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## **AI for enhancing and preserving Dance Cultural Heritage: a Case Study on Rudolf Nureyev's Costumes**

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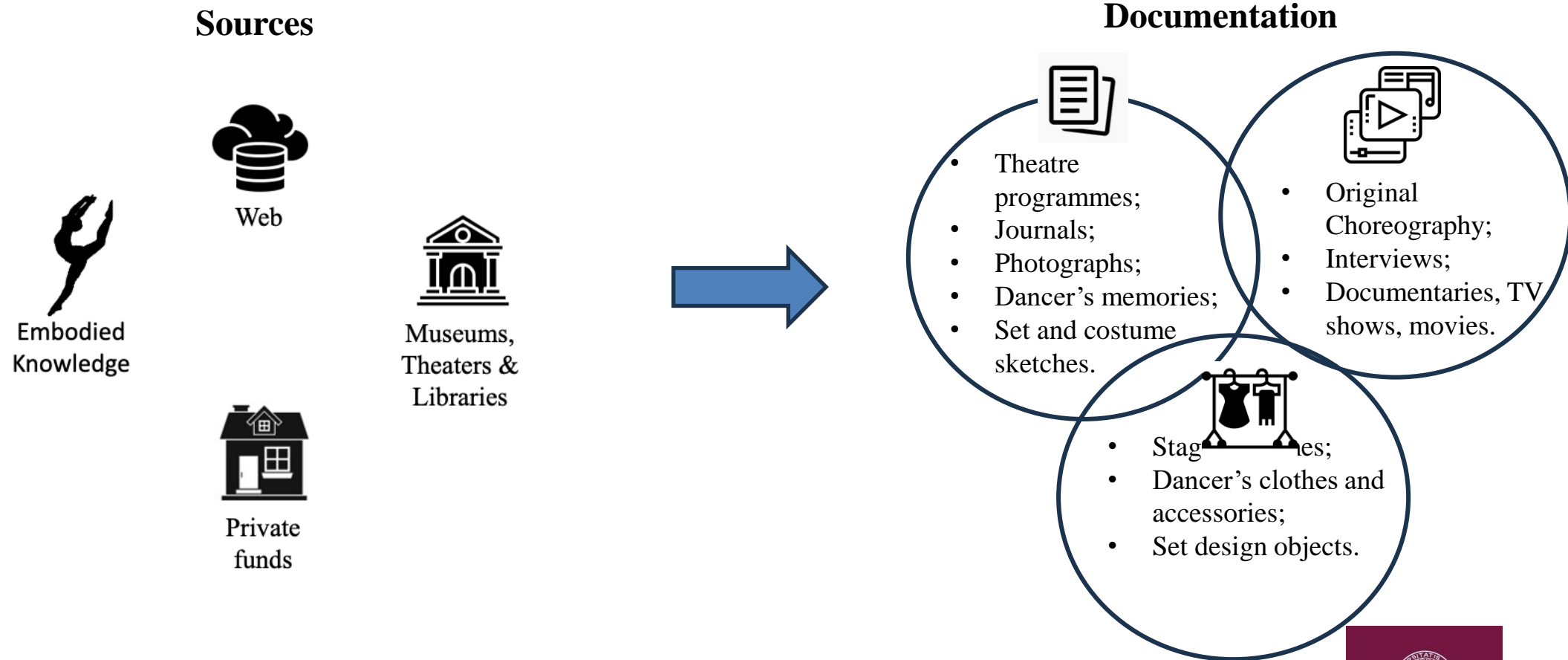
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# Outline

- Dance material sources and cultural heritage;
- Fashion and Dance Relationships;
- How we can apply AI paradigms to preserve, promote and eventually discover novel patterns?
- Why we should do that? → Two birds with one stone
- Why we should include XR paradigms in the loop?

