

MEG: Multi-Evidence GNN for Multimodal Semantic Forensics

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Multimodal Semantic Forensics

- Fake news often involves semantic manipulation of images
- Misrepresentation of images with multimodal metadata
- Also known as *Image Repurposing* in literature
- Image Repurposing involves:
 - untampered images
 - questionable metadata



Multimedia Package

- Comprises:
 - Image
 - Related metadata
 - Text
 - Location information

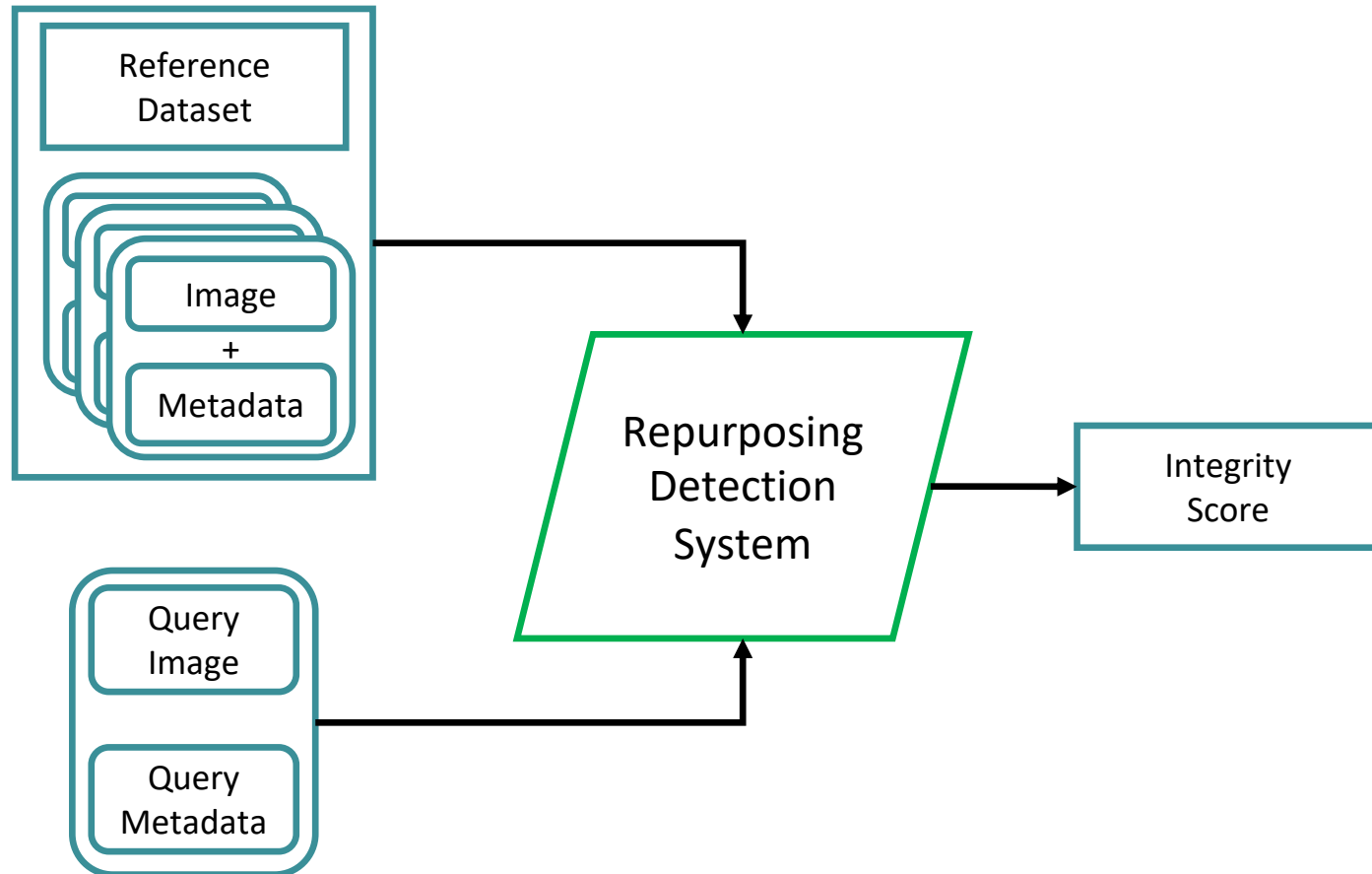


Ex Convento at **Dorena Bridge** completed in
1555

United States, Lane, Oregon, Row River. GPS:
43.737553, -122.883646

Multimedia Package

Image Repurposing Detection



Contribution

A novel graph neural network (GNN) based approach to image repurposing detection, that leverages multiple evidences.

