



# NEURIPS 2022 REPORT

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  - Invited Talks
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# NEURIPS 2022 OVERVIEW



- Neural Information Processing Systems Conference (NEURIPS) 2022 held in New Orleans, LA
  - Main Conference Nov 29 - Dec17 2022
  - Workshop Dec 2 – Dec 4
  - Virtual workshops Dec 5 - Dec 9
- Total 2672 Papers
- 63 workshops, 700+ workshop papers
- 6 Invited Talks
- Best Paper Award: [Announcing the NeurIPS 2022 Awards – NeurIPS Blog](#)

# NEURIPS 2022 OVERVIEW



## ➤ 10 Major Topics/Fields

- Language Models and Prompting
- Diffusion Models
- Self-Supervised Learning
- Graph Neural Networks
- Reinforcement Learning
- Brain-Inspired
- Out-of-Domain Generalization
- Learning Theory
- Adversarial Robustness, Federated Learning, Compression
- Datasets & Benchmarks

<https://medium.com/towards-artificial-intelligence/10-topics-and-50-papers-you-shouldnt-miss-ac1c15844733>

<https://zhuanlan.zhihu.com/p/591398408>

# INVITED TALKS



- **Algorithms On the Bench: Examining Validity of ML Systems in the Public Sphere**  
by Rediet Abebe
- **Interaction-Centric AI**  
by Juho Kim
- **Conformal Prediction in 2022**  
by Emmanuel Candes
- **Blueprint for an AI Bill of Rights Making Automated Systems Work for the American People**  
by Alondra Nelson
- **The Forward-Forward Algorithm for Training Deep Neural Networks**  
by Geoffrey Hinton
- **The Data-Centric Era: How ML is Becoming an Experimental Science**  
by Isabelle Guyon

# PAPERS INTERESTED

## Language Models and Prompting

1、 Flamingo: a Visual Language Model for Few-Shot Learning

💡 DeepMind: <https://arxiv.org/abs/2204.14198>

2、 Solving Quantitative Reasoning Problems with Language Models (Minerva)

💡 Google : <https://arxiv.org/abs/2206.14858>

3、 Training language models to follow instructions with human feedback (InstructGPT)

💡 OpenAI: <https://arxiv.org/abs/2203.02155>

# PAPERS INTERESTED

## Language Models and Prompting

### 1、 Flamingo: a Visual Language Model for Few-Shot Learning

💡 DeepMind

#### Contributions:

- (i) Introduced the Flamingo family of VLMs which can perform various multimodal tasks
- (ii) Quantitatively evaluate how Flamingo models can be adapted to various tasks via few-shot learning.
- (iii) Flamingo sets a new state of the art in few-shot learning on a wide array of 16 multimodal language and image/video understanding tasks on five additional challenging benchmarks: VQA<sub>v2</sub>, VATEX, VizWiz, MSRVTQA, and HatefulMemes.

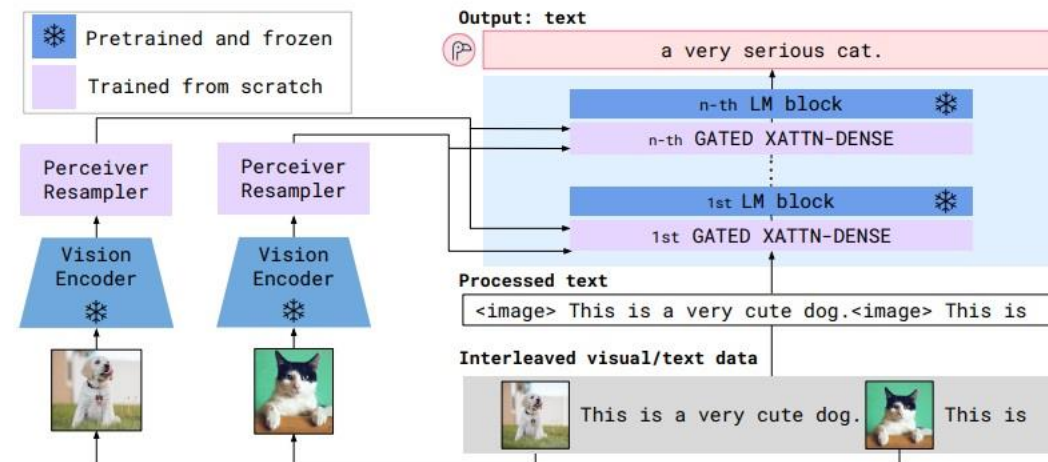


Figure 3: **Flamingo architecture overview.** Flamingo is a family of visual language models (VLMs) that take as input visual data interleaved with text and produce free-form text as output.