# Dance Heritage Material Preservation: Exploring the Intersection of Tangible and Intangible



# Dance and Costumes: Connections



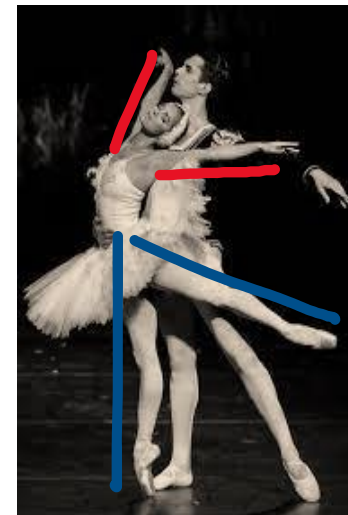
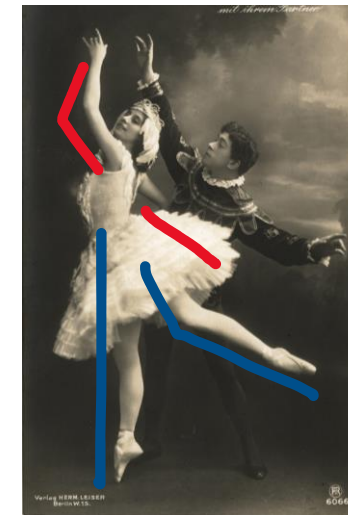
**Aesthetics**



**Specificity**



**Technicalities**



# Fashion and Dance relationships

- **Historical and Cultural Influences**: Costumes in both fashion and dance reflect cultural heritage and historical periods, inspiring designs that mirror specific regions and eras.
- **Technical Considerations**: Dance costumes prioritize functionality alongside aesthetics, requiring collaboration between fashion designers and choreographers to create garments that support movement while embodying artistic vision.
- **Trends and Innovation**: Fashion trends influence dance costumes, and innovative dance costume designs can inspire fashion trends, bridging the gap between everyday wear and performance attire.
- **Performance and Presentation**: Costumes are integral to conveying mood and character in dance performances, echoing the fashion designer's approach of using garments to narrate stories and evoke emotions.



# Fashion, Dance and Costumes: Opportunities in design inspiration



Portrait of Fuller by Frederick Glasier, 1902



Martha Graham performing “Letter to the World” (also called “The Kick”), 1940. Ph. Barbara Morgan—Underwood Archives/age fotostock

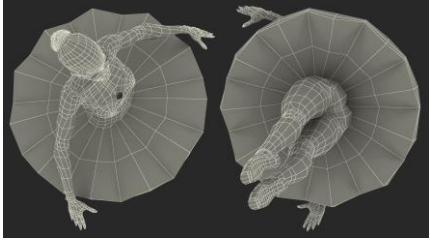
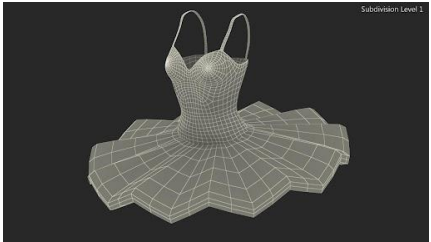
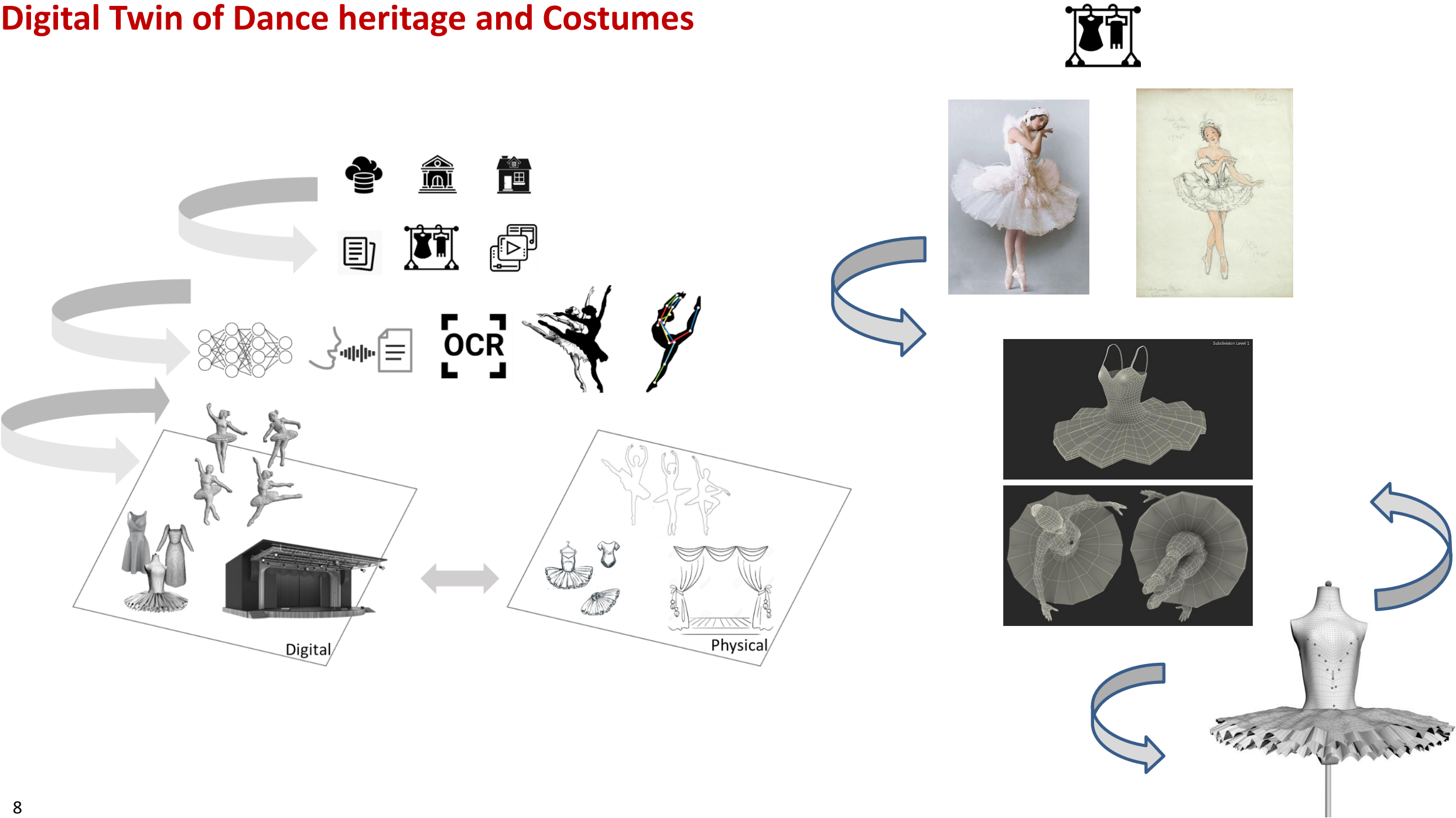
Influence Designers



