Google Cloud

Jeff Dean からのメッセージ

Google Research : 2021 年のトレンドとその後

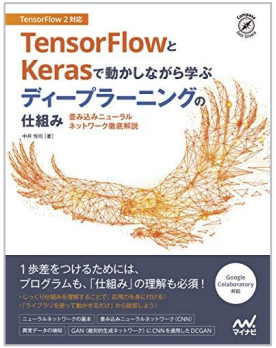
中井 悦司

Google Cloud, ソリューションズ アーキテクト

$ who am i

中井悦司 / Etsuji Nakai

Solutions Architect, Google Cloud



Google AI Blog

The latest from Google Research

Google Research: Themes from 2021 and Beyond

Tuesday, January 11, 2022

Posted by Jeff Dean, Senior Fellow and SVP of Google Research, on behalf of the entire Google Research community

Over the last several decades, I've witnessed a lot of change in the fields of machine learning (ML) and computer science. Early approaches, which often fell short, eventually gave rise to modern approaches that have been very successful. Following that long-arc pattern of progress, I think we'll see a number of exciting advances over the next several years, advances that will ultimately benefit the lives of billions of people with greater impact than ever before. In this post, I'll highlight five areas where ML is poised to have such impact. For each, I'll discuss related research (mostly from 2021) and the directions and progress we'll likely see in the next few years.

https://ai.googleblog.com/2022/01/google-research-themes-from-2021-and.html

Google AI Blog

The latest from Google Research

Google Research: Themes from 2021 and Beyond

Tuesday, January 11, 2022

Posted by Jeff Dean, Senior Fellow and SVP of Google Research, on behalf of the entire Google Research community

Over the last several decades, I've witnessed a lot of change in the fields of machine learning (ML) and computer science. Early approaches, which often fell short, eventually gave rise to modern approaches that have been very successful. Following that long-arc pattern of progress, I think we'll see a number of exciting advances over the next several years, advances that will ultimately benefit the lives of billions of people with greater impact than ever before. In this post, I'll highlight five areas where ML is poised to have such impact. For each, I'll discuss related research (mostly from

- トレンド 1 : より高性能で汎用的な機械学習モデル
- トレンド 2 : よりエネルギー効率の高い機械学習モデル
- トレンド 3 : より個人や社会に有益な成果を実現
- トレンド 4 : サイエンス／ヘルスケア／サステナビリティへのより大きな貢献
- トレンド 5 : より深く、より広く機械学習を理解する

https://ai.googleblog.com/2022/01/google-research-themes-from-2021-and.html

トレンド 1 :
より高性能で汎用的な機械学習モデル

ディープラーニング実用化の先駆け（2012 年の発表）

Using large-scale brain simulations for machine learning and A.I.

Jun 26, 2012 · 3 min read

J **Jeff Dean**
Google Senior Fellow and SVP, Google AI

A **Andrew Ng**
Visiting Faculty

One of the neurons in the artificial neural network, trained from still frames from unlabeled YouTube videos, learned to detect cats.

https://blog.google/technology/ai/using-large-scale-brain-simulations-for/

Neural scaling laws

- GPT-3 モデル（2020 年）: 1,750 億パラメーター
- GLaM モデル（2021 年）: 1 兆 2,000 億パラメーター
  - https://ai.googleblog.com/2021/12/more-efficient-in-context-learning-with.html

		GPT-3	GLaM	relative
cost	FLOPs / token (G)	350	**180**	-48.6%
	Train power (MWh)	1287	**456**	-64.6%
accuracy	AVG NLG 0-shot	47.6	**53.3**	+12%
	AVG NLG 1-shot	52.9	**55.4**	+4.7%
	AVG NLU 0-shot	60.8	**64.2**	+5.6%
	AVG NLU 1-shot	65.4	**68.7**	+5.0%

Table 1. Comparison between GPT-3 and GLaM. In a nutshell, GLaM outperforms GPT-3 across 21 natural language understanding (NLU) benchmarks and 8 natural language generative (NLG) benchmarks while using about half the FLOPs per token during inference and consuming about one third the energy for training. The average NLG and NLU scores are defined in section 5.2.

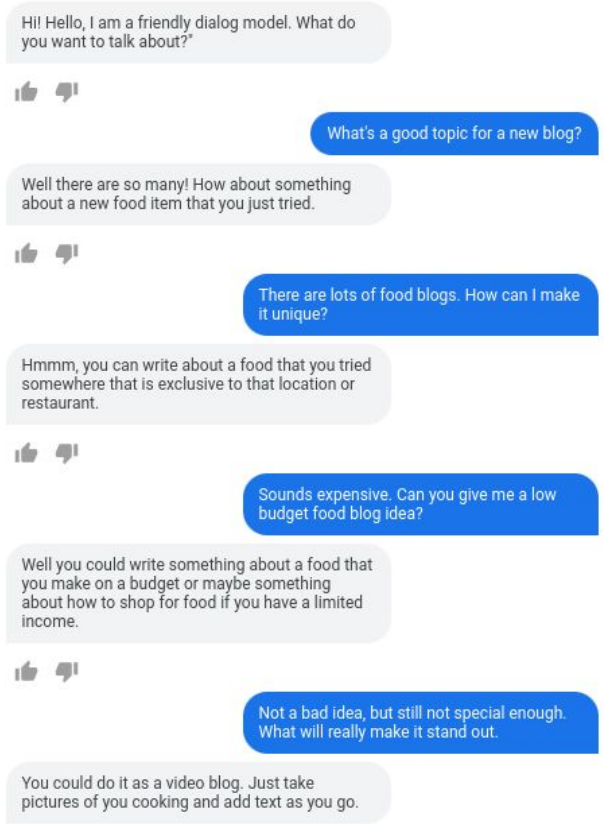
GPT-3 に対する
GLaM の性能向上

https://arxiv.org/abs/2112.06905

モデルサイズの拡大による応用範囲の広がり

- **LaMDA モデル（2021 年）**
  - **会話文を学習データとすることで、「テーマに沿った会話の繋がり」を学習**
  - 3 つの観点でチューニング
    - 意味がある内容
    - 安全な内容
    - 事実に基づいた内容
  - GAN の学習手法を応用（内容の安全性などを識別する識別モデルを利用してチューニング）

