## **Humanity's Last Exam**

#### **Organizing Team**

Long Phan\*1, Alice Gatti\*1, Ziwen Han\*2, Nathaniel Li\*1,

 $\label{eq:continuous} Josephina\ Hu^2,\ Hugh\ Zhang^{\ddagger},\ Chen\ Bo\ Calvin\ Zhang^2,\ Mohamed\ Shaaban^2,\ John\ Ling^2,\ Sean\ Shi^2,\ Michael\ Choi^2,\ Anish\ Agrawal^2,\ Arnav\ Chopra^2,\ Adam\ Khoja^1,\ Ryan\ Kim^{\dagger},\ Richard\ Ren^1,\ Jason\ Hausenloy^1,\ Oliver\ Zhang^1,\ Mantas\ Mazeika^1,$ 

Summer Yue\*\*2, Alexandr Wang\*\*2, Dan Hendrycks\*\*1

#### **Dataset Contributors**

Tung Nguyen, Daron Anderson, Imad Ali Shah, Mikhail Doroshenko, Alun Cennyth Stokes, Mobeen Mahmood, Jaeho Lee, Oleksandr Pokutnyi, Oleg Iskra, Jessica P. Wang, Robert Gerbicz, John-Clark Levin, Serguei Popov, Fiona Feng, Steven Y. Feng, Haoran Zhao, Michael Yu, Varun Gangal, Chelsea Zou, Zihan Wang, Mstyslav Kazakov, Geoff Galgon, Johannes Schmitt, Alvaro Sanchez, Yongki Lee, Will Yeadon, Scott Sauers, Marc Roth, Chidozie Agu, Søren Riis, Fabian Giska, Saiteja Utpala, Antrell Cheatom, Zachary Giboney, Gashaw M. Goshu, Sarah-Jane Crowson, Mohinder Maheshbhai Naiya, Noah Burns, Lennart Finke, Zerui Cheng, Hyunwoo Park, Francesco Fournier-Facio, Jennifer Zampese, John Wydallis, John B. Wydallis, Ryan G. Hoerr, Mark Nandor, Tim Gehrunger, Jiaqi Cai, Ben McCarty, Jungbae Nam, Edwin Taylor, Jun Jin, Gautier Abou Loume, Hangrui Cao, Alexis C Garretson, Damien Sileo, Qiuyu Ren, Doru Cojoc, Pavel Arkhipov, Usman Qazi, Aras Bacho, Lianghui Li, Sumeet Motwani, Christian Schroeder de Witt, Alexei Kopylov, Johannes Veith, Eric Singer, Paolo Rissone, Jaehyeok Jin, Jack Wei Lun Shi, Chris G. Willcocks, Ameya Prabhu, Longke Tang, Kevin Zhou, Emily de Oliveira Santos, Andrey Pupasov Maksimov, Edward Vendrow, Kengo Zenitani, Joshua Robinson, Aleksandar Mikov, Julien Guillod, Yuqi Li, Ben Pageler, Joshua Vendrow, Vladyslav Kuchkin, Pierre Marion, Denis Efremov, Jayson Lynch, Kaiqu Liang, Andrew Gritsevskiy, Dakotah Martinez, Nick Crispino, Dimitri Zvonkine, Natanael Wildner Fraga, Saeed Soori, Ori Press, Henry Tang, Julian Salazar, Sean R. Green, Lina Brüssel, Moon Twayana, Aymeric Dieuleveut, T. Ryan Rogers, Wenjin Zhang, Ross Finocchio, Bikun Li, Jinzhou Yang, Arun Rao, Gabriel Loiseau, Mikhail Kalinin, Marco Lukas, Ciprian Manolescu, Nate Stambaugh, Subrata Mishra, Ariel Ghislain Kemogne Kamdoum, Tad Hogg, Alvin Jin, Carlo Bosio, Gongbo Sun, Brian P Coppola, Haline Heidinger, Rafael Sayous, Stefan Ivanov, Joseph M Cavanagh, Jiawei Shen, Joseph Marvin Imperial, Philippe Schwaller, Shaipranesh Senthilkuma, Andres M Bran, Andres Algaba, Brecht Verbeken, Kelsey Van den Houte, Lynn Van Der Sypt, David Noever, Lisa Schut, Ilia Sucholutsky, Evgenii Zheltonozhskii, Qiaochu Yuan, Derek Lim, Richard Stanley, Shankar Sivarajan, Tong Yang, John Maar, Julian Wykowski, Martí Oller, Jennifer Sandlin, Anmol Sahu, Cesare Giulio Ardito, Yuzheng Hu, Felipe Meneguitti Dias, Tobias Kreiman, Kaivalya Rawal, Tobias Garcia Vilchis, Yuexuan Zu, Martin Lackner, James Koppel, Jeremy Nguyen, Daniil S. Antonenko, Steffi Chern, Bingchen Zhao, Pierrot Arsene, Sergey Ivanov, Rafał Poświata, Chenguang Wang, Daofeng Li, Donato Crisostomi, Ali Dehghan, Andrea Achilleos, John Arnold Ambay, Benjamin Myklebust, Archan Sen, David Perrella, Nurdin Kaparov, Mark H Inlow, Allen Zang, Kalyan Ramakrishnan, Daniil Orel, Vladislav Poritski, Shalev Ben-David, Zachary Berger, Parker Whitfill, Michael Foster, Daniel Munro, Linh Ho, Dan Bar Hava, Aleksey Kuchkin, Robert Lauff, David Holmes, Frank Sommerhage, Anji Zhang, Richard Moat, Keith Schneider, Daniel Pyda, Zakayo Kazibwe, Mukhwinder Singh, Don Clarke, Dae Hyun Kim, Sara Fish, Veit Elser, Victor Efren Guadarrama Vilchis, Immo Klose, Christoph Demian, Ujjwala Anantheswaran, Adam Zweiger, Guglielmo Albani, Jeffery Li, Nicolas Daans, Maksim Radionov, Václav Rozhoň, Vincent Ginis, Ziqiao Ma, Christian Stump, Jacob Platnick, Volodymyr Nevirkovets, Luke Basler, Marco Piccardo, Niv Cohen, Virendra Singh, Josef Tkadlec, Paul Rosu, Alan Goldfarb, Piotr Padlewski, Stanislaw Barzowski, Kyle Montgomery, Aline Menezes, Arkil Patel, Zixuan Wang, Jamie Tucker-Foltz, Jack Stade, Declan Grabb, Tom Goertzen, Fereshteh Kazemi, Jeremiah Milbauer, Abhishek Shukla, Hossam Elgnainy, Yan Carlos Leyva Labrador, Hao He, Ling Zhang, Alan Givré, Hew Wolff, Gözdenur Demir, Muhammad Fayez Aziz, Younesse Kaddar, Ivar Ängquist, Yanxu Chen, Elliott Thornley, Robin Zhang, Jiayi Pan, Antonio Terpin, Niklas Muennighoff, Hailey Schoelkopf, Eric Zheng, Avishy Carmi, Jainam Shah, Ethan D. L. Brown, Kelin Zhu, Max Bartolo, Richard Wheeler, Andrew Ho, Shaul Barkan, Jiaqi Wang, Martin Stehberger, Egor Kretov, Peter Bradshaw, JP Heimonen, Kaustubh Sridhar, Zaki Hossain, Ido Akov, Yury Makarychev, Joanna Tam, Hieu Hoang, David M. Cunningham, Vladimir Goryachev, Demosthenes Patramanis, Michael Krause, Andrew Redenti, David Aldous, Jesyin Lai, Shannon Coleman, Jiangnan Xu, Sangwon Lee, Ilias Magoulas, Sandy Zhao, Ning Tang, Michael K. Cohen, Micah Carroll, Orr Paradise, Jan Hendrik Kirchner, Stefan Steinerberger, Maksym Ovchynnikov, Jason

<sup>&</sup>lt;sup>1</sup> Center for AI Safety, <sup>2</sup> Scale AI

<sup>\*</sup>Co-first Authors. \*\* Senior Authors. † Work conducted while at Center for AI Safety. ‡ Work conducted while at Scale AI. Complete list of author affiliations in Appendix A. Correspondence to agibenchmark@safe.ai.

