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# KI og ressursforbruk

Erik Johannes Husom  
SINTEF Digital





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European Lighthouse to Manifest Trustworthy and Green AI

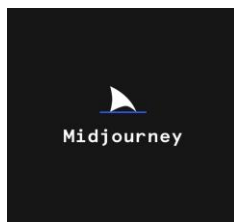
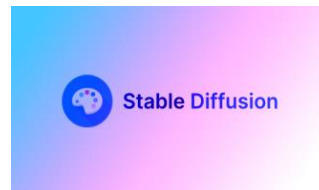
<https://www.enfield-project.eu/>





# Generativ KI

Trenes opp på store datamengder, for å kunne **generere** nytt materiale (tekst, bilder, video etc)





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# Mitt bidrag i dag

- Hvor mye strøm forbruker KI?
- utfordringer med å få til bærekraftig bruk av KI



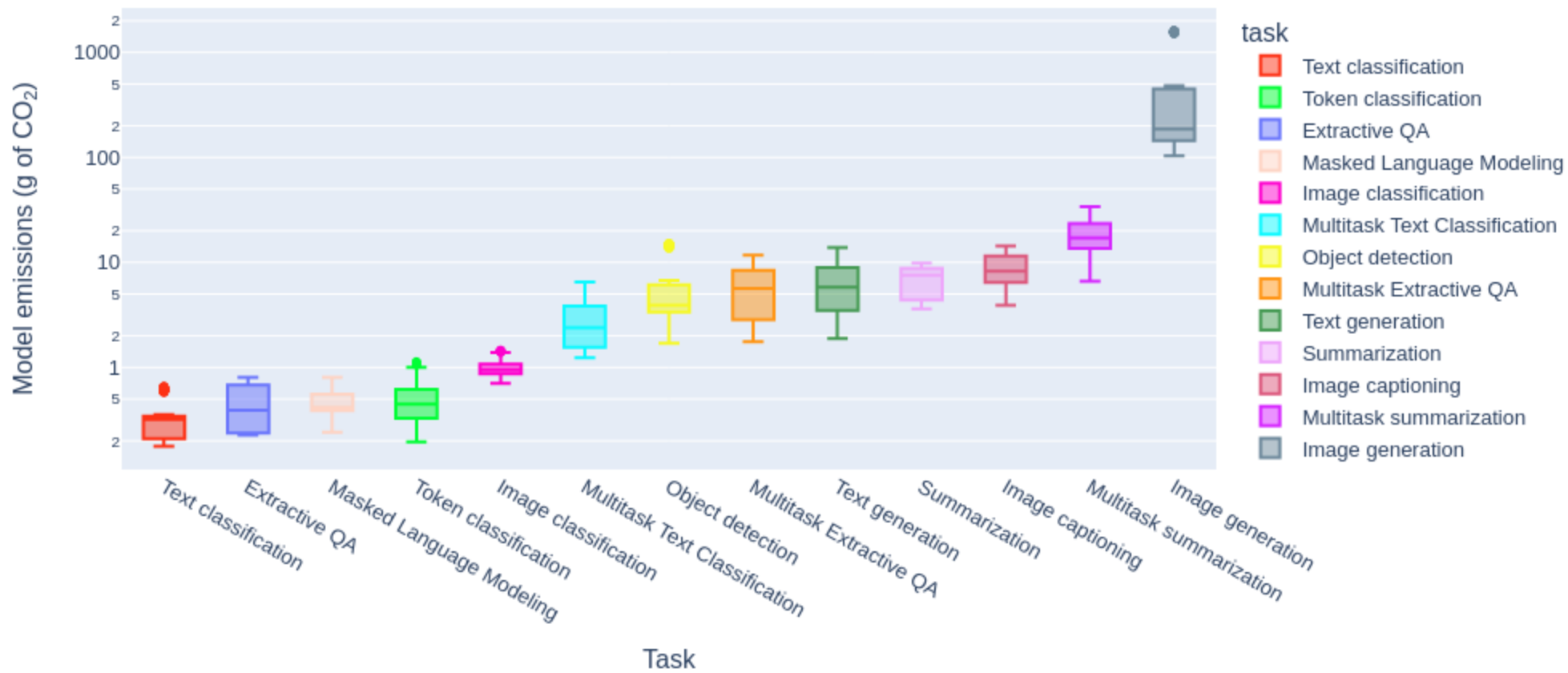
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# Hvor mye strøm forbruker KI?



