# MemorIA

## Interactive AI Historical Agents for Educational Contexts


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# Educational Context: Challenges in History Teaching

## Current Limitations in History Education

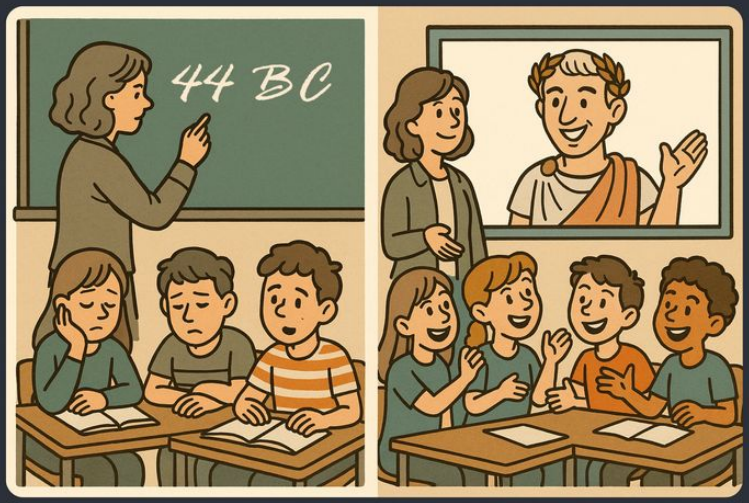
Students perceive history as **abstract and disconnected** (Audigier & Fink, 2010), while traditional teaching relies on **passive learning approaches** (reading and listening).

## Benefits of Active Learning Approaches

- Active participation fosters **deeper knowledge construction** (Moreno & Mayer, 2000)
- Enhances **motivation & personal engagement** (Hulleman & Harackiewicz, 2009)
- **Dialogue** as key element for knowledge construction (Moreno et al., 2007)

## Potential of Conversational AI in History Education

- Text-based historical AI agents **showed positive effects on curiosity and motivation** (Pataranutaporn et al., 2023)
- **Voice interaction** improves engagement through naturalness (Reicherts et al., 2022)




*Making history **accessible and engaging** through embodied AI agents*

## MemorIA: Beyond Text-Based Interaction

We propose **real-time oral dialogue** combined with **contextual facial expressions** to create more engaging and accessible historical learning experiences.

# Related Work: Embodied Agents in Education

## Social Agency Theory

- Learners apply **social interaction schemas** when engaging with embodied agents (Mayer & DaPra, 2012; Moreno et al., 2001)
- Visual and vocal elements serve as **social cues** that influence learning outcomes (Mayer, 2014)

## Embodiment, Social Presence & Emotional Expressiveness

- **Embodied visual presence** contributes to social presence and strengthens **emotional engagement & motivation** (Alemdag, 2022; Park, 2014)
- Agents displaying **contextually appropriate emotions** become more credible and engaging (Wang et al., 2023)
- Virtual instructor's emotional tone influences **learner motivation and emotional engagement.** (Horovitz & Mayer, 2021)

*Social presence through embodied interaction*

## MemorIA's Approach

Creating **socially present & emotionally expressive** historical agents to foster meaningful educational dialogue.

# Animation Technologies: Balancing Quality & Real-Time Performance

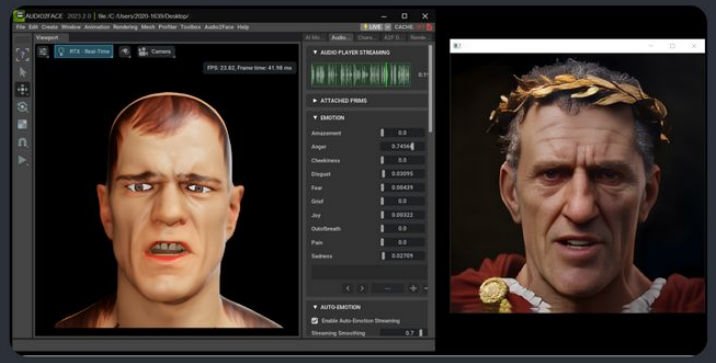
## Audio-Driven Animation

- **Challenge:** **Semantic understanding** for contextual expressions
- Recent systems (**VASA-1** (Xu et al., 2024), **EMOPortraits** (Drobyshev et al., 2024)) show advances but are often **closed-source**

## Video-Driven Animation

- High visual quality (e.g., **StyleAvatar** (Wang et al., 2023), **LIA** (Wang et al., 2024))
- **Challenges:** **Real-time performance**, resource-intensive

## MemorIA's Technical Approach



**NVIDIA Audio2Face** + **First Order Motion Model** (Siarohin et al., 2020)

### Key Advantages:

- **Beyond lip-sync:** Audio2Face detects basic emotions from audio features
- **Computational efficiency:** FOMM enables real-time performance on consumer hardware
- **Open-source accessibility:** FOMM allows adaptation and deployment flexibility

# MemorIA Architecture: Asynchronous Streaming Pipeline

MemorIA employs an **asynchronous streaming architecture** for responsive dialogue and real-time animation.