# PAPERS INTERESTED

## Language Models and Prompting

### 2、 Solving Quantitative Reasoning Problems with Language Models (Minerva)



Minerva, a language model that achieves strong performance on many quantitative reasoning tasks.

- able to process scientific and mathematical questions formulated in natural language,
- generate step-by-step solutions using correct LATEX notation.
- Figures 1, 2 and 3 show example responses from Minerva to mathematics and physics questions

**Question:** A line parallel to  $y = 4x + 6$  passes through  $(5, 10)$ . What is the  $y$ -coordinate of the point where this line crosses the  $y$ -axis?

**Target:** Since the line is parallel to  $y = 4x + 6$ , we know that its slope is 4. Thus the equation of the line is  $y = 4x + b$  where  $b$  is the  $y$ -intercept. Plugging  $(5, 10)$  into this gives  $10 = 4 \cdot 5 + b \Rightarrow b = \boxed{-10}$  which is what we wanted.

**Model output:** The line is parallel to  $y = 4x + 6$ , which means that it has the same slope as  $y = 4x + 6$ . Since the line passes through  $(5, 10)$ , we can use the point-slope form of a line to find the equation of the line:

$$\begin{aligned}y - 10 &= 4(x - 5) \\y - 10 &= 4x - 20 \\y &= 4x - 10\end{aligned}$$

Now that we have the equation of the line, we can find the  $y$ -coordinate of the point where the line crosses the  $y$ -axis by substituting  $x = 0$  into the equation:

$$y = 4 \cdot 0 - 10 = \boxed{-10}.$$

**Question:** Assume that the variance of the first  $n$  natural numbers is 10, and the variance of the first  $m$  even natural numbers is 16. Compute  $m + n$ .

**Model output:** Let  $\sigma^2$  be the variance of the first  $m$  even natural numbers, and  $\tau^2$  be the variance of the first  $n$  natural numbers. Then, we have  $\tau^2 = \frac{n^2-1}{12}$  and  $\sigma^2 = \frac{m^2-1}{3}$ . We solve the system of equations:

$$\begin{aligned}\frac{n^2-1}{12} &= 10 \\ \frac{m^2-1}{3} &= 16.\end{aligned}$$

This translates into the system

$$\begin{aligned}n^2 &= 121 \\ m^2 &= 48 + 1 = 49.\end{aligned}$$

Therefore,  $n = \boxed{11}$  and  $m = \boxed{7}$ , so  $n + m = \boxed{18}$ .

**Question:** For every  $a, b, b \neq a$  prove that

$$\frac{a^2+b^2}{2} > \left(\frac{a+b}{2}\right)^2.$$

**Model output:**

$$\begin{aligned}\frac{a^2+b^2}{2} &> \left(\frac{a+b}{2}\right)^2 \\ \Leftrightarrow \frac{a^2+b^2}{2} &> \frac{a^2+b^2+2ab}{4} \\ \Leftrightarrow a^2+b^2 &> \frac{a^2+b^2+2ab}{2} \\ \Leftrightarrow 2a^2+2b^2 &> a^2+b^2+2ab \\ \Leftrightarrow a^2+b^2 &> 2ab \\ \Leftrightarrow a^2+b^2-2ab &> 0 \\ \Leftrightarrow (a-b)^2 &> 0\end{aligned}$$

which is true, because the square of a real number is positive.

**Question:** A uniform solid disk starts from rest and rolls down an inclined plane without slipping. After some time, what fraction of the disk's total kinetic energy is rotational kinetic energy? What of the following is the right choice? Explain your answer.  
(A) 1/4 (B) 1/3 (C) 1/2 (D) 2/3

**Model output:** The disk has both translational and rotational kinetic energy. Let  $v$  be the speed of the center of mass of the disk,  $I$  be the moment of inertia of the disk,  $M$  be the mass of the disk, and  $R$  be the radius of the disk. The translational kinetic energy of the disk is given by

$$K_t = \frac{1}{2} M v^2.$$

The rotational kinetic energy of the disk is given by

$$K_r = \frac{1}{2} I \omega^2 = \frac{1}{2} \left(\frac{1}{2} M R^2\right) \left(\frac{v}{R}\right)^2 = \frac{1}{4} M v^2.$$

Therefore, the ratio of the rotational kinetic energy to the total kinetic energy is

$$\frac{K_r}{K_t + K_r} = \frac{\frac{1}{4} M v^2}{\frac{1}{2} M v^2 + \frac{1}{4} M v^2} = \frac{\frac{1}{4} M v^2}{\frac{3}{4} M v^2} = \frac{1}{3}.$$

Final Answer: The final answer is (B).