O. Matos, Adithya Shenoy, Michael Wang, Yuzhou Nie, Paolo Giordano, Philipp Petersen, Anna Sztyber-Betley, Paolo Faraboschi, Robin Riblet, Jonathan Crozier, Shiv Halasyamani, Antonella Pinto, Shreyas Verma, Prashant Joshi, Eli Meril, Zheng-Xin Yong, Allison Tee, Jérémy Andréoletti, Orion Weller, Raghav Singhal, Gang Zhang, Alexander Ivanov, Seri Khoury, Nils Gustafsson, Hamid Mostaghimi, Kunvar Thaman, Qijia Chen, Tran Quoc Khánh, Jacob Loader, Stefano Cavalleri, Hannah Szlyk, Zachary Brown, Himanshu Narayan, Jonathan Roberts, William Alley, Kunyang Sun, Ryan Stendall, Max Lamparth, Anka Reuel, Ting Wang, Hanmeng Xu, Pablo Hernández-Cámara, Freddie Martin, Thomas Preu, Tomek Korbak, Marcus Abramovitch, Dominic Williamson, Ida Bosio, Ziye Chen, Biró Bálint, Eve J. Y. Lo, Maria Inês S. Nunes, Yibo Jiang, M Saiful Bari, Peyman Kassani, Zihao Wang, Behzad Ansarinejad, Yewen Sun, Stephane Durand, Guillaume Douville, Daniel Tordera, George Balabanian, Earth Anderson, Lynna Kvistad, Alejandro José Moyano, Hsiaoyun Milliron, Ahmad Sakor, Murat Eron, Isaac C. McAlister, Andrew Favre D.O., Shailesh Shah, Xiaoxiang Zhou, Firuz Kamalov, Ronald Clark, Sherwin Abdoli, Tim Santens, Harrison K Wang, Evan Chen, Alessandro Tomasiello, G. Bruno De Luca, Shi-Zhuo Looi, Vinh-Kha Le, Noam Kolt, Niels Mündler, Avi Semler, Emma Rodman, Jacob Drori, Carl J Fossum, Luk Gloor, Milind Jagota, Ronak Pradeep, Honglu Fan, Tej Shah, Jonathan Eicher, Michael Chen, Kushal Thaman, William Merrill, Moritz Firsching, Carter Harris, Ștefan Ciobâcă, Jason Gross, Rohan Pandey, Ilya Gusev, Adam Jones, Shashank Agnihotri, Pavel Zhelnov, Siranut Usawasutsakorn, Mohammadreza Mofayezi, Alexander Piperski, Marc Carauleanu, David K. Zhang, Kostiantyn Dobarskyi, Dylan Ler, Roman Leventov, Ignat Soroko, Thorben Jansen, Scott Creighton, Pascal Lauer, Joshua Duersch, Vage Taamazyan, Dario Bezzi, Wiktor Morak, Wenjie Ma, William Held, Tran Đuc Huy, Ruicheng Xian, Armel Randy Zebaze, Mohanad Mohamed, Julian Noah Leser, Michelle X Yuan, Laila Yacar, Johannes Lengler, Katarzyna Olszewska, Hossein Shahrtash, Edson Oliveira, Joseph W. Jackson, Daniel Espinosa Gonzalez, Andy Zou, Muthu Chidambaram, Timothy Manik, Hector Haffenden, Dashiell Stander, Ali Dasouqi, Alexander Shen, Emilien Duc, Bita Golshani, David Stap, Mikalai Uzhou, Alina Borisovna Zhidkovskaya, Lukas Lewark, Miguel Orbegozo Rodriguez, Mátyás Vincze, Dustin Wehr, Colin Tang, Shaun Phillips, Fortuna Samuele, Jiang Muzhen, Fredrik Ekström, Angela Hammon, Oam Patel, Faraz Farhidi, George Medley, Forough Mohammadzadeh, Madellene Peñaflor, Haile Kassahun, Alena Friedrich, Claire Sparrow, Rayner Hernandez Perez, Taom Sakal, Omkar Dhamane, Ali Khajegili Mirabadi, Eric Hallman, Kenchi Okutsu, Mike Battaglia, Mohammad Maghsoudimehrabani, Alon Amit, Dave Hulbert, Roberto Pereira, Simon Weber, Handoko, Anton Peristyy, Stephen Malina, Samuel Albanie, Will Cai, Mustafa Mehkary, Rami Aly, Frank Reidegeld, Anna-Katharina Dick, Cary Friday, Jasdeep Sidhu, Hassan Shapourian, Wanyoung Kim, Mariana Costa, Hubeyb Gurdogan, Brian Weber, Harsh Kumar, Tong Jiang, Arunim Agarwal, Chiara Ceconello, Warren S. Vaz, Chao Zhuang, Haon Park, Andrew R. Tawfeek, Daattavya Aggarwal, Michael Kirchhof, Linjie Dai, Evan Kim, Johan Ferret, Yuzhou Wang, Minghao Yan, Krzysztof Burdzy, Lixin Zhang, Antonio Franca, Diana T. Pham, Kang Yong Loh, Joshua Robinson, Abram Jackson, Shreen Gul, Gunjan Chhablani, Zhehang Du, Adrian Cosma, Jesus Colino, Colin White, Jacob Votava, Vladimir Vinnikov, Ethan Delaney, Petr Spelda, Vit Stritecky, Syed M. Shahid, Jean-Christophe Mourrat, Lavr Vetoshkin, Koen Sponselee, Renas Bacho, Florencia de la Rosa, Xiuyu Li, Guillaume Malod, Leon Lang, Julien Laurendeau, Dmitry Kazakov, Fatimah Adesanya, Julien Portier, Lawrence Hollom, Victor Souza, Yuchen Anna Zhou, Julien Degorre, Yiğit Yalın, Gbenga Daniel Obikoya, Luca Arnaboldi, Rai (Michael Pokorny), Filippo Bigi, M.C. Boscá, Oleg Shumar, Kaniuar Bacho, Pierre Clavier, Gabriel Recchia, Mara Popescu, Nikita Shulga, Ngefor Mildred Tanwie, Denis Peskoff, Thomas C.H. Lux, Ben Rank, Colin Ni, Matthew Brooks, Alesia Yakimchyk, Huanxu (Quinn) Liu, Olle Häggström, Emil Verkama, Hans Gundlach, Leonor Brito-Santana, Brian Amaro, Vivek Vajipey, Rynaa Grover, Yiyang Fan, Gabriel Poesia Reis e Silva, Linwei Xin, Yosi Kratish, Jakub Łucki, Wen-Ding Li, Sivakanth Gopi, Andrea Caciolai, Justin Xu, Kevin Joseph Scaria, Freddie Vargus, Farzad Habibi, Long (Tony) Lian, Emanuele Rodolà, Jules Robins, Vincent Cheng, Tony Fruhauff, Brad Raynor, Hao Qi, Xi Jiang, Ben Segev, Jingxuan Fan, Sarah Martinson, Erik Y. Wang, Kaylie Hausknecht, Michael P. Brenner, Mao Mao, Xinyu Zhang, David Avagian, Eshawn Jessica Scipio, Alon Ragoler, Justin Tan, Blake Sims, Rebeka Plecnik, Aaron Kirtland, Omer Faruk Bodur, D.P. Shinde, Zahra Adoul, Mohamed Zekry, Ali Karakoc, Tania C. B. Santos, Samir Shamseldeen, Loukmane Karim, Anna Liakhovitskaia, Nate Resman, Nicholas Farina, Juan Carlos Gonzalez, Gabe Maayan, Sarah Hoback, Rodrigo De Oliveira Pena, Glen Sherman, Elizabeth Kelley, Hodjat Mariji, Rasoul Pouriamanesh, Wentao Wu, Sandra Mendoza, Ismail Alarab, Joshua Cole, Danyelle Ferreira, Bryan Johnson, Mohammad Safdari, Liangti Dai, Siriphan Arthornthurasuk, Alexey Pronin, Jing Fan, Angel Ramirez-Trinidad, Ashley Cartwright, Daphiny Pottmaier, Omid Taheri, David Outevsky, Stanley Stepanic, Samuel Perry, Luke Askew, Raúl Adrián Huerta Rodríguez, Ali M. R. Minissi, Sam Ali, Ricardo Lorena, Krishnamurthy Iyer, Arshad Anil Fasiludeen, Sk Md Salauddin, Murat Islam, Juan Gonzalez, Josh Ducey, Maja Somrak, Vasilios Mavroudis, Eric Vergo, Juehang Qin, Benjámin Borbás, Eric Chu, Jack Lindsey, Anil Radhakrishnan, Antoine Jallon, I.M.J. McInnis, Pawan Kumar, Laxman Prasad Goswami, Daniel Bugas, Nasser Heydari, Ferenc Jeanplong, Archimedes Apronti, Abdallah Galal, Ng Ze-An, Ankit Singh, Joan of Arc Xavier, Kanu Priya Agarwal, Mohammed Berkani, Benedito Alves de Oliveira Junior, Dmitry Malishev, Nicolas Remy, Taylor D. Hartman, Tim Tarver, Stephen Mensah, Javier Gimenez, Roselynn Grace Montecillo, Russell Campbell, Asankhaya Sharma, Khalida Meer, Xavier Alapont, Deepakkumar Patil, Rajat Maheshwari, Abdelkader Dendane, Priti Shukla, Sergei Bogdanov, Sören Möller, Muhammad Rehan Siddiqi, Prajvi Saxena, Himanshu Gupta, Innocent Enyekwe, Ragavendran P V, Zienab EL-Wasif, Aleksandr Maksapetyan, Vivien Rossbach, Chris Harjadi, Mohsen Bahaloohoreh, Song Bian, John Lai, Justine Leon Uro, Greg Bateman, Mohamed Sayed, Ahmed Menshawy, Darling Duclosel, Yashaswini Jain, Ashley Aaron, Murat Tiryakioglu, Sheeshram Siddh, Keith Krenek, Alex Hoover, Joseph McGowan, Tejal Patwardhan

Co-author list in progress. HUMANITY'S LAST EXAM is still accepting new questions. New questions can be submitted at lastexam.ai/submit for co-authorship in this section, but are not eligible for the prize pool.

#### **Abstract**

Benchmarks are important tools for tracking the rapid advancements in large language model (LLM) capabilities. However, benchmarks are not keeping pace in difficulty: LLMs now achieve over 90% accuracy on popular benchmarks like MMLU, limiting informed measurement of state-of-the-art LLM capabilities. In response, we introduce HUMANITY'S LAST EXAM (HLE), a multi-modal benchmark at the frontier of human knowledge, designed to be the final closed-ended academic benchmark of its kind with broad subject coverage. HLE consists of 2,700 questions across dozens of subjects, including mathematics, humanities, and the natural sciences. HLE is developed globally by subject-matter experts and consists of multiple-choice and short-answer questions suitable for automated grading. Each question has a known solution that is unambiguous and easily verifiable, but cannot be quickly answered via internet retrieval. State-of-the-art LLMs demonstrate low accuracy and calibration on HLE, highlighting a significant gap between current LLM capabilities and the expert human frontier on closed-ended academic questions. To inform research and policymaking upon a clear understanding of model capabilities, we publicly release HLE at https://lastexam.ai.

#### 1 Introduction

The capabilities of large language models (LLMs) have progressed dramatically, exceeding human performance across a diverse array of tasks. To systematically measure these capabilities, LLMs are evaluated upon *benchmarks*: collections of questions which assess model performance on tasks such as math, programming, or biology. However, state-of-the-art LLMs [3, 14, 16, 34, 37, 49, 56] now achieve over 90% accuracy on popular benchmarks such as MMLU [21], which were once challenging frontiers for LLMs. The saturation of existing benchmarks, as shown in Figure 1, limits our ability to precisely measure AI capabilities and calls for more challenging evaluations that can meaningfully assess the rapid improvements in LLM capabilities at the frontiers of human knowledge.

To address this gap, we introduce HUMANITY'S LAST EXAM (HLE), a benchmark of 2,700 extremely challenging questions from dozens of subject areas, designed to be the final closed-ended benchmark of broad academic capabilities. HLE is developed by academics and domain experts, providing a precise measure of capabilities as LLMs continue to improve (Section 3.1). HLE is multi-modal, featuring questions that are either text-only or accompanied by an image reference, and includes both multiple-choice and exact-match questions for automated answer verification. Questions are original, precise, unambiguous, and resistant to simple internet lookup or database retrieval. Amongst the diversity of questions in the benchmark, HLE emphasizes world-class mathematics problems aimed at testing deep reasoning skills broadly applicable across multiple academic areas.

We employ a multi-stage review process to thoroughly ensure question difficulty and quality (Section 3.2). Before submission, each question is tested against state-of-the-art LLMs to verify its difficulty - questions are rejected if LLMs can answer them correctly. Questions submitted then proceed through a two-stage reviewing process: (1) an initial feedback round with multiple graduate-level reviewers and (2) organizer and expert reviewer approval, ensuring quality and adherence to our submission criteria. Following release, we plan to further conduct a public review period, welcoming community feedback to correct any points of concern in the dataset.

Frontier LLMs consistently demonstrate low accuracy (less than 10%) across all models, highlighting a significant gap between current capabilities and expert-level academic performance (Section 4). Models also provide incorrect answers with high confidence rather than acknowledging uncertainty on these challenging questions, with RMS calibration errors above 80% across all models.

As AI systems approach human expert performance in many domains, precise measurement of their capabilities and limitations is essential for informing research, governance, and the broader public. High performance on HLE would suggest expert-level capabilities on closed-ended academic questions. To establish a common reference point for assessing these capabilities, we publicly release a large number of 2,700 questions from HLE to enable this precise measurement, while maintaining a private test set to assess potential model overfitting.

#### **Accuracy of LLMs Across Benchmarks**

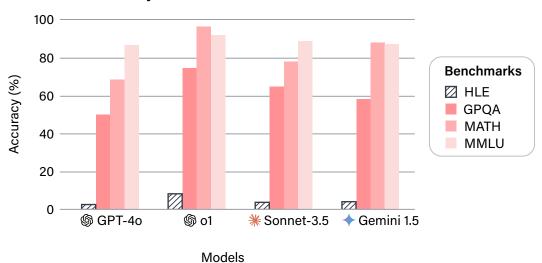


Figure 1: Compared against the saturation of some existing benchmarks, HUMANITY'S LAST EXAM accuracy remains low across several frontier models, demonstrating its effectiveness for measuring advanced, closed-ended, academic capabilities. The sources for our evaluation metrics are detailed in Appendix C.5. We further evaluate more frontier models on HLE in Table 1.

#### 2 Related Work

**LLM Benchmarks.** Benchmarks are important tools for tracking the rapid advancement of LLM capabilities, including scientific [10, 12, 21, 29, 30, 44, 47, 53, 61] and mathematical reasoning [13, 17–19, 22, 31, 45, 50], code generation [6, 9–11, 20, 26, 60], and general-purpose human assistance [1, 7, 8, 25, 40, 42, 43, 47, 54]. Due to their objectivity and ease of automated scoring at scale, evaluations commonly include multiple-choice and short-answer questions [15, 42, 51, 52, 58], with benchmarks such as MMLU [21] also spanning a broad range of academic disciplines and levels of complexity.

**Saturation and Frontier Benchmark Design.** However, state-of-the-art models now achieve nearly perfect scores on many existing evaluations [3, 14, 16, 34, 37, 49, 56], obscuring the full extent of current and future frontier AI capabilities [27, 32, 38, 39]. This has motivated the development of more challenging benchmarks which test for multi-modal capabilities [2, 10, 26, 28, 31, 46, 48, 53, 57, 59], strengthen existing benchmarks [24, 43, 45, 48, 53], filter questions over multiple stages of review [18, 27, 30, 33, 44], and employ experts to write tests for advanced academic knowledge [5, 18, 30, 34, 41, 44]. HLE combines these approaches: the questions are developed by subject-matter experts and undergo multiple rounds of review, while preserving the broad subject-matter coverage of MMLU. As a result, HLE provides a clear measurement of the gap between current AI capabilities and human expertise on closed-ended academic tasks, complementing other assessments of advanced capabilities in open-ended domains [10, 35, 36, 55].

