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AI IMPACT 2024  
40<sup>th</sup> Annual FPC Seminar + Expo  
Sept 29 - Oct 1, 2024

# The Intersection of Artificial Intelligence (AI) and Architecture

**Course Number:** AHCA 2024.03

Credit Designation: 1 LU/HSW

AIA CES Provider Number: E240

*September 30, 2024*



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# 1

OBJECTIVE

Understand the Integration of AI in healthcare design: Grasp how advancements in AI, including Large Language Models and 3D Computer Vision, are being used in healthcare architectural design to improve the safety of patients, staff and visitors.

# 2

OBJECTIVE

Explore AI's Latest Advancements: Gain insight into the cutting-edge developments in AI technology and their applications within the healthcare design.

# 3

OBJECTIVE

Apply best practices for effectively integrating AI and automation into the senior living design process, while considering the real-world development and construction challenges.

# 4

OBJECTIVE

Assess the potential benefits and considerations of utilizing AI and automation in addressing design process challenges such as speed to market, staff support, code compliance, and QA/QC management in senior living environments.

# Key words

to Know before application

## HALLUCINATION

How can I ensure that the generation is based on a source of truth? Does this limit my range of tasks?

## FINE-TUNED

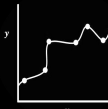
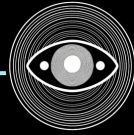
Is it better than a more general off-the-shelf model? If fine-tuning is required, do I have the specific data I want it to emulate?

## CLASSIFICATION

Does this task require identifying something within a piece of data? If so, how complex is the object that needs to be identified?

## BIAS

Is there a direction that the predictions are consistently steering towards?



## SCALE

Relationship Between Model Size, Dataset Size, and the Need for More Data with More Parameters

## ACCURACY

What is considered "good enough" for your application? Is 90% accuracy sufficient, or do you require 99%?