## Ressursbehov for trening av KI-modeller over tid

Kilde: Sevilla et al. (2022), Compute Trends Across Three Eras of Machine Learning.



## Karbonavtrykk for ulike typer oppgaver løst av KI

Kilde: Luccioni et al. (2024), Power Hungry Processing: Watts Driving the Cost of AI Deployment?.





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# Generativ KI og ressursforbruk

- Estimerer for ChatGPT: 0.003-0.010 kWh per spørring
- Google-søk: 0.0003 kWh  
(<https://googleblog.blogspot.com/2009/01/powering-google-search.html>, 2009)
- 1 generert bilde tilsvarer en mobiloppladning (0.012 kWh)



# ChatGPT

1 million brukere etter 5 dager

200 millioner ukentlige brukere (sep 2024)



# OpenAI Platform

API (automatisk/programmatisk bruk): Doblet siden juli

# Store språkmodeller



# Kasusstudie: Meta

- 350 millioner nedlastninger av Llama-modellene i år, 10 ganger så mye som i fjor
- Månedlig bruk av KI-tjenester har økt 10x fra januar til juli 2024
- Energiforbruk på datasentre: 34% økning fra 2022-2023 (ca 15 000 GWh)
- Energiintensitet per aktive person økte med 32%
- Vannuttak fra grunnvann økte 137%
  - Vannuttak fra steder med høyt press på grunnvann økte 20%
- Gjenoppretting av vannressurser har økt 150%
  
- Kilder:
  - <https://ai.meta.com/blog/llama-usage-doubled-may-through-july-2024/>
  - <https://sustainability.atmeta.com/wp-content/uploads/2024/08/Meta-2024-Sustainability-Report.pdf>



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## Prognoser

- Datasentre stod for 460 TWh i 2022 (ca 2% av det globale forbruket), og kan nå 1000 TWh innen 2026 ([IEA 2024](#))
- KI-sektoren kan forbruke mellom 85-134 TWh per år i 2027 ([Vries 2024](#))



# Hvordan kan vi få til bærekraftig bruk av KI?

"Komprimere" KI-modellene

Bedre informasjonsutvinning fra  
treningsdata

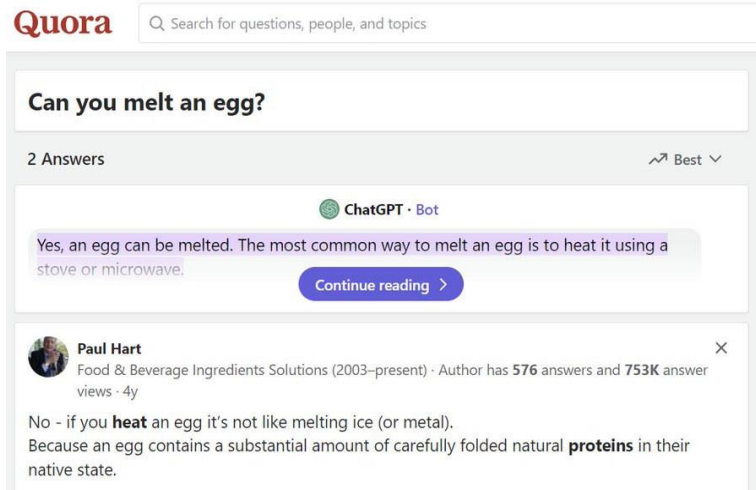
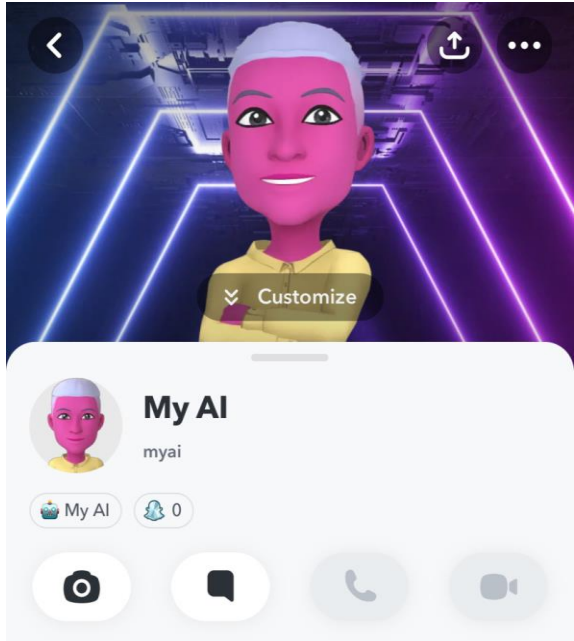
Faktisk måle og sammenligne  
energiforbruket til ulike KI-system