#### 3 Dataset

HUMANITY'S LAST EXAM (HLE) consists of 2,700 challenging questions across over a hundred subjects. A high level summary is provided in Figure 3. We publicly release these questions, while maintaining a private test set of held out questions to assess model overfitting.

#### 3.1 Collection

HLE is a global collaborative effort, with questions from nearly 1000 subject expert contributors affiliated with over 500 institutions across 50 countries – comprised mostly of professors, researchers, and graduate degree holders.



#### √x Mathematics

#### Question:

The set of natural transformations between two functors F,G:C o D can be expressed as the end

$$Nat(F,G)\cong \int_A Hom_D(F(A),G(A)).$$

Define set of natural cotransformations from F to G to be the coend

#### Let:

- $F=B_{ullet}(\Sigma_4)_{*/}$  be the under  $\infty$  -category of the nerve of the delooping of the symmetric group  $\varSigma_4$  on 4 letters under the unique 0-simplex \* of  $B_{\bullet}\Sigma_4$
- $G=B_{ullet}(\Sigma_7)_{*/}$  be the under  $\infty$  -category nerve of the delooping of the symmetric group  $\Sigma_7$  on 7 letters under the unique 0-simplex \*of  $B_{\bullet}\Sigma_{7}$ .

How many natural cotransformations are there between  ${\cal F}$  and  ${\cal G}$ ?

A Emily S

University of São Paulo

# %. Chemistry Question:

The reaction shown is a thermal pericyclic cascade that converts the starting heptaene into endiandric acid B methyl ester. The cascade involves three steps: two electrocyclizations followed by a cycloaddition. What types of electrocyclizations are involved in step 1 and step 2, and what type of cycloaddition is involved in step 3?

Provide your answer for the electrocyclizations in the form of  $[n\pi]\text{-}$ con or [n $\pi$ ]-dis (where n is the number of  $\pi$  electrons involved, and whether it is conrotatory or disrotatory), and your answer for the cycloaddition in the form of [m+n] (where m and n are the number of atoms on each component).

A Noah B

Stanford University

#### **⇔**Ecology

#### Question:

Hummingbirds within Apodiformes uniquely have a bilaterally paired oval bone, a sesamoid embedded in the caudolateral portion of the expanded, cruciate aponeurosis of insertion of m. depressor caudae. How many paired tendons are supported by this sesamoid bone? Answer with a number.

#### Computer Science

#### Question:

Let G be a graph. An edge-indicator of G is a function  $a:\{0,1\}$   $\to$ V(G) such that  $\{a(0),a(1)\}\in E(G)$ 

Consider the following Markov Chain M=M(G):

The statespace of M is the set of all edge-indicators of G, and the transitions are defined as follows:

Assume  $M_t = a$ 

- 1. pick  $b \in \{0,1\}$  u.a.r.
- 2. pick  $v \in N(a(1-b))$  u.a.r. (here N(v) denotes the open neighbourhood of v)
- 3. set a'(b) = v and a'(1 b) = a(1 b)
- 4. Set  $M_{t+1} = a'$

We call a class of graphs  ${\mathcal G}$  well-behaved if, for each  $G\in {\mathcal G}$  the Markov chain  ${\cal M}({\cal G})$  converges to a unique stationary distribution, and the unique stationary distribution is the uniform distribution

Which of the following graph classes is well-behaved?

- A. The class of all non-bipartite regular graphs
- B. The class of all connected cubic graphs
- C. The class of all connected graphs
- D. The class of all connected non-bipartite graphs
- E. The class of all connected bipartite graphs

A Marc R

Queen Mary University of London

### Question:

I am providing the standardized Biblical Hebrew source text from the Biblia Hebraica Stuttgartensia (Psalms 104:7). Your task is to distinguish between closed and open syllables. Please identify and list all closed syllables (ending in a consonant sound) based on the latest research on the Tiberian pronunciation tradition of Biblical Hebrew by scholars such as Geoffrey Khan, Aaron D. Hornkohl, Kim Phillips, and Benjamin Suchard. Medieval sources, such as the Karaite transcription manuscripts, have enabled modern researchers to better understand specific aspects of Biblical Hebrew pronunciation in the Tiberian tradition, including the qualities and functions of the shewa and which letters were pronounced as

אָרֶרְתְּךְ יְנִאַסְּוֹ מִן־קּוֹל בְעַמְרְ יְנִאַסְוּן מִן־קּוֹל בַּעַמְרְ יֵחָפַּזְוּן (Psalms 104:7) ?

consonants at the ends of syllables.

Figure 2: Samples of the diverse and challenging questions submitted to HUMANITY'S LAST EXAM.

**Question Style.** HLE contains two question formats: exact-match questions (models provide an exact string as output) and multiple-choice questions (the model selects one of five or more answer choices). HLE is a multi-modal benchmark, with 10% of questions requiring comprehending both text and an image reference. 80% of questions are exact-match with the remainder being multiple-choice.

Each question submission includes several required components: the question text itself, answer specifications (either an an exact-match answer, or multiple-choice options with the correct answer marked), detailed rationale explaining the solution, academic subject, and contributor name and institutional affiliation to maintain accountability and accuracy.

Submission Format. To ensure question quality and integrity, we enforce strict submission criteria. Questions should be precise, unambiguous, solvable, and non-searchable, ensuring models cannot rely on memorization or simple retrieval methods. All submissions must be original work or non-trivial syntheses of published information, though contributions from unpublished research are acceptable. Questions typically require graduate-level expertise or test knowledge of highly specific topics (e.g., precise historical details, trivia, local customs) and have specific, unambiguous answers accepted by domain experts. When LLMs provide correct answers with faulty reasoning, authors are encouraged to modify question parameters, such as the number of answer choices, to discourage false positives. We require clear English with precise technical terminology, supporting LATEX notation wherever necessary. Answers are kept short and easily verifiable for exact-match questions to support automatic grading. We prohibit open-ended questions, subjective interpretations, and content related to weapons of mass destruction. Finally, every question is accompanied by a detailed solution to verify accuracy.

**Prize Pool.** To attract high-quality submissions, we establish a \$500,000 USD prize pool, with prizes of \$5,000 USD for each of the top 50 questions and \$500 USD for each of the next 500 questions, as determined by organizers. This incentive structure, combined with the opportunity for paper co-authorship for anyone with an accepted question in HLE, draws participation from qualified experts, particularly those with advanced degrees or significant technical experience in their fields.

#### 3.2 Review

**LLM Difficulty Check** To ensure question difficulty, each question is first validated against several frontier LLMs prior to submission (Appendix B.1). If the LLMs cannot solve the question (or in the case of multiple choices, if the models on average do worse than random guessing), the question proceeds to the next stage: human expert review. In total, we logged over 70,000 attempts, resulting in approximately 13,000 questions which stumped LLMs that were forwarded to expert human review.

**Expert Review** Our human reviewers possess a graduate degree (eg. Master's, PhD, JD, etc.) in their fields. Reviewers select submissions in their domain, grading them against standardized rubrics and offering feedback when applicable. There are two rounds of reviews. The first round focuses on

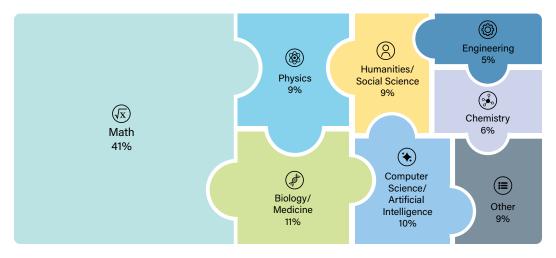


Figure 3: HLE consists of 2,700 exam questions in over a hundred subjects, grouped into high level categories here. We provide a more detailed list of subjects in Appendix B.3.

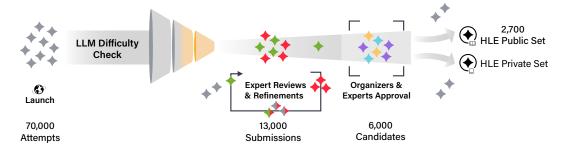


Figure 4: Dataset creation pipeline. We accept questions that make frontier LLMs fail, then iteratively refine them with the help of expert peer reviewers. Each question is then manually approved by organizers or expert reviewers trained by organizers. A private held-out set is kept in addition to the public set to assess model overfitting and gaming on the public benchmark.

iteratively refining submissions, with each question receiving between 1-3 reviews. In the second round, good and outstanding questions from the first round are identified and approved by organizers and reviewers to be included in the final HLE dataset. Details, instructions, and rubrics for both rounds can be found in Appendix B.2. Figure 4 details our full process.

Due to the advanced, specialized nature of many submissions, reviewers were not expected to verify the full accuracy of each provided solution rationale if it would take more than five minutes, instead focusing on whether the question aligns with guidelines. Given this limitation in the review process, we welcome community feedback. After initial release, we plan to conduct a public feedback period and periodically update the dataset, assessing any points of concern from the research community.

#### 4 Evaluation

We evaluate the performance of state-of-the-art LLMs on HLE and analyze their capabilities across different question types and domains. We describe our evaluation setup (Section 4.1) and present several quantitative results on metrics that track model performance (Section 4.2).

#### 4.1 Setup

After data collection and review, we evaluated our final HLE dataset on additional frontier multi-modal LLMs. We employ a standardized system prompt that structures model responses into explicit reasoning followed by a final answer. As the question-answers are precise and close-ended, we use GPT-40 as a judge to verify answer correctness against model predictions while accounting for equivalent formats (e.g., decimals vs. fractions or estimations). Evaluation prompts are detailed in Appendix C.1.1, and exact model versions are provided in Appendix C.4.

#### 4.2 Quantitative Results

**Accuracy.** All frontier models achieve low accuracy on HLE (Table 1), highlighting significant room for improvement in narrowing the gap between current LLMs and expert-level academic capabilities on closed-ended questions. These low scores are partially by design – the dataset collection process (Section 3.1) attempts to filter out questions that existing models can answer correctly. Nevertheless, we notice upon evaluation, models exhibit non-zero accuracy. This is due to inherent noise in model inference – models can inconsistently guess the right answer or guess worse than random chance for multiple choice questions. We choose to leave these questions in the dataset as a natural component instead of strongly adversarially filtering. However, we stress the true capability floor of frontier models on the dataset will remain an open question and small inflections close to zero accuracy are not strongly indicative of progress.

**Calibration Error.** Given low performance on HLE, models should be calibrated, recognizing their uncertainty rather than confidently provide incorrect answers, indicative of confabulation/hallucination. To measure calibration, we prompt models to provide both an answer and their confidence from 0% to 100% (Appendix C.1.1), employing the setup from Wei et al. [54]. The implementation of

Model	Accuracy (%)↑	Calibration Error (%) $\downarrow$
GPT-40	3.1	92.3
Grok 2	3.9	90.8
CLAUDE 3.5 SONNET	4.8	88.5
Gemini 1.5 Pro	5.2	93.0
GEMINI 2.0 FLASH THINKING	7.2	90.6
01	8.8	92.8
DEEPSEEK-R1*	8.6	81.4
o3-mini (medium)*	11.1	91.5
o3-mini (high)*	14.0	92.8

Table 1: Accuracy and RMS calibration error of different models on HLE, demonstrating low accuracy and high calibration error across all models, indicative of hallucination. \*Model is not multi-modal, evaluated on text-only subset. We report text-only results on all models in Appendix C.2.

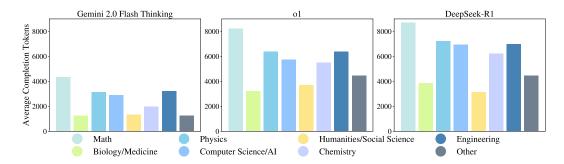


Figure 5: Average completion token counts of reasoning models tested, including both reasoning and output tokens. We also plot average token counts for non-reasoning models in Appendix C.3.

our RMS calibration error is from Hendrycks et al. [23]. A well-calibrated model's stated confidence should match its actual accuracy – for example, achieving 50% accuracy on questions where it claims 50% confidence. Table 1 reveals poor calibration across all models, reflected in high RMS calibration error scores. Models frequently provide incorrect answers with high confidence on HLE, failing to recognize when questions exceed their capabilities.

