



#BaselOne24

baselone.ch



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KaRaKuN

www.karakun.com

**Can generative AI understand
software engineering tasks? Should
you worry?**

Basel, 17.10.24

Zu meiner Person...



linkedin.com/in/iryna-dohndorf/

[@irynadohndorf@mastodon.social](https://mastodon.social/@irynadohndorf)

researchgate.net/profile/iryna-dohndorf

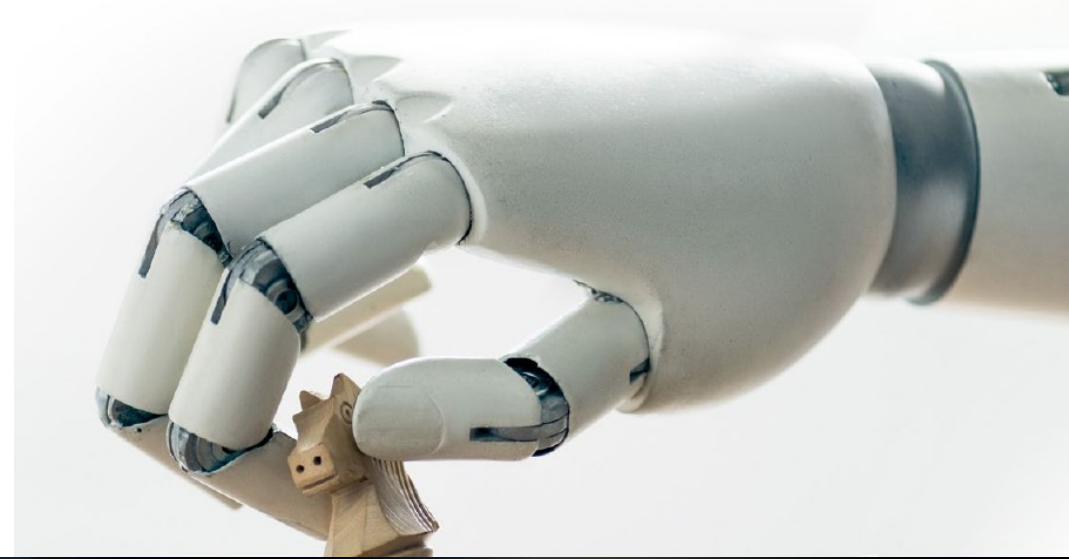
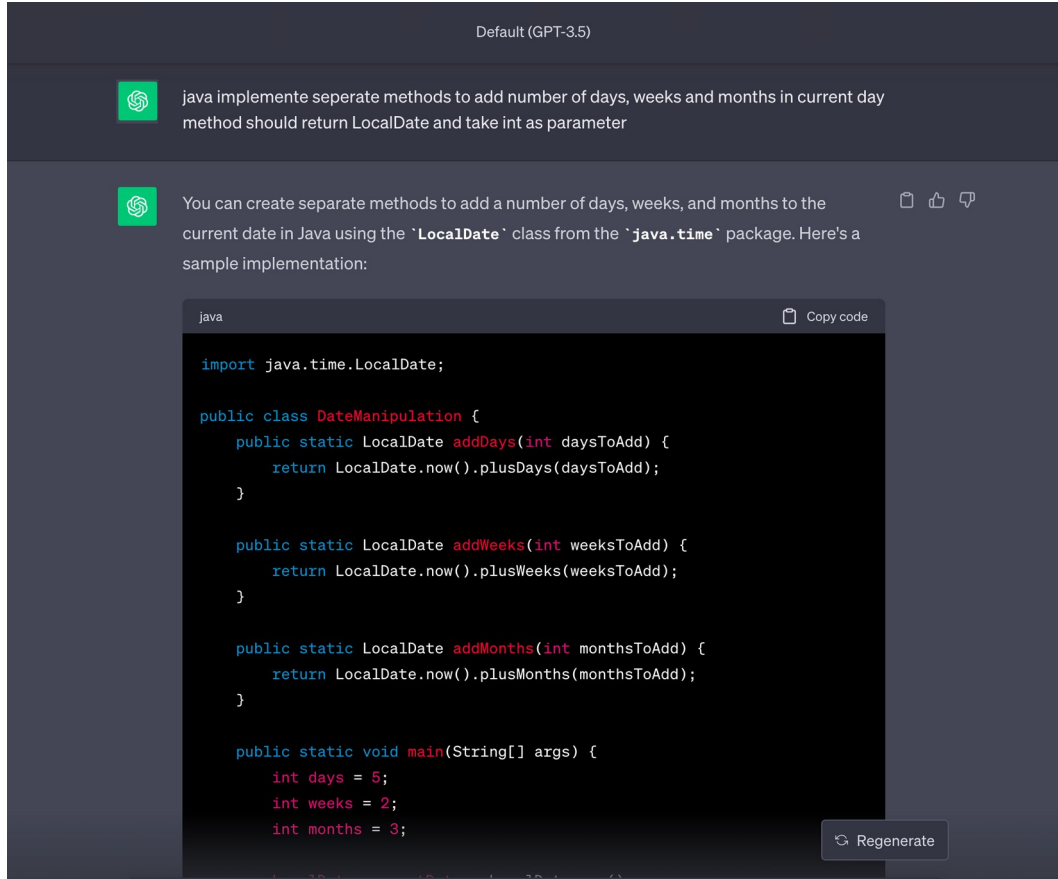
[scholar.google.de/citations?
user=eIKkTkYAAAAJ](https://scholar.google.de/citations?user=eIKkTkYAAAAJ)



Was Euch erwartet...



Warum das Thema?

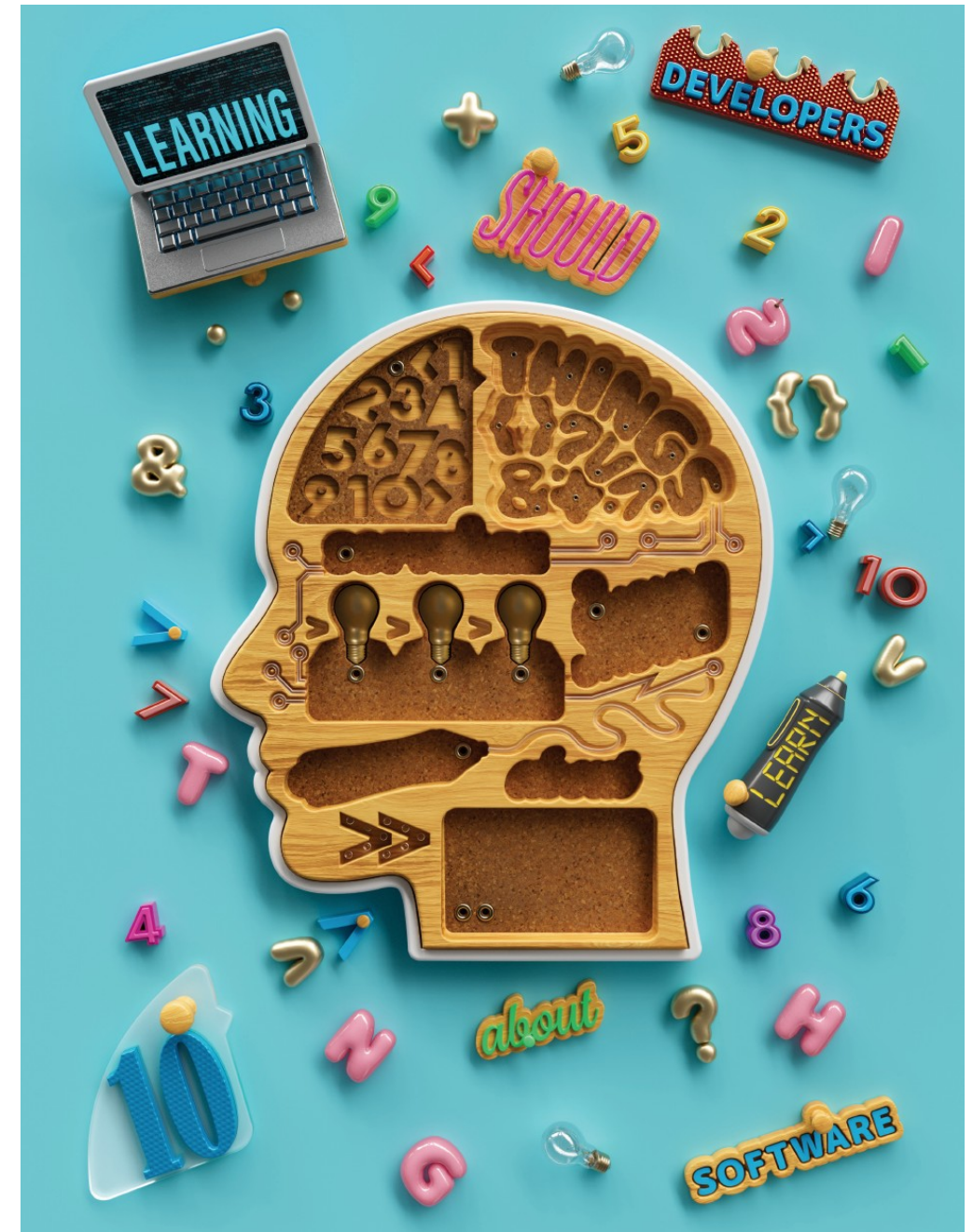


Warum das Thema?