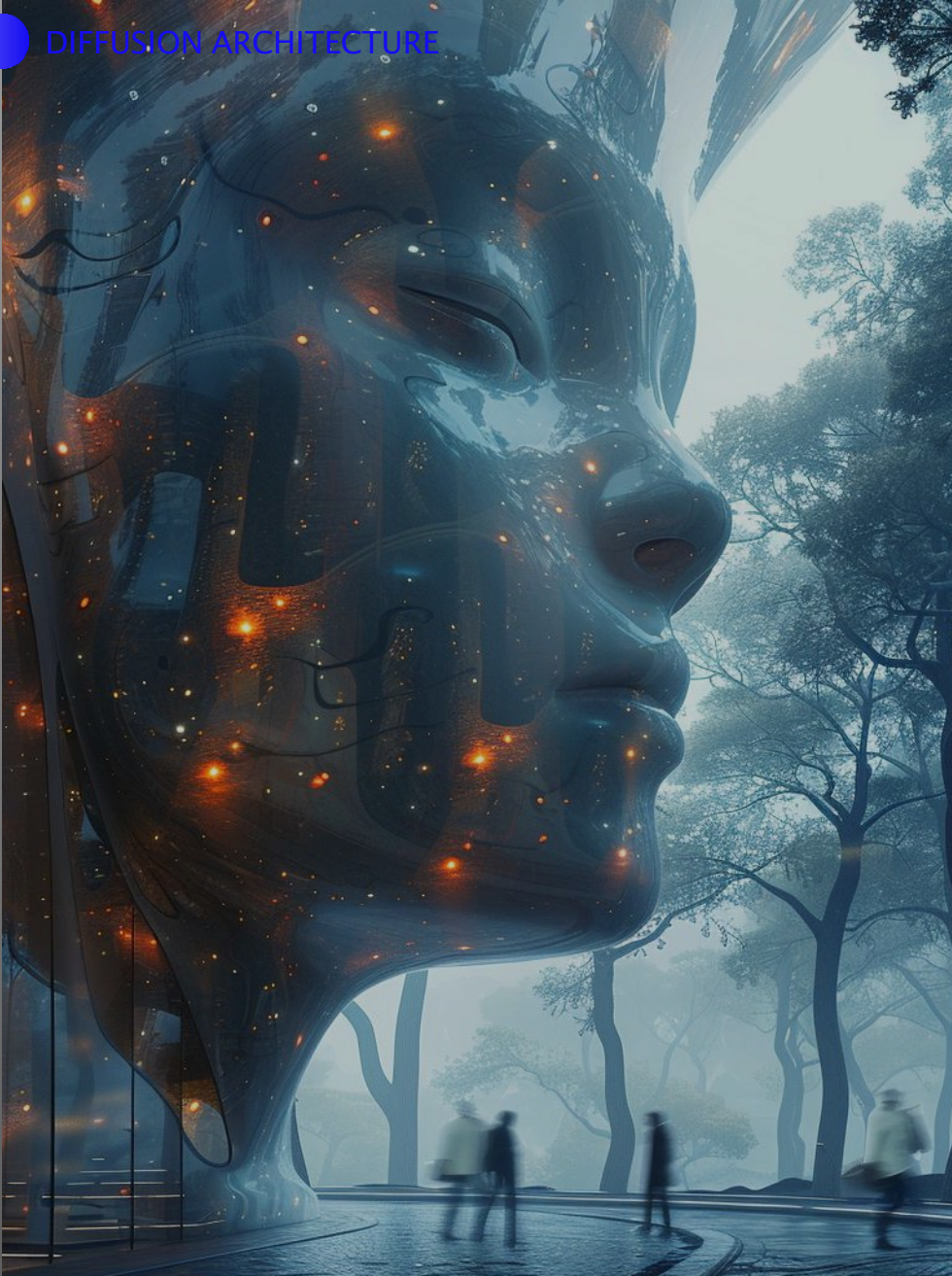
## GENERATION

What am I generating? Is it text, an image, or a plan? How precise does it need to be?

## AUTOMATION

It sounds good, but what exactly is it? Is it simply a loop over a repeatable task?





# Table of Contents

- 01 **AI context**
  - Current events
  - LLM & Computer vision?
- 02 **AI and Architecture**
- 03 **“Healthcare” Current Applications**

# AI Context

## Current Events

What has been happening in **Generative AI**?