**Token Counts.** Models with reasoning require substantially more inference time compute. To shed light on this in our evaluation, we analyze the number of completion tokens used across models. As shown in Figure 5, all reasoning models require generating significantly more tokens compared to non-reasoning models for an improvement in performance (Appendix C.3). We emphasize that future models should not only do better in terms of accuracy, but also strive to be compute-optimal.

#### 5 Discussion

**Future Model Performance.** While current LLMs achieve very low accuracy on HLE, recent history shows benchmarks are quickly saturated – with models dramatically progressing from near-zero to near-perfect performance in a short timeframe [12, 44]. Given the rapid pace of AI development, it is plausible that models could exceed 50% accuracy on HLE by the end of 2025. High accuracy on HLE would demonstrate expert-level performance on closed-ended, verifiable questions and cutting-edge scientific knowledge, but it would not alone suggest autonomous research capabilities or "artificial general intelligence." HLE tests structured academic problems rather than open-ended research or creative problem-solving abilities, making it a focused measure of technical knowledge and reasoning. HLE may be the last academic exam we need to give to models, but it is far from the last benchmark for AI.

**Impact.** By providing a clear measure of AI progress, HLE creates a common reference point for scientists and policymakers to assess AI capabilities. This enables more informed discussions about development trajectories, potential risks, and necessary governance measures.

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#### **A** Authors

We offered optional co-authorship to all question submitters with an accepted question in HUMAN-ITY'S LAST EXAM (including both public and private splits). All potential co-authors with an accepted question were contacted directly. Authorship order is ranked based on the number of accepted questions in HUMANITY'S LAST EXAM.

As we give co-authors the time and freedom to choose between opting-in or staying anonymous, we will periodically update this list. We further note that this list only represents a subset of our participating institutions and authors, many chose to remain anonymous.

#### A.1 Data Contributors & Affiliations

In progress. Sorted in descending order by number of accepted questions.

**Authors** Tung Nguyen<sup>82</sup>, Daron Anderson, Imad Ali Shah<sup>42</sup>, Mikhail Doroshenko, Alun Cennyth Stokes<sup>83</sup>, Mobeen Mahmood<sup>26</sup>, Jaeho Lee<sup>27</sup>, Oleksandr Pokutnyi<sup>84,85</sup>, Oleg Iskra<sup>11</sup>, Jessica P. Wang<sup>86</sup>, Robert Gerbicz<sup>87</sup>, John-Clark Levin<sup>5</sup>, Serguei Popov<sup>88</sup>, Fiona Feng<sup>89</sup>, Steven Y. Feng<sup>6</sup>, Haoran Zhao<sup>15</sup>, Michael Yu, Varun Gangal, Chelsea Zou<sup>6</sup>, Zihan Wang<sup>28</sup>, Mstyslav Kazakov<sup>90</sup>, Geoff Galgon<sup>91</sup>, Johannes Schmitt<sup>9</sup>, Alvaro Sanchez, Yongki Lee<sup>92</sup>, Will Yeadon<sup>43</sup>, Scott Sauers<sup>93</sup>, Marc Roth Additional Activity of Park and Park Antonia Chester <sup>95</sup>, Zincher and Park <sup>94</sup>, Antonia Chester <sup>95</sup>, Zincher and Park <sup>94</sup>, Antonia Chester <sup>95</sup>, Zincher <sup>95</sup>, Zinche Galgon<sup>91</sup>, Johannes Schmitt<sup>9</sup>, Alvaro Sanchez, Yongki Lee<sup>92</sup>, Will Yeadon<sup>43</sup>, Scott Sauers<sup>93</sup>, Marc Roth<sup>44</sup>, Chidozie Agu<sup>94</sup>, Søren Riis<sup>44</sup>, Fabian Giska, Saiteja Utpala<sup>45</sup>, Antrell Cheatom<sup>95</sup>, Zachary Giboney<sup>96</sup>, Gashaw M. Goshu, Sarah-Jane Crowson<sup>97</sup>, Mohinder Maheshbhai Naiya<sup>98</sup>, Noah Burns<sup>6</sup>, Lennart Finke<sup>9</sup>, Zerui Cheng<sup>14</sup>, Hyunwoo Park<sup>11</sup>, Francesco Fournier-Facio<sup>5</sup>, Jennifer Zampese<sup>99</sup>, John Wydallis, John B. Wydallis, Ryan G. Hoerr<sup>100</sup>, Mark Nandor, Tim Gehrunger<sup>9</sup>, Jiaqi Cai<sup>4</sup>, Ben McCarty<sup>101</sup>, Jungbae Nam<sup>102</sup>, Edwin Taylor, Jun Jin, Gautier Abou Loume<sup>103,104</sup>, Hangrui Cao<sup>11</sup>, Alexis C Garretson<sup>105,106</sup>, Damien Sileo<sup>46</sup>, Qiuyu Ren<sup>3</sup>, Doru Cojoc<sup>16</sup>, Pavel Arkhipov<sup>107</sup>, Usman Qazi<sup>21,108</sup>, Aras Bacho<sup>29</sup>, Lianghui Li<sup>10</sup>, Sumeet Motwani<sup>8</sup>, Christian Schroeder de Witt<sup>8</sup>, Alexei Kopylov, Johannes Veith<sup>30,109</sup>, Eric Singer<sup>110</sup>, Paolo Rissone<sup>22</sup>, Jaehyeok Jin<sup>16</sup>, Jack Wei Lun Shi<sup>111</sup>, Chris G. Willcocks<sup>43</sup>, Ameya Prabhu<sup>23</sup>, Longke Tang<sup>14</sup>, Kevin Zhou<sup>3</sup>, Emily de Oliveira Santos<sup>31</sup>, Andrey Pupasoy Maksimoy<sup>112</sup>, Edward Vendrow<sup>4</sup>, Kengo Zenitani, Joshua Robinson<sup>47</sup>, Aleksandar Andrey Pupasov Maksimov<sup>112</sup>, Edward Vendrow<sup>4</sup>, Kengo Zenitani, Joshua Robinson<sup>47</sup>, Aleksandar Mikov<sup>10</sup>, Julien Guillod<sup>48,113</sup>, Yuqi Li<sup>114</sup>, Ben Pageler, Joshua Vendrow<sup>4</sup>, Vladyslav Kuchkin<sup>115</sup>, Mikov<sup>10</sup>, Julien Guillod<sup>48,113</sup>, Yuqi Li<sup>114</sup>, Ben Pageler, Joshua Vendrow<sup>4</sup>, Vladyslav Kuchkin<sup>115</sup>, Pierre Marion<sup>10</sup>, Denis Efremov<sup>116</sup>, Jayson Lynch<sup>4</sup>, Kaiqu Liang<sup>14</sup>, Andrew Gritsevskiy<sup>117</sup>, Dakotah Martinez, Nick Crispino<sup>12</sup>, Dimitri Zvonkine<sup>49,50</sup>, Natanael Wildner Fraga, Saeed Soori<sup>17</sup>, Ori Press<sup>23</sup>, Henry Tang<sup>8</sup>, Julian Salazar<sup>32</sup>, Sean R. Green, Lina Brüssel<sup>5</sup>, Moon Twayana<sup>51</sup>, Aymeric Dieuleveut<sup>118</sup>, T. Ryan Rogers<sup>119</sup>, Wenjin Zhang<sup>12</sup>, Ross Finocchio, Bikun Li<sup>13</sup>, Jinzhou Yang<sup>120</sup>, Arun Rao<sup>33</sup>, Gabriel Loiseau<sup>46</sup>, Mikhail Kalinin<sup>121</sup>, Marco Lukas<sup>52</sup>, Ciprian Manolescu<sup>6</sup>, Nate Stambaugh<sup>122</sup>, Subrata Mishra<sup>123</sup>, Ariel Ghislain Kemogne Kamdoum<sup>53</sup>, Tad Hogg<sup>124</sup>, Alvin Jin<sup>4</sup>, Carlo Bosio<sup>3</sup>, Gongbo Sun<sup>34</sup>, Brian P Coppola<sup>54</sup>, Haline Heidinger<sup>125,126</sup>, Rafael Sayous<sup>50</sup>, Stefan Ivanov<sup>5</sup>, Joseph M Cavanagh<sup>3</sup>, Jiawei Shen<sup>12</sup>, Joseph Marvin Imperial<sup>127,128</sup>, Philippe Schwaller<sup>10</sup>, Shaipranesh Senthilkuma<sup>10</sup> Andres M Bran<sup>10</sup> Andres Algaba<sup>18</sup> Brecht Verbeken<sup>18</sup> Kelsey Van den Shaipranesh Senthilkuma<sup>10</sup>, Andres M Bran<sup>10</sup>, Andres Algaba<sup>18</sup>, Brecht Verbeken<sup>18</sup>, Kelsey Van den Houte<sup>18,129</sup>, Lynn Van Der Sypt<sup>18,129</sup>, David Noever<sup>130</sup>, Lisa Schut<sup>8</sup>, Ilia Sucholutsky<sup>35</sup>, Evgenii Zheltonozhskii<sup>131</sup>, Qiaochu Yuan, Derek Lim<sup>4</sup>, Richard Stanley<sup>4,132</sup>, Shankar Sivarajan<sup>55</sup>, Tong Zheltonozhskii<sup>131</sup>, Qiaochu Yuan, Derek Lim<sup>4</sup>, Richard Stanley<sup>4,132</sup>, Shankar Sivarajan<sup>33</sup>, Tong Yang<sup>11</sup>, John Maar<sup>56</sup>, Julian Wykowski<sup>5</sup>, Martí Oller<sup>5</sup>, Jennifer Sandlin<sup>24</sup>, Anmol Sahu, Cesare Giulio Ardito<sup>133</sup>, Yuzheng Hu<sup>25</sup>, Felipe Meneguitti Dias<sup>31</sup>, Tobias Kreiman<sup>3</sup>, Kaivalya Rawal<sup>8</sup>, Tobias Garcia Vilchis<sup>134</sup>, Yuexuan Zu<sup>4</sup>, Martin Lackner<sup>57</sup>, James Koppel, Jeremy Nguyen<sup>135</sup>, Daniil S. Antonenko<sup>58</sup>, Steffi Chern<sup>11</sup>, Bingchen Zhao<sup>36</sup>, Pierrot Arsene<sup>59</sup>, Sergey Ivanov, Rafał Poświata<sup>136</sup>, Chenguang Wang<sup>12</sup>, Daofeng Li<sup>12</sup>, Donato Crisostomi<sup>22</sup>, Ali Dehghan, Andrea Achilleos<sup>137</sup>, John Arnold Ambay<sup>138</sup>, Benjamin Myklebust<sup>139</sup>, Archan Sen<sup>3</sup>, David Perrella<sup>140</sup>, Nurdin Kaparov<sup>141</sup>, Mark H Inlow<sup>142</sup>, Allen Zang<sup>13</sup>, Kalyan Ramakrishnan<sup>8</sup>, Daniil Orel<sup>60</sup>, Vladislav Poritski, Shalev Ben-David<sup>61</sup>, Zachary Berger<sup>4</sup>, Parker Whitfill<sup>4</sup>, Michael Foster, Daniel Munro<sup>28</sup>, Linh Ho, Dan Bar Haya<sup>143</sup> Aleksey Kuchkin, Robert Lauff<sup>56</sup>, David Holmes<sup>144</sup>, Frank Sommerhage<sup>145</sup>, Anii Zhang<sup>4</sup> Hava<sup>143</sup>, Aleksey Kuchkin, Robert Lauff<sup>56</sup>, David Holmes<sup>144</sup>, Frank Sommerhage<sup>145</sup>, Anji Zhang<sup>4</sup>, Richard Moat<sup>146</sup>, Keith Schneider, Daniel Pyda<sup>147</sup>, Zakayo Kazibwe<sup>148</sup>, Mukhwinder Singh<sup>149</sup>, Don Clarke<sup>150</sup>, Dae Hyun Kim<sup>151</sup>, Sara Fish<sup>7</sup>, Veit Elser<sup>62</sup>, Victor Efren Guadarrama Vilchis<sup>152</sup>, Immo Klose<sup>16</sup>, Christoph Demian<sup>30</sup>, Ujjwala Anantheswaran<sup>24</sup>, Adam Zweiger<sup>4</sup>, Guglielmo Albani<sup>153</sup>, Jeffery Li<sup>4</sup>, Nicolas Daans<sup>154</sup>, Maksim Radionov<sup>155</sup>, Václav Rozhoň<sup>63</sup>, Vincent Ginis<sup>7,18</sup>, Ziqiao Ma<sup>54</sup>, Christian Stump<sup>156</sup>, Jacob Platnick<sup>19</sup>, Volodymyr Nevirkovets<sup>64</sup>, Luke Basler<sup>157</sup>, Marco Piccardo<sup>158</sup>, Niv Cohen<sup>35</sup>, Virendra Singh<sup>159</sup>, Josef Tkadlec<sup>37</sup>, Paul Rosu<sup>65</sup>, Alan Goldfarb<sup>3</sup>, Piotr Padlewski, Stanislaw Barzowski, Kyle Montgomery<sup>12</sup>, Aline Menezes, Arkil Patel<sup>26,160</sup>, Zixuan Wang<sup>14</sup>, Jamie Tucker-Foltz<sup>7</sup>, Jack Stade<sup>161</sup>, Declan Grabb<sup>6</sup>, Tom Goertzen<sup>66</sup>, Fereshteh Kazemi, Jeremiah Milbauer<sup>11</sup>, Abhishek Shukla<sup>67</sup>, Hossam Elgnainy<sup>162</sup>, Yan Carlos Leyva Labrador<sup>163</sup>, Hao

