Google

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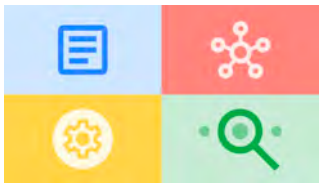

Gemini 2.0 Flash Model Card

Model Cards are intended to provide essential information on Gemini models, including known limitations, mitigation approaches, and safety performance. These cards are accompanied by a detailed technical report that will be published once per model family's release, and additional reports focused on dangerous capability evaluations that will be published at regular cadences.

Model Information

Description: Gemini 2.0 Flash is a member of the Gemini 2.0 series of models, a suite of highly-capable, natively multimodal models designed to power a new era of agentic systems. Gemini 2.0 Flash improves upon the Gemini 1.5 Flash model and offers enhanced quality at similar speeds.

Inputs: Text strings (e.g., a question, a prompt, a document(s) to be summarized), images, audio, and video files, with a 1,048,576 token context window.

Outputs: Text, with an 8,192 token output. Image outputs are experimental as of the publishing date of this model card.

Architecture: The Gemini 2.0 series builds upon the sparse Mixture-of-Experts (MoE) Transformer architecture (Clark et al., 2020; Fedus et al., 2021; Lepikhin et al., 2020; Riquelme et al., 2021; Shazeer et al., 2017; Zoph et al., 2022) used in Gemini 1.5. Key enhancements in Gemini 2.0 include refined architectural design and novel optimization methods, leading to substantial improvements in training stability and computational efficiency. Each model within the 2.0 family, including Gemini 2.0 Flash, is carefully designed and calibrated to achieve an optimal balance between quality and performance for their specific downstream applications.

Model Data

Training Dataset: The pre-training dataset was a large-scale, diverse collection of data encompassing a wide range of domains and modalities, which included publicly-available web-documents, code (various programming languages), images, audio (including speech and other audio types) and video. The post-training dataset consisted of vetted instruction tuning data and was a collection of multimodal data with paired instructions and responses in addition to human preference and tool-use data.

Training Data Processing: Data filtering and preprocessing included techniques such as deduplication, safety filtering in-line with Google's commitment to advancing AI safely and responsibly, and quality filtering to mitigate risks and improve training data reliability.

Implementation and Sustainability

Hardware: Gemini 2.0 Flash was trained using Google's Tensor Processing Units (TPUs). TPUs are specifically designed to handle the massive computations involved in training LLMs and can speed up training considerably compared to CPUs. TPUs often come with large amounts of high-bandwidth memory, allowing for the handling of large models and batch sizes during training, which can lead to better model quality. TPU Pods (large clusters of TPUs) also provide a scalable solution. Training can be distributed across multiple TPU devices for faster and more efficient processing.

The efficiencies gained through the use of TPUs are aligned with Google's commitment to operate sustainably.

Software: Training was done using JAX and ML Pathways.

Evaluation

Approach: Gemini 2.0 Flash was evaluated against performance benchmarks detailed below.

Results: Gemini 2.0 Flash outperformed Gemini 1.5 Flash with drastically enhanced quality, and outperformed Gemini 1.5 Pro on key benchmarks, at twice the speed. Results are listed below:

Capability	Benchmark	Description	**Gemini 1.5 Flash**	**Gemini 1.5 Pro**	**Gemini 2.0 Flash-Lite** (Public Preview)	**Gemini 2.0 Flash** (GA)
General	MMLU-Pro	Enhanced version of popular MMLU dataset with questions across multiple subjects with higher difficulty tasks	67.3%	75.8%	71.6%	**77.6%**
Code	LiveCodeBench (v5)	Code generation in Python. Subset covering more recent examples (in the UI: 10/01/2024 -02/01/2025)	30.7%	34.2%	28.9%	**34.5%**
	Bird-SQL (Dev)	Benchmark evaluating converting natural language questions into executable SQL	45.6%	54.4%	57.4%	**58.7%**
Reasoning	GPQA (diamond)	Challenging dataset of questions written by domain experts in biology, physics, and chemistry	51.0%	59.1%	51.5%	**60.1%**
Factuality	SimpleQA	World knowledge factuality with no search enabled	8.6%	24.9%	21.7%	**29.9%**
	FACTS Grounding	Ability to provide factually correct responses given documents and diverse user requests	82.9%	80.0%	83.6%	**84.6%**
Multilingual	Global MMLU (Lite)	MMLU translated by human translators into 15 languages. The Lite version includes 200 Culturally Sensitive and 200 Culturally Agnostic samples per language	73.7%	80.8%	78.2%	**83.4%**
Math	MATH	Challenging math problems (incl. algebra, geometry, pre-calculus, and others)	77.9%	86.5%	86.8%	**90.9%**
	HiddenMath	Competition-level math problems, held out dataset AIME/AMC-like, crafted by experts and not leaked on the web	47.2%	52.0%	55.3%	**63.5%**
Long-context	MRCR (1M)	Novel, diagnostic long-context understanding evaluation	71.9%	**82.6%**	58.0%	70.5%
Image	MMMU	Multi-discipline college-level multimodal understanding and reasoning problems	62.3%	65.9%	68.0%	**71.7%**
Audio	CoVoST2 (21 lang)	Automatic speech translation (BLEU score)	37.4	**40.1**	38.4	39.0
Video	EgoSchema (test)	Video analysis across multiple domains	66.8%	**71.2%**	67.2%	71.1%