- KI hat sich in den letzten Jahren stark entwickelt und wird immer häufiger in der Softwareentwicklung eingesetzt
 - Ein Verständnis der Technologie ist enorm wichtig
- Technologie kann dazu beitragen den Entwicklungsprozess stark zu beschleunigen
- Kann die Qualität der Entwicklung verbessern
- Ermöglicht Entwicklung neuer Arten von Anwendungen, innovative Lösungen und hilft bei Tests.
- Kann sich auf Fähigkeiten von Softwareentwicklern auswirken
- Generative AI und LLMs bringen auch viele Risiken mit sich



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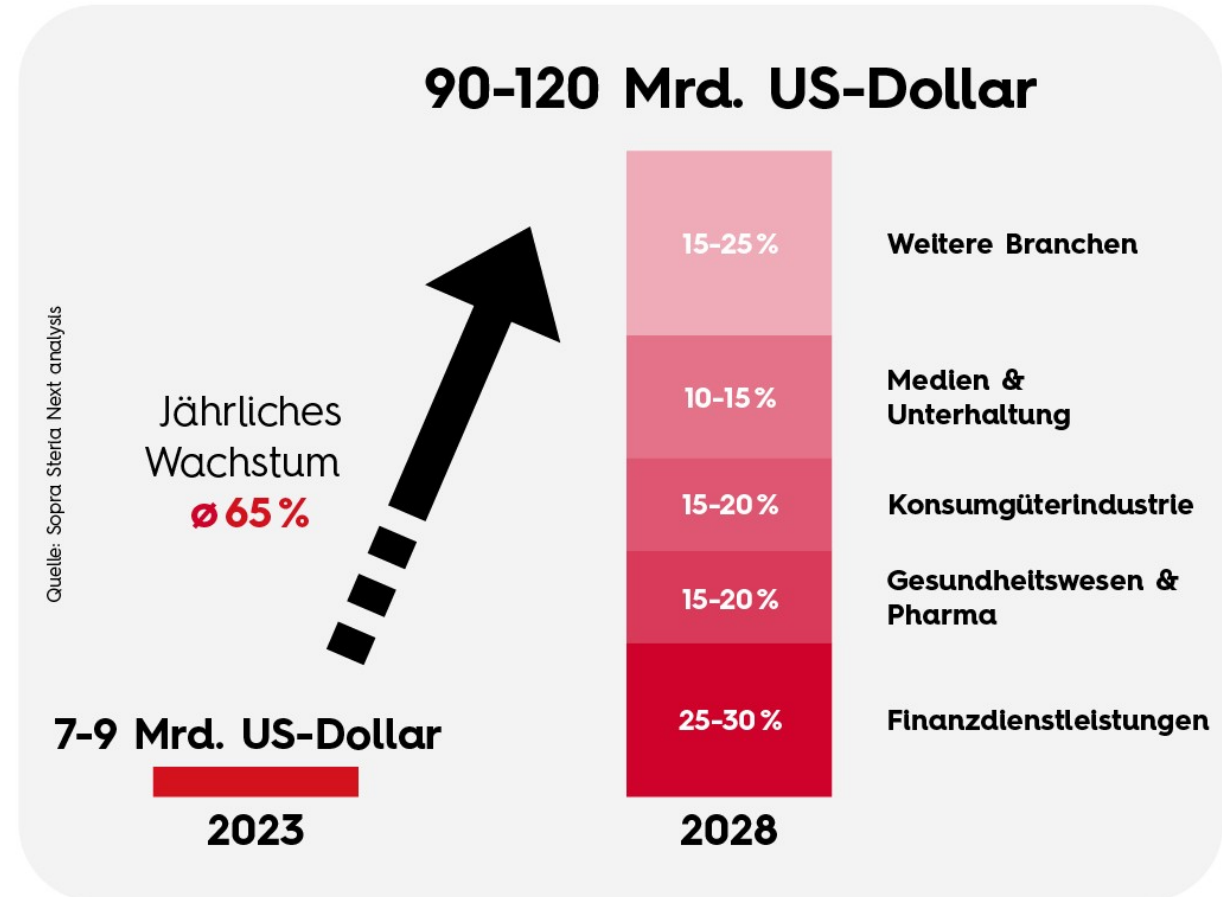


Quelle: N. Brown, F.J. Hermans, L. E. Margulieux, 10 Things Software Developers Should Learn about Learning

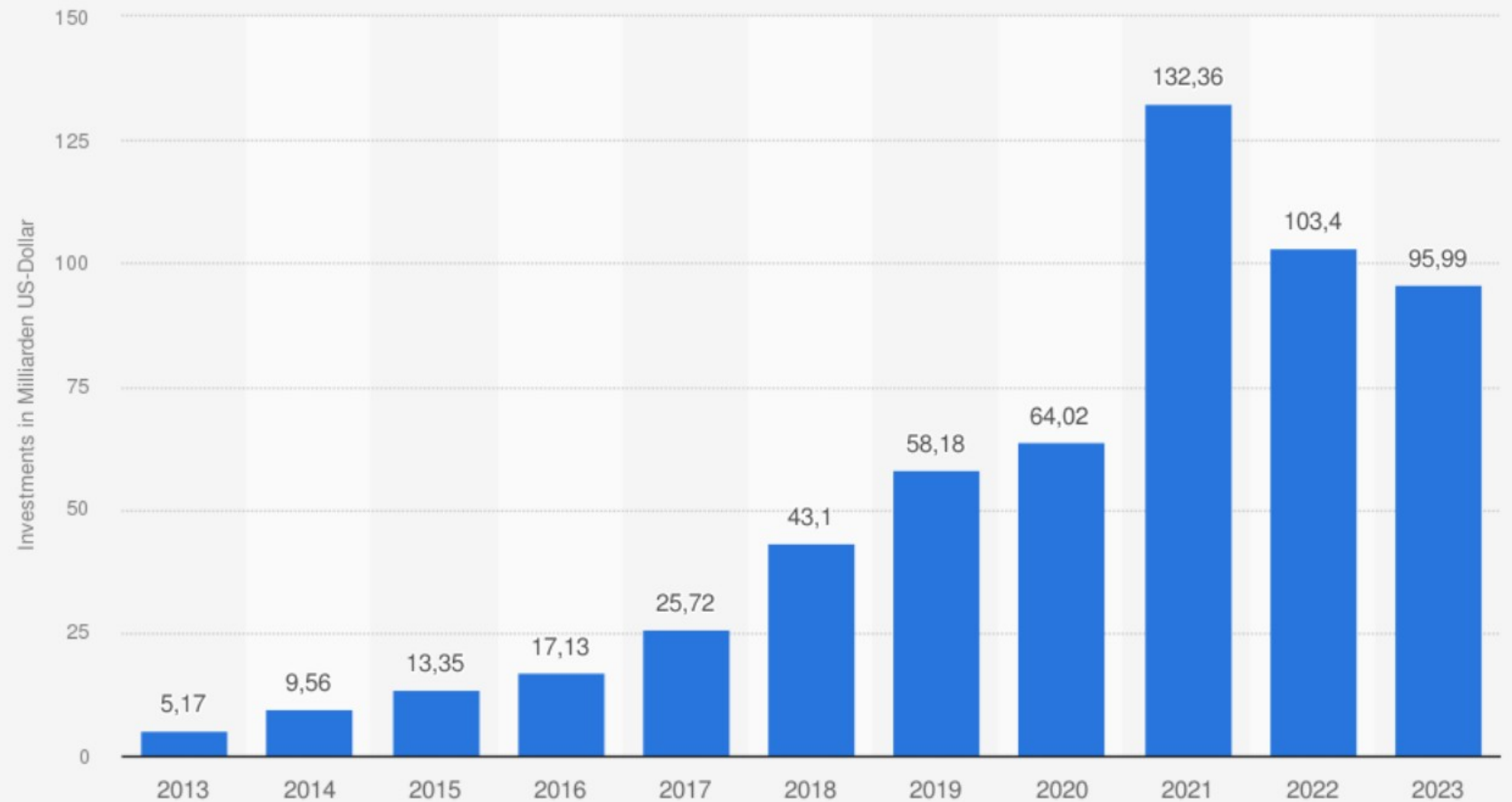
AI Code Tools

- 330 Mrd. Euro könnte allein generative KI in Zukunft zur Bruttowertschöpfung in Deutschland beitragen, sofern 50% der Unternehmen in Deutschland KI nutzen (IW-Studie 2023)
- Mehr als zwei Drittel der Unternehmen mit 20 oder mehr Mitarbeitern in Deutschland sind der Meinung, KI sei die wichtigste Zukunftstechnologie (Bitcom Studie 2023)

Prognose der GenKI-Marktentwicklung nach Anwender-Branchen



Private Investments im Bereich Künstliche Intelligenz weltweit in den Jahren 2013 bis 2023 (in Milliarden US-Dollar)



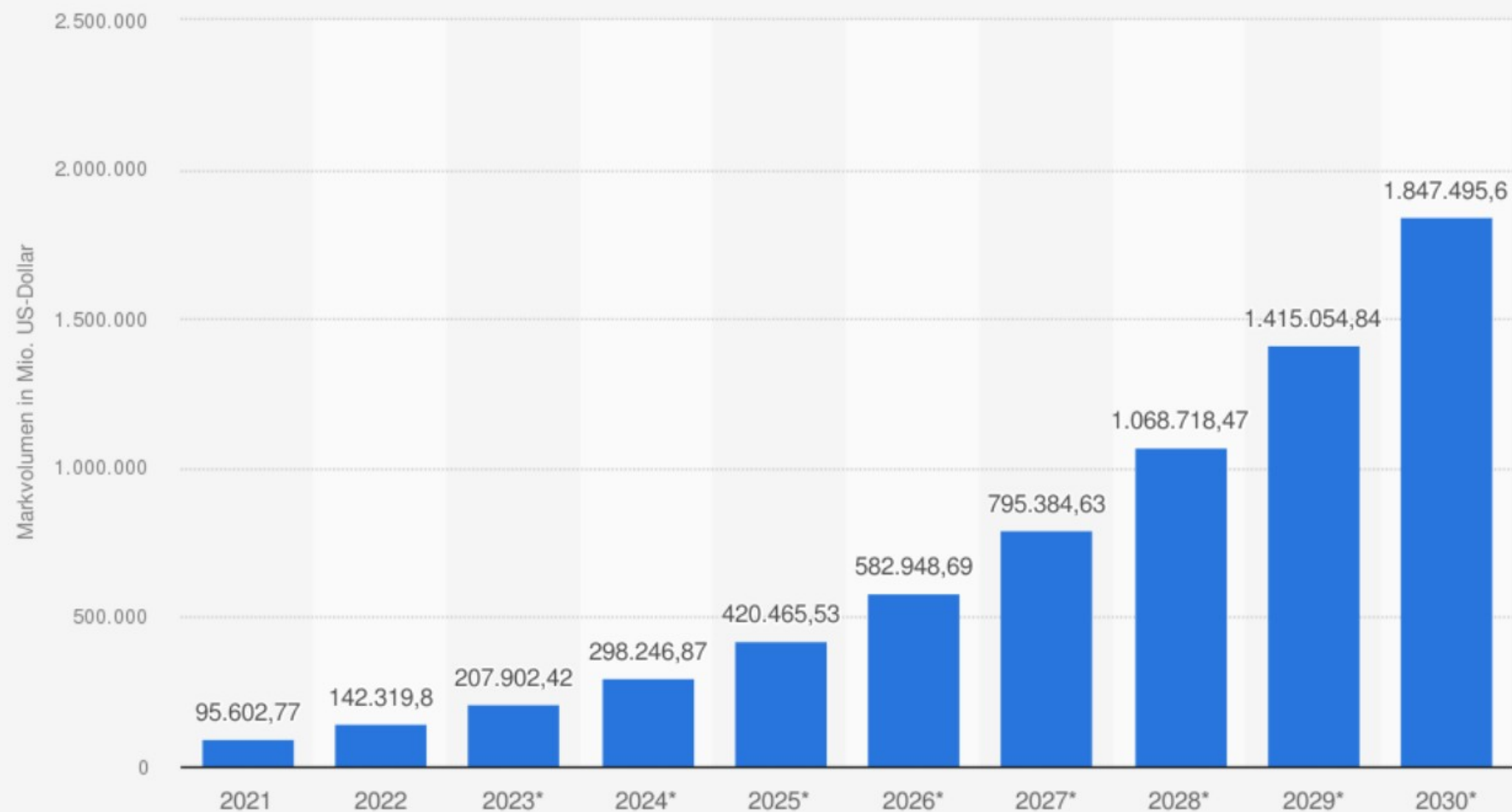
Quellen

Stanford University; NetBase Quid
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Weitere Informationen:

