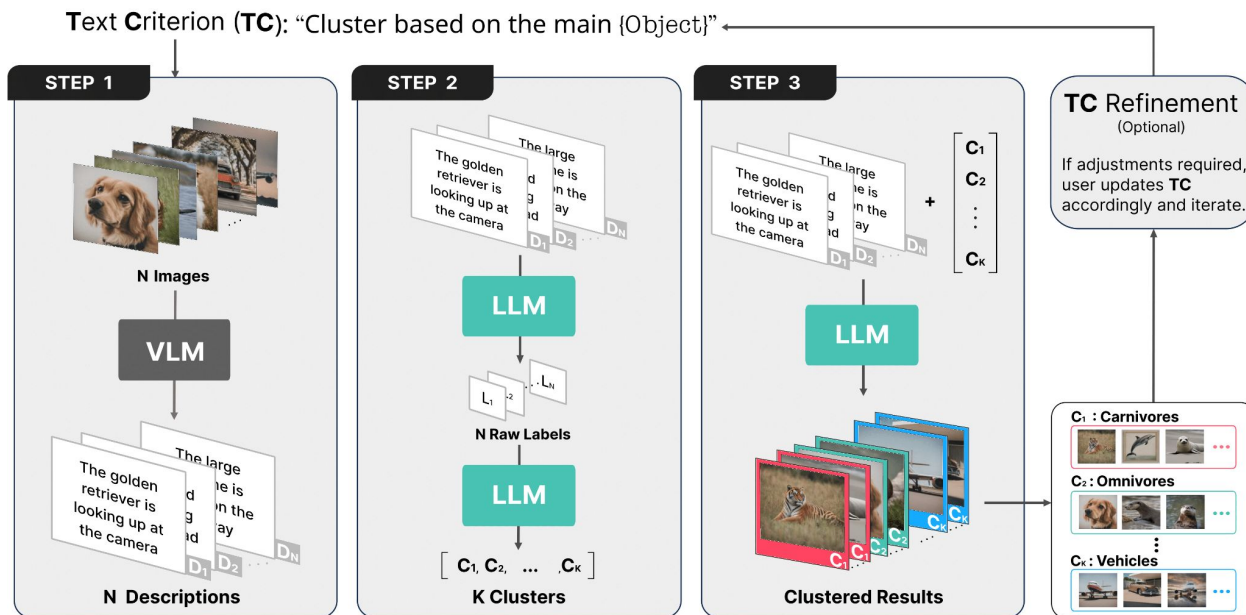
## CLIP + UMAP (9 Categories)