He<sup>68</sup>, Ling Zhang<sup>68</sup>, Alan Givré<sup>164</sup>, Hew Wolff, Gözdenur Demir, Muhammad Fayez Aziz<sup>25</sup>, Younesse Kaddar<sup>8</sup>, Ivar Ängquist<sup>38</sup>, Yanxu Chen<sup>39</sup>, Elliott Thornley<sup>165</sup>, Robin Zhang<sup>4</sup>, Jiayi Pan<sup>3</sup>, Antonio Terpin<sup>9</sup>, Niklas Muennighoff<sup>6</sup>, Hailey Schoelkopf, Eric Zheng<sup>11</sup>, Avishy Carmi<sup>166</sup>, Jainam Shah<sup>167</sup>, Ethan D. L. Brown<sup>168</sup>, Kelin Zhu<sup>55</sup>, Max Bartolo<sup>169</sup>, Richard Wheeler<sup>36</sup>, Andrew Ho<sup>170</sup>, Shaul Barkan<sup>69</sup>, Jiaqi Wang<sup>15</sup>, Martin Stehberger, Egor Kretov<sup>171</sup>, Peter Bradshaw<sup>25</sup>, JP Heimonen<sup>172</sup>, Kaustubh Sridhar<sup>40</sup>, Zaki Hossain<sup>173</sup>, Ido Akov<sup>174</sup>, Yury Makarychev<sup>175</sup>, Joanna Tam<sup>70</sup>, Hieu Hoang<sup>176</sup>, David M. Cunningham<sup>177</sup>, Vladimir Goryachev, Demosthenes Patramanis<sup>8</sup>, Michael Krause<sup>178</sup>, Andrew Redenti<sup>16</sup>, David Aldous<sup>3</sup>, Jesyin Lai<sup>179</sup>, Shannon Coleman<sup>21</sup>, Jiangnan Xu<sup>180</sup>, Sangwon Lee, Ilias Magnulas<sup>181</sup>, Sandy Zhao, Ning Tang<sup>3</sup>, Michael K. Cohen<sup>3</sup>, Michael Xu<sup>180</sup>, Sangwon Lee, Ilias Magoulas<sup>181</sup>, Sandy Zhao, Ning Tang<sup>3</sup>, Michael K. Cohen<sup>3</sup>, Micah Carroll<sup>3</sup>, Orr Paradise<sup>3</sup>, Jan Hendrik Kirchner<sup>71</sup>, Stefan Steinerberger<sup>15</sup>, Maksym Ovchynnikov<sup>182</sup>, Jason O. Matos<sup>70</sup>, Adithya Shenoy, Michael Wang<sup>3</sup>, Yuzhou Nie<sup>41</sup>, Paolo Giordano<sup>72</sup>, Philipp Petersen<sup>72</sup>, Anna Sztyber-Betley<sup>183</sup>, Paolo Faraboschi<sup>184</sup>, Robin Riblet<sup>59</sup>, Jonathan Crozier<sup>73</sup>, Shiv Halasyamani<sup>185</sup>, Antonella Pinto<sup>74</sup>, Shreyas Verma<sup>186</sup>, Prashant Joshi<sup>187</sup>, Eli Meril<sup>188</sup>, Zheng-Xin Yong<sup>27</sup>, Allison Tee<sup>6</sup>, Jérémy Andréoletti<sup>48</sup>, Orion Weller<sup>75</sup>, Raghav Singhal<sup>60</sup>, Gang Zhang, Alexander Ivanov<sup>189</sup>, Seri Khoury<sup>63</sup>, Nils Gustafsson<sup>38</sup>, Hamid Mostaghimi<sup>53</sup>, Kunvar Thaman<sup>190</sup>, Qijia Chen<sup>7</sup>, Tran Quoc Khánh<sup>191</sup>, Jacob Loader<sup>5</sup>, Stefano Cavalleri<sup>192</sup>, Hannah Szlyk<sup>12</sup>, Zachary Brown<sup>4</sup>, Himanshu Narayan, Jonathan Roberts<sup>5</sup>, William Alley, Kunyang Sun<sup>3</sup>, Ryan Stendall<sup>193</sup>, Max Lamparth<sup>6</sup>, Anka Reuel<sup>6</sup>, Ting Wang<sup>12</sup>, Hanmeng Xu<sup>58</sup>, Pablo Hernández-Cámara<sup>194</sup>, Freddie Martin, Thomas Preu<sup>195</sup>, Tomek Korbak<sup>196</sup>, Marcus Abramovitch, Dominic Williamson<sup>66</sup>, Ida Bosio<sup>197</sup>, Ziye Chen<sup>20</sup>, Biró Bálint, Eve J. Y. Lo<sup>198</sup>, Maria Inês S. Nunes<sup>199</sup>, Yibo Jiang<sup>13</sup>, M Saiful Bari<sup>200</sup>, Peyman Kassani<sup>201</sup>, Zihao Wang<sup>13</sup>, Behzad Ansarinejad, Yewen Sun<sup>202</sup>, Stephane Durand<sup>203</sup>, Guillaume Douville, Daniel Tordera<sup>204</sup>, George Balabanian<sup>40</sup>, Earth Anderson<sup>205</sup>, Lynna Kvistad<sup>206</sup>, Alejandro José Moyano<sup>207</sup>, Hsiaoyun Milliron<sup>208</sup>, Ahmad Sakor<sup>52</sup>, Murat Eron<sup>209</sup>, Isaac C. McAlister, Andrew Favre D.O.<sup>210</sup>, Shailesh Shah<sup>211</sup>, Xiaoxiang Zhou<sup>30</sup>, Firuz Kamalov<sup>212</sup>, Ronald Clark<sup>8</sup>, Sherwin Abdoli<sup>74</sup>, Tim Santens<sup>5</sup>, Harrison K Wang<sup>7</sup>, Evan Chen<sup>4</sup>, Alessandro Carroll<sup>3</sup>, Orr Paradise<sup>3</sup>, Jan Hendrik Kirchner<sup>71</sup>, Stefan Steinerberger<sup>15</sup>, Maksym Ovchynnikov<sup>182</sup>, Ronald Clark<sup>8</sup>, Sherwin Abdoli<sup>74</sup>, Tim Santens<sup>5</sup>, Harrison K Wang<sup>7</sup>, Evan Chen<sup>4</sup>, Alessandro Tomasiello<sup>213</sup>, G. Bruno De Luca<sup>6</sup>, Shi-Zhuo Looi<sup>29</sup>, Vinh-Kha Le<sup>3</sup>, Noam Kolt<sup>69</sup>, Niels Mündler<sup>9</sup>, Avi Semler<sup>8</sup>, Emma Rodman<sup>214</sup>, Jacob Drori, Carl J Fossum<sup>215</sup>, Luk Gloor, Milind Jagota<sup>3</sup>, Ronak Pradeep<sup>61</sup>, Honglu Fan<sup>216</sup>, Tej Shah<sup>217</sup>, Jonathan Eicher<sup>218</sup>, Michael Chen<sup>29</sup>, Kushal Thaman<sup>6</sup>, William Merrill<sup>35</sup>, Moritz Firsching<sup>219</sup>, Carter Harris<sup>220</sup>, Ştefan Ciobâcă<sup>221</sup>, Jason Gross, Rohan William Merrill<sup>35</sup>, Moritz Firsching<sup>219</sup>, Carter Harris<sup>220</sup>, Stefan Ciobâcă<sup>221</sup>, Jason Gross, Rohan Pandey, Ilya Gusev, Adam Jones, Shashank Agnihotri<sup>76</sup>, Pavel Zhelnov<sup>17</sup>, Siranut Usawasutsakorn<sup>222</sup>, Mohammadreza Mofayezi<sup>17</sup>, Alexander Piperski<sup>223</sup>, Marc Carauleanu<sup>224</sup>, David K. Zhang<sup>6</sup>, Kostiantyn Dobarskyi, Dylan Ler, Roman Leventov<sup>225</sup>, Ignat Soroko<sup>51</sup>, Thorben Jansen<sup>226</sup>, Scott Creighton, Pascal Lauer<sup>227,228</sup>, Joshua Duersch<sup>229</sup>, Vage Taamazyan<sup>230</sup>, Dario Bezzi<sup>231</sup>, Wiktor Morak, Wenjie Ma<sup>3</sup>, William Held<sup>6,19</sup>, Tran Đuc Huy<sup>232</sup>, Ruicheng Xian<sup>25</sup>, Armel Randy Zebaze<sup>233</sup>, Mohanad Mohamed<sup>234</sup>, Julian Noah Leser<sup>57</sup>, Michelle X Yuan, Laila Yacar<sup>235</sup>, Johannes Lengler<sup>9</sup>, Katarzyna Olszewska, Hossein Shahrtash<sup>236</sup>, Edson Oliveira<sup>237</sup>, Joseph W. Jackson<sup>238</sup>, Daniel Espinosa Gonzalez<sup>41</sup>, Andy Zou<sup>11,239</sup>, Muthu Chidambaram<sup>65</sup>, Timothy Manik, Hector Haffenden, Dashiell Stander<sup>240</sup>, Ali Dasouqi<sup>75</sup>, Alexander Shen<sup>241</sup>, Emilien Duc<sup>9</sup>, Bita Golshani, David Stap<sup>39</sup>, Mikalai Uzhou<sup>242</sup>, Alina Borisovna Zhidkovskaya<sup>243</sup>, Lukas Lewark<sup>9</sup>, Miguel Orbegozo Rodriguez<sup>244</sup>, Mátyás Vincze<sup>245,246</sup>, Dustin Wehr, Colin Tang<sup>11</sup>, Shaun Phillips, Fortuna Samuele<sup>247</sup>, Jiang Muzhen, Fredrik Ekström, Angela Hammon, Oam Patel<sup>7</sup>, Faraz Farhidi<sup>248</sup>, George Medley, Forough Mohammadzadeh, Madellene Peñaflor<sup>249</sup>, Haile Kassahun<sup>26</sup>, Alena Friedrich<sup>250</sup>, Samuele<sup>247</sup>, Jiang Muzhen, Fredrik Ekström, Angela Hammon, Oam Patel<sup>7</sup>, Faraz Farhidi<sup>248</sup>, George Medley, Forough Mohammadzadeh, Madellene Peñaflor<sup>249</sup>, Haile Kassahun<sup>26</sup>, Alena Friedrich<sup>250</sup>, Claire Sparrow<sup>13</sup>, Rayner Hernandez Perez<sup>251</sup>, Taom Sakal<sup>41</sup>, Omkar Dhamane<sup>252</sup>, Ali Khajegili Mirabadi<sup>21</sup>, Eric Hallman, Kenchi Okutsu<sup>253</sup>, Mike Battaglia, Mohammad Maghsoudimehrabani<sup>254</sup>, Alon Amit<sup>255</sup>, Dave Hulbert, Roberto Pereira<sup>256</sup>, Simon Weber<sup>9</sup>, Handoko, Anton Peristyy, Stephen Malina<sup>257</sup>, Samuel Albanie, Will Cai<sup>3</sup>, Mustafa Mehkary<sup>17,77</sup>, Rami Aly<sup>5</sup>, Frank Reidegeld, Anna-Katharina Dick<sup>23</sup>, Cary Friday<sup>258</sup>, Jasdeep Sidhu, Hassan Shapourian<sup>259</sup>, Wanyoung Kim<sup>260</sup>, Mariana Costa, Hubeyb Gurdogan<sup>33</sup>, Brian Weber<sup>261</sup>, Harsh Kumar<sup>262</sup>, Tong Jiang<sup>7</sup>, Arunim Agarwal<sup>263</sup>, Chiara Ceconello, Warren S. Vaz, Chao Zhuang, Haon Park<sup>264,265</sup>, Andrew R. Tawfeek<sup>15</sup>, Daattavya Aggarwal<sup>5</sup>, Michael Kirchhof<sup>23</sup>, Linjie Dai<sup>4</sup>, Evan Kim<sup>4</sup>, Johan Ferret<sup>32</sup>, Yuzhou Wang<sup>19</sup>, Minghao Yan<sup>34</sup>, Krzysztof Burdzy<sup>15</sup>, Lixin Zhang, Antonio Franca<sup>5</sup>, Diana T. Pham<sup>266</sup>, Kang Yong Loh<sup>6</sup>, Joshua Robinson<sup>267</sup>, Abram Jackson, Shreen Gul<sup>268</sup>, Gunjan Chhablani<sup>19</sup>, Zhehang Du<sup>40</sup>, Adrian Cosma<sup>269</sup>, Jesus Colino, Colin White<sup>270</sup>, Jacob Votava<sup>14</sup>, Vladimir Vinnikov, Ethan Du<sup>40</sup>, Adrian Cosma<sup>269</sup>, Jesus Colino, Colin White<sup>270</sup>, Jacob Votava<sup>14</sup>, Vladimir Vinnikov, Ethan Delaney<sup>42</sup>, Petr Spelda<sup>37</sup>, Vit Stritecky<sup>37</sup>, Syed M. Shahid<sup>271</sup>, Jean-Christophe Mourrat<sup>49,272</sup>, Lavr Vetoshkin<sup>273</sup>, Koen Sponselee<sup>274</sup>, Renas Bacho<sup>275</sup>, Florencia de la Rosa<sup>276</sup>, Xiuyu Li<sup>3</sup>, Guillaume Malod<sup>277</sup>, Leon Lang<sup>39</sup>, Julien Laurendeau<sup>10</sup>, Dmitry Kazakov<sup>7</sup>, Fatimah Adesanya, Julien Portier<sup>5</sup>, Lawrence Hollom<sup>5</sup>, Victor Souza<sup>5</sup>, Yuchen Anna Zhou<sup>279</sup>, Julien Degorre<sup>280</sup>, Yiğit Yalın<sup>281</sup>, Gbenga Daniel Obikoya, Luca Arnaboldi<sup>10</sup>, Rai (Michael Pokorny)<sup>78</sup>, Filippo Bigi<sup>10</sup>, M.C. Boscá<sup>282</sup>, Oleg Shumar, Kaniuar Bacho<sup>36</sup>, Pierre Clavier<sup>283</sup>, Gabriel Recchia<sup>284</sup>, Mara Popescu<sup>79</sup>, Nikita