Weltweit; NetBase Quid

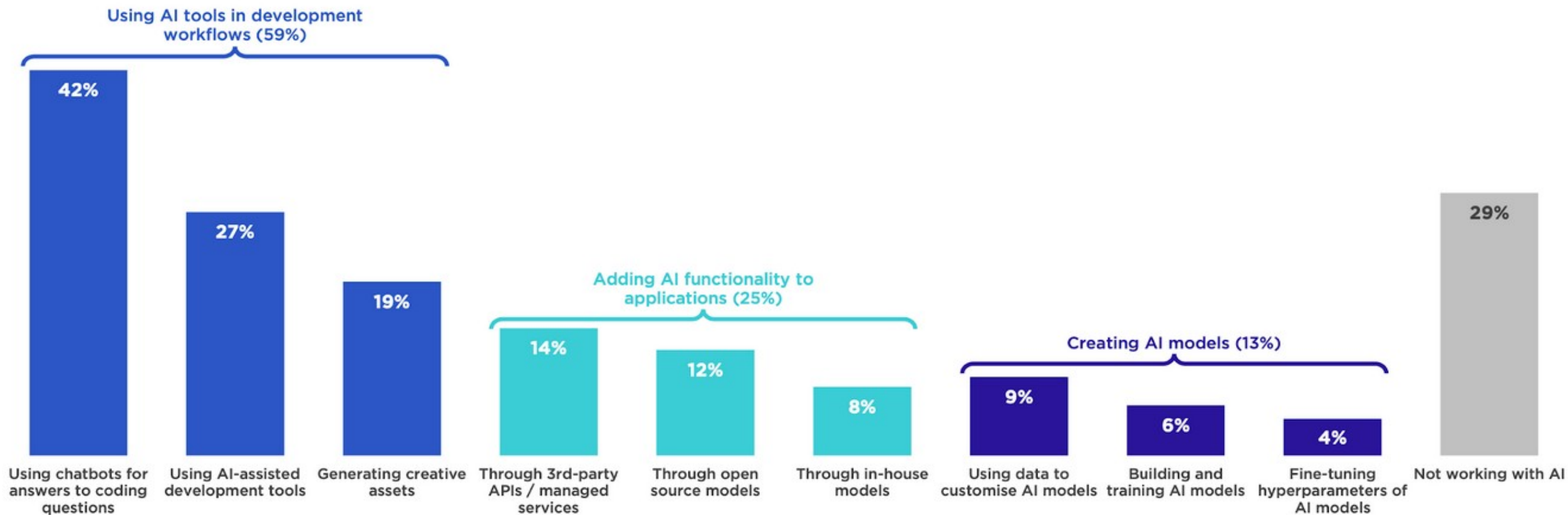
Marktvolumen für Künstliche Intelligenz weltweit im Jahr 2021 und 2022 mit einer Prognose bis 2030 (in Millionen US-Dollar)



Quelle
Next Move Strategy Consulting
© Statista 2024

Weitere Informationen:
Weltweit; Januar 2023

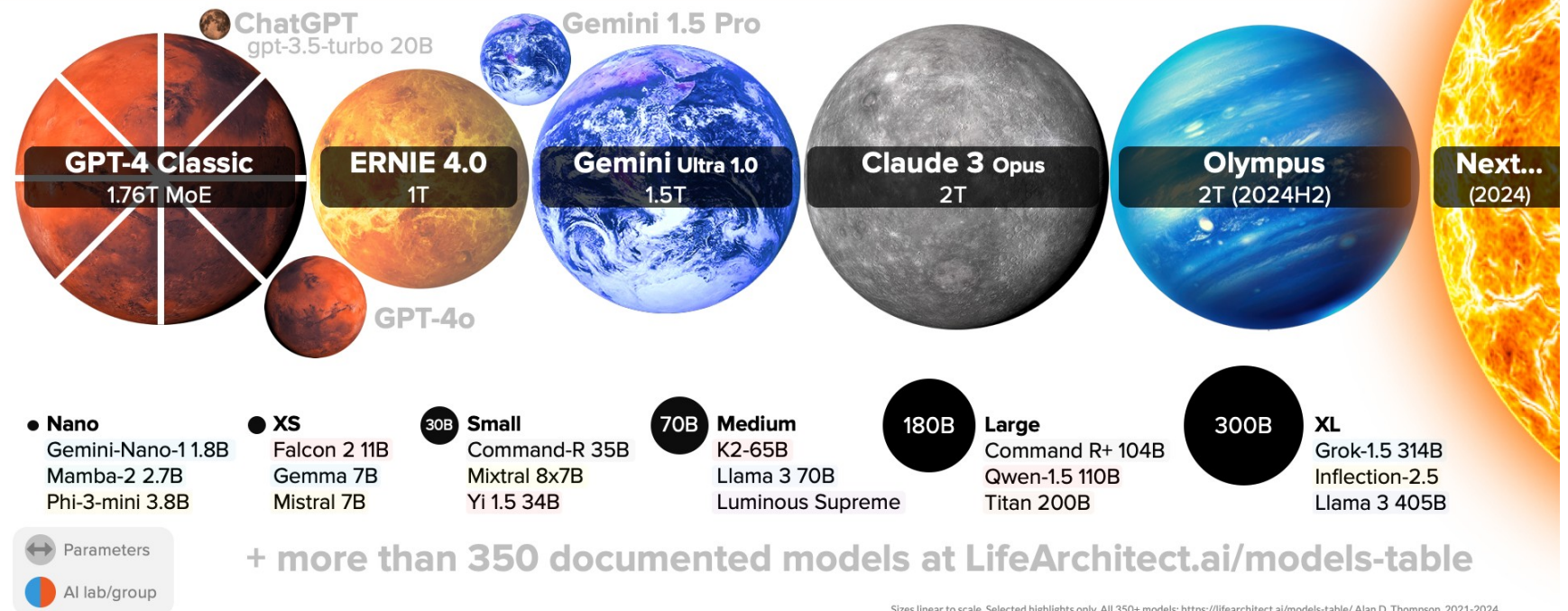
How developers work with ML/AI models, tools, APIs, or services



Question wording: Do you work with ML/AI models, tools, APIs, or services? If so, in which of the following ways?
% of developers (n=10,271)

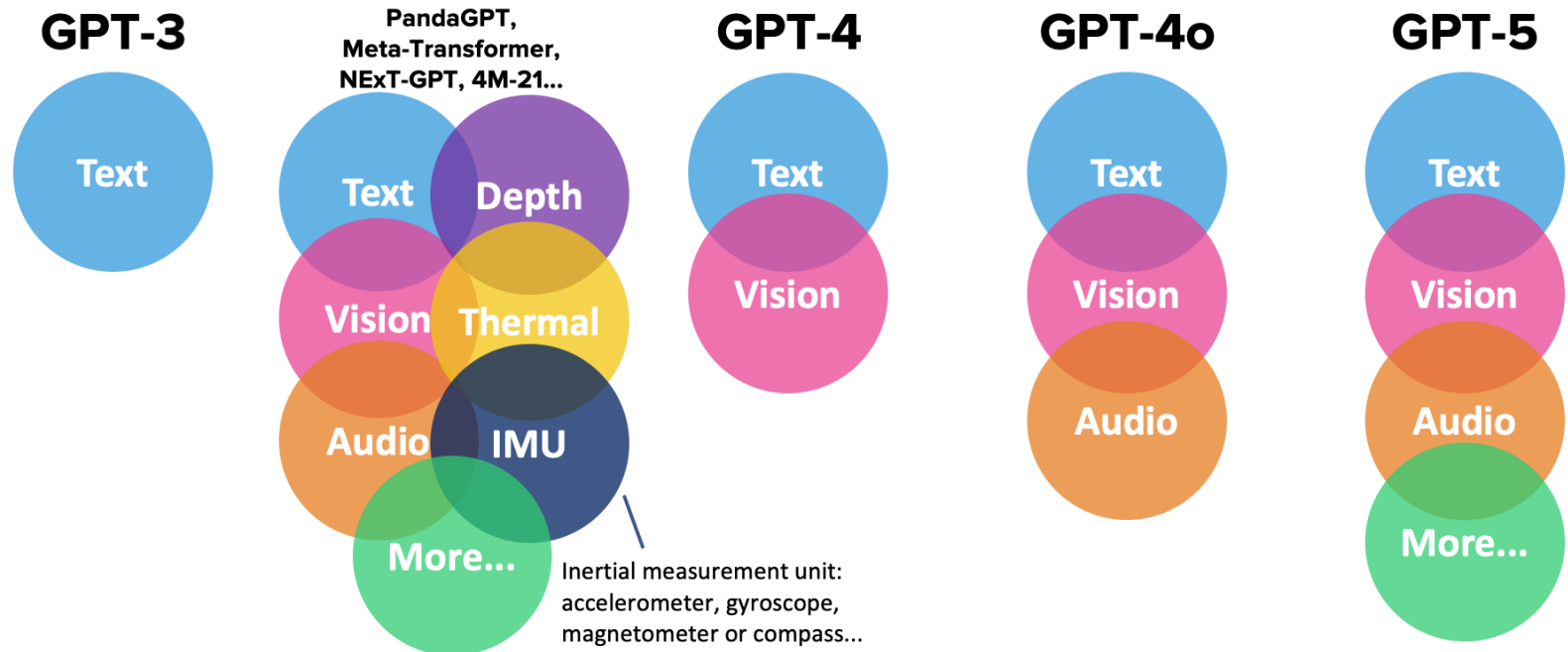
LLM Highlights

LARGE LANGUAGE MODEL HIGHLIGHTS (JUN/2024)