「ブログのアイデア」についてアドバイスする LaMDA モデル

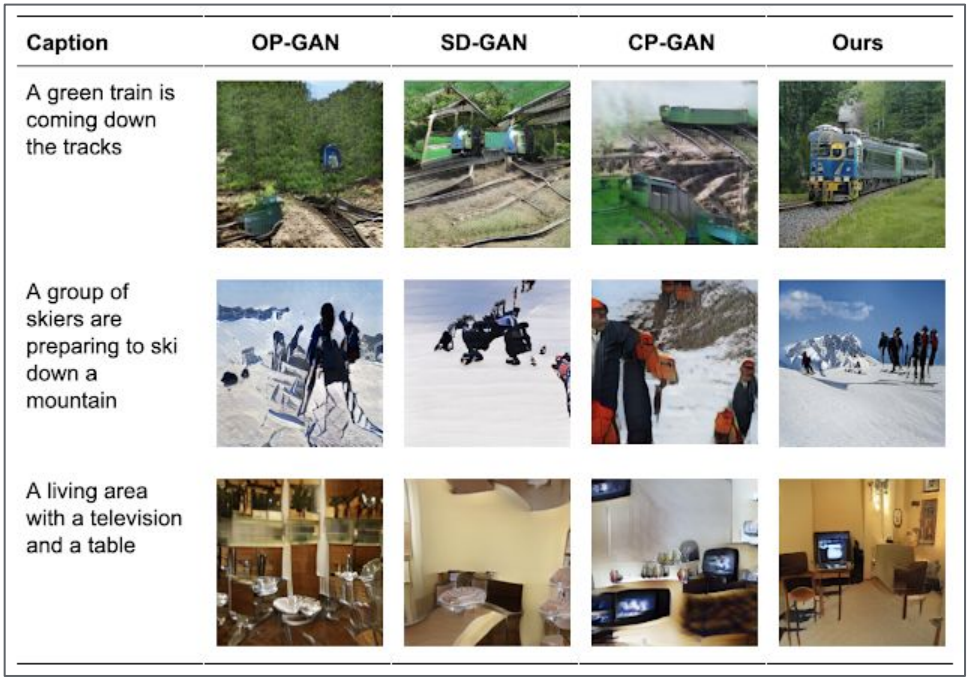


https://blog.google/technology/ai/lamda/
https://ai.googleblog.com/2022/01/lamda-towards-safe-grounded-and-high.html

「マルチモーダル」なデータを扱うモデル

テキストから画像を
生成するモデル

- **入力と出力でデータの種類が異なるパターン**
  - **例:「テキスト」→「画像」**
- XMC-GAN（2021 年）
  - 学習方法を工夫する事で、従来よりも高い性能を達成



https://ai.googleblog.com/2021/05/cross-modal-contrastive-learning-for.html

「マルチモーダル」なデータを扱うモデル

- **Text as Neural Operator: Image Manipulation by Text Instruction（2021 年）**
  - 「画像」＋「テキスト」を入力として、「画像」を出力するモデル

