Introduction to Scientific Research

Paper reading and bibliographic research

Polytech Nice

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UNIVERSITÉ CÔTE D'AZUR

Inria

Outline

- Reading a scientific paper
- Organizing your bibliography
- Referencing and citing
- Using overleaf to write your report (and cite references)

Inspired and partially adapted from slides by Pr. Marco Winckler

Why learn about bibliography?

- **Short term**: bibliography for PER project (10-40 papers)
- **Medium term**: doing a thesis, market analysis, propose a project (100+ papers)
- **Long term**:
  - Keeping up with (technical) developments of the world
  - Entering and deepening your **knowledge** in a domain
  - Making **informed** decisions and **convincing** arguments

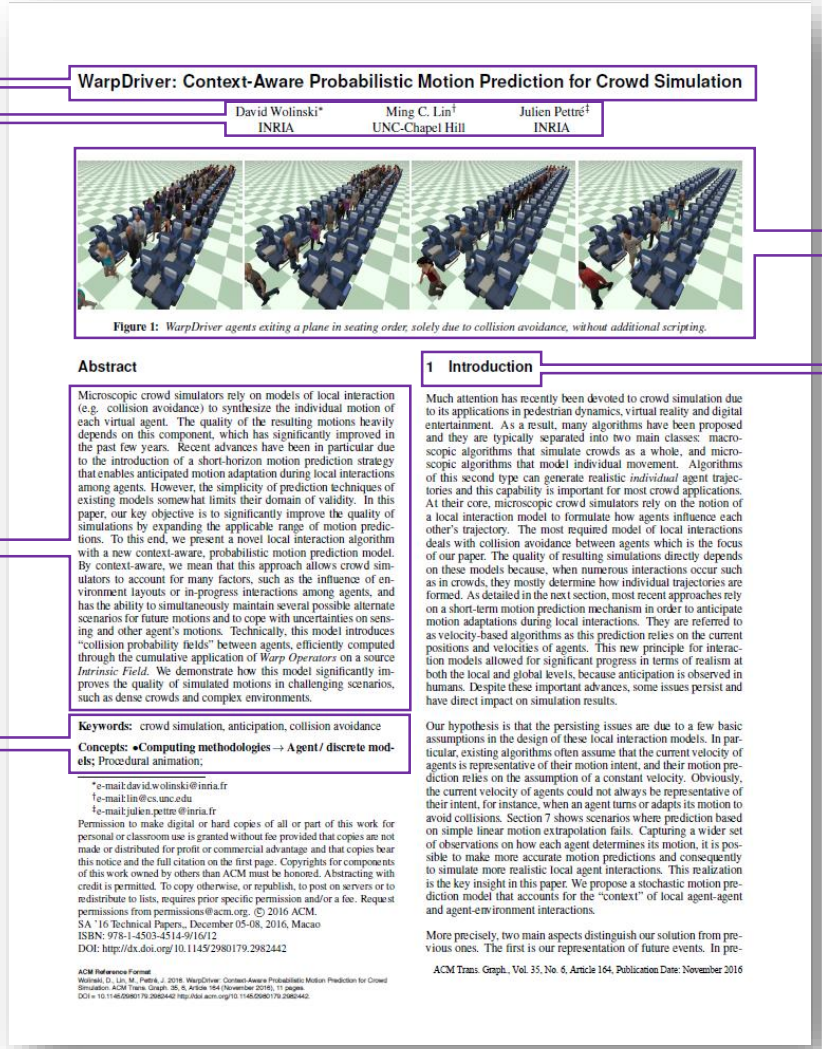
What will you learn today?

- How to **get the most out of** reading a paper
- Tools to help you **establish and organize** your own library
- How to correctly **acknowledge and critique** existing work

Reading a scientific paper

… and survive doing it

(usual) Anatomy of a scientific paper



WarpDriver: Context-Aware Probabilistic Motion Prediction for Crowd Simulation

David Wolinski* INRIA · Ming C. Lin† UNC-Chapel Hill · Julien Pettré‡ INRIA

Figure 1: *WarpDriver agents exiting a plane in seating order, solely due to collision avoidance, without additional scripting.*

Abstract

Microscopic crowd simulators rely on models of local interaction (e.g. collision avoidance) to synthesize the individual motion of each virtual agent. The quality of the resulting motions heavily depends on this component, which has significantly improved in the past few years. Recent advances have been in particular due to the introduction of a short-horizon motion prediction strategy that enables anticipated motion adaptation during local interactions among agents. However, the simplicity of prediction techniques of existing models somewhat limits their domain of validity. In this paper, our key objective is to significantly improve the quality of simulations by expanding the applicable range of motion predictions. To this end, we present a novel local interaction algorithm with a new context-aware, probabilistic motion prediction model. By context-aware, we mean that this approach allows crowd simulators to account for many factors, such as the influence of environment layouts or in-progress interactions among agents, and has the ability to simultaneously maintain several possible alternate scenarios for future motions and to cope with uncertainties on sensing and other agent's motions. Technically, this model introduces "collision probability fields" between agents, efficiently computed through the cumulative application of *Warp Operators* on a source *Intrinsic Field*. We demonstrate how this model significantly improves the quality of simulated motions in challenging scenarios, such as dense crowds and complex environments.