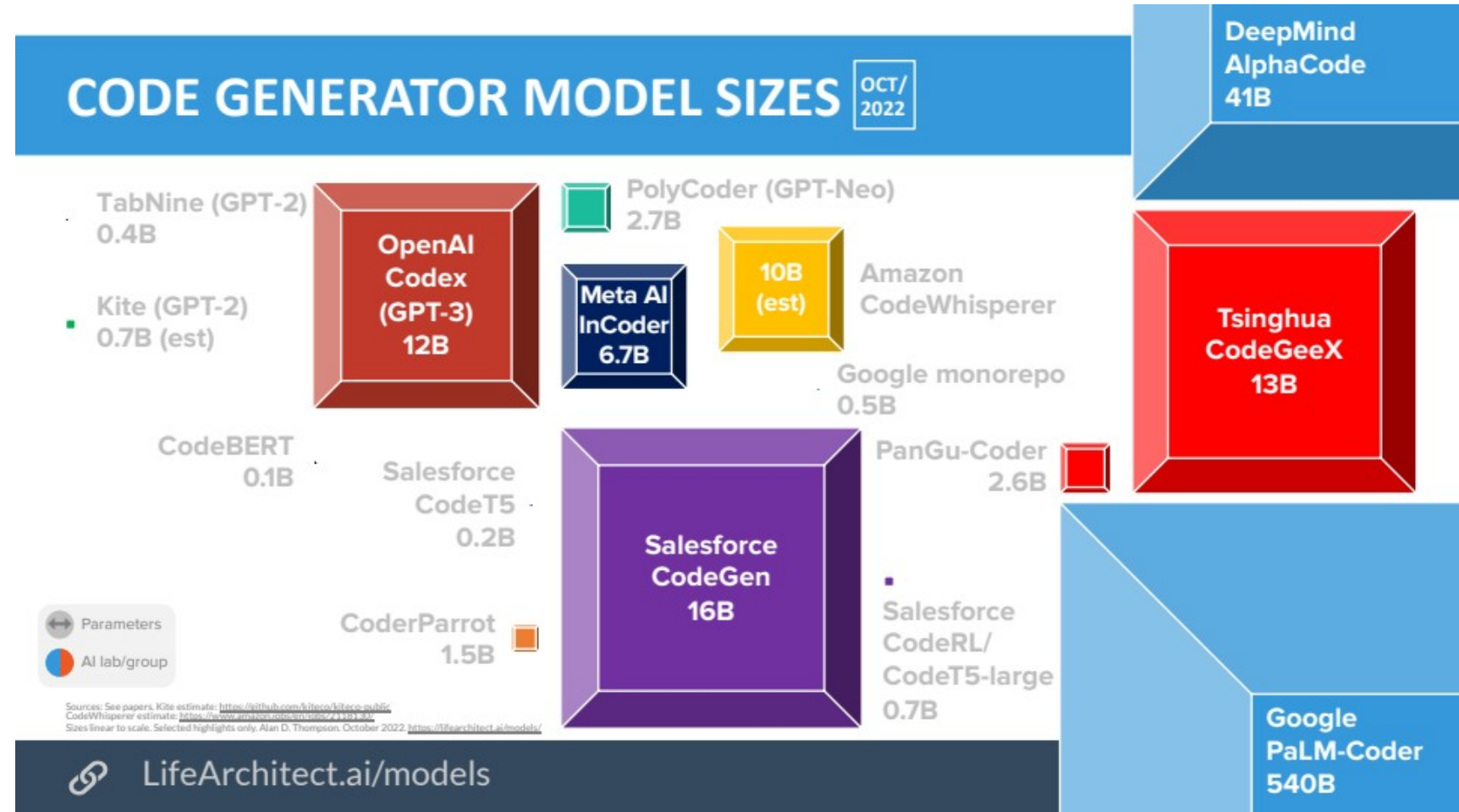
AI at Scale

GPT MODALITIES (2024)

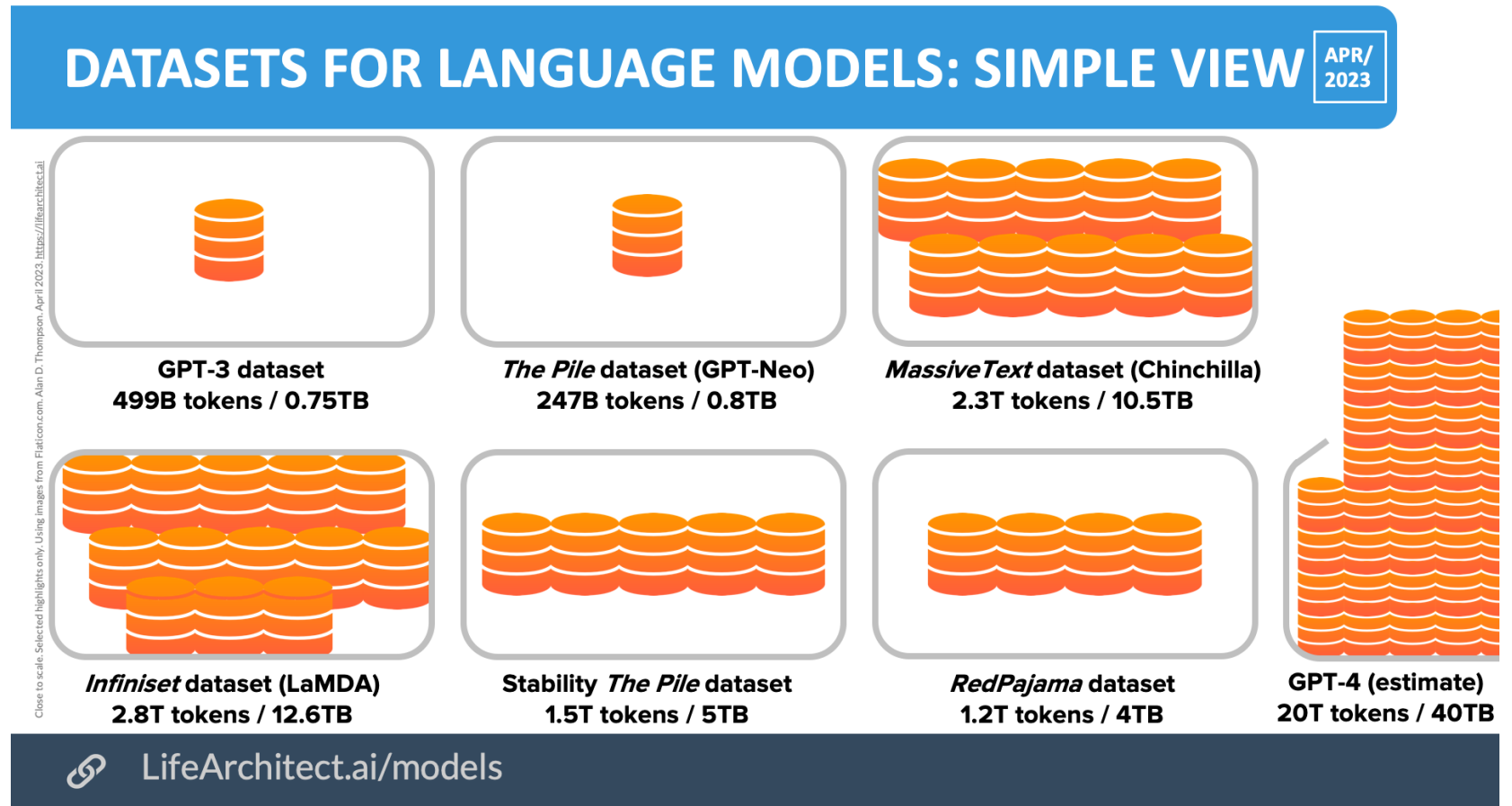


[LifeArchitect.ai/gpt-5](https://life architect.ai/gpt-5)

AI at Scale



GPT-4 Dataset



Quelle: <https://life architect.ai/models/>, Dr. Alan D. Thompson

Generative KI

CodeGen,
OpenAI Codex,
Copilot,
ChatGPT,
Devin,
Auto-GPT,
CodeGPT,
AlphaCode,
Tabnine
PolyCoder



how should i go about tidying up this room?