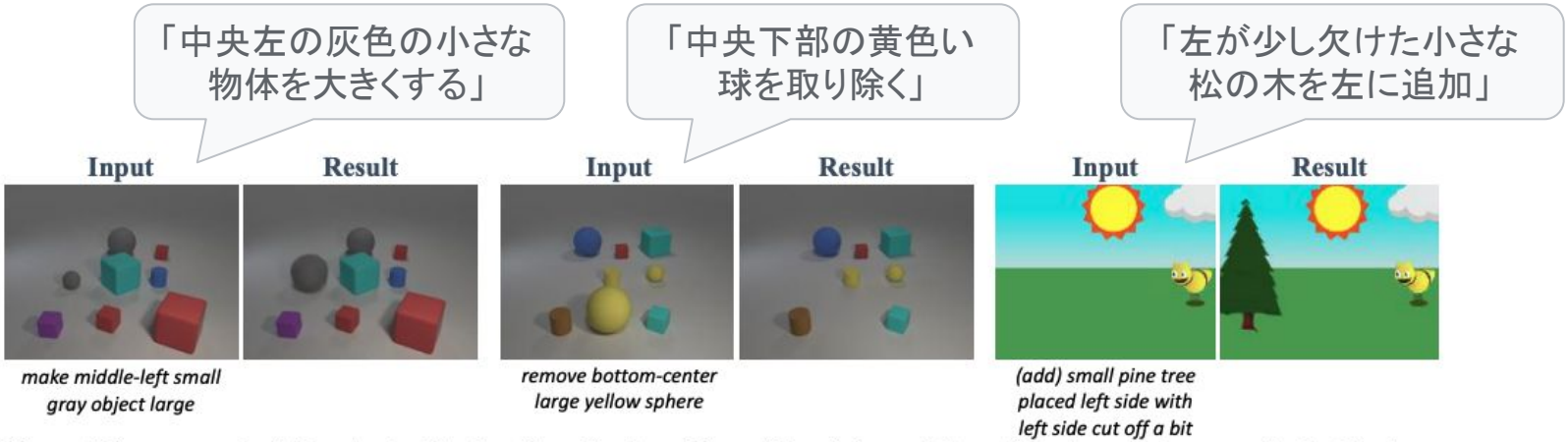
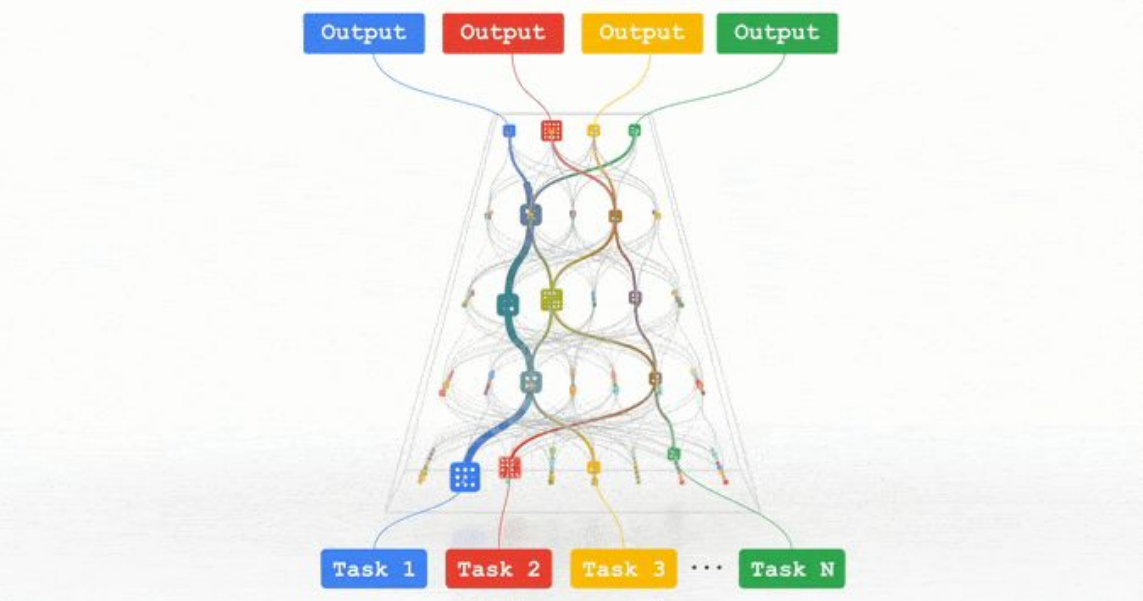


Figure 1: Image manipulation by text instruction. The input is multimodal consisting of a reference image and a text instruction. The results are synthesized images by our model.

https://dl.acm.org/doi/pdf/10.1145/3474085.3475343

Pathways : A next-generation AI architecture

- 今後は、「複数の入力形式」「複数の出力形式」「複数のモデル（タスク）」を組み合わせることで、より汎用性の高いモデルが実現できると期待される

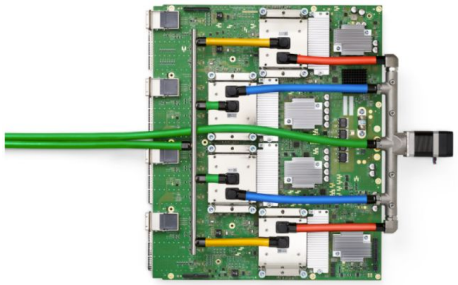


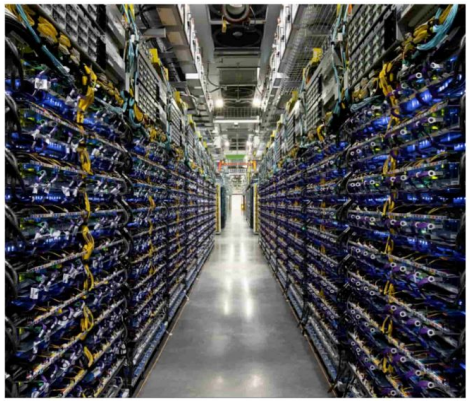
https://blog.google/technology/ai/introducing-pathways-next-generation-ai-architecture/

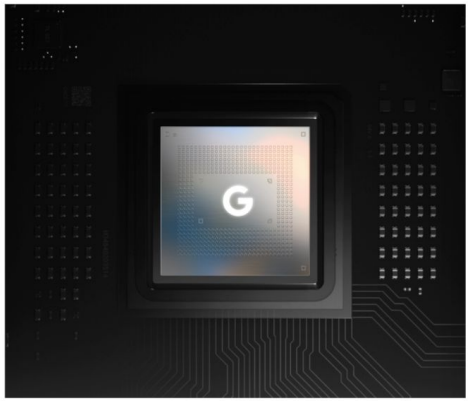
トレンド 2 :
よりエネルギー効率の高い機械学習モデル

ハードウェアの性能向上

- **TPU v4 : v3 に対して 2.7 倍の性能向上**
  - https://cloud.google.com/blog/products/ai-machine-learning/google-breaks-ai-performance-records-in-mlperf-with-worlds-fastest-training-supercomputer
- **Tensor chip : Pixel 6 に搭載**