**Question:** A particle moves so that it is at  $(3 \sin \frac{t}{4}, 3 \cos \frac{t}{4})$  at time  $t$ . Find the speed of the particle, measured in unit of distance per unit of time.

**Target:** The parametric curve  $(x, y) = (3 \sin \frac{t}{4}, 3 \cos \frac{t}{4})$  describes a circle with radius 3. Furthermore, it makes a full revolution at time  $t = 8\pi$ . (figure) Therefore, the speed of the particle is  $\frac{3\pi}{4} = \boxed{\frac{3}{4}}$ .

**Model output:** The speed is the magnitude of the velocity vector. Therefore, we must first find the velocity vector, which is the derivative of the position vector. We have

$$\mathbf{v} = \frac{d}{dt} \left( 3 \sin \frac{t}{4}, 3 \cos \frac{t}{4} \right) = 3 \left( \cos \frac{t}{4}, -\sin \frac{t}{4} \right) = \left( \frac{3}{4} \cos \frac{t}{4}, -\frac{3}{4} \sin \frac{t}{4} \right).$$

Therefore, the magnitude of the velocity vector is

$$\begin{aligned}|\mathbf{v}| &= \sqrt{\left(\frac{3}{4} \cos \frac{t}{4}\right)^2 + \left(-\frac{3}{4} \sin \frac{t}{4}\right)^2} = \sqrt{\frac{9}{16} \cos^2 \frac{t}{4} + \frac{9}{16} \sin^2 \frac{t}{4}} \\ &= \frac{3}{4} \sqrt{\cos^2 \frac{t}{4} + \sin^2 \frac{t}{4}} = \frac{3}{4}.\end{aligned}$$

Therefore, the speed of the particle is  $\boxed{\frac{3}{4}}$ .



# PAPERS INTERESTED

## Language Models and Prompting

### 3、 Training language models to follow instructions with human feedback (InstructGPT)



OpenAI

#### InstructGPT

- i. outputs over outputs from GPT-3
- ii. showed promising generalization to instructions outside of the RLHF finetuning distribution.
- iii. shows ability to follow instructions in non-English languages, and perform summarization and question-answering for code

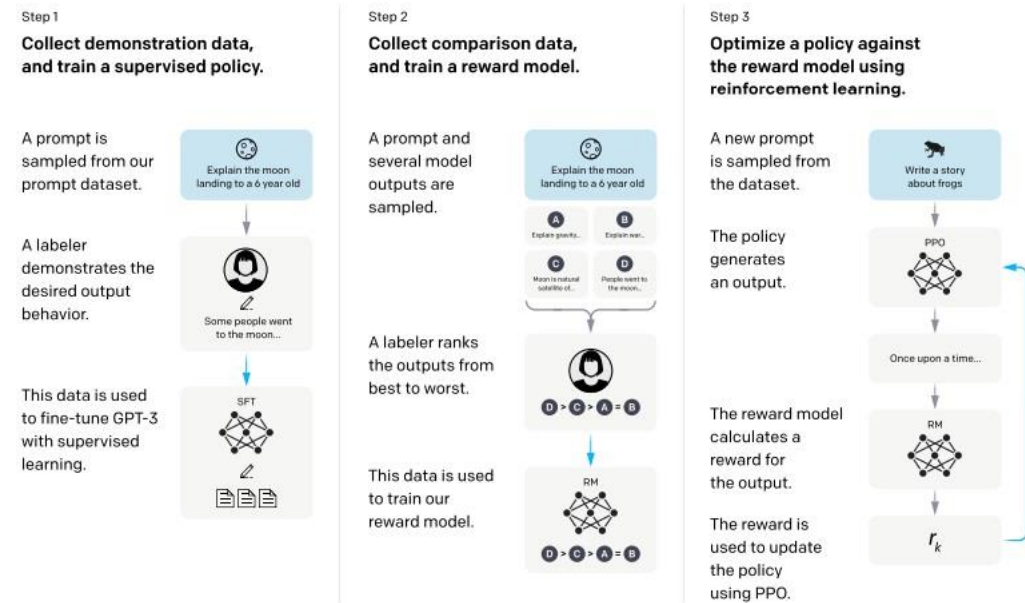


Figure 2: A diagram illustrating the three steps of our method: (1) supervised fine-tuning (SFT), (2) reward model (RM) training, and (3) reinforcement learning via proximal policy optimization (PPO) on this reward model. Blue arrows indicate that this data is used to train one of our models. In Step 2, boxes A-D are samples from our models that get ranked by labelers. See Section 3 for more details on our method.