Mange tekniske løsninger!

Men hva med Jevons paradoks?



# Fra forbrukerens synspunkt





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what's better for a family with kids under 3 and a dog, bryce canyon or X



Converse Shopping Images Videos News Maps Books Flights Finance

Generative AI is experimental

Both Bryce Canyon and Arches National Parks are family-friendly. Although both parks prohibit dogs on unpaved trails, Bryce Canyon has two paved trails that allow dogs.

Bryce Canyon has distinctive features like hoodoos, natural bridges, and waterfalls. At the visitor center's interactive exhibits, children can learn about the geology, wildlife, and people of the area. You can bring your dog on the paved sections of both the Rim Trail and the Shared Use Path, both of which are also stroller-friendly.

At Arches, children may enjoy the rock formations, and some say that Arches has more variety than Bryce Canyon. Pets aren't allowed on any trails, though they are allowed at campgrounds, pullouts, roads, and parking lots.

Both parks offer guided tours, ranger-led programs, picnic areas, and restrooms, and both parks require pets to be leashed.



Kids & Youth - Bryce Canyon National Park...

National...



Arches National Park vs Bryce...

Sampling...



Visiting Bryce Canyon National Park...

Gopetfriend...

Ask a follow up

How long to spend at Bryce Canyon with kids?

How many days do you need in Arches National Park for kids?



Action Tour Guide  
<https://actiontourguide.com> · 2022/02/17 · which-is-b...

### Action Tour Guide

Feb 17, 2022 — Arches only allow dogs at campgrounds, parking lots, and along established roads, making it a lot harder to experience the park with your dog.



The MOM Trotter  
<https://themomtrotter.com> · bryce-canyon-national-pa...

### A Guide To Planning A Trip To Bryce Canyon National ...







# "Språkmodell-feber" i tek-bransjen

- Bruk av LLM-er er (foreløpig) svært billig
- Ekstremt lett å ta i bruk (gode API-er)

## GPT-4o mini

GPT-4o mini is our most cost-efficient small model that's smarter and cheaper than GPT-3.5 Turbo, and has vision capabilities. The model has 128K context and an October 2023 knowledge cutoff.

[Learn about GPT-4o mini ↗](#)

Model	Pricing	Pricing with Batch API*
gpt-4o-mini	\$0.150 / 1M input tokens	\$0.075 / 1M input tokens
	\$0.600 / 1M output tokens	\$0.300 / 1M output tokens
gpt-4o-mini-2024-07-18	\$0.150 / 1M input tokens	\$0.075 / 1M input tokens
	\$0.600 / 1M output tokens	\$0.300 / 1M output tokens