 Tidying up a room can be a daunting task, especially if it's cluttered. Here's a step-by-step guide to help you tidy up the room in the image:

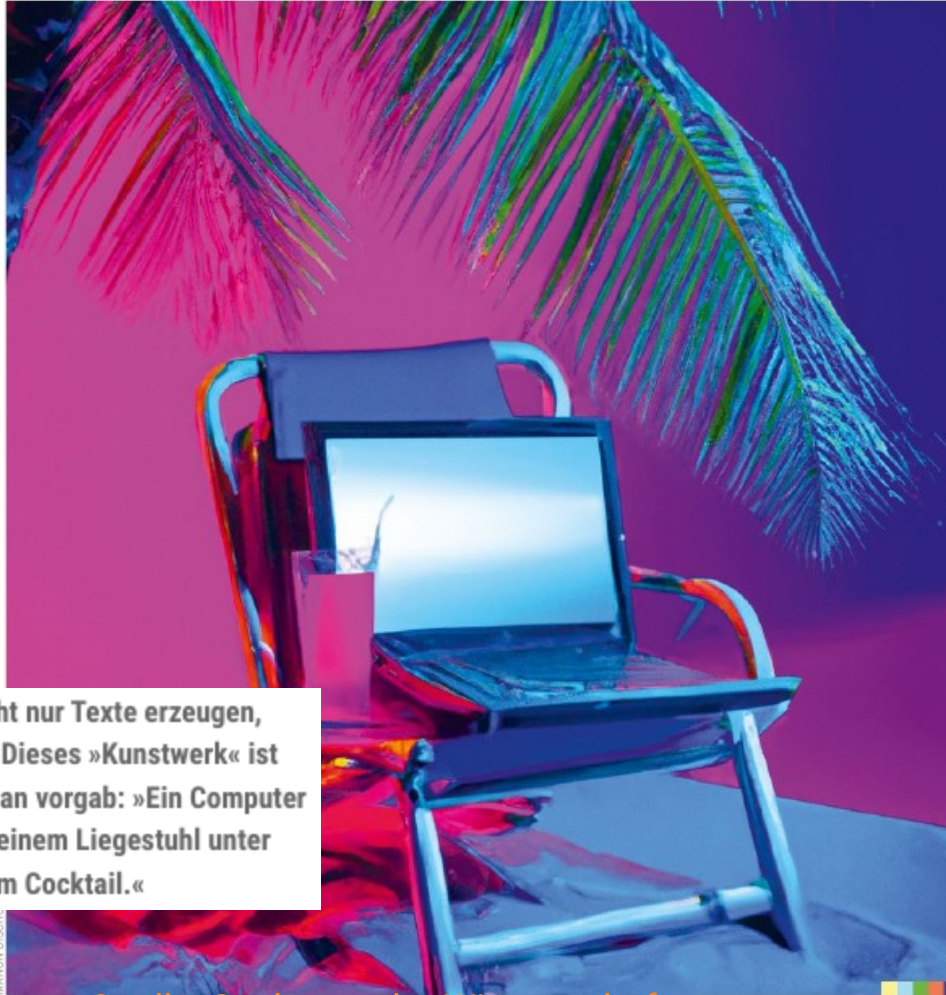
1. **Gather Supplies:** Before you start, gather some cleaning supplies like garbage bags or a bin, cleaning cloths, a vacuum or broom, and any necessary cleaning solutions.
2. **Create Zones:** Divide the room into zones. For example, in the picture, the zones could be the desk area, the bed area, and the floor space.
3. **Pick Up Trash:** Walk through the room and pick up any obvious trash. Throw it into the garbage bag or bin.
4. **Clear The Floor:** Start by picking up items from the floor. Place the shoes in the shoe rack or closet, hang the ironing board, and pick up any clothes.
5. **Make The Bed:** A made bed can instantly make the room look neater. Straighten the sheets and fluff the pillows.
6. **Tackle The Desk Area:**

[Regenerate response](#)

* Start by clearing off everything from the desk

Send a message 

Generative KI



DALL-E | KI kann nicht nur Texte erzeugen, sondern auch Bilder. Dieses »Kunstwerk« ist entstanden, indem man vorgab: »Ein Computer an einem Strand auf einem Liegestuhl unter einer Palme mit einem Cocktail.«



karakun

Quelle: Spektrum der Wissenschaft,
Ausgabe SdW Kompakt Künstliche Gespräche

Quelle: buffed (DALL-E)

Wie stellst du dich als KI selbst vor? Wie sieht dein Selbstporträt aus, DALL-E?



Das ist eine interessante und kreative Frage! Hier ist ein Vorschlag für mein Selbstporträt:

Prompt:

"Ein digitales Selbstporträt von DALL-E, einer KI, die Bilder generiert. Die Darstellung könnte ein abstrahiertes, futuristisches Gesicht oder eine Form sein, die Intelligenz und Kreativität symbolisiert. Elemente wie ein Netzwerk von leuchtenden Linien und Knoten könnten die neuronalen Netzwerke darstellen. Das Bild sollte in einem modernen, futuristischen digitalen Kunststil gehalten sein, mit einer Mischung aus Blau- und Violetttönen, um Technologie und Innovation zu symbolisieren."

Ich werde diesen Prompt jetzt in ein Bild umsetzen.

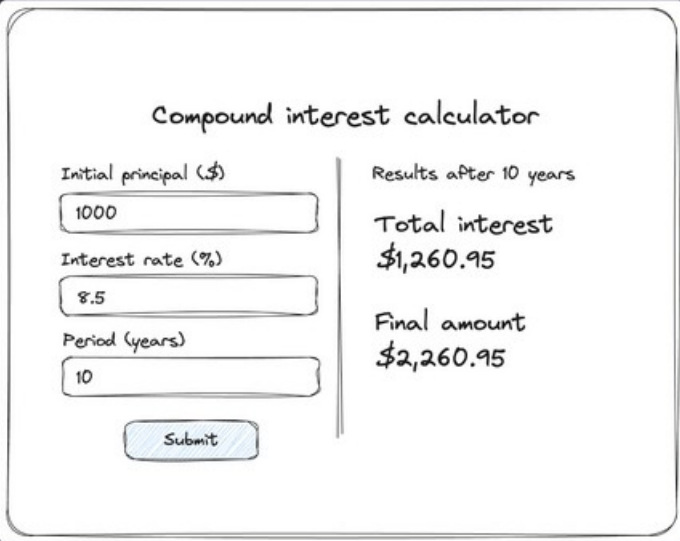
Bildbeschreibung für DALL-E:

"A digital self-portrait of DALL-E, an AI that generates images. The representation could be an abstract, futuristic face or form symbolizing intelligence and creativity. Elements like a network of glowing lines and nodes could represent neural networks. The image should be in a modern, futuristic digital art style, with a mix of blue and purple tones to symbolize technology and innovation."



Prototyp mit GPT-4

Model: GPT-4 with vision ALPHA



Can you help me write the code for this website?

Certainly! To create a simple website like the one depicted in the image, you can use HTML for the structure, CSS for styling, and JavaScript for the calculation logic.

Below is an example of how you can create the structure and functionality for this Compound Interest Calculator.

1. **HTML (index.html):** This is the main structure of your webpage.

html

Stop generating

Copy code

Send a message

ChatGPT may produce inaccurate information about people, places, or facts. [ChatGPT July 20 Version](#)

Model: GPT-4 with vision ALPHA

for the structure, CSS for styling, and JavaScript for the calculation logic.

Below is an example of how you can create the structure and functionality for this Compound Interest Calculator.

1. **HTML (index.html):** This is the main structure of your webpage.

html

Copy code

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta http-equiv="X-UA-Compatible" content="IE=edge">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <link rel="stylesheet" href="styles.css">
  <title>Compound Interest Calculator</title>
</head>
<body>
  <div class="calculator">
    <h1>Compound Interest Calculator</h1>
    <label for="principal">Initial principal ($):</label>
    <input type="number" id="principal" placeholder="1000">

    <label for="rate">Interest rate (%):</label>
    <input type="number" id="rate" placeholder="8.5">

    <label for="period">Period (years):</label>
    <input type="number" id="period" placeholder="10">