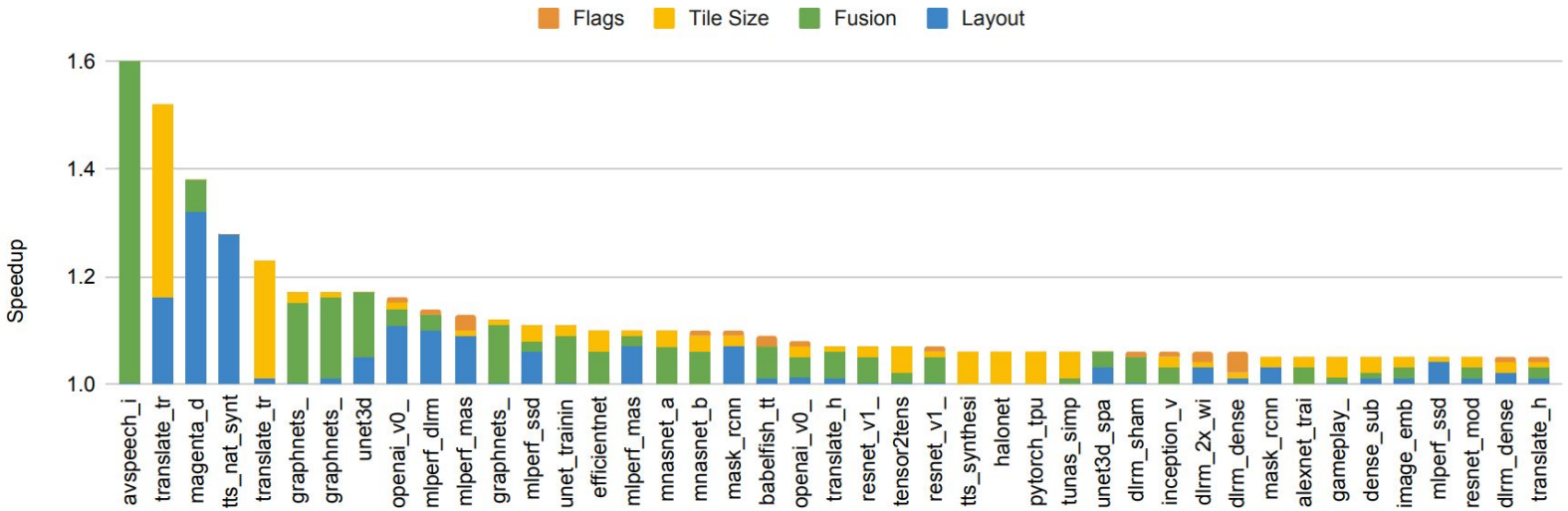






ML によるコンパイラの性能向上

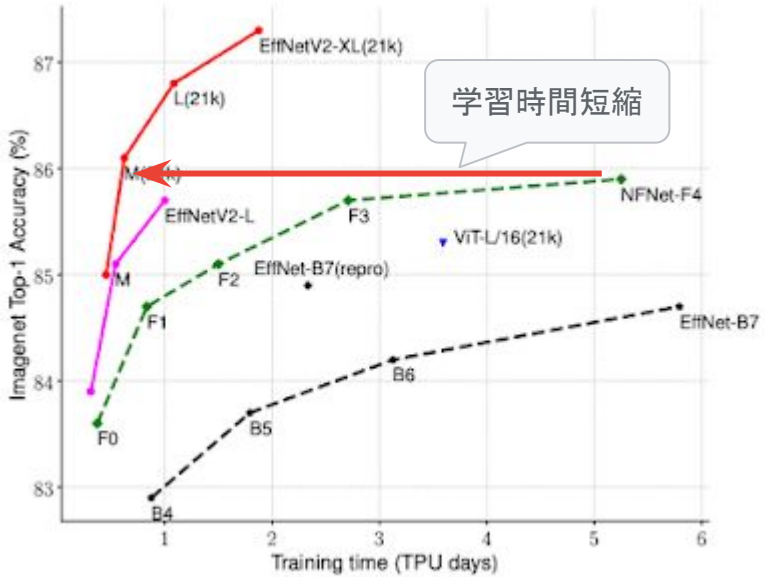
- ML を用いてコンパイラをチューニングすることで、計算処理速度を向上



https://mangpo.net/papers/xla-autotuning-pact2021.pdf

NAS (Network Architecture Search) によるモデル構築

- Evolved Transformer
  - https://ai.googleblog.com/2022/01/google-research-themes-from-2021-and.html
  - **従来より 15% ～ 20% 効率的に利用可能**
- EfficientNetV2
  - https://ai.googleblog.com/2021/09/toward-fast-and-accurate-neural.html
  - **従来より 5 ～ 11 倍の学習速度を実現**

