GoldenFossils: Advancing Vision-Language Fossil Identification through Fine-Grained Annotations

I designed and implemented a new Annotation Framework for Fossil Identification and propose a new machine-actionable Dataset. By leveraging multimodal Vision-Language Models (VLMs) as high-speed "digital interns", the application handles the heavy lifting of scientific pre-filling, while empowering experts to steer the final narrative through precision image markers and conversational.

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Context of use: Education
Level of education: Master

Impact on society

What impact is expected from your technology?

This category is only partial filled.

What is exactly the problem? Is it really a problem? Are you sure?

Documenting fossil remains is labor-intensive and results in unstructured data that lacks the morphological detail needed for modern AI training. This is a issue because it creates massive backlogs in museums and hinders the development of reliable automated identification tools.

Are you sure that this technology is solving the RIGHT problem?

This question has not been answered yet.

How is this technology going to solve the problem?

This question has not been answered yet.

What negative effects do you expect from this technology?

This question has not been answered yet.

In what way is this technology contributing to a world you want to live in?

This question has not been answered yet.

Now that you have thought hard about the impact of this technology on society (by filling out the questions above), what improvements would you like to make to the technology? List them below.

This question has not been answered yet.

Hateful and criminal actors

What can bad actors do with your technology?

This category is only partial filled.

In which way can the technology be used to break the law or avoid the consequences of breaking the law?

The framework could potentially be misused to generate plausible-sounding scientific justifications for illegally excavated or trafficked fossils to make them appear legitimate for sale. Additionally, someone could use the AI to falsify the stratigraphic context or discovery location of a find to circumvent national heritage laws regarding "in-situ" archaeological discoveries.

Can fakers, thieves or scammers abuse the technology?

This question has not been answered yet.

Can the technology be used against certain (ethnic) groups or (social) classes?

This question has not been answered yet.

In which way can bad actors use this technology to pit certain groups against each other? These groups can be, but are not constrained to, ethnic, social, political or religious groups.

This question has not been answered yet.

How could bad actors use this technology to subvert or attack the truth?

This question has not been answered yet.

Now that you have thought hard about how bad actors can impact this technology, what improvements would you like to make? List them below.

This question has not been answered yet.

Privacy

Are you considering the privacy & personal data of the users of your technology?

This category is only partial filled.

Does the technology register personal data? If yes, what personal data?

Yes, the technology registers institutional login credentials, including usernames and email addresses, to manage expert authentication via Supabase. It also processes data linked to citizen scientist accounts from the oervondstchecker.nl platform, which may include the names or IDs of the original discoverers.

Do you think the technology invades the privacy of the stakeholders? If yes, in what way?

This question has not been answered yet.

Is the technology is compliant with prevailing privacy and data protection law? Can you indicate why?

This question has not been answered yet.

Does the technology mitigate privacy and data protection risks/ concerns (privacy by design)? Please indicate how.

This question has not been answered yet.

In which way can you imagine a future impact of the collection of personal data?

This question has not been answered yet.

Now that you have thought hard about privacy and data protection, what improvements would you like to make? List them below.

This question has not been answered yet.

Human values

How does the technology affect your human values?

This category is only partial filled.

How is the identity of the (intended) users affected by the technology?

For domain experts, their identity shifts from being primary "generators of knowledge" to "auditors of AI," which potentially changes the nature of paleontological expertise toward system supervision. For citizen scientists, the technology elevates their role from simple hobbyists to valued contributors of high-quality "scientific training signals" used to improve global AI models.

How does the technology influence the users' autonomy?

This question has not been answered yet.

What is the effect of the technology on the health and/or well-being of users?

This question has not been answered yet.

Now that you have thought hard about the impact of your technology on human values, what improvements would you like to make to the technology? List them below.

This question has not been answered yet.

Stakeholders

Have you considered all stakeholders?

This category is only partial filled.

Who are the main users/targetgroups/stakeholders for this technology? Think about the intended context by answering these questions.

Name of the stakeholder
Paleontologists

How is this stakeholder affected?
-

Did you consult the stakeholder?
No

Are you going to take this stakeholder into account?
No

Name of the stakeholder
Student

How is this stakeholder affected?
-

Did you consult the stakeholder?
No

Are you going to take this stakeholder into account?
No

Name of the stakeholder
Company Mentor

How is this stakeholder affected?
-

Did you consult the stakeholder?
No

Are you going to take this stakeholder into account?