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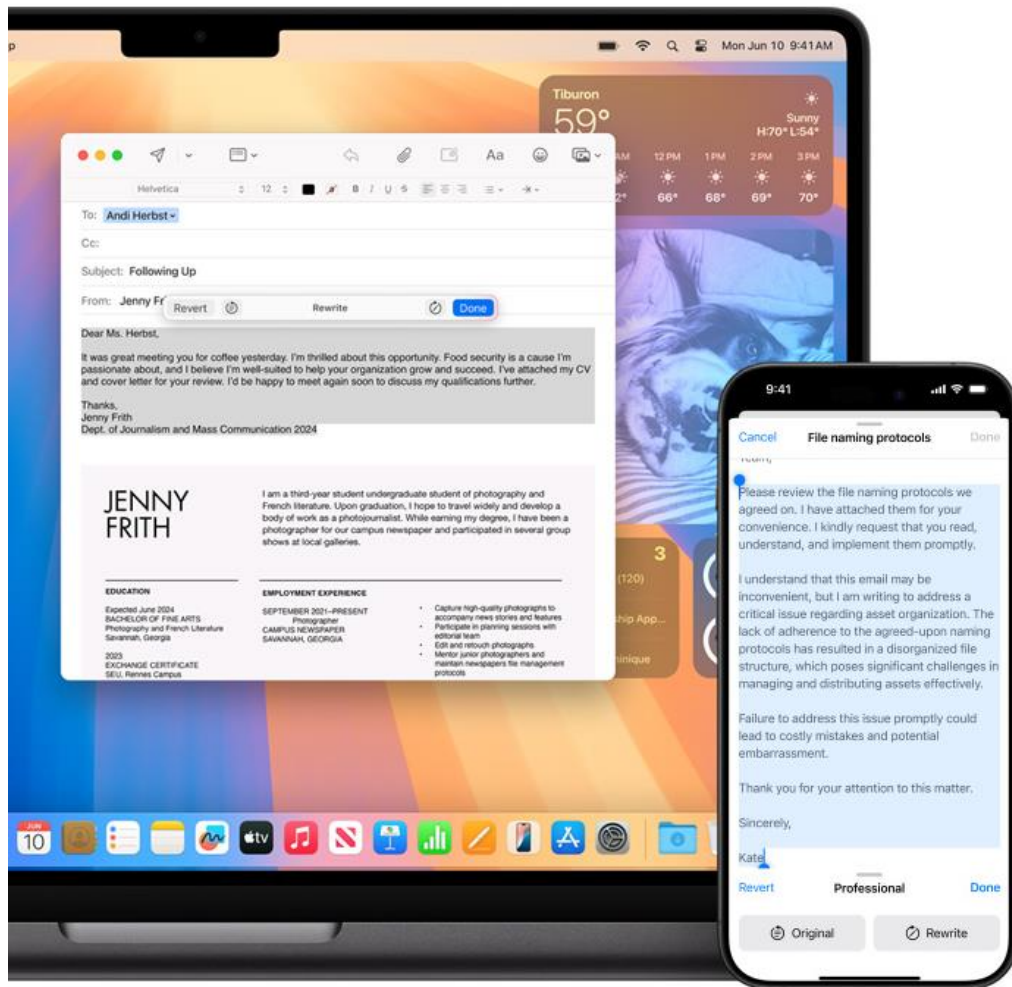
## Apple Intelligence

Overview

iOS 18 Preview

iPadOS 18 Preview

macOS Sequoia Preview



# Write with intelligent new tools. Everywhere words matter.

Apple Intelligence powers new Writing Tools, which help you find just the right words virtually everywhere you write. With enhanced language capabilities, you can summarize an entire lecture in seconds, get the short version of a long group thread, and minimize unnecessary distractions with prioritized notifications.



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# Great powers come with great **privacy.**

Apple Intelligence is designed to protect your privacy at every step. It's integrated into the core of your iPhone, iPad, and Mac through on-device processing. So it's aware of your personal information without collecting your personal information. And with groundbreaking Private Cloud Compute, Apple Intelligence can draw on larger server-based models, running on Apple silicon, to handle more complex requests for you while protecting your privacy.