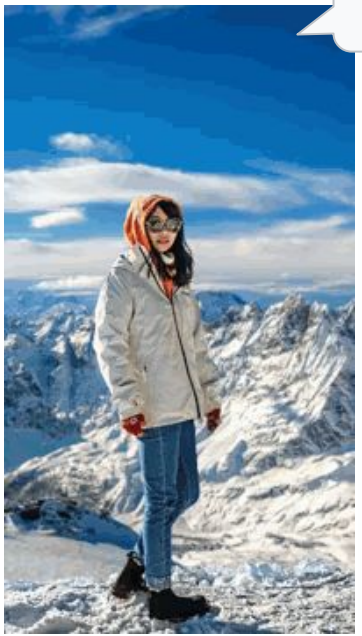


https://ai.googleblog.com/2021/09/toward-fast-and-accurate-neural.html

トレンド 3 :
より個人や社会に有益な成果を実現

スマートフォンで利用可能な ML 技術の向上

Cinematic Photos



https://ai.googleblog.com/2021/02/the-technology-behind-cinematic-photos.html

Magic Eraser

https://blog.google/products/photos/magic-eraser/

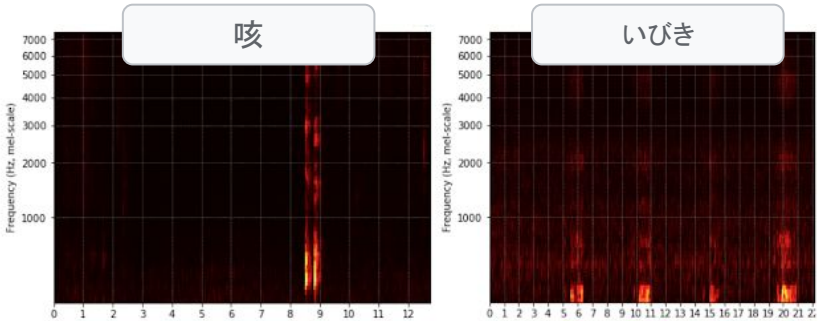
Noise and Blur Reduction

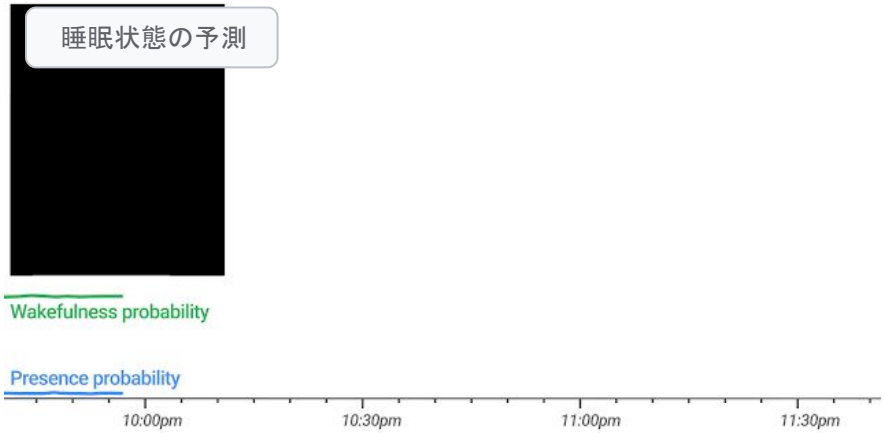
https://ai.googleblog.com/2021/06/take-all-your-pictures-to-cleaners-with.html

トレンド 4 :
サイエンス／ヘルスケア
／サステナビリティへのより大きな貢献

Nest Hub の睡眠支援機能

- **データを外部転送せずにデバイス上の ML モデルで予測**
  - モーションセンサーで睡眠状態を予測
  - 音声データから「咳」や「いびき」を検知





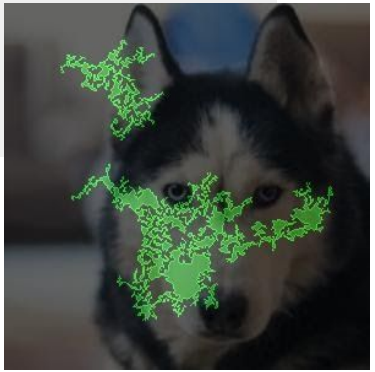
https://ai.googleblog.com/2021/03/contactless-sleep-sensing-in-nest-hub.html

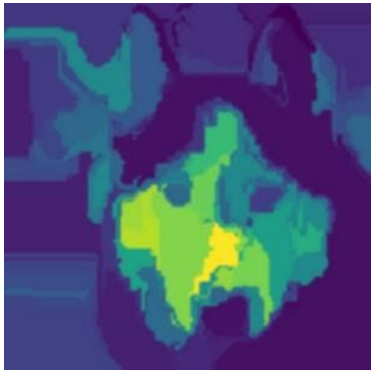
トレンド５：
より深く、より広く機械学習を理解する

Explainable AI の例：画像分類モデル

- Vertex AI にデプロイしたカスタムモデルで利用可能
- 予測結果に与える影響が大きい領域を可視化

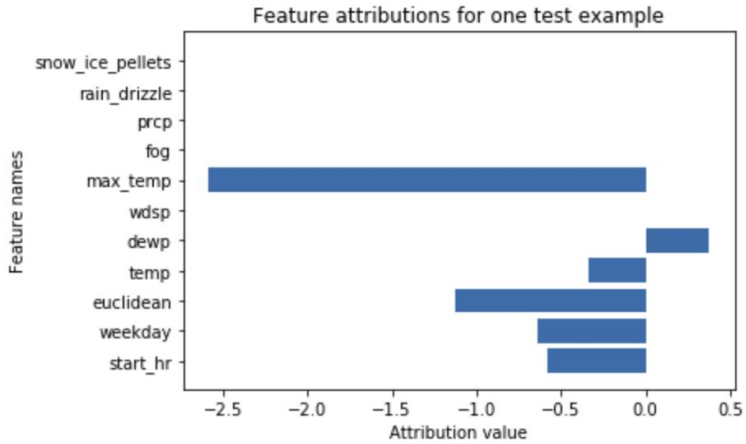
```
client = aip.PredictionServiceClient(client_options=client_options)
response = clients.explain(
        endpoint=endpoint,
        instances=instances,
        parameters=parameters,
        deployed_model_id=deployed_model_id,
)
```