# PAPERS INTERESTED

## Diffusion Models

1、 Photorealistic Text-to-Image Diffusion Models with Deep Language Understanding (Imagen)

💡 Google Brain : <https://arxiv.org/abs/2205.11487>

2、 Denoising Diffusion Restoration Models (DDRM)

💡 Technion/Stanford/Nvidia: <https://arxiv.org/pdf/2201.11793.pdf>

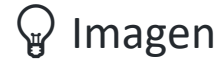
3、 Flexible Diffusion Modeling of Long Videos

💡 UBC : <https://arxiv.org/pdf/2205.11495.pdf>

# PAPERS INTERESTED

## Diffusion Models

### 1、 Photorealistic Text-to-Image Diffusion Models with Deep Language Understanding (Imagen)



- i. a text-to-image diffusion model with an unprecedented degree of photorealism and a deep level of language understanding
- ii. increasing the size of the language model in Imagen boosts both sample fidelity and imagetext alignment much more than increasing the size of the image diffusion model
- iii. significantly outperforming prior work such as GLIDE and the concurrent work of DALL-E 2



Figure 1: Imagen 1.0 - 1000x1000 images generated by the model. The images are generated by the model.

# PAPERS INTERESTED

## Diffusion Models

### 2、 Denoising Diffusion Restoration Models (DDRM)

💡 pretrained ddpm + un-supervised ddrmm

- i. a general sampling-based linear inverse problem solver based on unconditional/class-conditional diffusion generative models as learned priors
- ii. only requires a few number of NFEs, achieves scalability in multiple useful scenarios, including denoising, super-resolution, deblurring, inpainting, and colorization

**Linear Inverse Problems.** A general linear inverse problem is posed as

$$\mathbf{y} = \mathbf{H}\mathbf{x} + \mathbf{z}, \quad (1)$$

where we aim to recover the signal  $\mathbf{x} \in \mathbb{R}^n$  from measurements  $\mathbf{y} \in \mathbb{R}^m$ , where  $\mathbf{H} \in \mathbb{R}^{m \times n}$  is a known linear degradation matrix, and  $\mathbf{z} \sim \mathcal{N}(0, \sigma_y^2 \mathbf{I})$  is an *i.i.d.* additive Gaussian noise with