Shulga<sup>285</sup>, Ngefor Mildred Tanwie<sup>286</sup>, Denis Peskoff<sup>14</sup>, Thomas C.H. Lux<sup>287</sup>, Ben Rank, Colin Ni<sup>33</sup>, Matthew Brooks, Alesia Yakimchyk<sup>288</sup>, Huanxu (Quinn) Liu<sup>289</sup>, Olle Häggström<sup>290</sup>, Emil Verkama<sup>38</sup>, Hans Gundlach<sup>4</sup>, Leonor Brito-Santana<sup>291</sup>, Brian Amaro<sup>6</sup>, Vivek Vajipey<sup>6</sup>, Rynaa Grover<sup>19</sup>, Yiyang Fan, Gabriel Poesia Reis e Silva<sup>6</sup>, Linwei Xin<sup>13</sup>, Yosi Kratish<sup>64</sup>, Jakub Łucki<sup>9</sup>, Wen-Ding Li<sup>62</sup>, Sivakanth Gopi<sup>45</sup>, Andrea Caciolai<sup>22</sup>, Justin Xu<sup>8</sup>, Kevin Joseph Scaria<sup>24</sup>, Freddie Vargus<sup>292</sup>, Farzad Habibi<sup>293</sup>, Long (Tony) Lian<sup>3</sup>, Emanuele Rodolà<sup>22</sup>, Jules Robins, Vincent Cheng<sup>28</sup>, Tony Fruhauff, Brad Raynor<sup>294</sup>, Hao Qi<sup>20</sup>, Xi Jiang<sup>13</sup>, Ben Segev<sup>16</sup>, Jingxuan Fan<sup>7</sup>, Sarah Martinson<sup>7</sup>, Erik Y. Wang<sup>7</sup>, Kaylie Hausknecht<sup>7</sup>, Michael P. Brenner<sup>7</sup>, Mao Mao<sup>20</sup>, Xinyu Zhang<sup>20</sup>, David Avagian<sup>76</sup>, Eshawa Jessica Scinio<sup>295</sup>, Alon Ragoler<sup>296</sup>, Justin Tan<sup>5</sup>, Blake Sims, Pabeka David Avagian<sup>76</sup>, Eshawn Jessica Scipio<sup>295</sup>, Alon Ragoler<sup>296</sup>, Justin Tan<sup>5</sup>, Blake Sims, Rebeka Plecnik, Aaron Kirtland<sup>27</sup>, Omer Faruk Bodur, D.P. Shinde, Zahra Adoul<sup>297</sup>, Mohamed Zekry<sup>298</sup>, Ali Karakoc<sup>299</sup>, Tania C. B. Santos, Samir Shamseldeen<sup>300</sup>, Loukmane Karim<sup>77</sup>, Anna Liakhovitskaia<sup>301</sup>, Nate Resman<sup>80</sup>, Nicholas Farina, Juan Carlos Gonzalez<sup>302</sup>, Gabe Maayan<sup>20</sup>, Sarah Hoback<sup>7</sup>, Rodrigo De Oliveira Pena<sup>303</sup>, Glen Sherman, Elizabeth Kelley<sup>80</sup>, Hodjat Mariji, Rasoul Pouriamanesh, drigo De Oliveira Pena<sup>303</sup>, Glen Sherman, Elizabeth Kelley<sup>80</sup>, Hodjat Mariji, Rasoul Pouriamanesh, Wentao Wu<sup>21</sup>, Sandra Mendoza<sup>304,305</sup>, Ismail Alarab<sup>306</sup>, Joshua Cole<sup>307</sup>, Danyelle Ferreira, Bryan Johnson<sup>308</sup>, Mohammad Safdari<sup>309</sup>, Liangti Dai<sup>8</sup>, Siriphan Arthornthurasuk, Alexey Pronin<sup>310</sup>, Jing Fan<sup>79</sup>, Angel Ramirez-Trinidad, Ashley Cartwright<sup>311</sup>, Daphiny Pottmaier<sup>312</sup>, Omid Taheri<sup>313</sup>, David Outevsky<sup>314</sup>, Stanley Stepanic<sup>315</sup>, Samuel Perry, Luke Askew<sup>316</sup>, Raúl Adrián Huerta Rodríguez, Ali M. R. Minissi<sup>81</sup>, Sam Ali<sup>47</sup>, Ricardo Lorena<sup>317</sup>, Krishnamurthy Iyer<sup>318</sup>, Arshad Anil Fasiludeen<sup>5</sup>, Sk Md Salauddin<sup>319</sup>, Murat Islam<sup>320</sup>, Juan Gonzalez, Josh Ducey<sup>321</sup>, Maja Somrak, Vasilios Mavroudis<sup>322</sup>, Eric Vergo, Juehang Qin<sup>323</sup>, Benjámin Borbás<sup>324</sup>, Eric Chu<sup>32</sup>, Jack Lindsey<sup>71</sup>, Anil Radhakrishnan<sup>73</sup>, Antoine Jallon, I.M.J. McInnis, Pawan Kumar<sup>325</sup>, Laxman Prasad Goswami<sup>67</sup>, Daniel Bugas, Nasser Heydari, Ferenc Jeannlong<sup>326</sup>, Archimedes Apronti<sup>327</sup>, Abdallah Galal<sup>328</sup> Daniel Bugas, Nasser Heydari, Ferenc Jeanplong<sup>326</sup>, Archimedes Apronti<sup>327</sup>, Abdallah Galal<sup>328</sup>, Ng Ze-An<sup>329</sup>, Ankit Singh<sup>330</sup>, Joan of Arc Xavier, Kanu Priya Agarwal, Mohammed Berkani<sup>331</sup>, Benedito Alves de Oliveira Junior<sup>31</sup>, Dmitry Malishev, Nicolas Remy<sup>332</sup>, Taylor D. Hartman<sup>333</sup>, Tim Tarver<sup>334</sup>, Stephen Mensah<sup>335</sup>, Javier Gimenez, Roselynn Grace Montecillo<sup>336</sup>, Russell Campbell<sup>337</sup>, Asankhaya Sharma<sup>338</sup>, Khalida Meer, Xavier Alapont, Deepakkumar Patil<sup>339</sup>, Rajat Maheshwari<sup>340</sup>, Abdelkader Dendane, Priti Shukla<sup>341</sup>, Sergei Bogdanov<sup>342</sup>, Sören Möller<sup>343</sup>, Muhammad Rehan Siddiqi<sup>344,345</sup>, Prajvi Saxena<sup>346</sup>, Himanshu Gupta<sup>24</sup>, Innocent Enyekwe, Ragavendran P V, Zienab EL-Wasif<sup>81</sup>, Aleksandr Maksapetyan, Vivien Rossbach, Chris Harjadi<sup>6</sup>, Mohsen Bahaloohoreh, Song Bian<sup>34</sup>, John Lai, Justine Leon Uro, Greg Bateman, Mohamed Sayed, Ahmed Menshawy<sup>347</sup>, Darling Duclosel<sup>348</sup>, Yashaswini Jain<sup>349</sup>, Ashley Aaron, Murat Tiryakioglu, Sheeshram Siddh, Keith Krenek, Alex Hoover<sup>13</sup>, Joseph McGowan<sup>17</sup>, Tejal Patwardhan<sup>78</sup>

#### **Affiliations**

- 3. University of California, Berkeley
- 4. Massachusetts Institute of Technology
- 5. University of Cambridge
- 6. Stanford University
- 7. Harvard University
- 8. University of Oxford
- 9. ETH Zürich
- École Polytechnique Fédérale de Lausanne
- 11. Carnegie Mellon University
- 12. Washington University
- 13. University of Chicago
- 14. Princeton University
- 15. University of Washington
- 16. Columbia University
- 17. University of Toronto
- 18. Vrije Universiteit Brussel
- 19. Georgia Institute of Technology
- 20. Boston University

- 21. University of British Columbia
- 22. Sapienza University of Rome
- 23. University of Tübingen
- 24. Arizona State University
- 25. University of Illinois Urbana-Champaign
- 26. McGill University
- 27. Brown University
- 28. University of California, San Diego
- 29. California Institute of Technology
- 30. Humboldt-Universität zu Berlin
- 31. University of Sao Paulo
- 32. Google DeepMind
- 33. University of California, Los Angeles
- 34. University of Wisconsin-Madison
- 35. New York University
- 36. University of Edinburgh
- 37. Charles University
- 38. KTH Royal Institute of Technology