Keywords: crowd simulation, anticipation, collision avoidance

Concepts: •**Computing methodologies** → **Agent / discrete models**; Procedural animation;

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1 Introduction

Much attention has recently been devoted to crowd simulation due to its applications in pedestrian dynamics, virtual reality and digital entertainment. As a result, many algorithms have been proposed and they are typically separated into two main classes: macroscopic algorithms that simulate crowds as a whole, and microscopic algorithms that model individual movement. Algorithms of this second type can generate realistic *individual* agent trajectories and this capability is important for most crowd applications. At their core, microscopic crowd simulators rely on the notion of a local interaction model to formulate how agents influence each other's trajectory. The most required model of local interactions deals with collision avoidance between agents which is the focus of our paper. The quality of resulting simulations directly depends on these models because, when numerous interactions occur such as in crowds, they mostly determine how individual trajectories are formed. As detailed in the next section, most recent approaches rely on a short-term motion prediction mechanism in order to anticipate motion adaptations during local interactions. They are referred to as velocity-based algorithms as this prediction relies on the current positions and velocities of agents. This new principle for interaction models allowed for significant progress in terms of realism at both the local and global levels, because anticipation is observed in humans. Despite these important advances, some issues persist and have direct impact on simulation results.

Our hypothesis is that the persisting issues are due to a few basic assumptions in the design of these local interaction models. In particular, existing algorithms often assume that the current velocity of agents is representative of their motion intent, and their motion prediction relies on the assumption of a constant velocity. Obviously, the current velocity of agents could not always be representative of their intent, for instance, when an agent turns or adapts its motion to avoid collisions. Section 7 shows scenarios where prediction based on simple linear motion extrapolation fails. Capturing a wider set of observations on how each agent determines its motion, it is possible to make more accurate motion predictions and consequently to simulate more realistic local agent interactions. This realization is the key insight in this paper. We propose a stochastic motion prediction model that accounts for the "context" of local agent-agent and agent-environment interactions.

More precisely, two main aspects distinguish our solution from previous ones. The first is our representation of future events. In pre-

title
Authors & affiliations

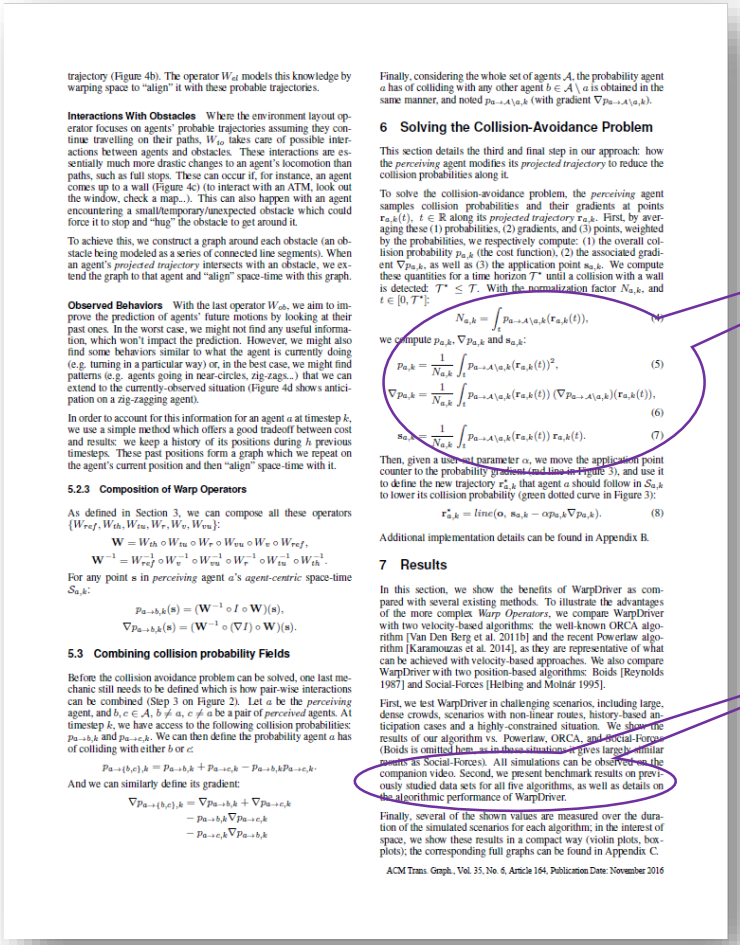
Abstract

Keywords

Figures, captions, tables…

Sections
- *Introduction*
- *Related work*
- *Methodology*
- *Results*
- *Discussion*
- *Conclusion*
- *Acknowledgements*

(usual) Anatomy of a scientific paper



trajectory (Figure 4b). The operator W_{el} models this knowledge by warping space to "align" it with these probable trajectories.

Interactions With Obstacles Where the environment layout operator focuses on agents' probable trajectories assuming they continue travelling on their paths, W_{to} takes care of possible interactions between agents and obstacles. These interactions are essentially much more drastic changes to an agent's locomotion than paths, such as full stops. These can occur if, for instance, an agent comes up to a wall (Figure 4c) (to interact with an ATM, look out the window, check a map...). This can also happen with an agent encountering a small/temporary/unexpected obstacle which could force it to stop and "hug" the obstacle to get around it.

To achieve this, we construct a graph around each obstacle (an obstacle being modeled as a series of connected line segments). When an agent's *projected trajectory* intersects with an obstacle, we extend the graph to that agent and "align" space-time with this graph.

Observed Behaviors With the last operator W_{ob}, we aim to improve the prediction of agents' future motions by looking at their past ones. In the worst case, we might not find any useful information, which won't impact the prediction. However, we might also find some behaviors similar to what the agent is currently doing (e.g. turning in a particular way) or, in the best case, we might find patterns (e.g. agents going in near-circles, zig-zags...) that we can extend to the currently-observed situation (Figure 4d shows anticipation on a zig-zagging agent).

In order to account for this information for an agent a at timestep k, we use a simple method which offers a good tradeoff between cost and results: we keep a history of its positions during h previous timesteps. These past positions form a graph which we repeat on the agent's current position and then "align" space-time with it.