## BLIP2 + UMAP (9 Categories)



# An IC/TC Implementation

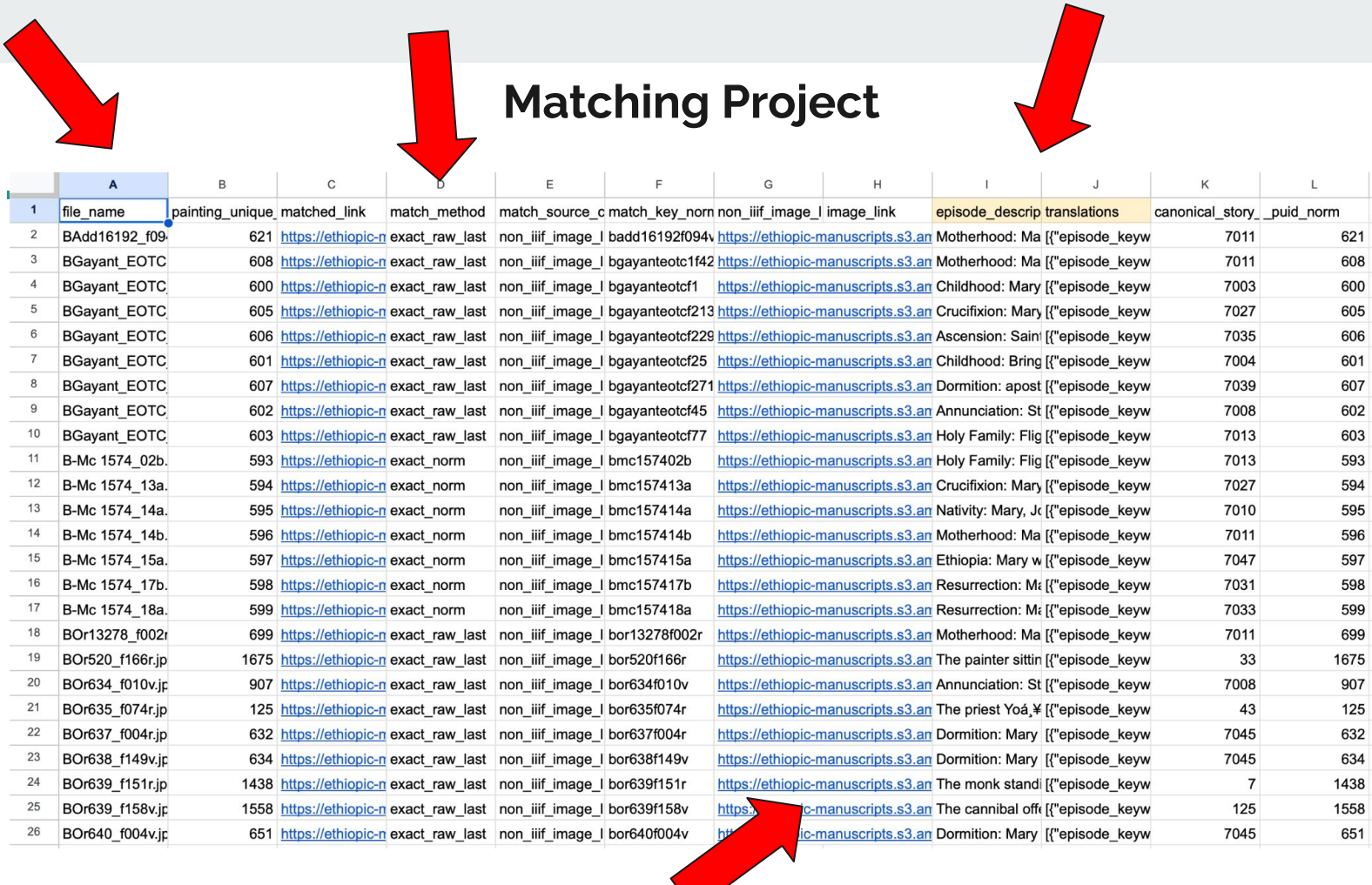




## Metadata & Captions

- BLIP-2 captions were too vague
- Using PEMM metadata for ICTC-style captions
- Ajay matched metadata to images
- Shravan converted descriptions to captions

# Matching Project



	A	B	C	D	E	F	G	H	I	J	K	L
1	file_name	painting_unique	matched_link	match_method	match_source_c	match_key_norm	non_iiif_image_l	image_link	episode_descrp	translations	canonical_story_	_puid_norm
2	BAdd16192_f09	621	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	badd16192f09v	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Motherhood: Ma	{["episode_keyw	7011	621	
3	BGayant_EOTC	608	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bgayanteotc1f42	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Motherhood: Ma	{["episode_keyw	7011	608	
4	BGayant_EOTC	600	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bgayanteotcf1	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Childhood: Mary	{["episode_keyw	7003	600	
5	BGayant_EOTC	605	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bgayanteotcf213	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Crucifixion: Mary	{["episode_keyw	7027	605	
6	BGayant_EOTC	606	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bgayanteotcf229	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Ascension: Saini	{["episode_keyw	7035	606	
7	BGayant_EOTC	601	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bgayanteotcf25	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Childhood: Bring	{["episode_keyw	7004	601	
8	BGayant_EOTC	607	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bgayanteotcf271	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Dormition: apost	{["episode_keyw	7039	607	
9	BGayant_EOTC	602	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bgayanteotcf45	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Annunciation: St	{["episode_keyw	7008	602	
10	BGayant_EOTC	603	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bgayanteotcf77	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Holy Family: Flig	{["episode_keyw	7013	603	
11	B-Mc 1574_02b.	593	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_norm	non_iiif_image_l	bmc157402b	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Holy Family: Flig	{["episode_keyw	7013	593	
12	B-Mc 1574_13a.	594	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_norm	non_iiif_image_l	bmc157413a	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Crucifixion: Mary	{["episode_keyw	7027	594	
13	B-Mc 1574_14a.	595	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_norm	non_iiif_image_l	bmc157414a	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Nativity: Mary, Jc	{["episode_keyw	7010	595	
14	B-Mc 1574_14b.	596	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_norm	non_iiif_image_l	bmc157414b	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Motherhood: Ma	{["episode_keyw	7011	596	
15	B-Mc 1574_15a.	597	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_norm	non_iiif_image_l	bmc157415a	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Ethiopia: Mary w	{["episode_keyw	7047	597	
16	B-Mc 1574_17b.	598	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_norm	non_iiif_image_l	bmc157417b	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Resurrection: M:	{["episode_keyw	7031	598	
17	B-Mc 1574_18a.	599	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_norm	non_iiif_image_l	bmc157418a	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Resurrection: M:	{["episode_keyw	7033	599	
18	BOr13278_f002r	699	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bor13278f002r	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Motherhood: Ma	{["episode_keyw	7011	699	
19	BOr520_f166r.jp	1675	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bor520f166r	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	The painter sittin	{["episode_keyw	33	1675	
20	BOr634_f010v.jp	907	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bor634f010v	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Annunciation: St	{["episode_keyw	7008	907	
21	BOr635_f074r.jp	125	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bor635f074r	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	The priest Yoà,¥	{["episode_keyw	43	125	
22	BOr637_f004r.jp	632	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bor637f004r	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Dormition: Mary	{["episode_keyw	7045	632	
23	BOr638_f149v.jp	634	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bor638f149v	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Dormition: Mary	{["episode_keyw	7045	634	
24	BOr639_f151r.jp	1438	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bor639f151r	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	The monk standi	{["episode_keyw	7	1438	
25	BOr639_f158v.jp	1558	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bor639f158v	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	The cannibal off	{["episode_keyw	125	1558	
26	BOr640_f004v.jp	651	<a href="https://ethiopic-n">https://ethiopic-n</a>	exact_raw_last	non_iiif_image_l	bor640f004v	<a href="https://ethiopic-manuscripts.s3.an">https://ethiopic-manuscripts.s3.an</a>	Dormition: Mary	{["episode_keyw	7045	651	