- 39. University of Amsterdam
- 40. University of Pennsylvania
- 41. University of California, Santa Barbara
- 42. University of Galway
- 43. Durham University
- 44. Queen Mary University of London
- 45. Microsoft Research
- 46. Inria
- 47. University of Southern California
- 48. École Normale Supérieure
- 49. CNRS
- 50. Université Paris-Saclay
- 51. University of North Texas
- 52. Leibniz University Hannover
- 53. University of Calgary
- 54. University of Michigan
- 55. University of Maryland
- 56. Technische Universität Berlin
- 57. TU Wien
- 58. Yale University
- 59. École Normale Supérieure Paris-Saclay
- 60. Mohamed bin Zayed University of Artificial Intelligence
- 61. University of Waterloo
- 62. Cornell University
- 63. INSAIT
- 64. Northwestern University
- 65. Duke University
- 66. The University of Sydney
- 67. Indian Institute of Technology Delhi
- 68. The Australian National University
- 69. Hebrew University
- 70. Northeastern University
- 71. Anthropic
- 72. University of Vienna
- 73. North Carolina State University
- 74. Independent researcher
- 75. Johns Hopkins University
- 76. University of Mannheim
- 77. The Hospital for Sick Children
- 78. OpenAI
- 79. Heidelberg University
- 80. University of Oklahoma
- 81. Cairo University

- 82. Texas A&M University
- 83. Gift Horse Mouth Inspections
- 84. Institute of Mathematics of NAS of Ukraine
- 85. Kiev School of Economics
- 86. RWTH Aachen University
- 87. ELTE
- 88. University of Porto
- 89. Queen's University
- 90. Kyiv Polytechnic Institute
- 91. Nimbus AI
- 92. Georgia Southern University
- 93. University of Minnesota Twin Cities
- 94. Alberta Health Services
- 95. University of Illinois
- 96. ZG Law
- 97. Hereford College of Arts
- 98. Auckland University of Technology
- 99. University of Canterbury
- 100. Metropolitan State University of Denver
- 101. Accenture Labs
- 102. CICMA
- 103. Université de Yaoundé I
- 104. Ecole Nationale Supérieure Polytechnique de Yaoundé
- 105. Tufts University
- 106. The Jackson Laboratory
- 107. Institute of Science and Technology Austria
- 108. RUSM
- 109. Charité Universitätsmedizin
- 110. Happy Technologies LLC
- 111. National University of Singapore
- 112. Universidade Federal de Juiz de Fora
- 113. Sorbonne Université
- 114. C. N. Yang institute for Theoretical Physics
- 115. University of Luxembourg
- 116. Rockwell Automation
- 117. Contramont Research
- 118. Institut Polytechnique de Paris
- 119. TRR Designs
- 120. Maastricht University
- 121. Martin-Luther-University Halle-Wittenberg
- 122. Diverging Mathematics
- 123. Indian Institute of Technology Bombay

- 124. Institute for Molecular Manufacturing
- 125. St. Petersburg College
- 126. La Molina National Agrarian University
- 127. University of Bath
- 128. National University Philippines
- 129. UZ Brussel
- 130. PeopleTec, Inc.
- Technion Israel Institute of Technology
- 132. University of Miami
- 133. University of Manchester
- 134. Universidad Iberoamericana
- 135. Swinburne University of Technology
- 136. National Information Processing Institute
- 137. University College London
- 138. University of Technology Sydney
- 139. Ecco IT
- 140. University of Western Australia
- 141. Snorkel AI
- 142. Indiana State University
- 143. Manhattan School of Music
- 144. Universiteit Leiden
- 145. Synbionix
- 146. The Open University
- 147. Drexel University
- 148. Corteva Agriscience
- 149. Saint Mary's University
- 150. Sanford Burnham Preybs
- 151. Yonsei University
- 152. University of Leeds
- 153. Politecnico di Milano
- 154. KU Leuven
- 155. Brandenburg University of Technology
- 156. Ruhr University Bochum
- 157. University of Arizona
- 158. Universidade de Lisboa,
- 159. Indian Institute of Technology Kharagpur
- 160. Mila
- 161. University of Copenhagen
- 162. Cairo University Specialized Pediatric Hospital
- 163. Center for Scientific Research and Higher Education at Ensenada (CI-CESE)

- 164. University of Buenos Aires
- 165. Oxford University
- 166. Ben-Gurion University
- 167. blurrylogic
- Donald and Barbara Zucker School of Medicine
- 169. Cohere
- 170. Ivy Natal
- 171. Fraunhofer IMTE
- 172. Siili Solutions Oyj
- 173. Cambridge University
- 174. Aalto University
- 175. Toyota Technological Institute at Chicago
- 176. Case Wester Reserve University
- 177. EHC Investments LLC
- 178. University of Windsor
- 179. St. Jude Children's Research Hospital
- 180. Rochester Institute of Technology
- 181. Emory University
- 182. CERN
- 183. Warsaw University of Technology
- 184. Hewlett Packard Enterprise
- 185. University of Houston
- 186. Simplr AI, Asurion
- 187. All India Institute of Medical Sciences
- 188. Tel Aviv University
- 189. Ruhr-Universität Bochum
- 190. Standard Intelligence
- Posts and Telecommunications Institute of Technology
- 192. Clearhorse Ltd
- 193. Cranfield University
- Image Processing Lab, Universitat de Valencia
- 195. Universität Zürich
- 196. UK AI Safety Institute
- 197. University of Padua
- 198. Royal Veterinary College
- 199. Instituto Superior Técnico
- 200. SDAIA
- 201. Children's Hospital of Orange County
- 202. The Ohio State University
- 203. University of Montreal
- 204. Universidad de Valencia
- 205. University of Arkansas

- 206. Monash University
- 207. OncoPrecision
- 208. Van Andel Institute
- 209. IEEE Life Member
- 210. Larkin Community Hospital
- 211. The University of Texas at Dallas
- 212. Canadian University Dubai
- 213. Università di Milano-Bicocca
- 214. University of Massachusetts Lowell
- 215. Virginia Tech
- 216. University of Geneva
- 217. Rutgers University
- 218. MolMind
- 219. Google Research
- 220. Cal Poly San Luis Obispo
- 221. Alexandru Ioan Cuza University
- 222. Chulalongkorn University
- 223. Stockholm University
- 224. AE Studio
- 225. Gaia Lab
- 226. Leibniz Institute for Science and Mathematics Education
- 227. Australian National University
- 228. Saarland University
- 229. College of Eastern Idaho
- 230. Intrinsic Innovation LLC
- 231. University of Bologna
- 232. HUTECH
- 233. INRIA
- 234. King Saud University
- 235. Universidad de Buenos Aires
- 236. Pennsylvania College of Technology
- 237. CERo Therapeutics Holdings, Inc.
- 238. The Univeirsty of Tennessee
- 239. Gray Swan AI
- 240. EleutherAI
- 241. University of Montpellier
- 242. HomeEquity Bank
- 243. Materials Platform for Data Science LLC
- 244. ETH Zurich
- 245. University of Trento
- 246. Fondazione Bruno Kessler
- 247. University of Pisa

- 248. Georgia State University
- 249. Polytechnic University of the Philippines
- 250. University of Oregon
- 251. The University of Chicago
- 252. University of Mumbai
- 253. Gakushuin University
- 254. University of Guelph
- 255. Intuit
- 256. CTTC / CERCA
- 257. Dyno Therapeutics
- 258. Lewis Katz School of Medicine
- 259. Cisco
- 260. Fyaora Labs
- 261. Intelligent Geometries
- 262. Indian Institute of Technology (BHU)
- 263. Center for AI Safety
- 264. AIM Intelligence
- 265. Seoul National University
- 266. The University of Texas at Arlington
- 267. The Hartree Centre
- Missouri University of Science and Technology
- 269. POLITEHNICA Bucharest National University of Science and Technology
- 270. Abacus.AI
- 271. Eastern Institute of Technology (EIT)
- 272. ENS Lyon
- 273. Czech Technical University in Prague
- 274. University of Hamburg
- CISPA Helmholtz Center for Information Security
- 276. Universidad de Morón
- 277. Université Paris Cité and Sorbonne Université
- 278. Sheffield Hallam University
- 279. The New School
- 280. Creative Choice LLC
- 281. Max Planck Institute for Software Systems
- 282. Universidad de Granada
- 283. École Polytechnique
- 284. Modulo Research
- 285. La Trobe University
- 286. University of Yaoundé I
- 287. Lux Labs
- 288. University of Innsbruck

- 289. Nabu Technologies Inc
- 290. Chalmers University of Technology
- Unidade Local de Saúde de Lisboa Ocidental
- 292. Quotient AI
- 293. University of California, Irvine
- 294. Bison Fellers LLC
- 295. The Future Paralegals of America
- 296. Eastlake High School
- 297. University of Bradford
- 298. Beni Suef University
- 299. Bogazici University
- 300. Mansoura University
- 301. University of Bristol
- 302. Jala University
- 303. Florida Atlantic University
- 304. CONICET
- 305. Universidad Tecnológica Nacional
- 306. Bournemouth University
- 307. University of Warwick
- 308. University of Alabama Huntsville
- 309. University of Hertfordshire
- 310. Central College
- 311. Sheffield Teaching Hospitals NHS Foundation Trust
- 312. Nottingham Trent University
- 313. Max Planck Institute for Intelligent Systems
- 314. Outevsky Bespoke Dance Education
- 315. University of Virginia
- 316. Dartmouth College
- 317. INESC Microsistemas e Nanotecnologias
- 318. University of Minnesota
- 319. Aligarh Muslim University

- 320. John Crane UK Ltd
- 321. James Madison University
- 322. Alan Turing Institute
- 323. Rice University
- 324. HUN-REN
- 325. Pondicherry Engineering College
- 326. Mānuka Honey and Beekeeping Consultancy Ltd
- 327. Royal Holloway, University of London
- 328. Tanta University
- 329. University of Malaya
- 330. Hemwati Nandan Bahuguna Garhwal University
- 331. University Mohammed I
- 332. LGM
- 333. Northern Illinois University
- 334. Bethune-Cookman University
- 335. National University
- 336. Central Mindanao University
- 337. University of the Fraser Valley
- 338. Patched Codes, Inc
- 339. CSMSS Chh. Shahu College of Engineering
- 340. Genomia Diagnostics Research Pvt Ltd
- 341. EF Polymers Pvt Ltd
- 342. Ecole polytechnique
- 343. Forschungszentrum Jülich
- 344. RMIT University
- 345. Universal Higher Education
- 346. German Research Center for Artificial Intelligence
- 347. Menoufia University
- 348. Instituto Politécnico Nacional
- 349. Manipal University Jaipur

#### **B** Dataset

#### **B.1** Submission Process

To ensure question difficulty, we automatically check the accuracy of frontier LLMs on each question prior to submission. Our testing process uses multi-modal LLMs for text-and-image questions (GPT-40, GEMINI 1.5 PRO, CLAUDE 3.5 SONNET, O1) and adds two non-multi-modal models (O1-MINI, O1-PREVIEW) for text-only questions. We use different submission criteria by question type: exact-match questions must stump all models, while multiple-choice questions must stump all but one model to account for potential lucky guesses. Users are instructed to only submit questions that meet this criteria. We note due to non-determinism in models and a non-zero floor in multiple-choice questions, further evaluation on the dataset exhibits some low but non-zero accuracy.

We use a standardized system prompt (Appendix C.1.1) to structure model responses into "Reasoning" and "Final Answer" formatting, and employ an automated GPT-40 judge to evaluate response correctness against the provided answers.

#### **B.2** Human Review Instructions

Questions which merely stump models are not necessarily high quality – they could simply be adversarial to models without testing advanced knowledge. To resolve this, we employ two rounds of human review to ensure our dataset is thorough and sufficiently challenging as determined by human experts in their respective domains.

#### **B.2.1** Review Round 1

We recruit human subject expert reviewers to score, provide feedback, and iteratively refine all user submitted questions. This is similar to the peer review process in academic research, where reviewers give feedback to help question submitters create better questions. We train all reviewers on the instructions and rubric below.