5.2.3 Composition of Warp Operators

As defined in Section 3, we can compose all these operators $\{W_{ref}, W_{th}, W_{tu}, W_r, W_v, W_{vu}\}$:

$$\mathbf{W} = W_{th} \circ W_{tu} \circ W_r \circ W_{vu} \circ W_v \circ W_{ref},$$
$$\mathbf{W}^{-1} = W_{ref}^{-1} \circ W_v^{-1} \circ W_{vu}^{-1} \circ W_r^{-1} \circ W_{tu}^{-1} \circ W_{th}^{-1}.$$

For any point $\mathbf{s}$ in *perceiving* agent a's *agent-centric* space-time $S_{a,k}$:

$$p_{a\to b,k}(\mathbf{s}) = (\mathbf{W}^{-1} \circ I \circ \mathbf{W})(\mathbf{s}),$$
$$\nabla p_{a\to b,k}(\mathbf{s}) = (\mathbf{W}^{-1} \circ (\nabla I) \circ \mathbf{W})(\mathbf{s}).$$

5.3 Combining collision probability Fields

Before the collision avoidance problem can be solved, one last mechanic still needs to be defined which is how pair-wise interactions can be combined (Step 3 on Figure 2). Let a be the *perceiving* agent, and $b, c \in \mathcal{A}$, $b \neq a$, $c \neq a$ be a pair of *perceived* agents. At timestep k, we have access to the following collision probabilities: $p_{a\to b,k}$ and $p_{a\to c,k}$. We can then define the probability agent a has of colliding with either b or c:

$$p_{a\to\{b,c\},k} = p_{a\to b,k} + p_{a\to c,k} - p_{a\to b,k} p_{a\to c,k}.$$

And we can similarly define its gradient:

$$\nabla p_{a\to\{b,c\},k} = \nabla p_{a\to b,k} + \nabla p_{a\to c,k} - p_{a\to b,k} \nabla p_{a\to c,k} - p_{a\to c,k} \nabla p_{a\to b,k}$$

Finally, considering the whole set of agents $\mathcal{A}$, the probability agent a has of colliding with any other agent $b \in \mathcal{A} \setminus a$ is obtained in the same manner, and noted $p_{a\to\mathcal{A}\setminus a,k}$ (with gradient $\nabla p_{a\to\mathcal{A}\setminus a,k}$).

6 Solving the Collision-Avoidance Problem

This section details the third and final step in our approach: how the *perceiving* agent modifies its *projected trajectory* to reduce the collision probabilities along it.

To solve the collision-avoidance problem, the *perceiving* agent samples collision probabilities and their gradients at points $\mathbf{r}_{a,k}(t)$, $t \in \mathbb{R}$ along its *projected trajectory* $\mathbf{r}_{a,k}$. First, by averaging these (1) probabilities, (2) gradients, and (3) points, weighted by the probabilities, we respectively compute: (1) the overall collision probability $p_{a,k}$ (the cost function), (2) the associated gradient $\nabla p_{a,k}$, as well as (3) the application point $\mathbf{s}_{a,k}$. We compute these quantities for a time horizon $\mathcal{T}^\star$ until a collision with a wall is detected: $\mathcal{T}^\star \leq \mathcal{T}$. With the normalization factor $N_{a,k}$, and $t \in [0, \mathcal{T}^\star]$:

$$N_{a,k} = \int_t p_{a\to\mathcal{A}\setminus a,k}(\mathbf{r}_{a,k}(t)), \tag{4}$$

we compute $p_{a,k}$, $\nabla p_{a,k}$ and $\mathbf{s}_{a,k}$:

$$p_{a,k} = \frac{1}{N_{a,k}} \int_t p_{a\to\mathcal{A}\setminus a,k}(\mathbf{r}_{a,k}(t))^2, \tag{5}$$

$$\nabla p_{a,k} = \frac{1}{N_{a,k}} \int_t p_{a\to\mathcal{A}\setminus a,k}(\mathbf{r}_{a,k}(t)) \, (\nabla p_{a\to\mathcal{A}\setminus a,k})(\mathbf{r}_{a,k}(t)), \tag{6}$$

$$\mathbf{s}_{a,k} = \frac{1}{N_{a,k}} \int_t p_{a\to\mathcal{A}\setminus a,k}(\mathbf{r}_{a,k}(t)) \, \mathbf{r}_{a,k}(t). \tag{7}$$

Then, given a user-set parameter α, we move the application point counter to the probability gradient (red line in Figure 3), and use it to define the new trajectory $\mathbf{r}^\star_{a,k}$ that agent a should follow in $S_{a,k}$ to lower its collision probability (green dotted curve in Figure 3):

$$\mathbf{r}^\star_{a,k} = line(\mathbf{o}, \mathbf{s}_{a,k} - \alpha p_{a,k} \nabla p_{a,k}). \tag{8}$$

Additional implementation details can be found in Appendix B.

7 Results

In this section, we show the benefits of WarpDriver as compared with several existing methods. To illustrate the advantages of the more complex *Warp Operators*, we compare WarpDriver with two velocity-based algorithms: the well-known ORCA algorithm [Van Den Berg et al. 2011b] and the recent Powerlaw algorithm [Karamouzas et al. 2014], as they are representative of what can be achieved with velocity-based approaches. We also compare WarpDriver with two position-based algorithms: Boids [Reynolds 1987] and Social-Forces [Helbing and Molnár 1995].

First, we test WarpDriver in challenging scenarios, including large, dense crowds, scenarios with non-linear routes, history-based anticipation cases and a highly-constrained situation. We show the results of our algorithm vs. Powerlaw, ORCA, and Social-Forces (Boids is omitted here, as in these situations it gives largely similar results as Social-Forces). All simulations can be observed on the companion video. Second, we present benchmark results on previously studied data sets for all five algorithms, as well as details on the algorithmic performance of WarpDriver.

Finally, several of the shown values are measured over the duration of the simulated scenarios for each algorithm; in the interest of space, we show these results in a compact way (violin plots, box-plots); the corresponding full graphs can be found in Appendix C.