PEMM\_Project [SSH: della]

EXPLORER

- PEMM\_PROJECT [SSH: DELLA]
- Processed Images
- Directus-paintings\_8-15-2025.xlsx
- match\_paintings\_to\_metadata.py
- processed\_image\_filenames.txt

match\_paintings\_to\_metadata.py > main

```
7 --images-dir /path/to/processed_images \
8 --directus-xlsx /path/to/Directus-paintings_8-15-2025.xlsx \
9 --out-csv /path/to/master_paintings_ic_tc.csv
10
11 Notes:
12 - We match primarily on 'painting_unique_id' <-> filename stem.
13 - Filename stem normalization: lowercase, strip extension, collapse whitespace/underscores/dashes to single hyphen, remove non-alnum except
14 - If your filenames contain the exact 'painting_unique_id', you'll get perfect recall.
15 """"
16
17 import argparse
18 import pandas as pd
19 import re
20 import sys
21 from pathlib import Path
22
23 def normalize_stem(s: str) -> str:
24     if pd.isna(s):
25         return ""
26     s = str(s).strip().lower()
27     s = re.sub(r"[\t]+", "-", s)
28     s = s.replace("_", "-")
29     s = re.sub(r"\.[a-z0-9]{1,5}$", "", s)
30     s = re.sub(r"[a-z0-9\-]", "", s)
31     s = re.sub(r"-{2,}", "-", s)
32     return s.strip("-")
33
34 def tokenize(s: str):
35     return [t for t in re.split(r"[-_]+", s) if t]
36
37 def main():
38     ap = argparse.ArgumentParser()
39     ap.add_argument("--images-dir", required=True, help="Directory with processed images")
40     ap.add_argument("--directus-xlsx", required=True, help="Path to Directus export Excel file")
41     ap.add_argument("--sheet", default=None, help="Optional sheet name (auto-detect if omitted)")
42     ap.add_argument("--out-csv", required=True, help="Where to write the matched master CSV")
43     args = ap.parse_args()
44
45     images_dir = Path(args.images_dir)
46     if not images_dir.exists():
47         sys.exit(f"Images directory not found: {images_dir}")
48
49     exts = {".jpg", ".jpeg", ".png", ".webp", ".tif", ".tiff"}
50     files = [p for p in images_dir.rglob("*") if p.suffix.lower() in exts]
51     if not files:
52         sys.exit(f"No images found under {images_dir}")
53
```