## Private Cloud Compute

- ✓ Your data is never stored
- ✓ Used only for your requests
- ✓ Verifiable privacy promise





# Kostnad vs nytte



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# Kostnad vs nytte: Kreativitet

## Gemini

Supercharge your creativity  
and productivity

Chat to start writing, planning, learning and  
more with Google AI

Sign in



Help me pack for a weekend camping trip. We're bringing our labradoodle, fishing for salmon, and planning to stargaze.



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# Kostnad vs nytte: Kreativitet

- "Participants who used AI produced fewer ideas, with less variety and lower originality compared to a baseline."



## The Effects of Generative AI on Design Fixation and Divergent Thinking

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### ABSTRACT

Generative AI systems have been heralded as tools for augmenting human creativity and inspiring divergent thinking, though with little empirical evidence for these claims. This paper explores the effects of exposure to AI-generated images on measures of design fixation and divergent thinking in a visual ideation task. Through a between-participants experiment (N=60), we found that support from an AI image generator during ideation leads to higher fixation on an initial example. Participants who used AI produced fewer ideas, with less variety and lower originality compared to a baseline. Our qualitative analysis suggests that the effectiveness of co-ideation with AI rests on participants' chosen approach to prompt creation and on the strategies used by participants to generate ideas in response to the AI's suggestions. We discuss opportunities for designing generative AI systems for ideation support and incorporating these AI tools into ideation workflows.

### CCS CONCEPTS

• Human-centered computing → Empirical studies in HCI

### KEYWORDS

Design fixation, Generative-AI, Creativity support tools,

### ACM Reference Format:

Samangi Wadinambarachchi, Ryan M. Kelly, Saumya Pareek, Qiushi Zhou, and Eduardo Velloso. 2024. The Effects of Generative AI on Design Fixation and Divergent Thinking. In *Proceedings of the CHI Conference on Human Factors in Computing Systems (CHI '24)*, May 11–16, 2024, Honolulu, HI, USA. ACM, New York, NY, USA, 18 pages. <https://doi.org/10.1145/3613904.3642919>

### 1 INTRODUCTION

Consider a team of designers discussing ideas for environmentally friendly transport solutions for a city. One team member kicks off the discussion with a suggestion about electric buses. The rest of the

team then spends an hour discussing variations on this idea, all involving electric vehicles, until an intern who arrived late asks "have you considered bicycles?". Until the intern's suggestion, the ideas were anchored on a salient characteristic of the first proposal—an electric motor. The design literature dubs this phenomenon *design fixation*—the "blind adherence to a set of ideas or concepts limiting the output of conceptual design" [30, p. 1]. This is a common experience in any creative task, from art to engineering, and happens when exposure to one idea anchors and biases subsequent ideas, restricting exploration of the design space. Fixation happens both consciously and unconsciously, regardless of the level of experience of the practitioner [30, 76] and in all areas of creative work. The severe negative impact that design fixation has on the creative process makes it a key concern in design studies.

In the initial stages of the design process, it is common for designers to conduct precedence studies and create mood boards by compiling external stimuli as sources of inspiration to broaden their ideation space [41]. However, the exposure to previous solutions during this process can potentially be a source of design fixation. Previous studies have shown that exposure to examples of similar design solutions has mixed effects on creativity [75]. It tends to drive designers towards the example, narrowing the explored solution space [30, 38]. Further, variations in the modality [64, 68], the fidelity [13, 64], the quality [64], the diversity and novelty of the exposed stimuli, the time of exposure, and its proximity to the design problem [64] can vary the intensity of design fixation [63].

Recent developments in generative artificial intelligence (GenAI) have been heralded as the harbinger of a new paradigm of creative work, often under the guise of augmenting human creativity [22]. Publicly available AI image generators such as DALL·E<sup>1</sup>, Artbreeder<sup>2</sup>, Stable Diffusion<sup>3</sup>, and Midjourney<sup>4</sup> have made it possible for designers to turn their thoughts into high-quality visuals quickly and at a low cost. The ability of these tools to generate "original" images based on user prompts potentially offers a rich source of inspiration. For example, Chiou et al. [14] have shown that when used in co-ideation tasks, AI can open up a broader conceptual space quickly and effortlessly, promoting divergent thinking [14].