Formulae

$$N_{a,k} = \int_t p_{a\to\mathcal{A}\setminus a,k}(\mathbf{r}_{a,k}(t)), \tag{4}$$

we compute $p_{a,k}$, $\nabla p_{a,k}$ and $\mathbf{s}_{a,k}$:

$$p_{a,k} = \frac{1}{N_{a,k}} \int_t p_{a\to\mathcal{A}\setminus a,k}(\mathbf{r}_{a,k}(t))^2, \tag{5}$$

$$\nabla p_{a,k} = \frac{1}{N_{a,k}} \int_t p_{a\to\mathcal{A}\setminus a,k}(\mathbf{r}_{a,k}(t)) \, (\nabla p_{a\to\mathcal{A}\setminus a,k})(\mathbf{r}_{a,k}(t)), \tag{6}$$

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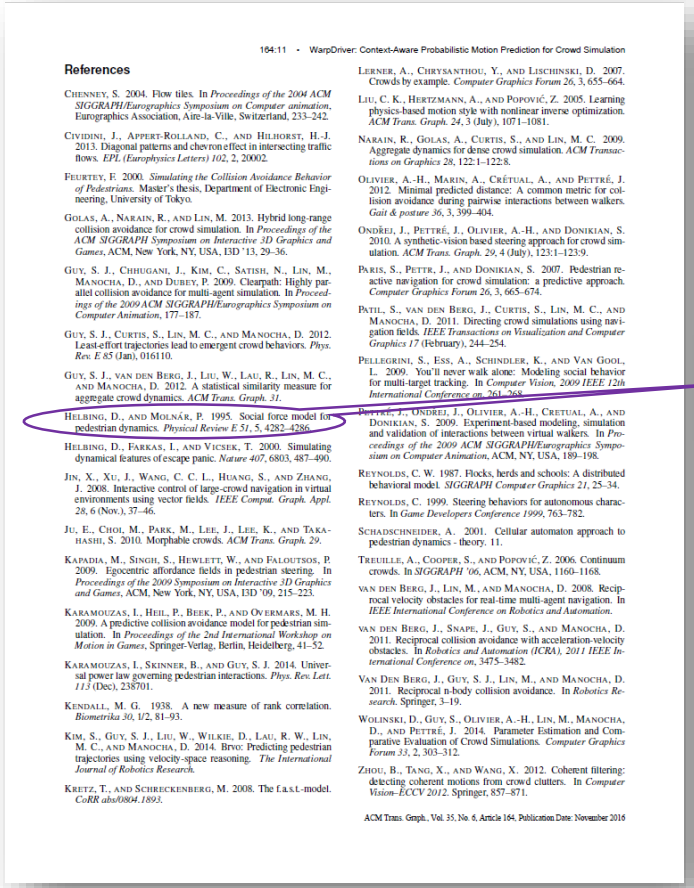
Citations and references

(usual) Anatomy of a scientific paper



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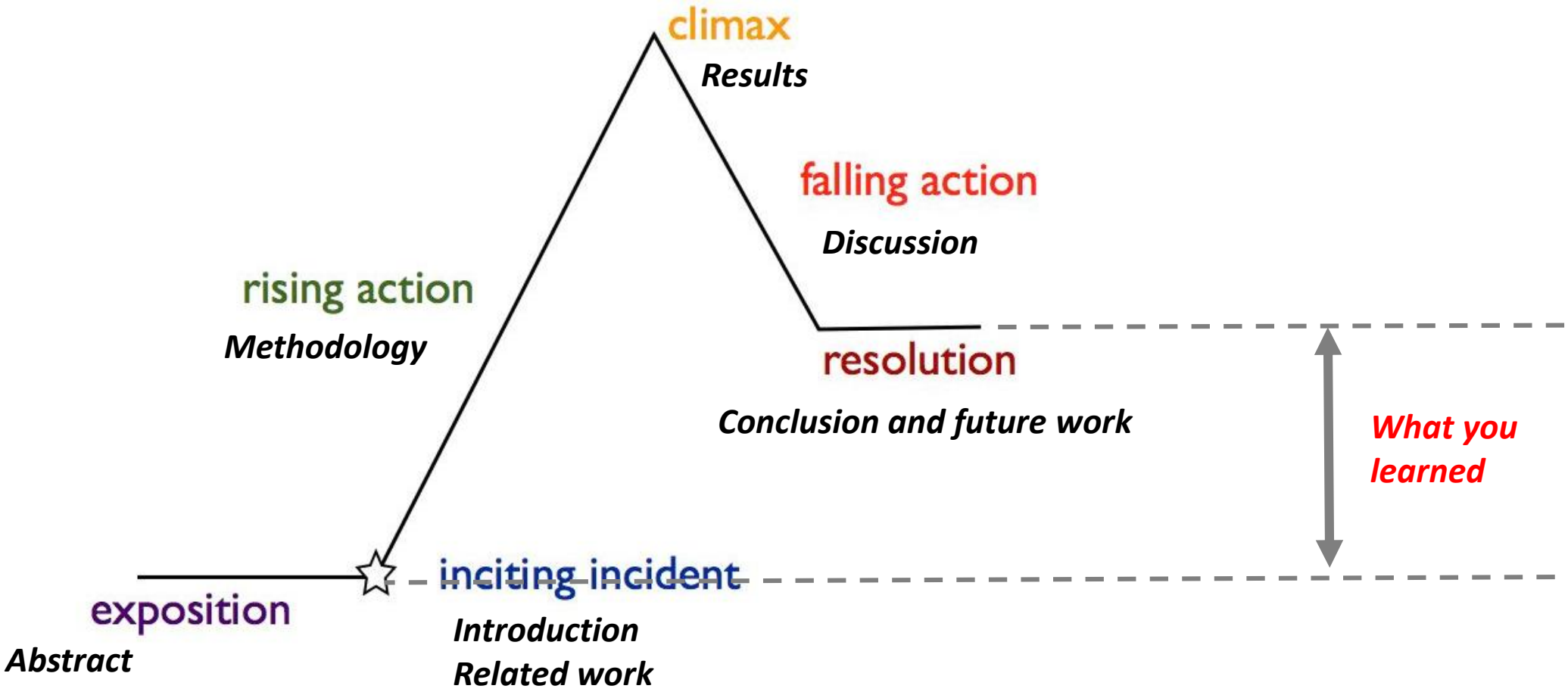
Helbing, D., and Molnár, P. 1995. Social force model for pedestrian dynamics. *Physical Review E 51*, 5, 4282–4286.