SSH: della 0 0 0 0 Ln 110, Col 22 Spaces: 4 UTF-8 LF ( ) Python 3.9.21

	A	B
1	episode_description	generated_caption
2	Motherhood: Madonna and child	Mary, Jesus Christ with throne, handkerchief in Motherhood: Madonna and child, surrounded by ornate details and expressive gestures.
3	Motherhood: Madonna and child	jewelry, couch accompanying Mary, Jesus Christ, Michael, Gabriel, angel throughout Motherhood: Madonna and child, arranged with symbolic gestures and radiant.
4	The monk standing praying in a church before	The monk standing praying in a church before the icon of the Virgin and Child with his skull-cap fallen to.
5	The man with the petrified foot standing and	church, icon, throne, rock accompanying Mary, Jesus Christ throughout The man with the petrified foot standing and praying before an.
6	SofyÄ_x0081_ lying on top of a building before	Mary, Jesus Christ, angel holding building, icon during SofyÄ_x0081_ lying on top of a building before the icon of the.
7	Dormition: Mary prays for those in Sheol	Mary, angel depicted alongside church in Dormition: Mary prays for those in Sheol, framed with sacred patterns and vivid imagery.
8	Motherhood: Madonna and child	Mary, Jesus Christ with tree, flower in Motherhood: Madonna and child, surrounded by ornate details and expressive gestures.
9	Resurrection: Mary at the Ascension of Jesus	In Resurrection: Mary at the Ascension of Jesus, Mary, Jesus Christ, disciple stand near heavenly clouds, marked by reverence and.
10	ZakÄ_x0081_ ryÄ_x0081_ s prostrating himself	In ZakÄ_x0081_ ryÄ_x0081_ s prostrating himself, figures stand near objects, marked by reverence and intricate ornamentation. sacred.
11	Motherhood: Madonna and child	Mary, Jesus Christ, Michael, Gabriel, angel depicted alongside throne, sword, handkerchief, book in Motherhood: Madonna and child, framed with sacred.
12	Resurrection: Mary prays at Golgotha	Resurrection: Mary prays at Golgotha where Mary, Jesus Christ appear beside Golgotha, spear, shield, hat, forming a solemn and spiritual.
13	Giyorgis standing healed from his wounds	In Giyorgis standing healed from his wounds, figures stand near arch, church, marked by reverence and intricate ornamentation.
14	St Mary speaks to Nekwal while he is imprisoned	sign, post, walking stick, building, jail, heavenly clouds, shackles, bonds, jewelry accompanying Mary, angel throughout St Mary speaks to Nekwal.
15	The chain for the lamp before the icon of St M	church, icon, throne, lamp, lantern, chain, curtain accompanying Mary, priest throughout The chain for the lamp before the icon of.
16	The king orders the falsely accused official to	king holding handkerchief, rug, couch during The king orders the falsely accused official to be hung, emphasizing devotion and sacred.
17	The group of virgins gathered around the well	figures depicted alongside pitcher, jar, tree, bird in The group of virgins gathered around the well while one of them.
18	Motherhood: Madonna and child	In Motherhood: Madonna and child, Mary, Jesus Christ, Michael, Gabriel, angel stand near couch, sword, book, handkerchief, marked by reverence.
19	The two thieves attempting to eat the bread t	In The two thieves attempting to eat the bread they stole from YolyÄ_x0081_nÄ_x0081_ and BarbÄ_x0081_rÄ_x0081_, figures stand near shield, hat,.
20	Pentecost: Mary at Pentecost	Mary, disciple holding church, flame, fire, handkerchief during Pentecost: Mary at Pentecost, emphasizing devotion and sacred atmosphere.
21	Crucifixion: Mary at the cross	Crucifixion: Mary at the cross where Mary, Jesus Christ, thief, John, angel, patron appear beside sun, moon, stars, nail, blood,.
22	Motherhood: Madonna and child	Mary, Jesus Christ, Michael, Gabriel, angel, patron holding couch, curtain, handkerchief, book, jewelry during Motherhood: Madonna and child, emphasizing devotion.
23	The disciples surround the body of Mary	The disciples surround the body of Mary where Mary, disciples appear beside bed, blanket, bier, folio, book, forming a solemn.
24	Two figures embrace in front of a church	church, tree accompanying figures throughout Two figures embrace in front of a church, arranged with symbolic gestures and radiant elements.
25	SofyÄ_x0081_ lying on top of a building before	SofyÄ_x0081_ lying on top of a building before the icon of the Virgin and Child while an angel carries away.
26	Ê¼AnÇ_x009d_sá¹Ä_x0081_syos lying before :	bed, blanket accompanying Mary throughout Ê¼AnÇ_x009d_sá¹Ä_x0081_syos lying before St Mary, who together with the Child is extending her hand towards.
27	Motherhood: Madonna and child	Motherhood: Madonna and child where Mary, Jesus Christ, Michael, Gabriel, angel, patron appear beside couch, curtain, handkerchief, book, hand cross,.
28	DÇ_x009d_myÄ_x0081_nos lying down before	Mary with head covering, handkerchief, pillow, bed, blanket, jewelry in DÇ_x009d_myÄ_x0081_nos lying down before the icon of Mary, which performs.
29	The sick pilgrim standing before the places to	figures with church, building, tree in The sick pilgrim standing before the places to which Mary carries him: unidentified, surrounded.
30	The youth ZakÄ_x0081_ ryÄ_x0081_ s fastenin	In The youth ZakÄ_x0081_ ryÄ_x0081_ s fastening a crown of roses to an icon of St Mary, Mary, Jesus Christ stand near.
31	BÄ_x0081_ rok being consecrated as a monk	church, Eucharist, Eucharistic bread, cup, chalice, food accompanying figures throughout BÄ_x0081_ rok being consecrated as a monk, arranged with symbolic gestures.
32	St Mary, who holds the soul of the cannibal, st	Mary, angel, soul, demon, angel of darkness with weighing scales, sword, handkerchief, jewelry, water in St Mary, who holds the.