a drawing of a giraffe

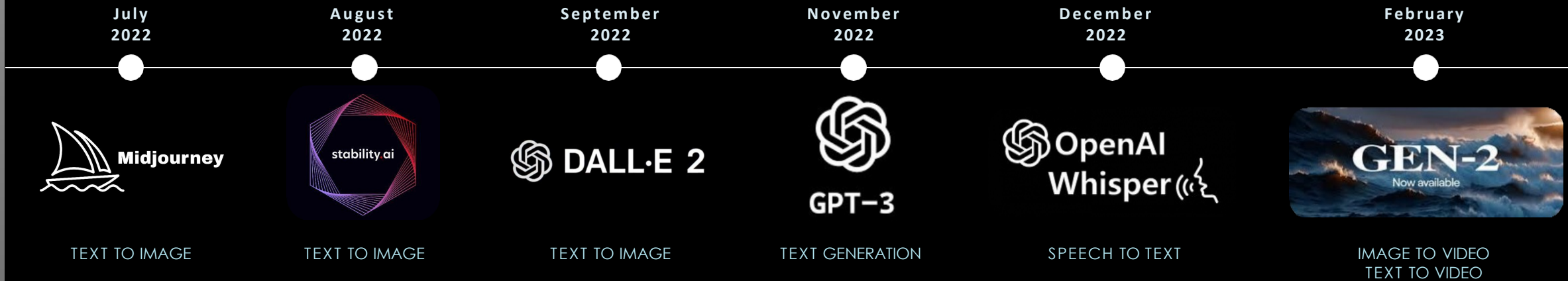


a photo of a dress



a painting of a truck

# Going Mainstream



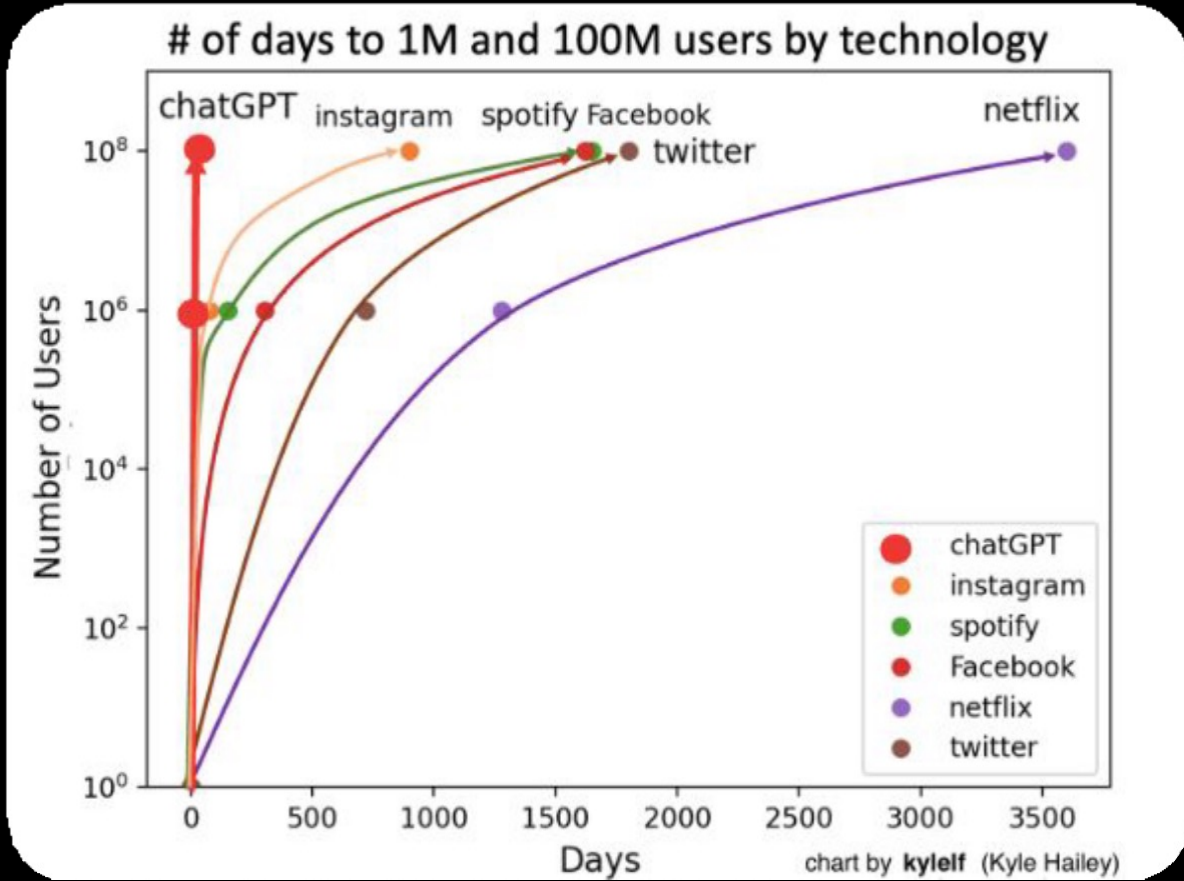
\*

**Generative AI** is a type of AI that is trained on data. It can create new content and ideas including text, images, videos, and code.



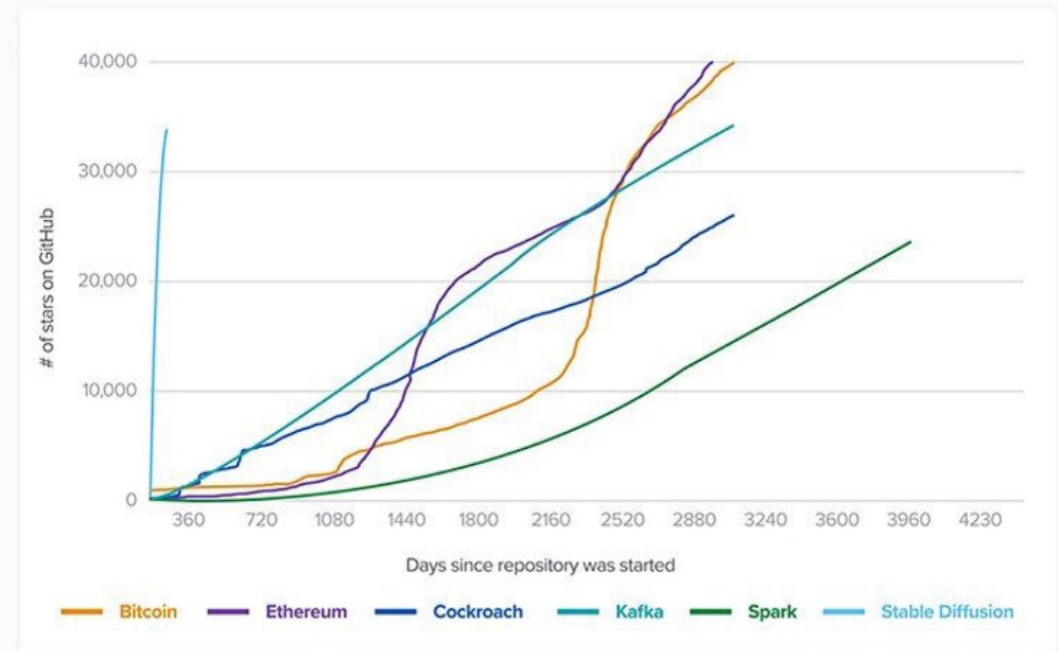
# The hype

Fast user adoption to know before application



source: <https://johnnosta.medium.com/the-most-important-chart-in-100-years-1095915e1605>

## Stable Diffusion Developer Adoption



Stars on GitHub for major open source infrastructure technologies. Stable Diffusion accumulated 33,600 stars in its first 90 days, a benchmark other projects achieve in years or decades.