*Where Dance and Fashion Collide, New York Times*  
<https://www.nytimes.com/2020/05/30/opinion/dance-fashion-herpen-jalet.html>

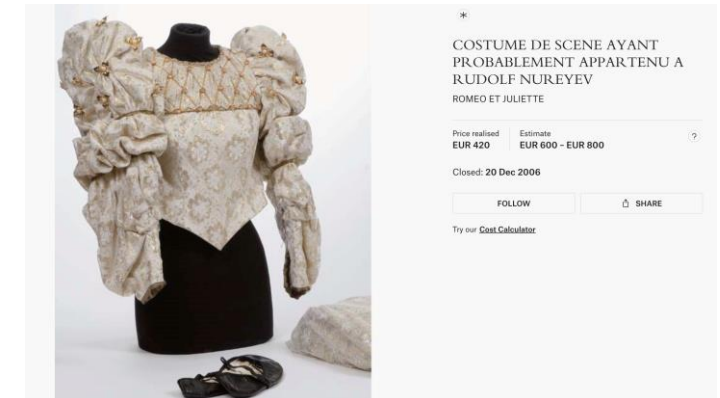
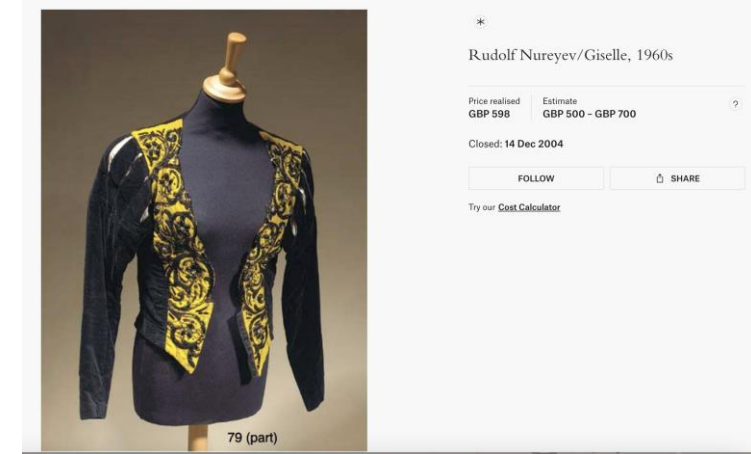
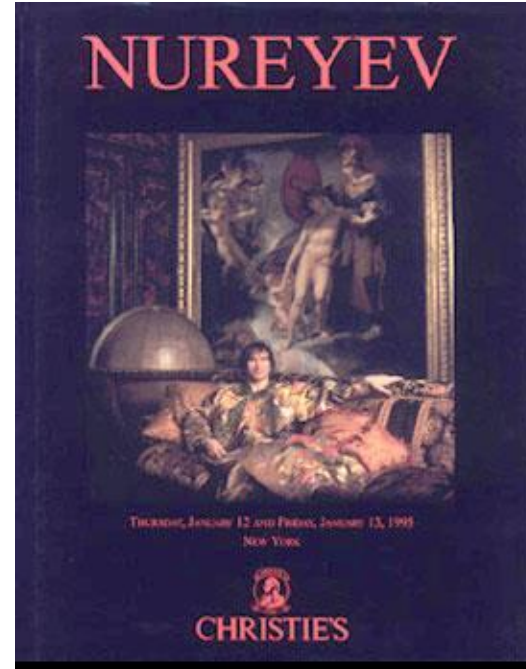
**Is it possible to project Dance costumes visual material  
in the digital realm through AI?**