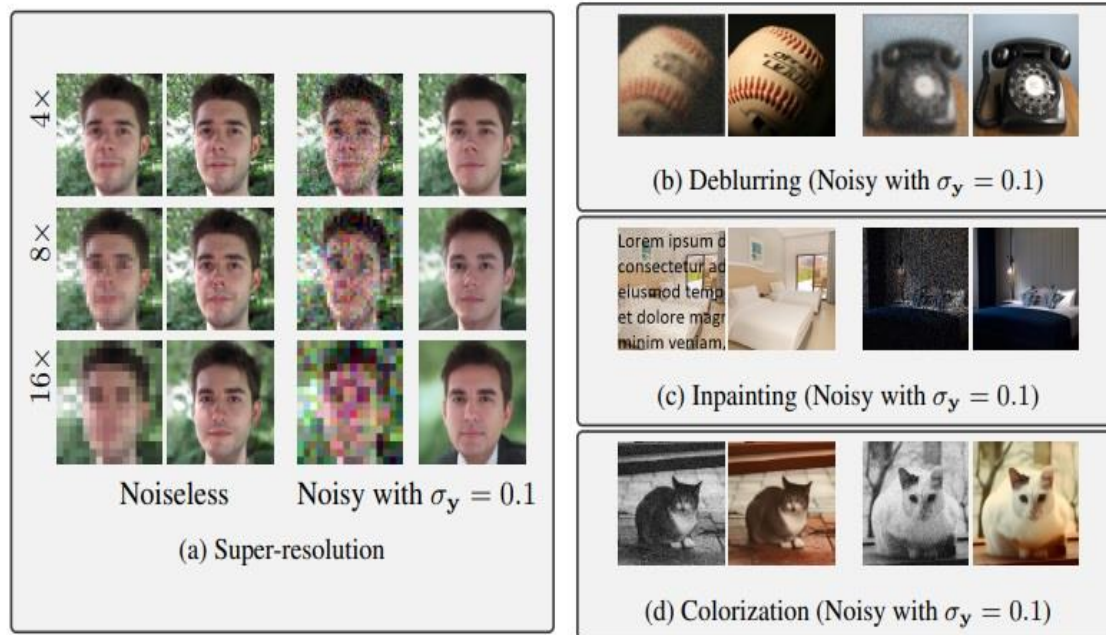


Figure 1: Pairs of measurements and recovered images with a 20-step DDRM on super-resolution, deblurring, inpainting, and colorization, with or without noise, and with unconditional generative models. The images are not accessed during training.

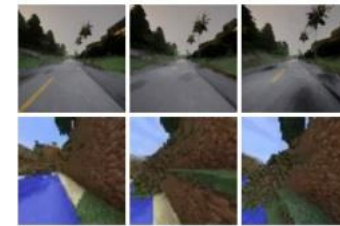
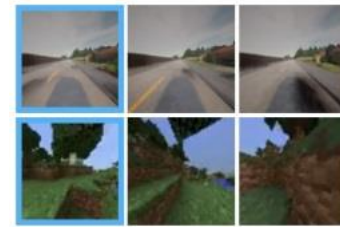
# PAPERS INTERESTED

## Diffusion Models

### 3、 Flexible Diffusion Modeling of Long Videos

💡 ddpm plus long video

- i. a framework for video modeling based on denoising diffusion probabilistic models that produces long-duration video
- ii. a new video modeling dataset



5 minutes



25 minutes

# PAPERS INTERESTED

## Datasets & Benchmarks (163 papers)

- 1、 LAION-5B: An open large-scale dataset for training next generation image-text models  
💡 LAION/UCB,etc : <https://paperswithcode.com/dataset/laion-5b>
- 2、 DC-BENCH: Dataset Condensation Benchmark  
💡 UCLA/Google : <https://github.com/data-centric-ai/dcbench>
- 3、 NeoRL: A Near Real-World Benchmark for Offline Reinforcement Learning  
💡 NJU/SJTU : <https://github.com/polixir/NeoRL>
- 4、 A Unified Evaluation of Textual Backdoor Learning: Frameworks and Benchmarks  
💡 TshinghuaU/Huazhong/UIUC : <https://arxiv.org/pdf/2206.08514.pdf>
- 5、 PEER: A Comprehensive and Multi-Task Benchmark for Protein Sequence Understanding  
💡 Mila : <https://arxiv.org/abs/2206.02096>



# WORKSHOPS

- Second Workshop on Efficient Natural Language and Speech Processing (ENLSP-II)
- AI for Science: Progress and Promises
- Synthetic Data for Empowering ML Research
- 3rd Offline Reinforcement Learning Workshop: Offline RL as a "Launchpad"
- Federated Learning: Recent Advances and New Challenges
- Challenges in Deploying and Monitoring Machine Learning Systems
- Graph Learning for Industrial Applications: Finance, Crime Detection, Medicine and Social Media
- Workshop on Machine Learning Safety
- Deep Reinforcement Learning Workshop
- InterNLP: Workshop on Interactive Learning for Natural Language Processing
- Transfer Learning for Natural Language Processing

# WORKSHOPS

- [NeurIPS 2022 Workshop on Meta-Learning](#)
- [Memory in Artificial and Real Intelligence \(MemARI\)](#)
- [New Frontiers in Graph Learning](#)
- [Shared Visual Representations in Human and Machine Intelligence \(SVRHM\)](#)
- [Medical Imaging meets NeurIPS](#)
- [Robustness in Sequence Modeling](#)
- [Learning from Time Series for Health](#)
- [Self-Supervised Learning: Theory and Practice](#)
- [Symmetry and Geometry in Neural Representations \(NeurReps\)](#)
- [Workshop on Distribution Shifts: Connecting Methods and Applications](#)
- [OPT 2022: Optimization for Machine Learning](#)
- [Self-Supervised Learning: Theory and Practice](#)

*THANK YOU*