Aristotle's dramatic structure



The three-pass method

Pass 1: Title, Abstract, Figures (and captions), Section headings

Objective: determine if the paper is worth reading (WHAT)

Pass 2: Introduction, Results, Discussions, Conclusion

Objective: understanding the main contributions of the paper (WHY)

Pass 3: Related work, Methodology, References

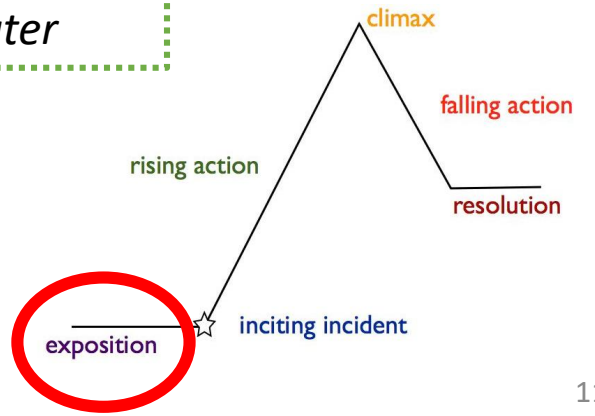
Objective: understanding how the paper is positioned and implemented (HOW)

Title and authors

- Title is very descriptive (often states the main finding) and is not about being creative and “catchy”!
- Order of authors is important. What can you tell from it?

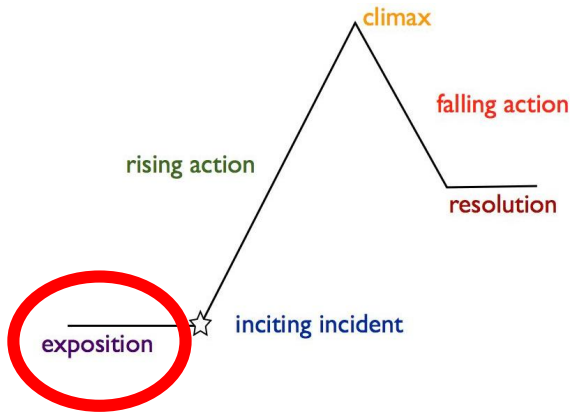
Example

Embodiment in a Child-Like Talking Virtual Body Influences Object Size Perception, Self-Identification, and Subsequent Real Speaking
Ana Tajadura-Jiménez, Domna Banakou, Nadia Bianchi-Berthouze & Mel Slater



Abstract/Summary

- Brief background of subject
- Purpose for the research
- Major findings
- Relationship between these findings and the field

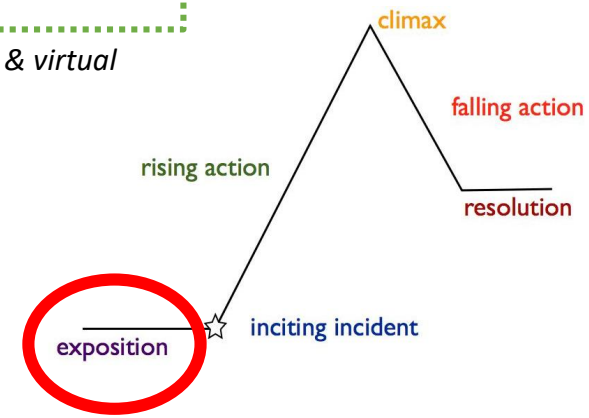


Abstract/Summary

Example

While augmented and virtual reality technologies are becoming mainstream, it is still technically challenging and time-consuming to create new applications. Many designers draw from traditional low-fidelity prototyping methods that do not lend themselves well to designing in 3D. Developers use high-end programming frame-works such as Unity and Unreal which require significant hardware/software setups and coding skills. We see a gap in the medium-fidelity range where there is an opportunity for new tools to leverage the advantages of 360◦ content for AR/VR prototyping. Existing tools, however, have only limited support for 3D geometry, spatial and proxemic interactions, puppeteering, and storytelling. We present 360theater, a new method and a tool for rapid prototyping of AR/VR experiences, which takes dioramas into the virtual realm by enhancing 360◦ video capture with 3D geometry and simulating spatial interactions via Wizard of Oz. Our comparative evaluation of techniques with novice and experienced AR/VR designers shows that 360theater can close the gap and achieve a higher fidelity and more realistic AR/VR prototypes than comparable methods.

Speicher, M., Lewis, K., & Nebeling, M. (2021). Designers, the stage is yours! medium-fidelity prototyping of augmented & virtual reality interfaces with 360theater. Proceedings of the ACM on human-computer interaction, 5(EICS), 1-25.