# Digital Twin of Dance heritage and Costumes



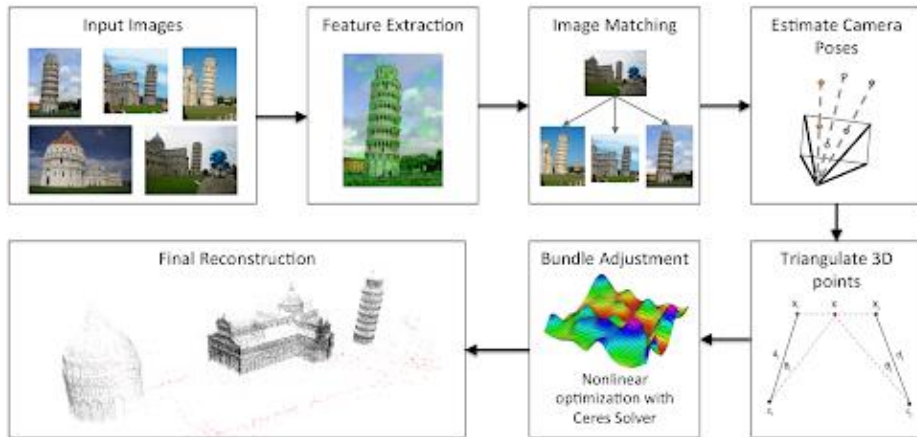


# Case Study: Rudolf Nureyev (1938-1993)



# Deep Learning and Computer Vision to support 2D human dance heritage material preservation

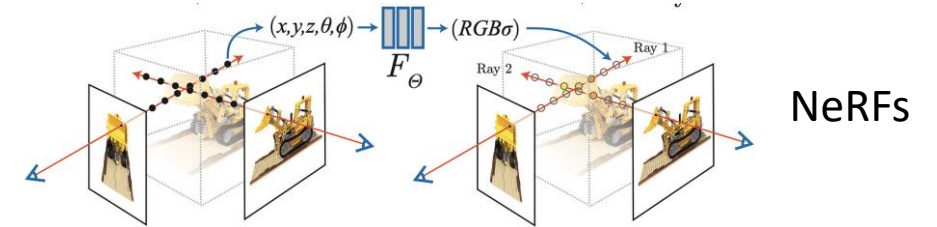
## Structure From Motion (Photogrammetry)



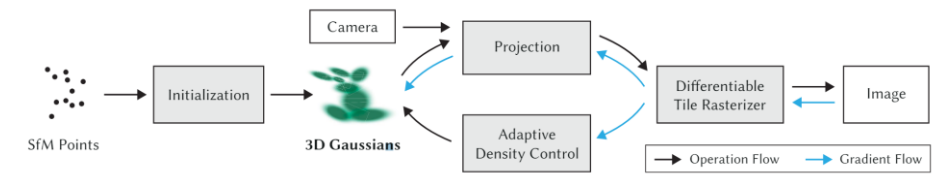
AI Transition



## Neural Rendering (NR)



NeRFs



3DGS

	<b>Photogrammetry</b>	<b>Neural Radiance Fields (NERF)</b>	<b>3D Gaussian Splatting</b>
Pros	- Scalability	- Photorealistic reconstructions	- Smooth renderings
	- Detailed surface information	- High fidelity	- Effective for dense data
	- Wide application range	- Captures fine-grained surface details	- Suitable for LiDAR, depth cameras
Cons	- Sensitivity to lighting, calibration, image quality	- High computational intensity	- Sensitivity to image quality, viewpoint variations
	- Limited accuracy in complex scenes	- Requires significant computational resources	- Moderate computational intensity
	- Time-consuming image capture	- Limited handling of complex scenes	- Limited handling of complex scenes