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CHI '24, May 11–16, 2024, Honolulu, HI, USA  
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ACM ISBN 978-1-609-59102-0/24/05  
<https://doi.org/10.1145/3613904.3642919>

<sup>1</sup><https://openai.com/dall-e-2>  
<sup>2</sup><https://www.artbreeder.com>  
<sup>3</sup><https://stablediffusionweb.com>  
<sup>4</sup><https://www.midjourney.com>



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NRK

Logg på

Vestland Snakk med oss Vestlandsrevyen P1 SF P1 H Vestland i dag

# Ber folk rydde i innboksen: – Bra for miljøet å slette e-post

IT-selskap oppfordrar nordmenn til å slette e-poster i innboksen sin hver dag: – Kan dekke den årlege straumt husstandar.



Logg på

16:11:09 Rogaland TV Radio Tips oss!



FEM OM DAGEN: Å slette gamle e-postar kan vera eit klimatilta FOTO: SCREENSHOT

# Disse Haaland-bildene krever enorme mengder strøm

– Det hoper seg opp med store mengder data hvert eneste år, sier forsker.



KREVER STRØM: Skjermdump av Norges største profil på Instagram, Erling Braut Haaland. FOTO: SKJERMDUMP

- Hilde Torgersen Journalist
- Øystein Ellingsen Journalist
- Johan Mihle Laugaland Journalist

Publisert 26. apr. 2021 kl. 19:08  
Oppdatert 27. apr. 2021 kl. 09:58

Artikkelen er flere år gammel.

NRK

Logg på

Nordland Nyhetssenter Mobilvideo Snakk med oss TV Radio Tips oss!

# Natur og Ungdom sin nettside får strykkarakter i klimatest

Natur og Ungdoms nettside får strykkarakter i karbonavtrykk. Equinors nettside får derimot nesten toppkarakter.

NRK

Logg på

Ytring

KRONIKK

# Feriebildene sluker energi

Det er på tide å rydde opp i det digitale søppelet.



Hege Svendsen  
daglig leder, Den norske dataforening

Publisert 1. aug. kl. 09:56

Rydd i skyen! Feriebildene våre lagres i enorme datasentre på servere som trenger energi, nedkjøling og areal, skriver kronikkforfatteren.

FOTO: PRIVAT

Sommeren er tiden for flest skilsmisser, myggstikk, solbrenthet, gode opplevelser, tid til å puste – og ikke minst

**Sand oss din**



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# Hva er utfordringene i et forbrukerperspektiv?

- Store teknologiselskaper sitter med mye makt
  - Vi eier ikke plattformene vi bruker
  - Vi har ikke fullt eierskap til maskinvaren vi bruker





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There's too much effort trying to create autonomous machines rather than trying to create machines that are useful tools for humans.