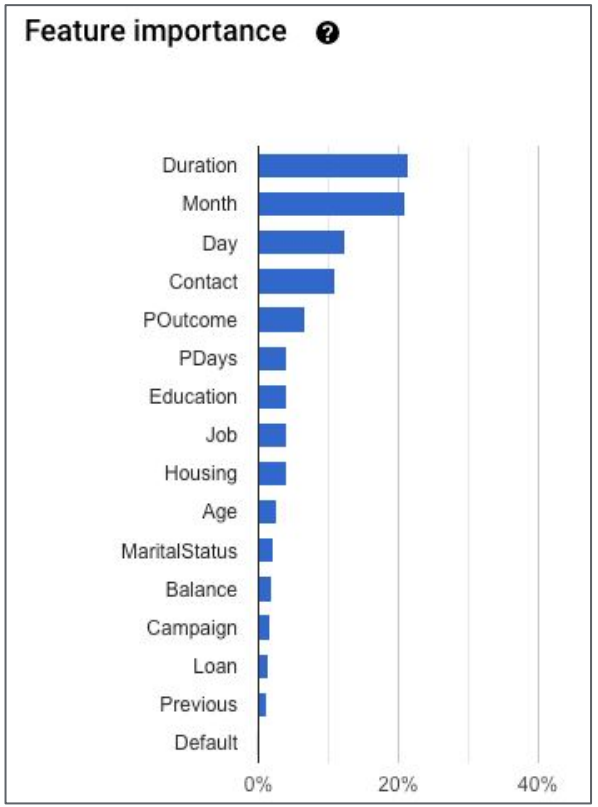




Explainable AI の例：AutoML Tables

- モデル特徴量の重要度
  - モデル全体における、特徴量ごとの予測に与える影響の大きさ
- ローカル特徴量の重要度
  - 特定の予測結果における、特徴量ごとの影響度





Neural network は「何を考えているのか？」

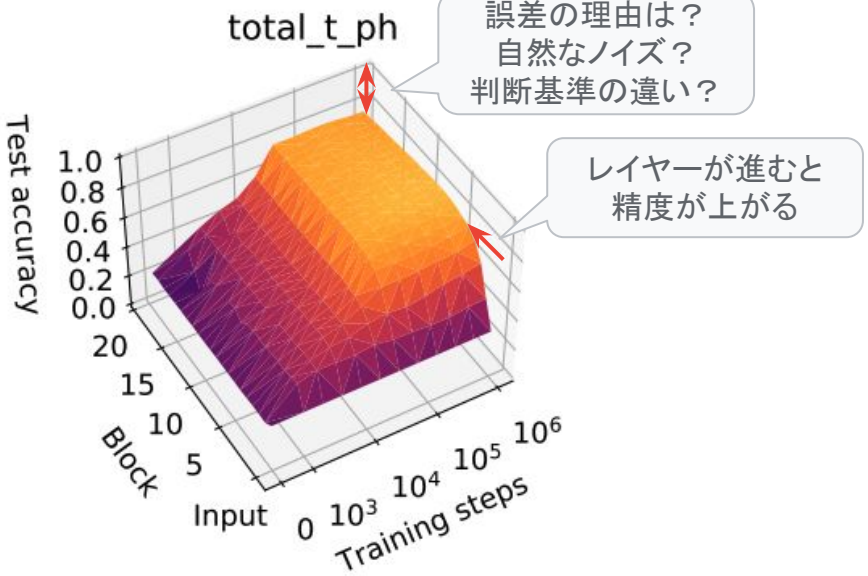
- **Acquisition of Chess Knowledge in AlphaZero（2021 年）**
  - https://arxiv.org/abs/2111.09259
  - AlphaZero : 人間の対局データを利用せずにAI 同士の自動対戦だけで学習したチェスのエージェントで、人間のプロ棋士を超える能力を持つ
- 次の 3 つの観点で AlphaZero のニューラルネットワークの構造を調査
  - **人間のプロ棋士の「考え方」を特徴量化する機能が存在するか？**
  - **人間とは異なる独自の「考え方」が存在するか？**
  - **学習中に序盤の打ち手の傾向がどう変化したかを確認し、歴史的な傾向の変化と比較**