Common cons: All of them requires a high number of pictures



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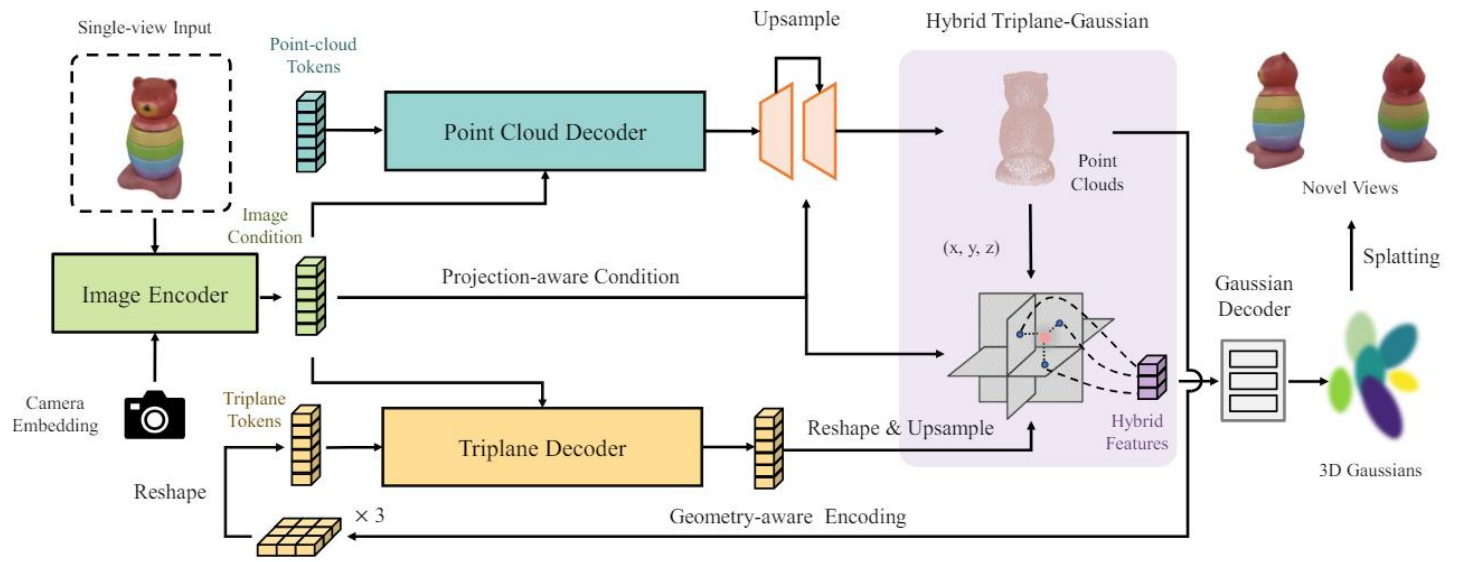
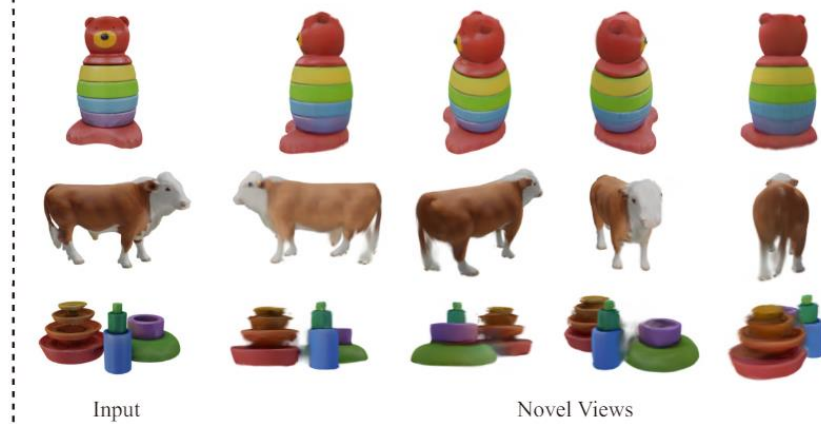
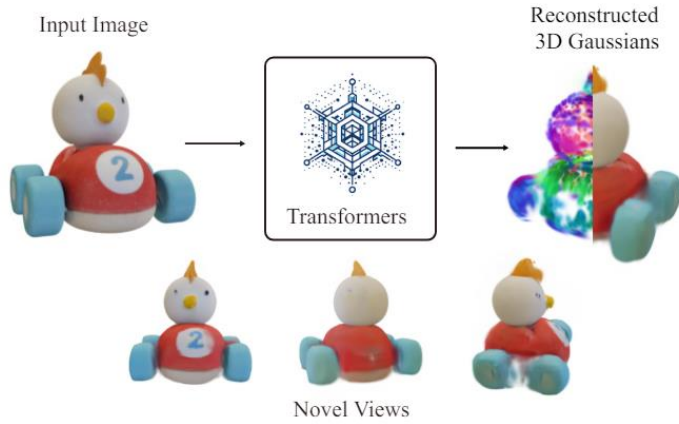
# What can we do about few-shot?