We have 1007 captions generated for all the images with metadata



## UI Development

- Built interactive UI with 3D plots
- Displays image thumbnails + keyword filters
- Next: integrate CLIP/BLIP outputs

# Miracles of Mary Clustering Explorer (3D)



## Filters

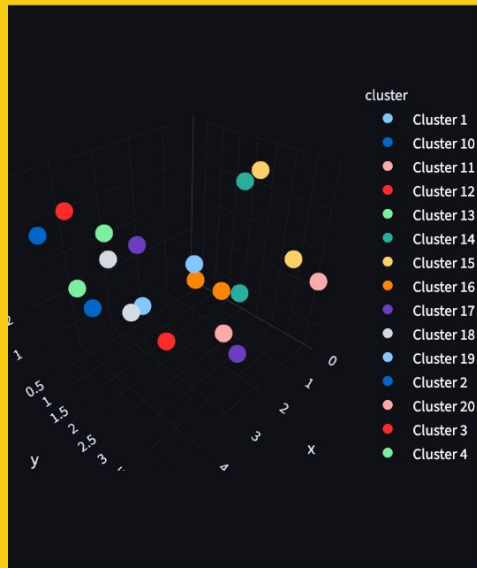
### Style

All ▾

### Feature

Choose an option ▾

## 3D Plot



## Gallery



### Cluster 1

View  
Cluster

### Cluster 2

View  
Cluster

### Cluster 3

View  
Cluster

### Cluster 4

View  
Cluster

### Cluster 5

View  
Cluster

### Cluster 6

View  
Cluster

### Cluster 7

View  
Cluster

### Cluster 8

View  
Cluster

### Cluster 9

View  
Cluster

### Cluster 10

View  
Cluster

# Miracles of Mary Clustering Explorer (3D)

## Filters

Style

All ⌵

Feature

Choose an option ⌵

## 3D Plot



## Gallery

[Back to All Clusters](#)**Painting 1**Details ⌵**Painting 2**Details ⌵**Painting 3**Details ⌵**Painting 4**Details ⌵**Painting 5**Details ⌵**Painting 6**Details ⌵



## Current Status

Produced results from 4 methods:

1. ResNet+PCA (hypertuned)
2. ResNet+UMAP (hypertuned)
3. CLIP+UMAP
4. BLIP-2+UMAP

Task: Evaluate categories & rank effectiveness

Captions in progress



## Future Steps

- Integrating the models and training systems with an interactive UI
- Continue working on IC/TC
  - Finalize fine tuning the VLM
- Explore other multimodal methods of training
  - Have PhD Students classify 1st & 2nd Gendering Styles
- Clusters will operate based on our training captions/ data
- Final Product → AI-search engine embedded within the UI