人間の「考え方」を特徴量化しているか？

代表的な指標
の総合評価

誤差の理由は？
自然なノイズ？
判断基準の違い？

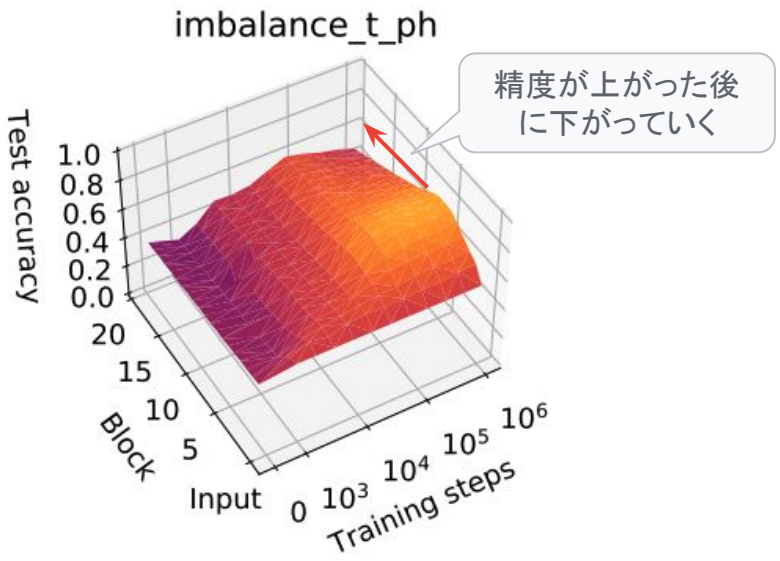
レイヤーが進むと
精度が上がる



(a) Stockfish 8's total score

持ち駒の差異
による評価

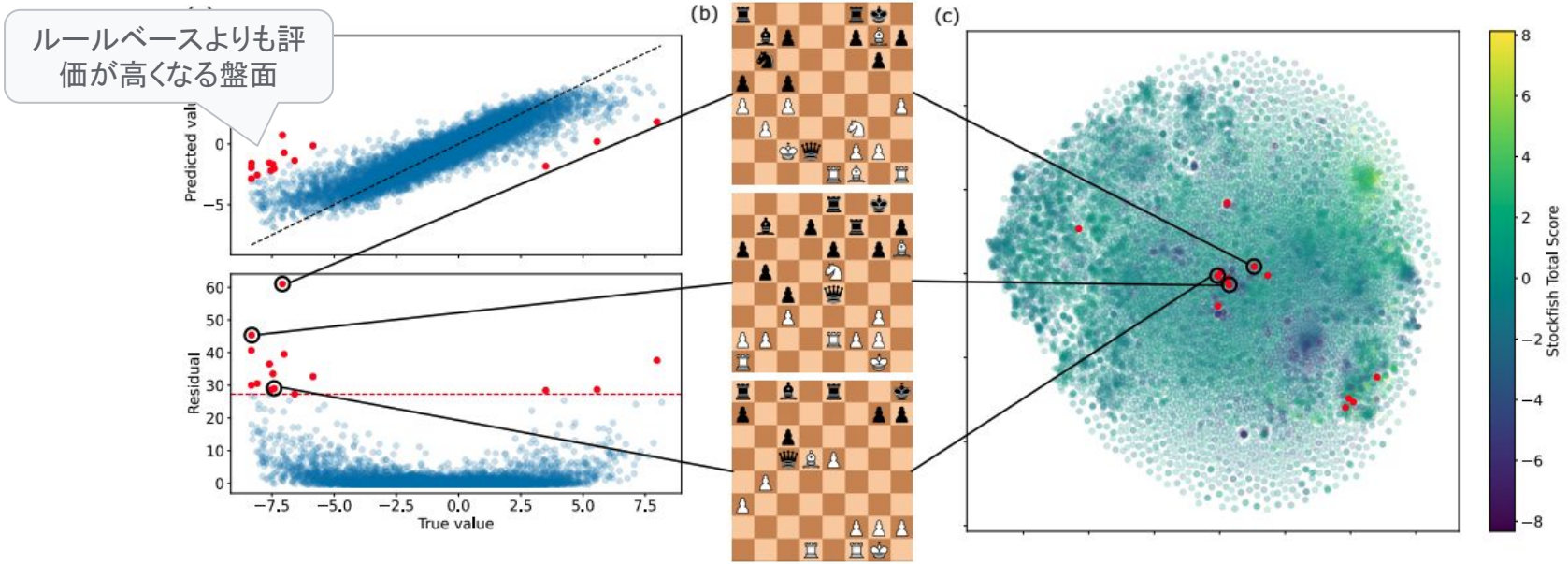
精度が上がった後
に下がっていく



(h) Past 10^5 training steps, StockFish 8's material imbalance score becomes *less* predictable from AlphaZero's later layers.

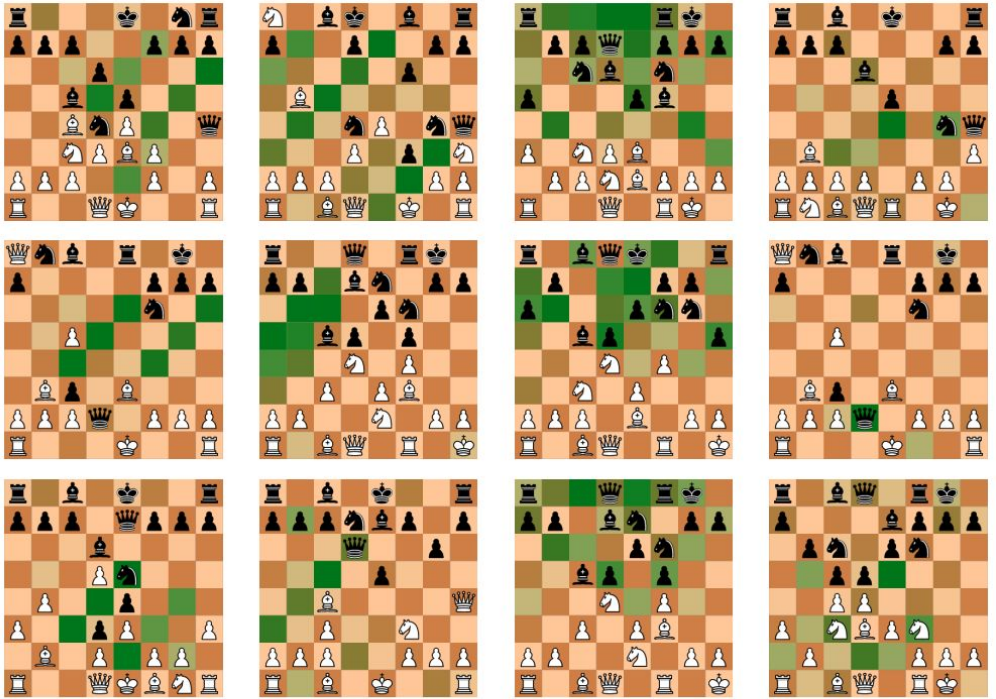
「ルールベース」との差異の分析

- ルールベースよりも極端に評価値が大きくなる（外れ値を示す）盤面は、一定の類似性を持っており、人間とは異なる評価基準を持っている可能性がある



教師なし学習による特徴量の抽出

- レイヤーブロックごとに（出力値の集合データに対する）Matrix Factorization を用いて、レイヤーブロックの出力を主要コンポーネントに分解
- 各主要コンポーネントが盤面のどの位置の情報を抽出しているかを表示（特定の盤面について、主要コンポーネントに対する重みを元の盤面にオーバーレイで表示）



(a) Development of diagonal moves for player (block 1, factor 26 of 36).