- Novel Neural Rendering techniques are developed every year in top-tier conference (CVPR,ECCV, ICCV, ISMAR...);
- However, while such methods are tested over “well-constructed” datasets, those are not often adopted in “in-the-wild” contexts with a very limited number of picture (1 or 2);
- For this reason, we here evaluate a 3DGS method based on a single shot, because it may be all what we have named Triplane Gaussians;



Often happens in Cultural Heritage!

# The Method



# Obtained results



2D view



3D view



3D view



3D view



Source



2D crop



3D view



3D view



Source



2D crop



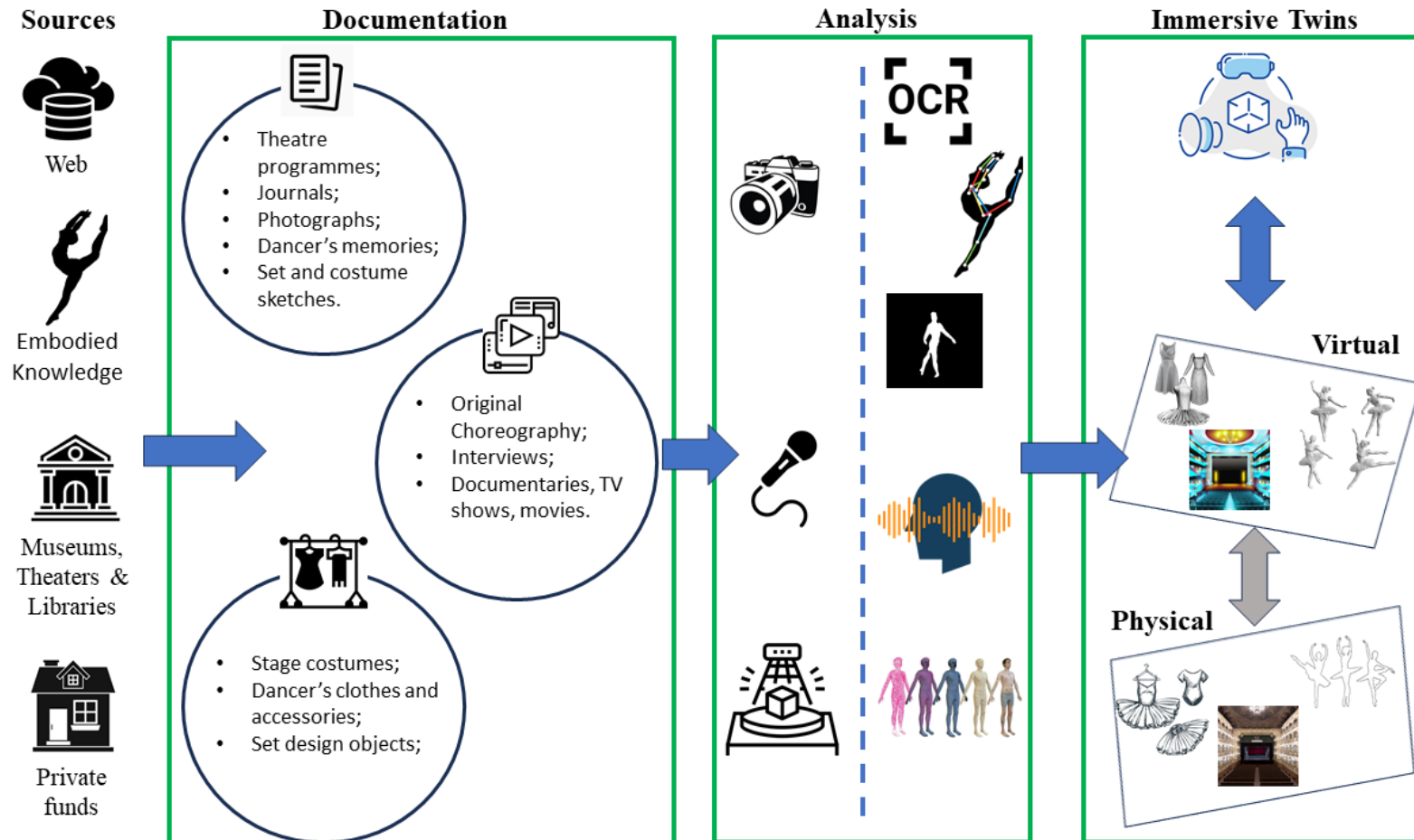
3D view



3D view

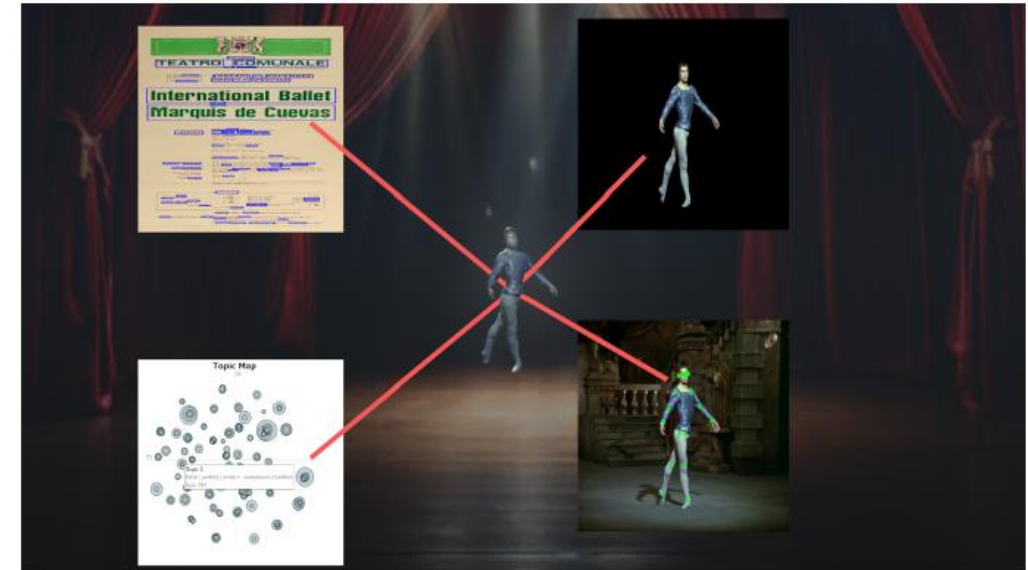


# Future works: a complete pipeline to map physical dance world to digital



# Future works: Extended Reality to bridge Multi-modal AI through

- **Understanding and Decision Making:** By combining various modalities of data, users can gain a more comprehensive understanding of complex information, as different types of data can complement each other and provide multiple perspectives on the same topic, supporting decision-making;
- **Synthesis of Information:** Multi-modal visualization facilitates the synthesis of information from diverse sources, allowing users to connect disparate data points and identify patterns, trends, and relationships that may not be apparent when analyzing each modality in isolation.
- **Storytelling:** The integration of text, audio, images, video, and 3D models enables powerful storytelling techniques, where data is presented in a narrative format that guides users through a cohesive and compelling storyline, making complex information more accessible and engaging.
- **Collaboration:** Immersive multi-modal visualization environments facilitate collaboration and knowledge sharing among users, as multiple individuals can interact with the same dataset simultaneously, share insights, and collaborate on data-driven tasks in real-time.





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