– Prof. Emily M. Bender



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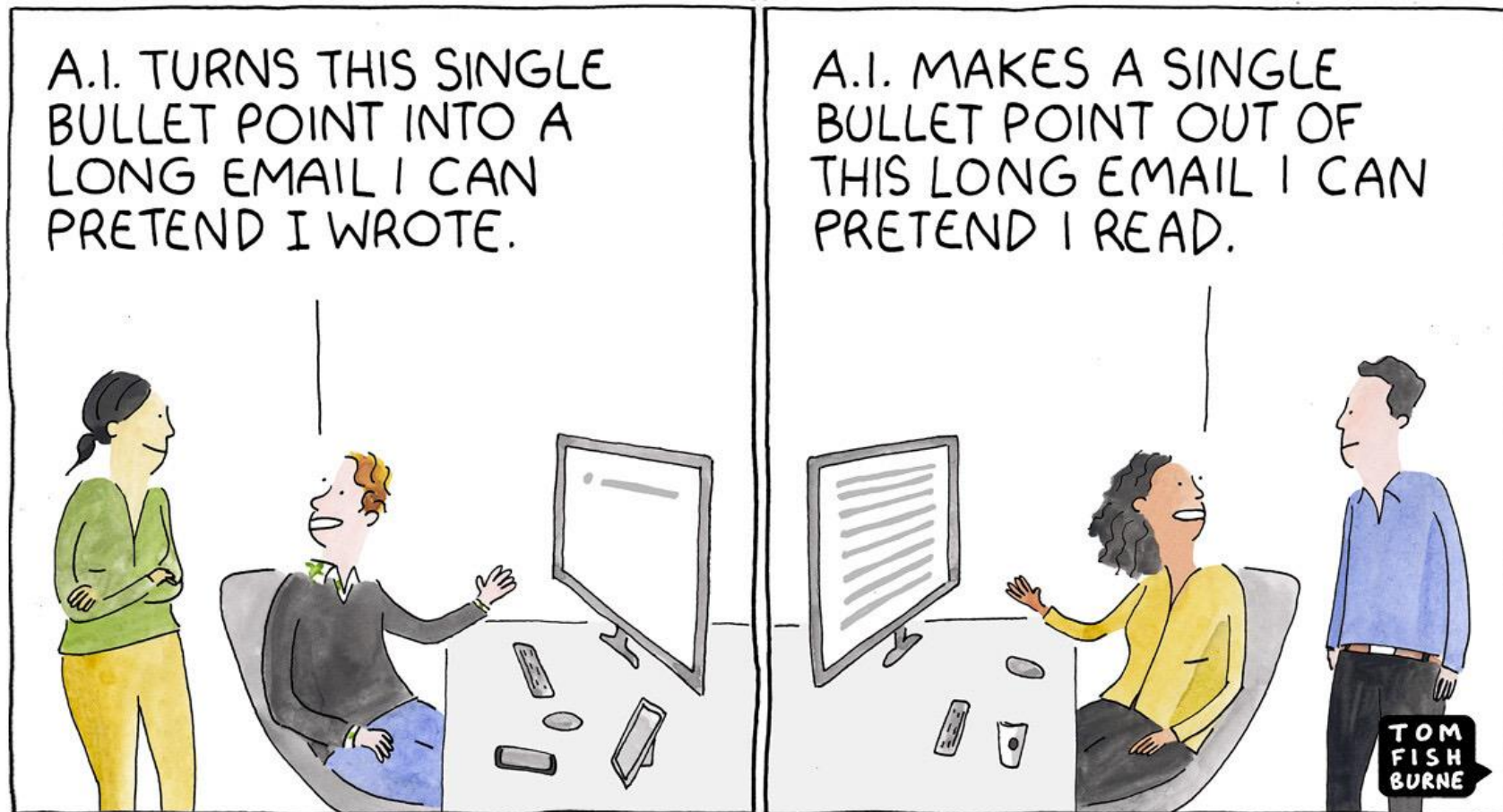
Skann QR-kode for lenke  
til presentasjonen

Technology for a better society



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# "Språkmodell-feber" i tek-bransjen





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# Hvordan kan man snu trenden?



- Bevisstgjøring
  - Energimerking av KI-tjenester?
- Motreaksjon – hvor nyttig er egentlig generativ KI i hverdagen?
- Nye gjennombrudd innen KI?
  - Yann LeCun: "Generative AI has reached a dead end"



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# Hvordan ser fremtiden ut?



Yann LeCun  

@ylecun

FAIR's mission is to develop the science and technology for human-level AI assistants: machines that understand the world, can perceive, remember, reason, plan, and act.

In the not-to-distant future, all of our interactions with the digital world will be mediated by AI assistants through our smart glasses and other devices.

We need these systems to have human-level intelligence if they are to understand the world, people, and tools, so as to help us in our daily lives.