    <button onclick="ca<div>Regenerate response</div>ton>
```

Send a message

ChatGPT may produce inaccurate information about people, places, or facts. [ChatGPT July 20 Version](#)



Model: GPT-4 with vision

ALPHA

The image shows a 'Star Data Table' and a Hertzsprung-Russell (H-R) diagram. The table lists stars with their Absolute Magnitude, Apparent Magnitude, Temperature (K), and Distance (Light Years). The H-R diagram plots Absolute Magnitude against Spectral Class (O, B, A, F, G, K, M) and Temperature (K), showing regions for Supergiants, Giants, Main Sequence, and White Dwarfs.

Star	Absolute Magnitude	Apparent Magnitude	Temperature (K)	Distance (Light Years)
Sun	+5	-26.5	6,000	--
Spica	-3	+1	20,000	220
Sirius B	+12	+8	7,000	8.6
Aldebaran	-0.7	+0.9	4,500	68
Betelgeuse	-5.5	+0.8	3,300	650
Proxima Centauri	+15	+11	3,000	4.2

Transcribe the information from the 'Star Data Table' into a table and then explain how the diagram is helpful for astronomers.

T

Here's the information from the 'Star Data Table' transcribed into a more readable table format:

Star	Absolute Magnitude	Apparent Magnitude	Temperature (K)	Distance (Light Years)
Sun	+5		6,000	--

+

Send a message

...

ChatGPT may produce inaccurate information about people, places, or facts. [ChatGPT July 20 Version](#)

Here's the information from the 'Star Data Table' transcribed into a more readable table format:

Star	Absolute Magnitude	Apparent Magnitude	Temperature (K)	Distance (Light Years)
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Betelgeuse	-5.5	+0.8	3,300	650
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The diagram in the image is a Hertzsprung-Russell (H-R) diagram, which is extremely helpful for astronomers. Here's how:

- Star Classification:** The H-R diagram helps in classifying stars based on their luminosity, spectral type, color, temperature, and evolutionary stage. The main sequence, giants, supergiants, and white dwarfs are easily distinguishable.
- Understanding Stellar Evolution:** It provides insights into how stars evolve over time. For example, a star like the Sun will eventually move off the main sequence and become a red giant as it exhausts the hydrogen in its core.
- Estimating Distances:** By comparing a star's apparent magnitude with its absolute magnitude (as shown in the H-R diagram), astronomers can estimate its distance from Earth.
- Star Composition and Temperature:** The diagram shows the relationship between the temperature of stars and their luminosities. This helps astronomers infer the composition and age of the stars.

+

Send a message

...

Regenerate response

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Rina Diane Caballar is a Contributing Editor covering tech and its intersection

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Matthew S. Smith is a Contributing Editor for IEEE Spectrum and the former Lead Reviews Editor at Digital Trends.

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Rina Diane Caballar is a Contributing Editor covering tech and its intersections with science, society, and the environment.

No Need to Lift a Finger Anymore? Assessing the Quality of Code Generation by ChatGPT

Zhijie Liu, Yutian Tang, Xiapu Luo, Yuming Zhou, and Liang Feng Zhang



Article

Program Code Generation with Generative AIs

Baskhad Idrisov and Tim Schlippe * 

Article

Program Code Generation with Generative AIs

Baskhad Idrisov and Tim Schlippe * 

Wie korrekt, effizient und wartbar ist der Code? Safety und security?

Datensatz aus 126 AI-generierten and 18 Menschen-generierte Programmcodes —

the AI/Human-Generated Program Code Dataset—

<https://github.com/Back3474/AI-Human-Generated-Program-Code-Dataset>

Codex (GPT-3.0),

CodeWhisperer,

BingAI Chat (GPT-4.0),

ChatGPT (GPT-3.5),

Code Llama (Llama 2),

StarCoder,

InstructCodeT5+

Wrong Detail,

Misunderstanding Certain Content,

Misunderstanding Problem,

Compile Error,

Syntax Error,

Runtime Error,

Functionally Incorrect

Analyse von AI-generierten Code

Java, Python and C++

18 Coding Probleme von LeetCode
Niveau: leicht, medium und schwer

leetcode.com



KARAKUN Quelle Paper "Program Code Generation
with Generative AIs" B. Idrisov, T. Schlippe

Problem List < > ↺

Description Editorial Solutions (27.9K) Submissions

1. Two Sum

Easy 53.3K 1.8K ☆ ↺

Companies

Given an array of integers `nums` and an integer `target`, return *indices of the two numbers such that they add up to* `target`.

You may assume that each input would have **exactly one solution**, and you may not use the *same* element twice.

You can return the answer in any order.

Example 1:

Input: `nums = [2,7,11,15], target = 9`
Output: `[0,1]`
Explanation: Because `nums[0] + nums[1] == 9`, we return `[0, 1]`.

Example 2:

Input: `nums = [3,2,4], target = 6`
Output: `[1,2]`

Example 3:

Input: `nums = [3,3], target = 6`
Output: `[0,1]`

Constraints:

- `2 <= nums.length <= 104`
- `-105 <= nums[i] <= 105`
- `-105 <= target <= 105`
- Only one valid answer exists.**

Follow-up: Can you come up with an algorithm that is less than `O(n2)` time complexity?

Article

Program Code Generation with Generative AIs

Baskhad Idrisov and Tim Schlippe * 

Codex (GPT-3.0),
CodeWhisperer,
BingAI Chat (GPT-4.0),
ChatGPT (GPT-3.5),
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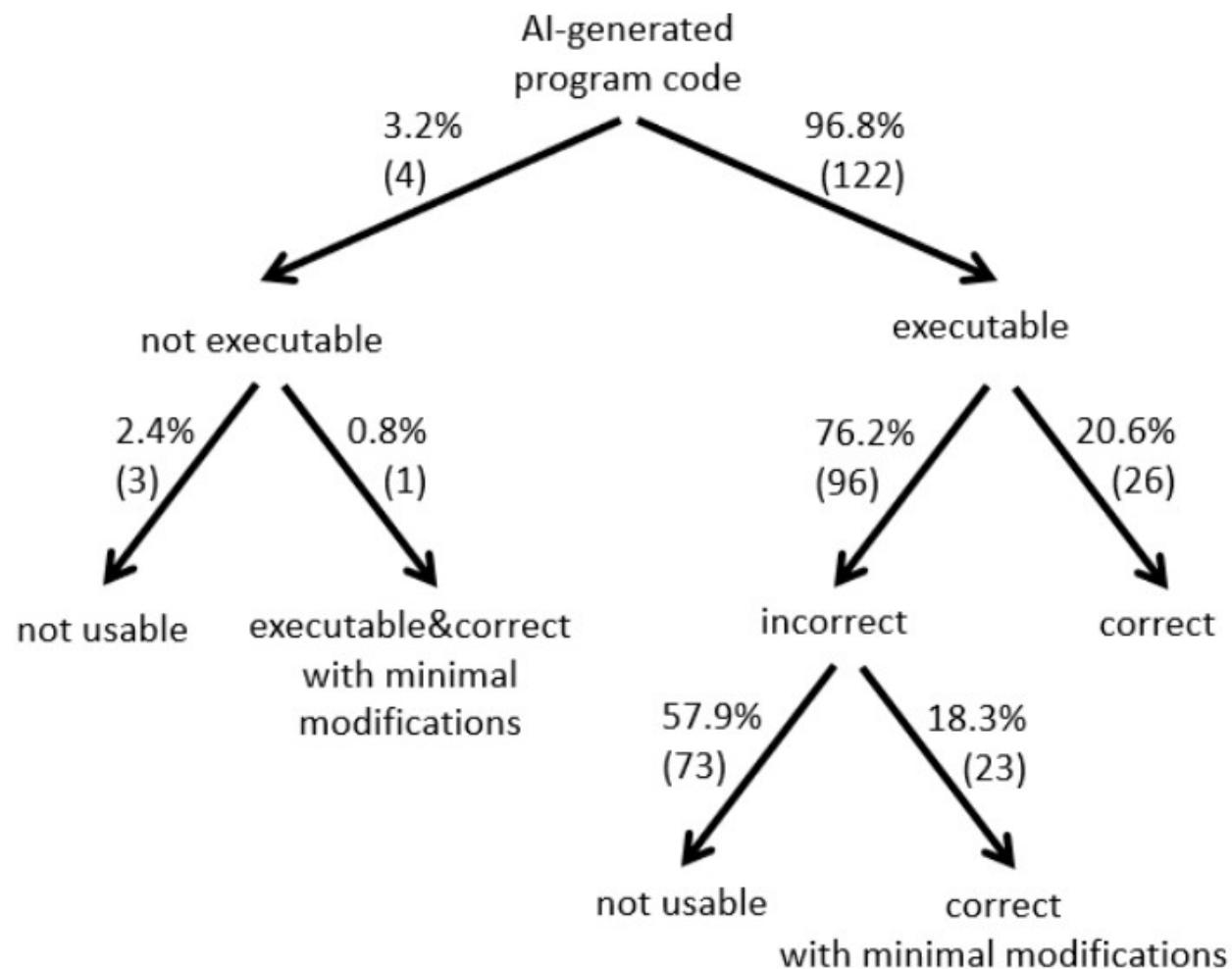


Figure 4. Distribution of AI-generated Codes.

2815. Max Pair Sum in an Array

Easy 276 95 ☆ ↻

Companies