#### **Reviewer Instructions**

- Questions should usually (but do not always need to) be at a graduate / PhD level or above. (Score 0 if the question is not complex enough and AI models can answer it correctly.)
  - If the model is not able to answer correctly and the question is below a graduate level, the question can be acceptable.
- Questions can be any field across STEM, law, history, psychology, philosophy, trivia, etc. as long as they are tough and interesting questions.
  - For fields like psychology, philosophy, etc. we usually check if the rationale contains some reference to a book, paper or standard theories.
  - For fields like law, the question text can be adjusted with "as of 2024". Make sure questions about law are time-bounded.
  - Questions do not always need to be academic. A handful of movie, TV trivia, classics, history, art, or riddle questions in the dataset are OK.
  - Trivia or complicated game strategy about chess, go, etc. are okay as long as they are difficult.
  - We generally want things that require a high level of human intelligence to figure out.
- Questions should ask for something precise and have an objectively correct, univocal answer.
  - If there is some non-standard jargon for the topic/field, it needs to be explained.
  - Questions must have answers that are known or solvable.
  - Questions should not be subjective or have personal interpretation.
  - Questions like "Give a proof of..."; "Explain why..."; "Provide a theory that explains..." are usually bad because they are not closed-ended and we cannot evaluate them properly. (Score 0)
  - No questions about morality or what is ethical/unethical. (Score 0)

- Questions should be original and not derived from textbooks or Google. (Score 0 if searchable on web)
- Questions need to be in English. (Score 1 and ask for translation in the review if the question is written in a different language)
- Questions should be formatted properly. (Score 1-3 depending on degree of revisions needed)
  - Question with numerical answers should have results approximated to max 2-3 decimals.
  - Fix LaTeX formatting if possible. Models often get questions right after LaTeX formatting is added or improved.
  - Questions that can be converted to text should be (converting images to text often helps models get them right).

#### Other Tips

- Please write detailed justifications and feedback. This is going out to the question submitter so please use proper language and be respectful.
  - Explanations should include at least some details or reference. If the rationale is unclear
    or not detailed, ask in the review to expand a bit.
  - Please check if the answer makes sense as a possible response to the question, but if you do not have knowledge/context, or if it would take more than 5 minutes to solve, that is okay.
- Please prioritize questions with no reviews and skip all questions with more than 3 reviews.
- Please double check that the model did actually answer the question wrong.
  - Sometimes the exact match feature does not work well enough, and there are false negatives. We have to discard any exact match questions that a model got right.
- On the HLE dashboard, look at least 10 examples reviewed by the organizers before starting to review, and review the examples from training.
- The average time estimated to review a question 3-5 minutes.
- Use a "-1 Unsure" review if the person submitting seems suspicious or if you're not convinced their answer is right.

Score	Scoring Guideline	Description
0	Discard	The question is out of scope, not original, spam, or otherwise not good enough to be included in the HLE set and should be discarded.
1	Major Revisions Needed	Major revisions are needed for this question or the question is too easy and simple.
2	Some Revisions Needed	Difficulty and expertise required to answer the question is borderline. Some revisions are needed for this question.
3	Okay	The question is sufficiently challenging but the knowledge required is not graduate-level nor complex. Minor revisions may be needed for this question.
4	Great	The knowledge required is at the graduate level or the question is sufficiently challenging.
5	Top-Notch	Question is top-notch and perfect.
Unsure	-	Reviewer is unsure if the question fits the HLE guidelines, or unsure if the answer is right.

#### B.2.2 Review Round 2

To thoroughly refine our dataset, we train a set of reviewers along with organizers to pick the best questions. These reviewers are identified by organizers from round 1 reviews as particularly high quality and thorough in their feedback. Different than the first round of reviews, reviewers are asked

to grade both the question and look at feedback from round 1 reviewers. Organizers then approve questions based on reviewer feedback in this round. We employ a new rubric for this round below.

Score	Scoring Guideline	Description
0	Discard	The question is out of scope, not original, spam, or otherwise not good enough to be included in the HLE set and should be discarded.
1	Not sure	Major revisions are needed for this question or you're just unsure about the question. Please put your thoughts in the comment box and an organizer will evaluate this.
2	Pending	You believe there are still minor revisions that are needed on this question. Please put your thoughts in the comment box and an organizer will evaluate this.
3	Easy questions models got wrong	These are very basic questions that models got correct or the question was easily found online. Any questions which are artificially difficult (large calculations needing a calculator, requires running/rendering code, etc.) should also belong in this category. The models we evaluate cannot access these tools, hence it creates an artificial difficulty bar. Important: "Found online" means via a simple search online. Research papers/journals/books are fine
4	Borderline	The question is not interesting OR The question is sufficiently challenging, but 1 or more of the models got the answer correct.
5	Okay to include in HLE benchmark	Very good questions (usually has score of 3 in the previous review round). You believe it should be included in the HLE Benchmark.
6	Top question in its category	Great question (usually has a score of 4-5 in the previous review round), at a graduate or research level. Please note that "graduate level" is less strict for Non-STEM questions. For Non-STEM questions and Trivia, they are fine as long as they are challenging and interesting.

#### **B.3** Subject List

We allow question contributors to choose or declare a subject the author felt best suited their question. We present the top fifty most popular subjects in HLE below, although we note there are over a hundred subjects in the overall dataset.

Mathematics, Physics, Computer Science, Chemistry, Applied Mathematics, Trivia, Electrical Engineering, Biology, Linguistics, Medicine, Genetics, History, Economics, Ecology, Artificial Intelligence, Musicology, Philosophy, Neuroscience, Law, Art History, Biochemistry, Astronomy, Classics, Chess, Chemical Engineering, Microbiology, Classical Ballet, Materials Science, Poetry, Quantum Mechanics, Aerospace Engineering, Civil Engineering, Mechanical Engineering, Geography, Robotics, Data Science, Molecular Biology, Statistics, Immunology, Education, Logic, Computational Biology, Psychology, English Literature, Machine Learning, Puzzle, Cultural Studies, Marine Biology, Archaeology, and Biophysics.

#### **C** Evaluation

#### C.1 Prompts

#### C.1.1 Evaluation

We use the following system prompt for evaluating LLMs on multiple-choice questions:

```
Your response should be in the following format:
Explanation: {your explanation for your answer choice}
Answer: {your chosen answer}
Confidence: {your confidence score between 0% and 100% for your answer}
```

We use the following system prompt for evaluating LLMs on exact-match questions:

```
Your response should be in the following format:
Explanation: {your explanation for your final answer}
Exact Answer: {your succinct, final answer}
Confidence: {your confidence score between 0% and 100% for your answer}
```

We use the following system prompt to judge the model answers against the correct answers for our evaluations in Table 1. We used o3-mini-2025-01-31 with structured decoding enabled to get an extracted\_final\_answer, reasoning, correct, confidence extraction for each output.

```
Judge whether the following [response] to [question] is correct or not
based on the precise and unambiguous [correct_answer] below.
[question]: {question}
[response]: {response}
Your judgement must be in the format and criteria specified below:
extracted_final_answer: The final exact answer extracted from the
[response]. Put the extracted answer as 'None' if there is no exact, final
answer to extract from the response.
[correct_answer]: {correct_answer}
reasoning: Explain why the extracted_final_answer is correct or incorrect
based on [correct_answer], focusing only on if there are meaningful
differences between [correct_answer] and the extracted_final_answer. Do
not comment on any background to the problem, do not attempt to solve
the problem, do not argue for any answer different than
[correct_answer], focus only on whether the answers match.
correct: Answer 'yes' if extracted_final_answer matches the
[correct_answer] given above, or is within a small margin of error for
numerical problems. Answer 'no' otherwise, i.e. if there if there is any
inconsistency, ambiguity, non-equivalency, or if the extracted answer is
incorrect.
confidence: The extracted confidence score between 0% and 100% from
[response]. Put 100 if there is no confidence score available.
```

Below is an example of a structured response using LLM judge:

#### Structured Judge Response Example

[correct\_answer]: 
$$\frac{\cos\left(\frac{\pi}{n}\right)}{2\left(1+\cos\left(\frac{\pi}{n}\right)\right)}$$

[extracted\_model\_answer]: 
$$\frac{\cot\left(\frac{\pi}{n}\right)}{2\cot\left(\frac{\pi}{2n}\right)}$$

**[reasoning]**: Using the half-angle identity  $\tan\left(\frac{\pi}{2n}\right) = \frac{\sin\left(\frac{\pi}{n}\right)}{1+\cos\left(\frac{\pi}{n}\right)}$  and recalling that  $\cot x = \frac{\cos x}{\sin x}$ , we express  $\cot\left(\frac{\pi}{n}\right) = \frac{\cos\left(\frac{\pi}{n}\right)}{\sin\left(\frac{\pi}{n}\right)}$  and  $\cot\left(\frac{\pi}{2n}\right) = \frac{1+\cos\left(\frac{\pi}{n}\right)}{\sin\left(\frac{\pi}{n}\right)}$ . Forming the quotient

$$\frac{\cos x}{\sin x}$$
, we express  $\cot \left(\frac{\pi}{n}\right) = \frac{\cos \left(\frac{\pi}{n}\right)}{\sin \left(\frac{\pi}{n}\right)}$  and  $\cot \left(\frac{\pi}{2n}\right) = \frac{1+\cos \left(\frac{\pi}{n}\right)}{\sin \left(\frac{\pi}{n}\right)}$ . Forming the quotient

$$\frac{\cot\left(\frac{\pi}{n}\right)}{2\cot\left(\frac{\pi}{2n}\right)} = \frac{\frac{\cos\left(\frac{\pi}{n}\right)}{\sin\left(\frac{\pi}{n}\right)}}{2\cdot\frac{1+\cos\left(\frac{\pi}{n}\right)}{\sin\left(\frac{\pi}{n}\right)}} = \frac{\cos\left(\frac{\pi}{n}\right)}{2(1+\cos\left(\frac{\pi}{n}\right))}, \text{ where the common } \sin\left(\frac{\pi}{n}\right) \text{ cancels out. This detailed inline simplification shows that the model answer is equivalent to the correct answer.}$$

detailed inline simplification shows that the model answer is equivalent to the correct answer. [correct]: yes

#### C.2 Text-Only Results

Model	Accuracy (%) ↑	Calibration Error $(\%) \downarrow$
GPT-40	2.6	90.3
Grok 2	3.8	92.3
CLAUDE 3.5 SONNET	4.9	86.7
Gemini 1.5 Pro	5.2	91.0
GEMINI 2.0 FLASH THINKING	7.1	88.6
01	8.4	91.5
DEEPSEEK-R1	8.6	81.4
o3-mini (medium)*	11.1	91.5
o3-mini (high)*	14.0	92.8

Table 2: Accuracy and RMS calibration error of models from Table 1 on the text-only questions of HLE, representing 90% of the public set.

#### **C.3** Non-Reasoning Model Token Counts

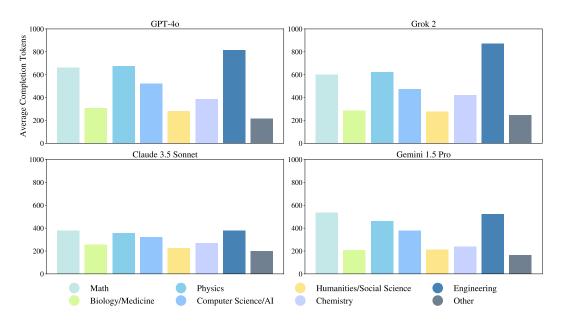


Figure 6: Average output token counts of non-reasoning models.

#### C.4 Model Versions

Model	Version
GPT-40	gpt-4o-2024-11-20
Grok 2	grok-2-latest
CLAUDE 3.5 SONNET	claude-3-5-sonnet-20241022
GEMINI 1.5 Pro	gemini-1.5-pro-002
GEMINI 2.0 FLASH THINKING	gemini-2.0-flash-thinking-exp-01-21*
01	o1-2024-12-17
DEEPSEEK-R1	January 20, 2025 release
O3-MINI (MEDIUM) & O3-MINI (HIGH)	o3-mini-2025-01-31

Table 3: Evaluated model versions. All models use temperature 0.0 when configurable and not otherwise stated. \*The first version of the paper along with Figure 5 used the now deprecated 12-19 model with temperature 0.0. The new model is sampled at temperature 0.7.

#### C.5 Benchmark Difficulty Comparison

In Figure 1, we evaluate the accuracy of all models on HLE using our zero-shot chain-of-thought prompts (Appendix C.1.1). On prior benchmarks, we list our sources here.

For GPT-40 and O1-PREVIEW, we report zero-shot, chain-of-thought results from OpenAI found at https://github.com/openai/simple-evals.

For GEMINI 1.5 PRO, we report 5-shot MMLU Team et al. [49] and other results from Google's reported results here.

For CLAUDE 3.5 SONNET, we report 0-shot chain-of-thought results from Anthropic [4].