Abstract/Summary

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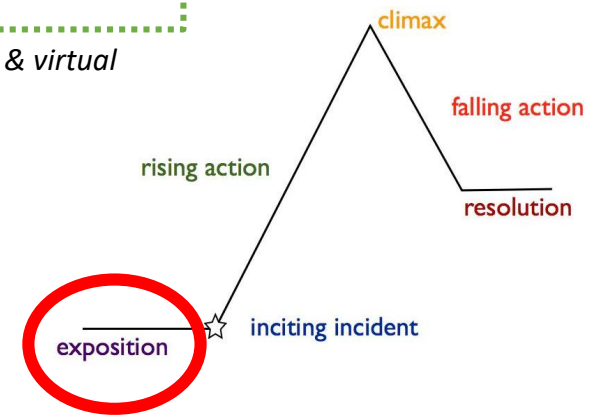
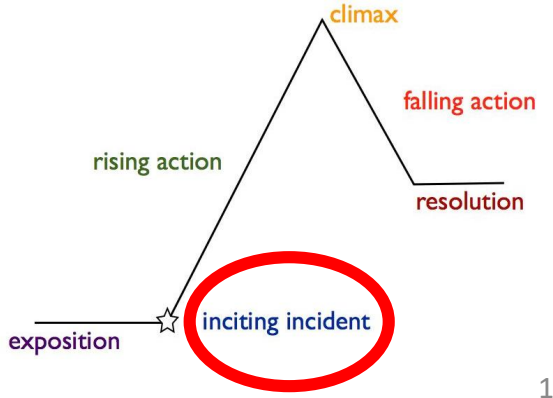


Introduction

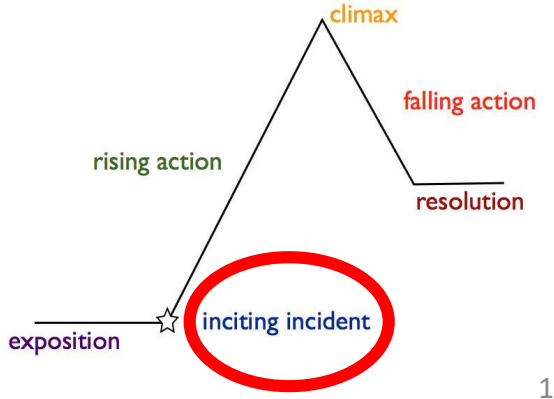
- Presents the background information for a fellow scientist (possibly in another field) to understand why the findings of this paper are significant.
- Structure is usually:
  - Context
  - Challenges / limitations
  - Hypothesis being tested / Contributions
  - Conclusions (scientists like being spoiled!)



How to approach the introduction

- **Grab a blank piece of paper:**
  - Take notes
  - Draw mini figures
  - Define vocabulary
    (wikipedia is a quick reference)

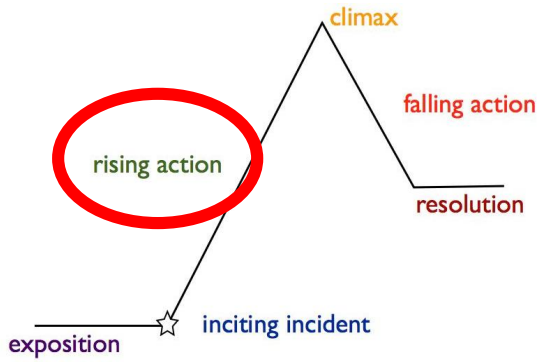
- **Ask questions:**
  - What is the accepted state of knowledge?
  - What data led directly to the work of this paper?
  - What is the hypothesis being tested?
  - What are the basic conclusions?
  - What are the breakthroughs of the paper?



Materials and Methods

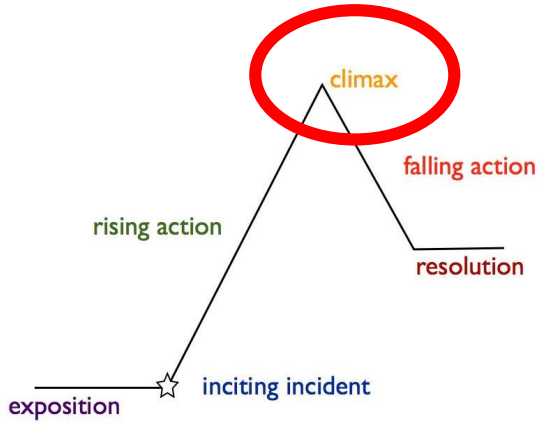
- Data, software, hardware, questionnaires, experimental protocols, conditions
  - Frequently based on existing methodologies (cited)

- **Reproducibility**:
  - To what extent can an expert in the field reproduce the research?
  - Are code, data, and software released



Results

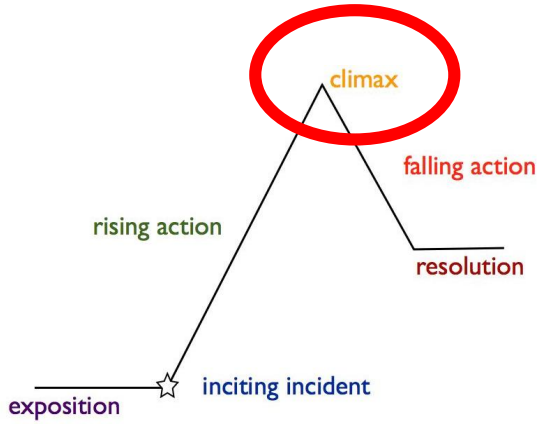
- The introduction **poses the questions being asked**, the results **describes the outcome of the experiments** that were done **to answer the questions**.
- Results are often simply stated with *interpretation* of them coming later in the discussion.
- Figures and tables allow the reader to see the outcomes of the experiments for themselves!