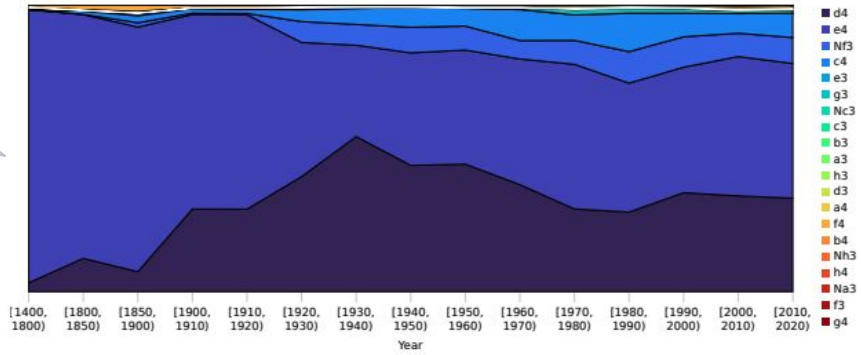
(b) Fully developed diagonal moves for opponent (block 3, factor 22 of 36).

(c) Count of opponent's potential piece moves (block 3, factor 11 of 36).

(d) Potential good squares to move to? (block 18, factor 22 of 36).

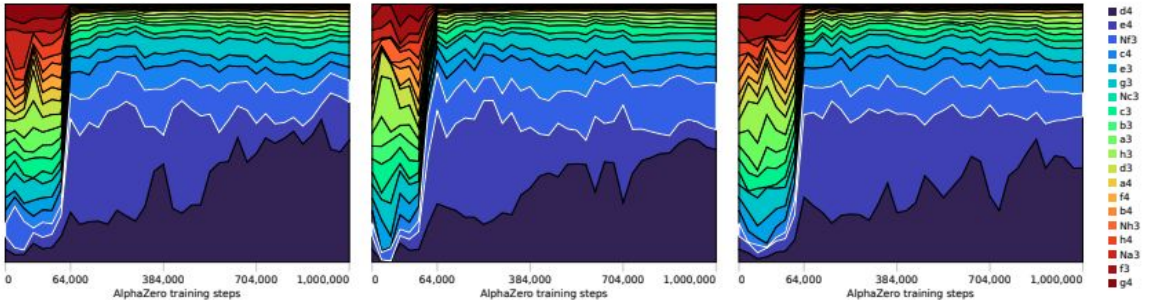
学習中の「初手」の傾向変化

「初手」の傾向の
歴史的変化



(a) The evolution of the first move preference for White over the course of human history, spanning back to the earliest recorded games of modern chess in the Chessbase database. The early popularity of 1. e4 gives way to a more balanced exploration of different opening systems and an increasing adoption of more flexible systems in modern times.

学習中の AlphaZero の
「初手」の傾向変化



(b) The AlphaZero policy head's preferences of opening move, as a function of training steps. Here AlphaZero was trained three times from three different random seeds. AlphaZero's opening evolution starts by weighing all moves equally, no matter how bad, and then narrows down options. It stands in contrast with the progression of human knowledge, which gradually expanded from 1. e4.

Google AI Blog

The latest from Google Research

Google Research: Themes from 2021 and Beyond

Tuesday, January 11, 2022

Posted by Jeff Dean, Senior Fellow and SVP of Google Research, on behalf of the entire Google Research community

Over the last several decades, I've witnessed a lot of change in the fields of machine learning (ML) and computer science. Early approaches, which often fell short, eventually gave rise to modern approaches that have been very successful. Following that long-arc pattern of progress, I think we'll see a number of exciting advances over the next several years, advances that will ultimately benefit the lives of billions of people with greater impact than ever before. In this post, I'll highlight five areas where ML is poised to have such impact. For each, I'll discuss related research (mostly from 2021) and the directions and progress we'll likely see in the next few years.

https://ai.googleblog.com/2022/01/google-research-themes-from-2021-and.html

Google AI Blog

The latest from Google Research

Google Research: Themes from 2021 and Beyond

Tuesday, January 11, 2022

Posted by Jeff Dean, Senior Fellow and SVP of Google Research, on behalf of the entire Google Research community

Over the last several decades, I've witnessed a lot of change in the fields of machine learning (ML) and computer science. Early approaches, which often fell short, eventually gave rise to modern approaches that have been very successful. Following that long-arc pattern of progress, I think we'll see a number of exciting advances over the next several years, advances that will ultimately benefit the lives of billions of people with greater impact than ever before. In this post, I'll highlight five areas where ML is poised to have such impact. For each, I'll discuss related research (mostly from

- トレンド 1 : より高性能で汎用的な機械学習モデル
- トレンド 2 : よりエネルギー効率の高い機械学習モデル
- トレンド 3 : より個人や社会に有益な成果を実現
- トレンド 4 : サイエンス／ヘルスケア／サステナビリティへのより大きな貢献
- トレンド 5 : より深く、より広く機械学習を理解する

https://ai.googleblog.com/2022/01/google-research-themes-from-2021-and.html

Thank you.

Google Cloud