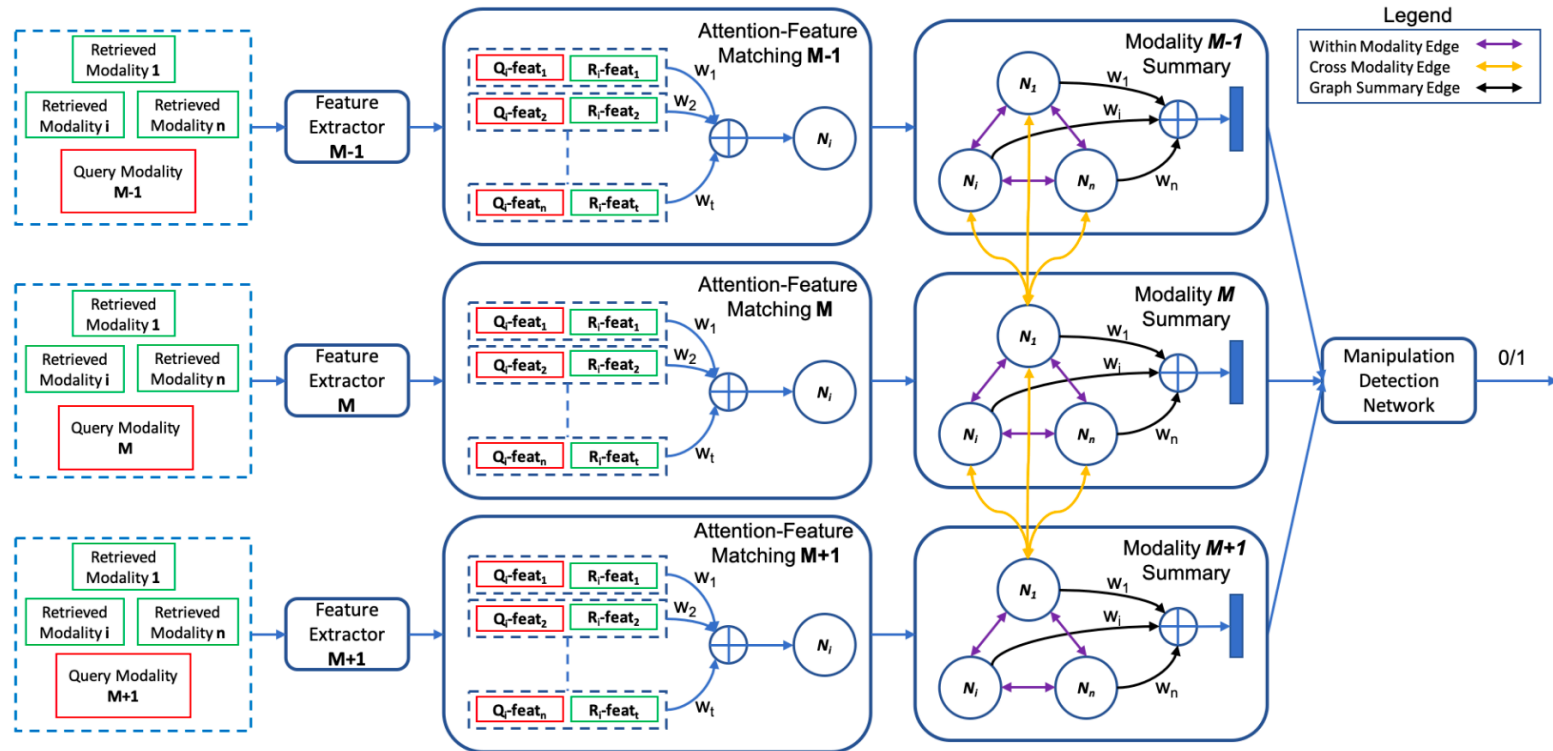
Our contributions:

- State-of-the-art performance on three standard benchmarks
- Order-invariant model with respect to the retrieved packages
- Flexible model that can handle arbitrary number of retrievals

Model

- The model has a branch for each modality in data and two major modules for each branch :
 - Attention Feature Matching module and
 - Modality Summary module.
- Attention feature matching module compares query and retrieved features.
- Modality summary module is a graph neural networks (GNNs). Feature matching embeddings populate the GNN.
- The GNN updates all nodes from their adjacent nodes.
- A feed-forward network assimilates all modalities for manipulation detection.