How to read the results:

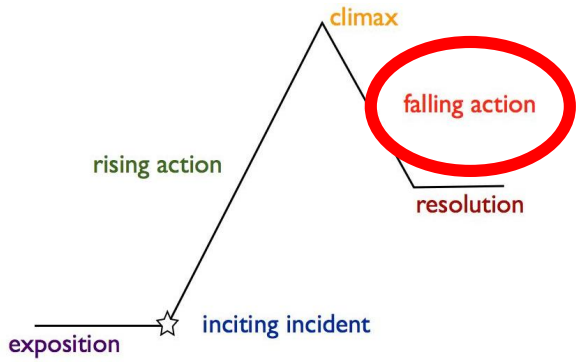
- Read the text straight through, but as a figure is referred to, examine the figure.
- Take notes, giving yourself a place to refer to about each figure
- With each experiment/figure you should be able to explain :

1) the basic procedure
2) the question it sought to answer
3) the results
4) the conclusion
5) criticisms



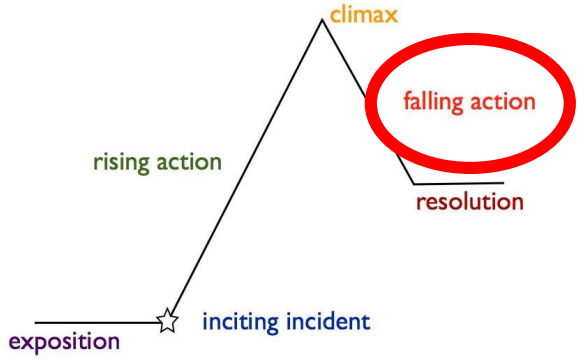
Discussion

- Data is analyzed to show what the authors believe the data show. (You don't have to agree with their interpretations!)
- Findings are related to other findings in the field (contribute to knowledge, correct errors, etc.)– How is this work significant?



How to read a discussion

- Go back to the questions you asked in the introduction and answer the questions:
  - What conclusions do the authors draw? Be sure to separate fact from their opinion/interpretation.
  - Describe for yourself why the study/data is significant. (Does it contribute to knowledge or correct errors?)



By now, you may be tired of this paper…
but don’t relax yet.

Save energy for the overall reflection and criticism.

Conclusion

- A global and concise view of what was done
- Perspectives on the future work

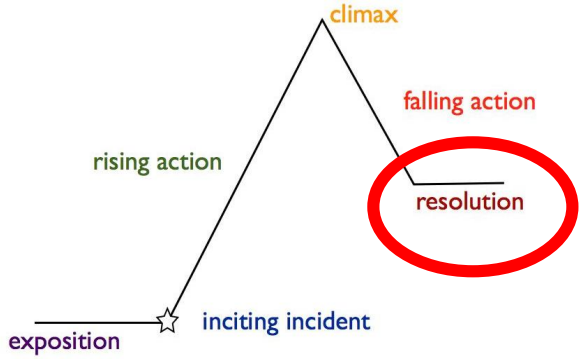
Conclusion

Example

In this paper, we pointed out three inherent drawbacks of the prevalent proposal-based framework, and proposed a new classification-then-grounding framework for VidSGG. **Under this framework, we reformulated** video scene graphs as temporal bipartite graphs, and proposed a novel VidSGG model BIG. **We validated** the effectiveness of BIG through extensive comparative and ablative experiments. **Limitations.** 1) Detecting long object tracklets in videos is still an **open problem**, and the fragmented tracklets may weaken the advantages of our framework, making it close to the proposal-based one. 2) **Multi-instance grounding may not be suitable for some extreme situations where** too many targets fall into the same bin (videos with dense relations).

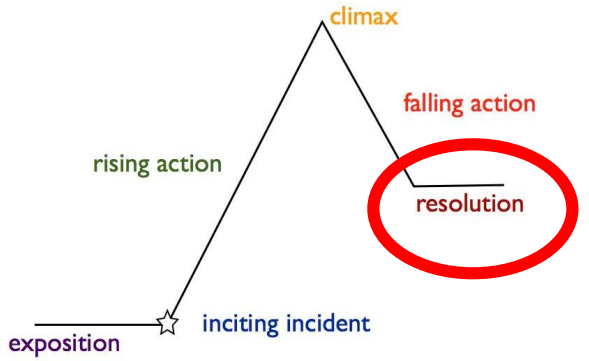
Gao, K., et al. (2022). Classification-then-grounding: Reformulating video scene graphs as temporal bipartite graphs. In Proc. of CVPR (pp. 19497-19506).

- A global and concise view of what was done
- Perspectives on the future work



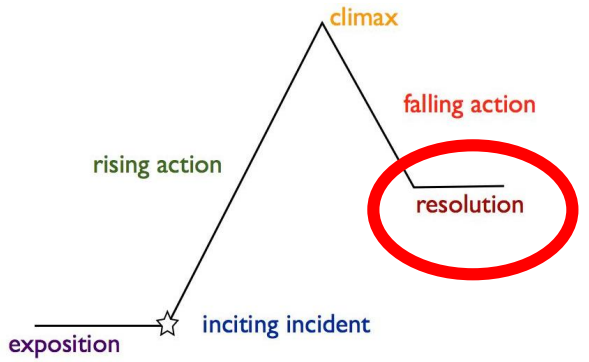
Acknowledgements

- Thank people who contributed materials.
- Thank people who contributed technically but maybe not intellectually (would not be authors).



References

- Papers cited in the text
- What parts of the paper cite other papers?
  - Introduction
  - Materials and Methods
  - Discussion
  - (Maybe a few in Results)



Question: How should we READ a scientific paper?

Answer: not necessarily in order!

A four-step method based on: **Ann McNeal, School of Natural Science, Hampshire College, Amherst MA**

http://leml.asu.edu/Wu_Website_4_Students/Reading-guides/*McNeal-How2ReadSciPaper.pdf