### Performance Targets

Achieved: **4s end-to-end response latency** (speech input to animated output)

Stable **25 FPS visual rendering** on consumer hardware

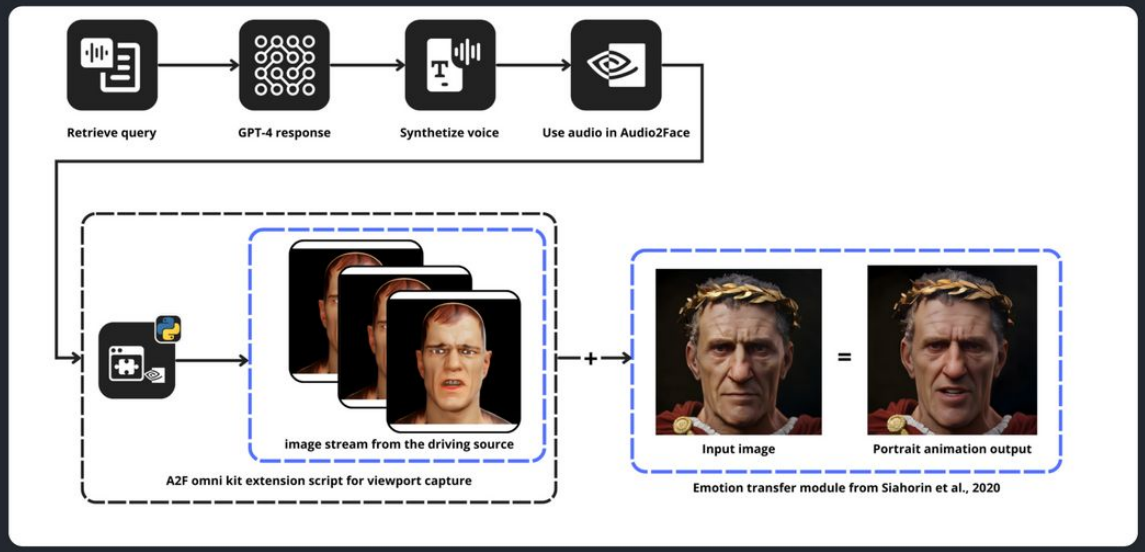



*Figure 1. MemorIA's asynchronous processing pipeline*

# Prompt Engineering: Historical Agent Design

## Implementation Approach

- **Standard GPT API:** No fine-tuning or custom training
- **Persona Instructions:** First-person historical embodiment
- **Response Guidance:** Max 250 tokens, age-appropriate

> *"You embody Julius Caesar, speak in the first person... Channel Caesar's emotions—share them naturally, with expressive pauses."*
>
> — Simplified prompt excerpt

## Attempted Prompting Strategies

- **Cultural Respect:** Encouraging multiple perspectives
- **Inclusivity:** Attempting to respect diverse viewpoints
- **Educational Alignment:** Co-designed with teacher input

## Limitations & Required Mediation

- **Prompt Adherence Variability:** Responses may deviate from instructions
- **Teacher Oversight:** Essential for content validation

## Educational Integration Challenges

The prompt design **attempted to balance** historical engagement with pedagogical appropriateness, while acknowledging the **inherent limitations** of prompting without fine-tuning.

# System Demonstration: Julius Caesar in the Classroom

# Pilot Study: Classroom Implementation

## Study Objectives

Assess **classroom deployment feasibility** and gather qualitative feedback on student engagement.