No

Name of the stakeholder
Citizen Scientists

How is this stakeholder affected?
-

Did you consult the stakeholder?
No

Are you going to take this stakeholder into account?
No

Name of the stakeholder
Naturalis Biodiversity Center

How is this stakeholder affected?
-

Did you consult the stakeholder?
No

Are you going to take this stakeholder into account?
No

Did you consider all stakeholders, even the ones that might not be a user or target group, but still might be of interest?
-

Now that you have thought hard about all stakeholders, what improvements would you like to make? List them below.
This question has not been answered yet.

Data

Is data in your technology properly used?

This category is only partial filled.

Are you familiar with the fundamental shortcomings and pitfalls of data and do you take this sufficiently into account in the technology?

The research explicitly acknowledges the "taphonomic filter" and "morphological convergence," which are major pitfalls where data can be misleading or "noisy." The framework addresses these shortcomings by requiring coordinate-based annotations (Segment 4), ensuring that conclusions are pinned to specific visual evidence rather than relying on the AIs often unreliable general intuition.

How does the technology organize continuous improvement when it comes to the use of data?

This question has not been answered yet.

How will the technology keep the insights that it identifies with data sustainable over time?

This question has not been answered yet.

In what way do you consider the fact that data is collected from the users?

This question has not been answered yet.

Now that you have thought hard about the impact of data on this technology, what improvements would you like to make? List them below.

This question has not been answered yet.

Inclusivity

Is your technology fair for everyone?

This category is only partial filled.

Will everyone have access to the technology?

This question has not been answered yet.

Does this technology have a built-in bias?

Yes, the benchmarking identified a significant "Megafauna Bias," where the underlying VLMs disproportionately favor high-prestige Pleistocene species like mammoths over common domestic animals. This bias causes the models to misidentify modern specimens as ancient fossils simply because they were told they were looking at data from an "ice age" context.

Does this technology make automatic decisions and how do you account for them?

This question has not been answered yet.

Is everyone benefitting from the technology or only a a small group? Do you see this as a problem? Why/why not?

This question has not been answered yet.

Does the team that creates the technology represent the diversity of our society?

This question has not been answered yet.

Now that you have thought hard about the inclusivity of the technology, what improvements would you like to make? List them below.

This question has not been answered yet.

Transparency

Are you transparent about how your technology works?

This category is only partial filled.

Is it explained to the users/stakeholders how the technology works and how the business model works?

The framework includes a "Welcome Disclaimer" and a "Privacy Shield" that explain the "Human-in-the-Loop" workflow and how data is used to fine-tune the AI. As an institutional research prototype, the "business model" is centered on contributing structured data to the museum's open-research database rather than commercial profit.

If the technology makes an (algorithmic) decision, is it explained to the users/stakeholders how the decision was reached?

This question has not been answered yet.

Is it possible to file a complaint or ask questions/get answers about this technology?

This question has not been answered yet.

Is the technology (company) clear about possible negative consequences or shortcomings of the technology?

This question has not been answered yet.

Now that you have thought hard about the transparency of this technology, what improvements would you like to make? List them below.

This question has not been answered yet.

Sustainability

Is your technology environmentally sustainable?

This category is only partial filled.

In what way is the direct and indirect energy use of this technology taken into account?

While not the primary focus of the study, the research acknowledges the significant computational energy required for running high-level multimodal models like Gemini. The use of a "Flash" model variant represents a conscious choice to utilize a more energy-efficient, "lite" version of the AI compared to the much heavier and more resource-intensive "Pro" models.

Do you think alternative materials could have been considered in the technology?

This question has not been answered yet.

Do you think the lifespan of the technology is realistic?

This question has not been answered yet.

What is the hidden impact of the technology in the whole chain?

This question has not been answered yet.

Now that you have thought hard about the sustainability of this technology, what improvements would you like to make? List them below.

This question has not been answered yet.

Future

Did you consider future impact?

This category is only partial filled.

What could possibly happen with this technology in the future?
In the future, this framework could lead to the development of a specialized "Paleo-VLM" capable of identifying fossils with near-human accuracy across a global network of museums. It could also become a real-time bridge where a citizen scientist's phone upload is automatically processed, expert-verified, and archived into a museum database within minutes.

Sketch a or some future scenario (s) (20-50 years up front) regarding the technology with the help of storytelling. Start with at least one utopian scenario.
This question has not been answered yet.

Sketch a or some future scenario (s) (20-50 years up front) regarding the technology with the help of storytelling. Start with at least one dystopian scenario.
This question has not been answered yet.

Would you like to live in one of this scenario's? Why? Why not?
This question has not been answered yet.

What happens if the technology (which you have thought of as ethically well-considered) is bought or taken over by another party?
This question has not been answered yet.

Impact Improvement: Now that you have thought hard about the future impact of the technology, what improvements would you like to make? List them below.
This question has not been answered yet.