Organizing your bibliography

… or how to not forget a paper immediately after you finished it

Tools for organizing bibliography

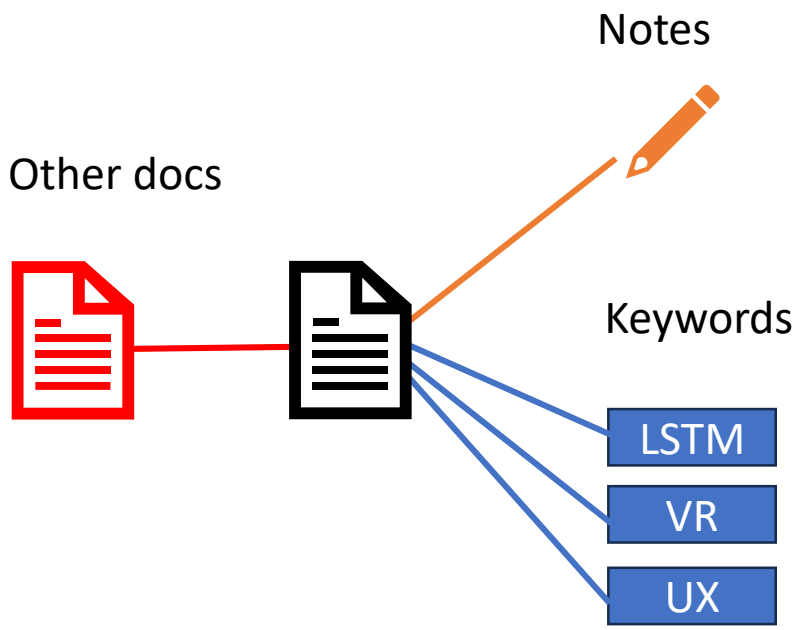
- Search through keyword
- Linking documents and notes
- Rapid export in citations and references

Bibliography management tools

	JabRef	Zotero	Mendeley	EndNote
				EndNote™
Price	Free	Free, cloud storage cost	Free	Paid
Characteristics	Configurable, open source	Rich functionalities through plugins	Social network	Professional integration

Zotero – demonstration

- Interface:
  - Metadata
  - Collections
  - Keywords / tags
  - Notes
- Adding references from Google scholar
- Exporting reference libraries



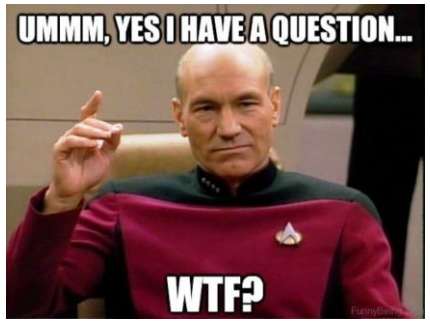
Referencing and citing

avoiding plagiarism and giving credit

Objectives of citing

- Giving your arguments a foundation (They say / I say)
- Giving credit
- Avoiding plagiarism

A word on style…



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Format: author | author-date | label | note | numeric

Fields: anthropology | astronomy | biology | botany | chemistry | communications | engineering | generic-base | geography | geology | history | humanities | law | linguistics | literature | math | medicine | philosophy | physics | political_science | psychology | science | social_science | sociology | theology | zoology

10,460 styles found:

- 2D Materials (2020-02-05 05:27:13)
- 3 Biotech (2014-05-18 01:40:32)
- 3D Printing and Additive Manufacturing (2022-04-17 23:21:42)
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- 3D Research (2015-04-21 12:08:45)
- 3D-Printed Materials and Systems (2015-04-21 12:08:45)
- 4OR (2014-05-18 01:40:32)
- AAPG Bulletin (2013-03-29 23:50:45)
- AAPS Open (2016-02-13 20:40:33)
- AAPS PharmSciTech (2014-05-18 01:40:32)
- Abhandlungen aus dem Mathematischen Seminar der Universität Hamburg (2014-05-18 01:40:32)

A word on style...

- Need help? If you are unfortunate enough to ever have to write your own citations...
  - https://owl.purdue.edu/owl/research_and_citation/resources.html
  - Psst... Google Scholar provides APA and MLA style that you can copy paste
  - Aaaand!!! Bib managers can bulk format citations for you

A word on style…

- Common styles:
  - MLA, APA: For humanities, psychology, general
  - IEEE, ACM, Nature: conference / journal specific

Example

APA

Tajadura-Jiménez, A., Banakou, D., Bianchi-Berthouze, N., & Slater, M. (2017). Embodiment in a child-like talking virtual body influences object size perception, self-identification, and subsequent real speaking. *Scientific reports*, *7*(1), 9637.

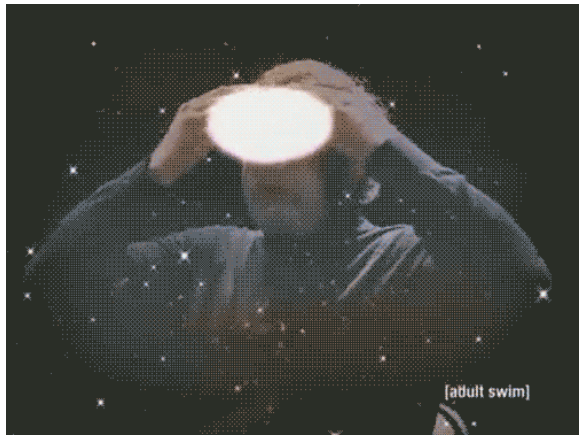
MLA

Tajadura-Jiménez, Ana, et al. "Embodiment in a child-like talking virtual body influences object size perception, self-identification, and subsequent real speaking." *Scientific reports* 7.1 (2017): 9637.

LaTeX + BibTeX

Question

But what if I want to use the same citations for multiple papers/articles?
What if I don't know which citations I want to include yet?



Answer

BibTeX

Refs.bib

Add (or copy from Google Scholar, or export from your bib manager)

```
@article{speicher2021designers,
   title={Designer, the stage is yours! medium-fidelity prototyping of augmented \& virtual reality interfaces with 360theater},
   author={Speicher, Maximilian and Lewis, Katy and Nebeling, Michael},
   journal={Proceedings of the ACM on human-computer interaction},
   volume={5},
   number={EICS},
   pages={1--25},
   year={2021},
   publisher={ACM New York, NY, USA} }
```

Then use

```
Speicher et al. \cite{speicher2021designers} propose a solution to the problem.
```

Overleaf demo

- Create an example project
- Anatomy of a paper
- References section
- Add a citation
- Cite it!