## Context & Participants

- **French middle school** (6th grade, ~11 years old)
- **4 classes, 60 students**, 4 history teachers
- Virtual **Julius Caesar** for Roman history curriculum
- **Open questioning:** Students could ask any respectful question related to Ancient Rome
- **Qualitative methodology**: classroom observation & qualitative feedback

## Teacher as Educational Mediator

- Providing **historical context** and guiding questions
- **Validating AI responses** and correcting inaccuracies
- Fostering **critical thinking** about AI-generated content
- **Complementing, not replacing** pedagogical expertise


*Figure 3. Classroom setup with teacher mediation*

### Session Structure (55 min)

**~30 min:** Direct student-agent Q&A

**~25 min:** Teacher-led reflection and **critical analysis**

# Pilot Results: Promising Initial Findings

## Enhanced Participation

> *"I was surprised to see students who rarely participate raise their hands several times to ask questions."*
>
> — Teacher

## Spontaneous Curiosity

> *"It's easier to ask questions when you have them directly in mind... it makes me want to know a lot more about life in Rome."*
>
> — Student

## Emotional Connection

> *"He seems sad when he talks about Brutus, it's strange to see him like that."*
>
> — Student

## Value of Oral Interaction

> *"What changes everything is that they can talk to him directly... Even shy students who are hesitant to write dare to ask questions."*
>
> — Teacher

*Students engaging with virtual Julius Caesar*

### Key Observations

- Oral interaction **lowered participation barriers**
- Facial expressions seemed to foster **emotional engagement**
- Dialogue sparked **spontaneous curiosity**
- **Immediate feedback** valued by students & teachers

# Limitations & Future Directions

## Current System Limitations

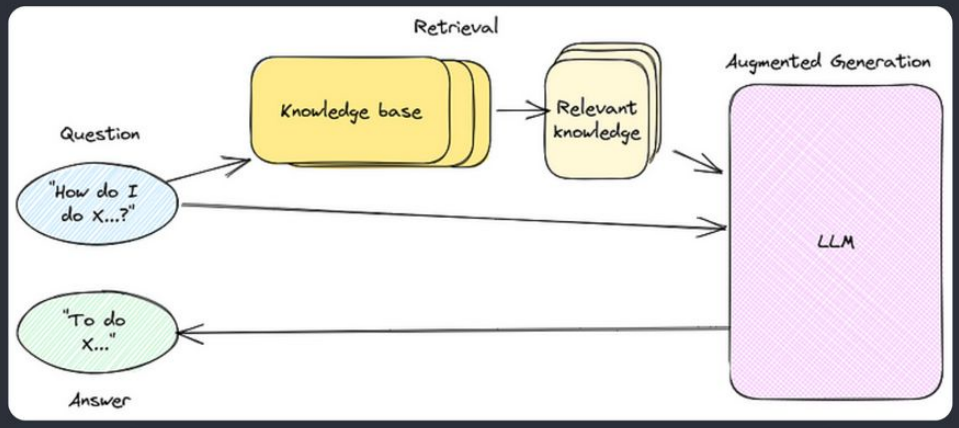
- **Historical Accuracy:** GPT responses may lack depth or exhibit bias/incompleteness
- **Visual Quality:** 256×256 resolution appears blurry on large displays
- **Study Scope:** Qualitative, single-figure study requires controlled comparisons

## Planned Technical Enhancements

- **RAG Integration:** Grounding responses in verified historical sources
- **Higher Resolution:** Explore 512×512 output with newer models (e.g., LivePortrait) (Guo et al., 2024)

## Ethical Considerations & Teacher Role

- **Critical Media Literacy:** Teaching students to evaluate AI-generated historical content
- **Teacher as Mediator:** Essential for maintaining historical accuracy & critical thinking
- **Bias Mitigation:** Addressing potential AI biases in historical narratives




*Proposed RAG system for **enhanced accuracy & transparency***

## Ethical Imperatives

- **Misinformation Risk:** Unguided AI responses may propagate historical inaccuracies
- **Bias Awareness:** AI systems can reflect training data biases

# Conclusion & Research Contributions

## Technical Achievements

- Functional system combining **real-time oral interaction** with **contextual facial animation**
- **Sub-4-second response latency** suitable for classroom deployment

## Educational Insights

- Pilot study indicates potential for **enhanced student engagement** and emotional connection
- Reinforced importance of **teacher mediation** for ethical AI use in education
- Highlighted need for **critical AI literacy** in historical education

## Future Research Directions

- RAG implementation for **enhanced historical accuracy** and bias reduction
- Controlled experiments with **quantitative metrics** and comparison groups
- Multi-domain applications and **scalability assessment**

MemorIA demonstrates a promising approach to make history more **interactive and engaging** through embodied AI, always under **careful pedagogical guidance**.

## Thank You — Questions?

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