You are given a **0-indexed** integer array `nums`. You have to find the **maximum** sum of a pair of numbers from `nums` such that the maximum **digit** in both numbers are equal.

Return the maximum sum or `-1` if no such pair exists.

Example 1:

Input: `nums = [51,71,17,24,42]`

Output: 88

Explanation:

For $i = 1$ and $j = 2$, `nums[i]` and `nums[j]` have equal maximum digits with a pair sum of $71 + 17 = 88$.

For $i = 3$ and $j = 4$, `nums[i]` and `nums[j]` have equal maximum digits with a pair sum of $24 + 42 = 66$.

It can be shown that there are no other pairs with equal maximum digits, so the answer is 88.

Example 2:

Input: `nums = [1,2,3,4]`

Output: -1

Explanation: No pair exists in `nums` with equal maximum digits.

Constraints:

- $2 \leq \text{nums.length} \leq 100$
- $1 \leq \text{nums}[i] \leq 10^4$

Hint ↻

solve the following problem with java code. Class name: Solution, Method name: `maxSum(int[] nums)`.

You are given a 0-indexed integer array `nums`. You have to find the maximum sum of a pair of numbers from `nums` such that the maximum digit in both numbers are equal.

Return the maximum sum or -1 if no such pair exists.

Example 1:

Input: `nums = [51,71,17,24,42]`

Output: 88

Explanation:

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It can be shown that there are no other pairs with equal maximum digits, so the answer is 88.

Example 2:

Input: `nums = [1,2,3,4]`

Output: -1

Explanation: No pair exists in `nums` with equal maximum digits.

Constraints:

- $2 \leq \text{nums.length} \leq 100$
- $1 \leq \text{nums}[i] \leq 10^4$

Program Code Generation with Generative AIs

Baskhad Idrisov and Tim Schlippe * 

Table 3. Correct Solutions (Java | Python | C++): Generative AI vs. *human*.

	Easy		Medium		Hard		Total
	#1 J P C	#2 J P C	#3 J P C	#4 J P C	#5 J P C	#6 J P C	J P C Σ
ChatGPT (GPT-3.5)	— — ✓	— ✓ ✓	— — —	— — —	— — —	— ✓ —	0 2 2 4
Bing AI (GPT-4.0)	— ✓ ✓	✓ ✓ ✓	— ✓ ✓	— ε —	— ε —	— — —	1 3 3 7
GH Copilot (GPT-3.0)	✓ — ✓	✓ ✓ ✓	✓ — ✓	✓ — ✓	— — —	— — —	4 1 4 9
StarCoder	— — —	✓ — —	— — —	— — —	— — —	— — —	1 0 0 1
CodeWhisperer	— — —	— — —	— — —	— — —	ε — —	— — —	0 0 0 0
Code Llama (Llama 2)	— — —	✓ ✓ ✓	✓ — —	— — —	— ε —	— — —	2 1 1 4
InstructCodeT5+	— — —	— ✓ —	— — —	— — —	— — —	— — —	0 1 0 1
<i>human</i>	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	6 6 6 18

Program Code Generation with Generative AIs

Baskhad Idrisov and Tim Schlippe * 

Table 4. Lines of Code (Java | Python | C++): Generative AI vs. *human*.

	Easy			Medium			Hard		
	#1	#2	#3	#4	#5	#6			
	J P C	J P C	J P C	J P C	J P C	J P C	J P C	J P C	J P C
ChatGPT (GPT-3.5)	— — 18	— 8 11	— — —	— — —	— — —	— — —	— 10 —		
Bing AI (GPT-4.0)	— 13 19	11 8 11	— 7 9	— — —	— — —	— — —	— — —		
GH Copilot (GPT-3.0)	19 — 20	11 8 14	10 — 10	45 — 21	— — —	— — —	— — —		
StarCoder	— — —	12 — —	— — —	— — —	— — —	— — —	— — —		
CodeWhisperer	— — —	— — —	— — —	— — —	— — —	— — —	— — —		
Code Llama (Llama 2)	— — —	12 8 12	10 — —	— — —	— — —	— — —	— — —		
InstructCodeT5+	— — —	— 8 —	— — —	— — —	— — —	— — —	— — —		
<i>human</i>	18 9 12	15 8 9	11 13 11	10 10 10	69 43 60	20 16 23			
best AI vs. <i>human</i> (Δ in %)	−5 −31 −33	+36 0 −18	+10 +86 +22	−78 — −52	— — —	— +60 —			

Program Code Generation with Generative AIs

Baskhad Idrisov and Tim Schlippe * 

Table 6. Time Complexity (Java | Python | C++): Generative AI vs. *human*.

	Easy									Medium									Hard								
	#1			#2			#3			#4			#5			#6											
	J	P	C	J	P	C	J	P	C	J	P	C	J	P	C	J	P	C									
ChatGPT (GPT-3.5)	—	—	n	—	n ²	n ²	—	—	—	—	—	—	—	—	—	—	n ^k	k	—								
Bing AI (GPT-4.0)	—	nlogn	n ² k	n ²	n ²	n ²	—	n ²	n ²	—	—	—	—	—	—	—	—	—	—								
GH Copilot (GPT-3.0)	n ² m	—	n k	n ²	n ²	n ²	n ²	—	n ²	n	—	n	—	—	—	—	—	—	—								
StarCoder	—	—	—	n ²	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—								
CodeWhisperer	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—								
Code Llama (Llama 2)	—	—	—	n ²	n ²	n ²	n ²	—	—	—	—	—	—	—	—	—	—	—	—								
InstructCodeT5+	—	—	—	—	n ²	—	—	—	—	—	—	—	—	—	—	—	—	—	—								
<i>human</i>	nm +nlogn +d	n	n	n ²	n ²	n	logn	logn	nlogn	n	n	n	nlogn +mlog (logm)	nlogn													
best AI vs. <i>human</i> (<i>h</i>)	AI	<i>h</i>	—	—	—	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	—	<i>h</i>	—	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>								

Table 7. Space Complexity (Java | Python | C++): Generative AI vs. *human*.

	Easy		Medium		Hard	
	#1 J P C	#2 J P C	#3 J P C	#4 J P C	#5 J P C	#6 J P C
ChatGPT (GPT-3.5)	— — 1	— n n	— — —	— — —	— — —	— k —
Bing AI (GPT-4.0)	— n 1	n n n	— 1 1	— — —	— — —	— — —
GH Copilot (GPT-3.0)	1 — k	n n n	1 — 1	1 — 1	— — —	— — —
StarCoder	— — —	n — —	— — —	— — —	— — —	— — —
CodeWhisperer	— — —	— — —	— — —	— — —	— — —	— — —
Code Llama (Llama 2)	— — —	n n n	1 — —	— — —	— — —	— — —
InstructCodeT5+	— — —	— n —	— — —	— — —	— — —	— — —
<i>human</i>	n n 1	n n n	n n n	1 1 1	n + m	n n n
best AI vs. <i>human</i> (<i>h</i>)	AI — —	— — —	AI AI AI	— — —	h h h	h AI h

Table 8. Runtime (Java | Python | C++): Generative AI vs. *human*.

	Easy						Medium						Hard					
	#1			#2			#3			#4			#5			#6		
	J	P	C	J	P	C	J	P	C	J	P	C	J	P	C	J	P	C
ChatGPT (GPT-3.5)	—	—	16	—	37	4	—	—	—	—	—	—	—	—	—	—	*	—
Bing AI (GPT-4.0)	—	126	42	3	49	8	—	*	*	—	—	—	—	—	—	—	—	—
GH Copilot (GPT-3.0)	4	—	23	3	47	3	*	—	*	5	—	209	—	—	—	—	—	—
StarCoder	—	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CodeWhisperer	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Code Llama (Llama 2)	—	—	—	3	55	13	*	—	—	—	—	—	—	—	—	—	—	—
InstructCodeT5+	—	—	—	—	33	—	—	—	—	—	—	—	—	—	—	—	—	—
human	9	107	11	3	51	0	107	1 k	213	2	365	234	390	7 k	718	46	1 k	458