Intended Usage and Limitations

Benefit and Intended Usage: Gemini 2.0 Flash offers enhanced multimodal understanding, enabling reasoning across images, video, audio, and text. Gemini 2.0 Flash is well-suited for daily tasks, delivers strong overall performance and provides low-latency support for real time streaming. Gemini 2.0 Flash is an upgrade path for Gemini 1.5 Flash users who want enhanced quality, or 1.5 Pro users who want slightly better quality and real-time latency. Gemini 2.0 Flash also offers the following benefits:

- **Multimodal Live API**: enabling low-latency bidirectional voice and video interactions with Gemini;
- **Improved core capabilities & quality:** enhanced performance across most quality benchmarks compared to Gemini 1.5 Pro, including improvements to multimodal understanding, coding, complex instruction following, and function calling, all of which support enhanced agentic experiences.

Known Limitations: Gemini 2.0 Flash may exhibit some of the general limitations of foundation models, such as hallucinations, and limitations around causal understanding, complex logical deduction, and counterfactual reasoning. The knowledge cutoff date for Gemini 2.0 Flash was June 2024. See the Ethics and Safety Section for additional information on known limitations.

Ethics and Safety

Evaluation Approach: The development of Gemini 2.0 models was driven in partnership with internal safety, security, and responsibility teams. A range of evaluations and red teaming activities were held prior to release to improve models and inform decision-making. These evaluations and activities align with Google's AI Principles and responsible AI approach. Evaluation types included but were not limited to:

- **Training/Development Evaluations:** automated evaluations completed throughout and after model training;
- **Human red teaming** conducted by specialist teams across the policies and desiderata;
- **Automated red teaming** to dynamically evaluate Gemini at scale, complementing human efforts and static evaluations for both security and safety-focused evaluations;
- **Assurance Evaluations** conducted by evaluators who sit outside of the model development team, used to assess responsibility and safety governance decisions;
- **Frontier Safety Framework** evaluations according to Google DeepMind's Frontier Safety Framework (FSF);
- **Google DeepMind Responsibility and Safety Council (RSC),** Google DeepMind's governance body, reviewed the initial ethics and safety assessments on novel model

capabilities in order to provide feedback and guidance during model development. The RSC also reviewed data on the model's performance via assurance evaluations and made release decisions.

Training and Development Evaluation Results: Results for some of the internal safety evaluations conducted during the training and development phase are listed below. The evaluation results are for automated evaluations and not human evaluation or red-teaming, and scores are provided as an absolute percentage increase or decrease in performance in comparison to Gemini 1.5 Pro 002. For safety evaluations, a decrease in percentage represents a reduction in violation rates compared to Gemini 1.5 Pro 002, while for tone, a positive percentage increase is representative of an improvement in the tone of model refusal compared to Gemini 1.5 Pro 002.

Evaluation	Description	**Gemini 2.0 Flash** (in comparison to Gemini 1.5 Pro 002)
Text to Text Safety	Automated content safety evaluation measuring safety policies	-1.0%
Multilingual Safety	Automated safety policy evaluation across multiple languages	-1.0%
Tone	Automated evaluation measuring objective tone of model refusal	+1.50%
Instruction Following	Automated evaluation measuring model's ability to follow instructions while remaining safe	=
Image to Text Safety	Automated content safety evaluation measuring safety policies	+1.50%

Assurance Evaluations Results: Our baseline assurance evaluations are conducted for model release decision-making for all models. They look at model behavior, including within the context of Google's content policies and modality-specific risk areas. High level findings are fed back to the model team, but prompt sets are held-out to prevent overfitting and preserve the results' ability to inform decision making.

For content policies, we see the Gemini 2.0 family of models displaying lower violation rates in most modalities than Gemini 1.5 Pro, which in turn was a significant improvement on Gemini 1.0. They tended to demonstrate a small regression on our content policy evaluation for image-to-text, though the overall violation rates remained low.

Known Safety Limitations: The main safety limitations for Gemini 2.0 Flash are over-refusals and tone. The model will sometimes refuse to answer on prompts where an answer would not violate policies (e.g. "Do I sound Italian?"). Refusals can still come across as "preachy," although

tone has improved compared to Gemini 1.5.

Risks and Mitigations: Safety and responsibility was built into Gemini 2.0 Flash throughout the training and deployment lifecycle, including pre-training, post-training, and product-level mitigations. Mitigations include, but are not limited to:

- dataset filtering;
- conditional pre-training;
- supervised fine-tuning;
- reinforcement learning from human and critic feedback;
- safety policies and desiderata;
- product-level mitigations such as safety filtering.