Model Architecture



Datasets

- Multimodal Entity Image Repurposing (MEIR) Dataset
 - Packages with Image, text and location modalities.
 - Person, Location and Organization entities manipulated.
- Painters by Numbers
 - Dataset introduced as part of a Kaggle competition.
 - Manipulate Ids of painters.
- Google Landmarks
 - Dataset introduced as part of a Kaggle competition.
 - Manipulate Ids of Locations.
- Metric: AUC

Results - MEIR

Package	SRS	DMT + voting	Ours w/o Cross-modal	Ours
1	0.63	0.88	0.90	0.91
2	0.65	0.87	0.91	0.92
3	0.66	0.86	0.91	0.92
4	0.67	0.86	0.90	0.92
5	0.67	0.85	0.90	0.92

Examples

Query



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United Kingdom Isle of Wight
England Atherfield
GPS: 50.611785, -1.363763



The Rotunda of Galerius is
125m northeast of the Arch of
Galerius It is now the **GM**, ...
dedicated **GM**, more here:

Greece Central Macedonia
Macedonia and Thrace
Thessaloniki
GPS: 40.633276, 22.952864



Draft Horse Town 2014

Canada Alberta Alberta Calgary
GPS: 51.036077, -114.054468



The Rotunda of Galerius is
125m ... It is now the Greek
Orthodox Church of Agios ...
dedicated UNESCO World
Heritage Site ...

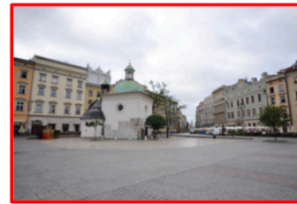
Greece Central Macedonia
Macedonia and Thrace
Thessaloniki
GPS: 40.633276, 22.952864

Retrieved Packages



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Canada Alberta Alberta
Calgary
GPS: 51.036077, -114.054468



The Church of St Adalbert or
Church of St Wojciech ...
and gave his sermons there [[Wikipedia.org](#)]

Poland Krakow Lesser Poland
Krakow
GPS: 50.060927, 19.937650



Hockwold Country Fair
2013 2nd June ... Samba
Dancers Morris Dancers

United Kingdom Isle of Wight
England Atherfield
GPS: 52.463838, -0.558081



The German Fountain is a
gazebo styled fountain in ...
and dome's interior is covered
with golden mosaics [[Wikipedia.org](#)]

Turkey Kartal Istanbul Istanbul
GPS: 41.006944, 28.976667

Results – Painters by Numbers

Package	SRS	DMT + voting	Ours w/o Cross-modal	Ours
1	0.68	0.75	0.69	0.76
2	0.72	0.80	0.76	0.81
3	0.74	0.82	0.79	0.83
4	0.76	0.83	0.80	0.85
5	0.77	0.83	0.81	0.86

Results – Google Landmarks

Package	SRS	DMT + voting	Ours w/o Cross-modal	Ours
1	0.89	0.93	0.94	0.93
2	0.91	0.94	0.94	0.95
3	0.92	0.94	0.94	0.95
4	0.92	0.93	0.94	0.95
5	0.93	0.93	0.94	0.94

Results – Order Invariance

Packages	GRU		LSTM		Ours w/o cross-modal		Ours	
	Before	After	Before	After	Before	After	Before	After
1	0.91	0.91	0.90	0.90	0.90	0.90	0.91	0.91
2	0.91	0.88	0.90	0.89	0.91	0.91	0.92	0.92
3	0.91	0.85	0.91	0.88	0.91	0.91	0.92	0.92
4	0.91	0.84	0.91	0.88	0.90	0.90	0.92	0.92
5	0.91	0.83	0.91	0.87	0.90	0.90	0.92	0.92

Thank You!