best AI vs. human (Δ in %)	+125	−15	−31	0	+55	−100	—	—	—	−60	—	+12	—	—	—	—	−100	—

* correct, but *Time Limit Exceeded* on LeetCode.

Generative KI

Tasks

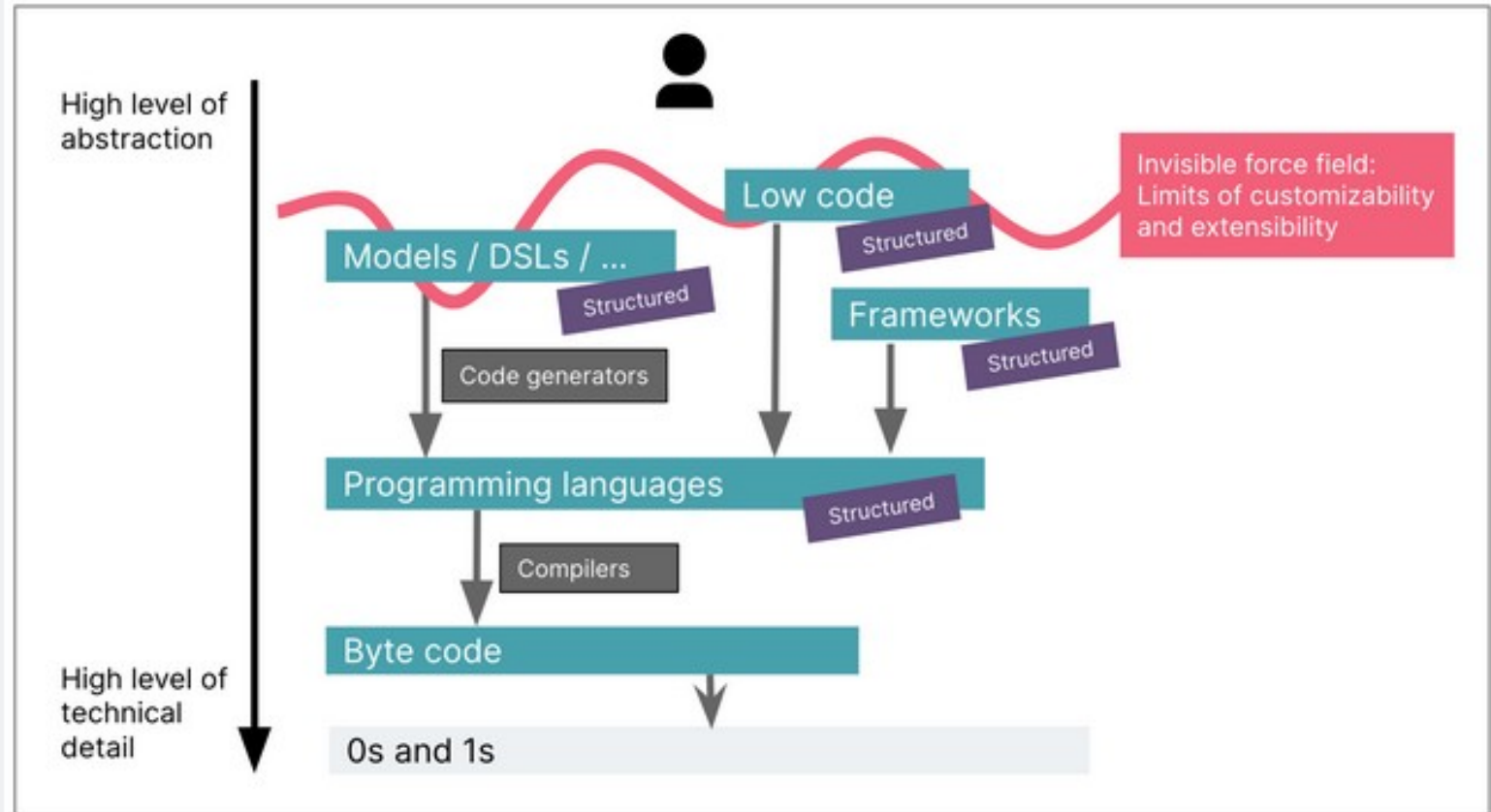
- Infos finden, schnell
- und im Kontext
- Code generieren
- Code erklären
- Code transformieren
- Tests schreiben
- Code optimieren
- generierten Code ausführen
- und debuggen
-



Tool	Tasks	Interaction	Prompt composition	Model	Origin / Hosting
<u>GitHub Copilot</u>	Code generation	In-line assistance	Composed by IDE extension	Trained with code, vulnerability filters	Commercial
<u>GitHub Copilot Chat</u>	All of them	Chat	Composed of user chat + open files	Trained with code	Commercial
<u>ChatGPT</u>	All of them	Chat	All done by user	Trained with code	Commercial
<u>GPT Engineer</u>	Code generation	CLI	Prompt composed based on user input	Choice of OpenAI models	Open Source, connecting to OpenAI API
"Team AIs"	All of them	Web UI	Prompt composed based on user input and use case	Most commonly with OpenAI's GPT models	Maintained by a team for their use cases, connecting to OpenAI APIs
<u>Meta's CodeCompose</u>	Code generation	In-line assistance	Composed by editor extension	Model fine-tuned on internal use cases and codebases	Self-hosted

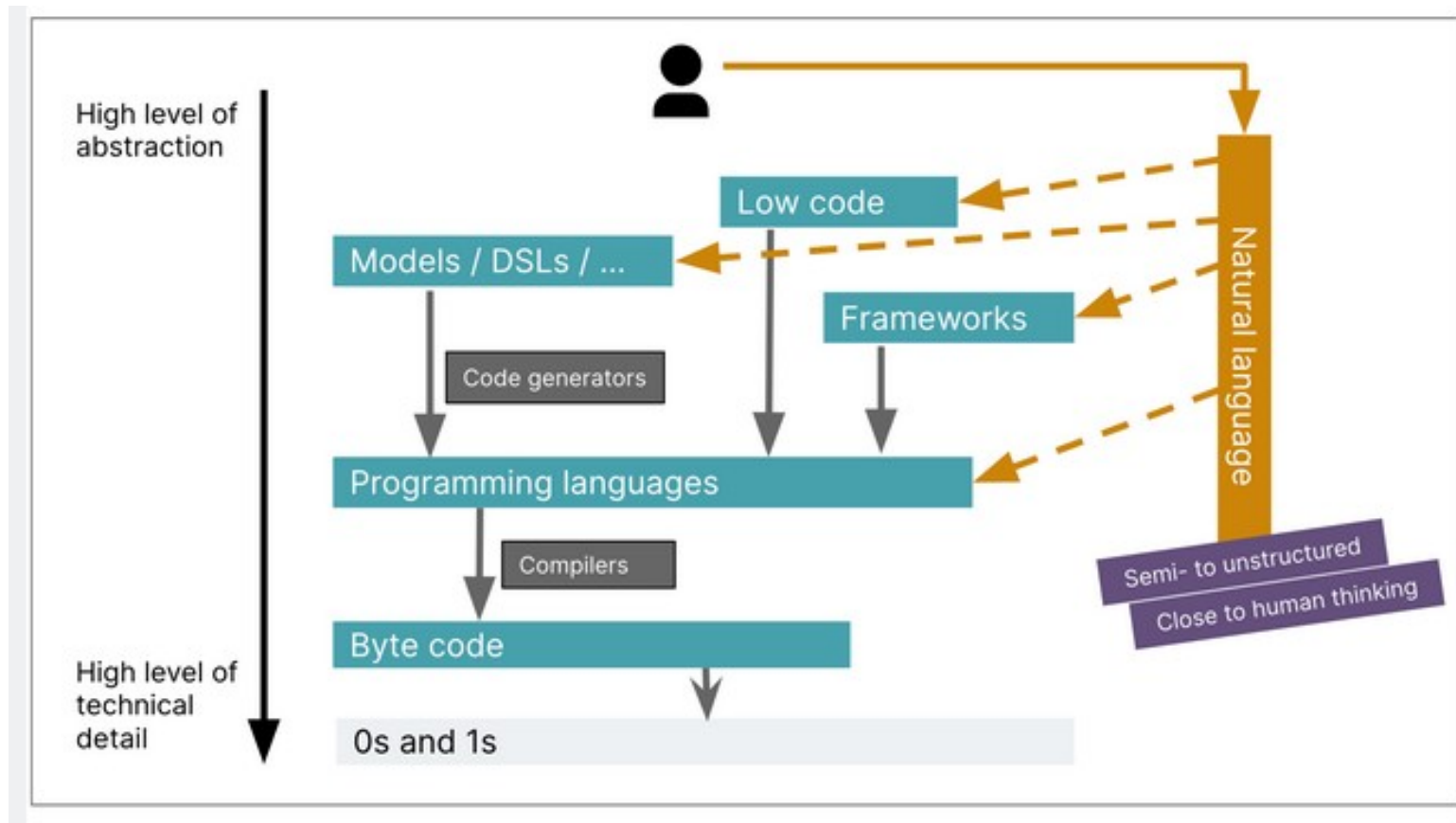
Unterschied zwischen Generativer AI und Code Generatoren

- Modelle dienen als Vertrag
- Modelle können auf unterschiedlichen Systemen für die Code-Generierung verwendet werden (Schnittstellenbeschreibung -> Client/Server)
- Modellsprache nicht intuitiv und ggf. schwer erlernbar
- Erzeugter Code kann nur über Modellanpassung modifiziert werden



Unterschied zwischen Generativer AI und Code Generatoren

- Natürlichsprachliche Anweisungen/Eingabe von Bildern
- Modelle können aber sehr mächtig sein. Nichtdeterminismus.
- Kein Erlernen zusätzlicher Modellsprache notwendig
- Es fehlt die Modellebene, die zwischen Entwicklern und Systemen austauschbar ist



10 Things Software Developers should learn about learning?

Papier von Neil C.C. Brown, Felienn F.J. Hermans, and Laurien E.Margulieux

» key insights

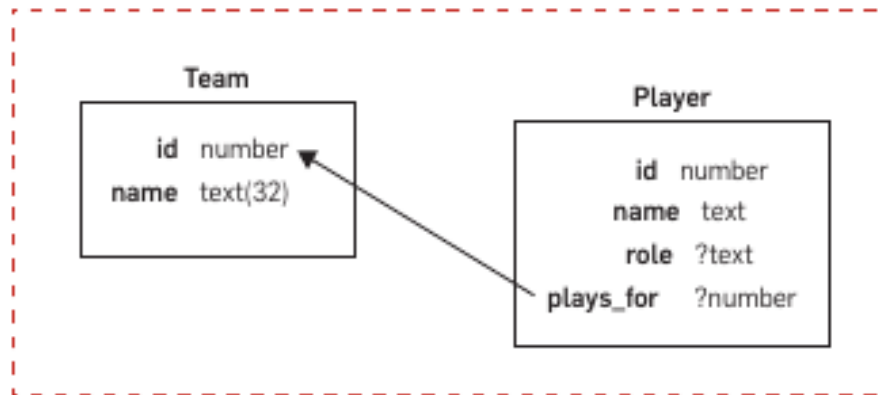
- Learning is vital for programmers, but the human mind works quite differently than a computer.
- Understanding how humans learn can help you learn more effectively.
- The Internet and LLMs have not made learning obsolete; learning is essential and takes time.
- Expertise changes how you think, letting you solve problems more easily but also potentially hindering your ability to teach.



Human memory is not made of bits

Two ways of presenting the same database schema description with differing extraneous cognitive load

The dashed box on the left contains exactly the same information as the awkward textual description in the dashed box on the right. But if a developer only received one of the two to create an SQL database, they are likely to find the diagram easier than the text. We say that the text here has a higher extraneous cognitive load.



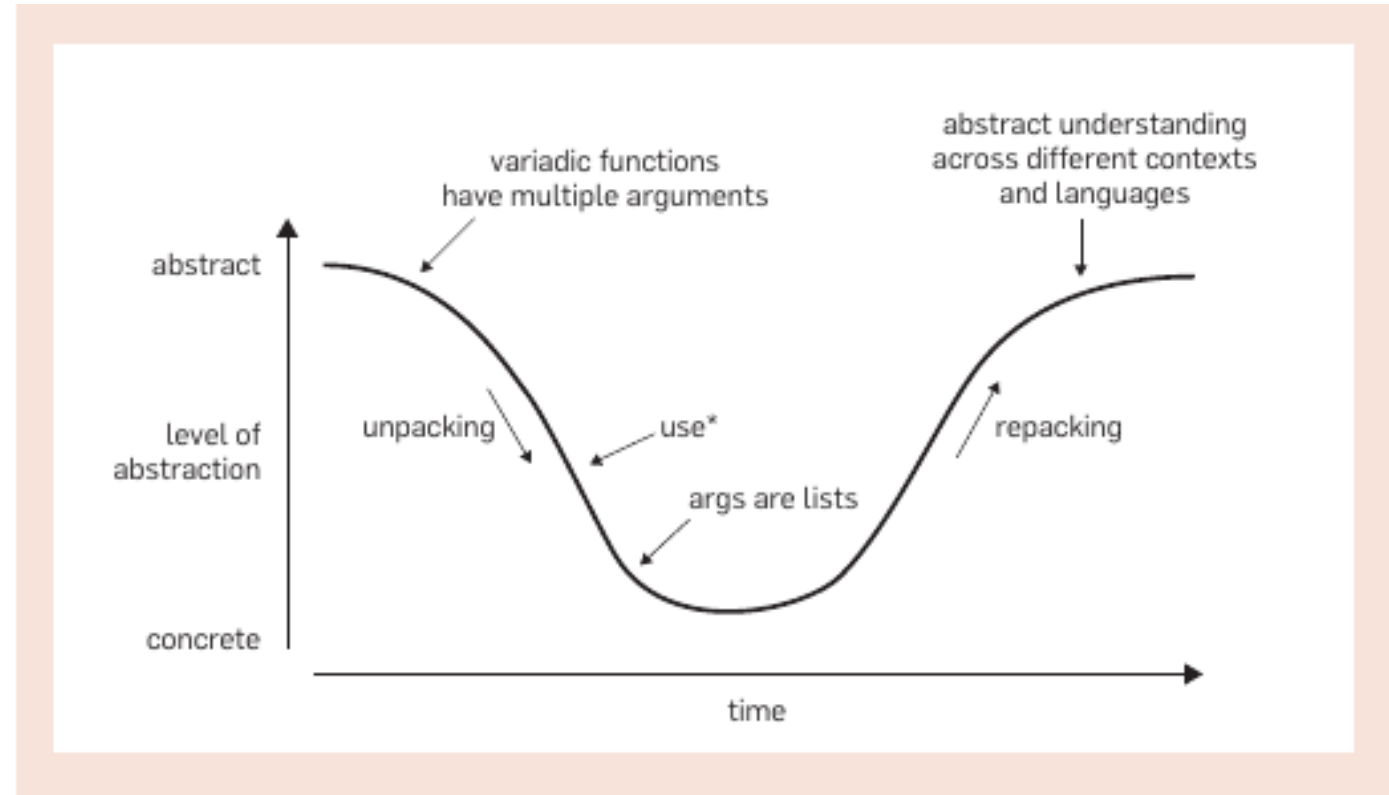
compared
to

A team should have an id and a name. The name should be a text, the id should be numeric. The name should have a maximum length, which is 32. There are also players: a player should have an id (which, like teams, should be numeric), a name (that is text, but unlimited in length), and role (although the role can be missing), and a plays_for which has the numeric id of their team. This link to the team can be missing.

Expert developers vs Juniors

Experts can reason at a higher level by having memorized common patterns in program code, which frees up their cognition

Understanding a concept goes from abstract to concrete and back



The Internet and LLMs have not made learning obsolete

Why is it worth learning details – or anything at all – if the knowledge is available from the Internet within seconds?

- The key distinction between a beginner who has never learned the details and thus lacks the memory connections, and an expert who has learned the deeper structure but searches for the forgotten fine details
- Searching the Internet and ChatGPT
 - the information was remembered less well
 - worse recall of the same information later, compared to first trying to think of the answer before resorting to searching
 - issue with cognitive load → switching between tasks, searching, and evaluating an AI-generated result

Pairprogramming ist unersetzbar (noch)

Benefits and purposes of Pair Programming

1+1 > 2	Flow	Avoid waste	Continuous Integration
• Knowledge sharing • Helps you get unstuck • Onboarding • Combine tactical and strategic modes of thinking	• Keeping each other focussed • Keep team's WIP (work in process") low	Pairing helps mitigate some of the "7 wastes of software development" (> M.&T. Poppendieck) • Partially Done Work • Extra Features • Relearning • Handoffs • Delays • Task Switching • Defects	(= developers integrate their work multiple times a day) • Code review on-the-go and just-in-time • Foster collective code ownership • Make frequent integration practices like trunk-based development possible



"[working in pairs,] you can criticise each other, and find each other's errors, and use the best ideas" Jean Bartik, ENIAC programmer

Practice skills needed on highly effective teams

Concentration

Time management

Empathy

Feedback

Task organisation

Communication

Benefits summarised from:

<https://www.youtube.com/watch?v=1C61GIBx6Yw>

<https://martinfowler.com/articles/on-pair-programming.html>

**Vielen Dank für
Ihre Aufmerksamkeit!**



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