Source: GitHub

aloz Enterprise

source: <https://stability.ai/news/stable-diffusion-v2-release>

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# Improvement

Midjourney

August  
2022



July  
2023



June  
2024



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# Beyond Images

Midjourney to LUMA



June  
2024



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# World Models

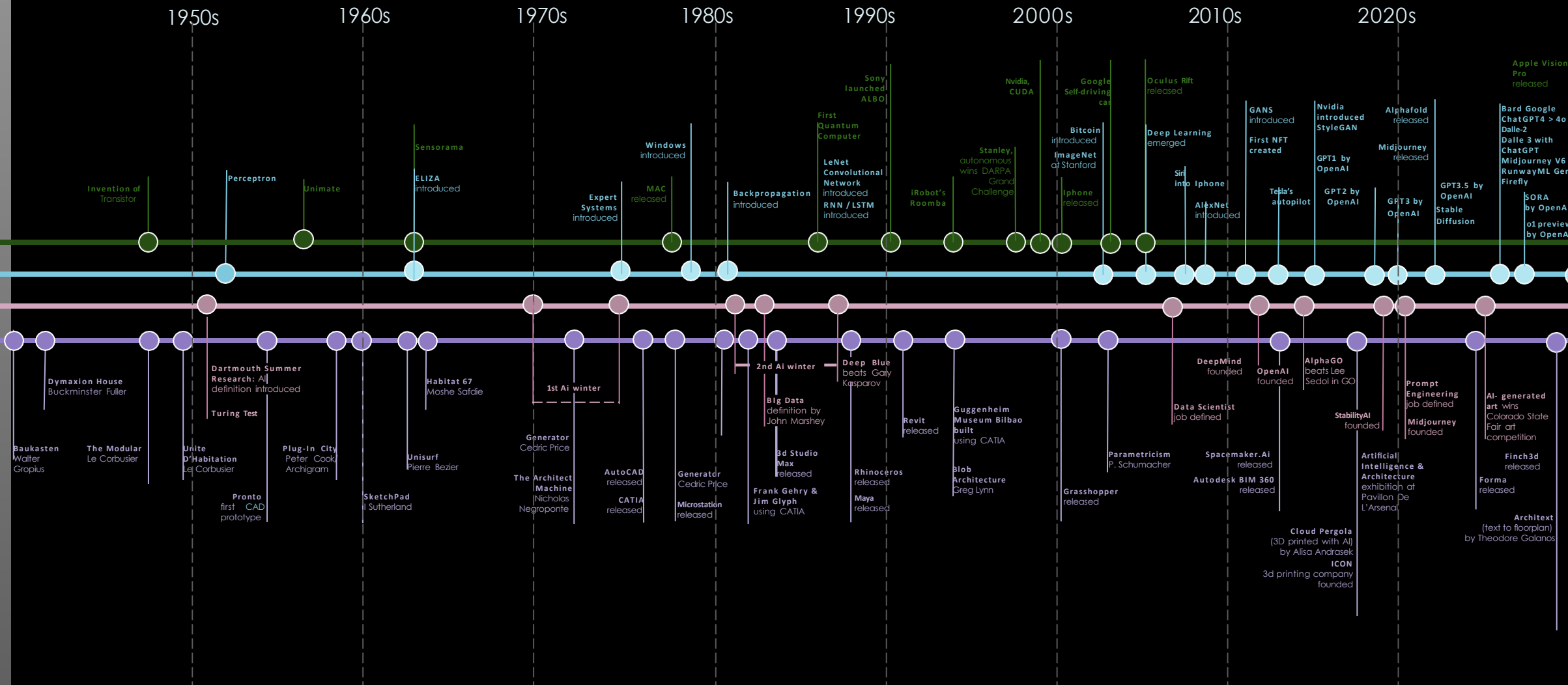
Can Ai understand the causal relationships in real world



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Hardware / Product  
Software/ Algorithm/ Model  
Event / Definition  
Architecture

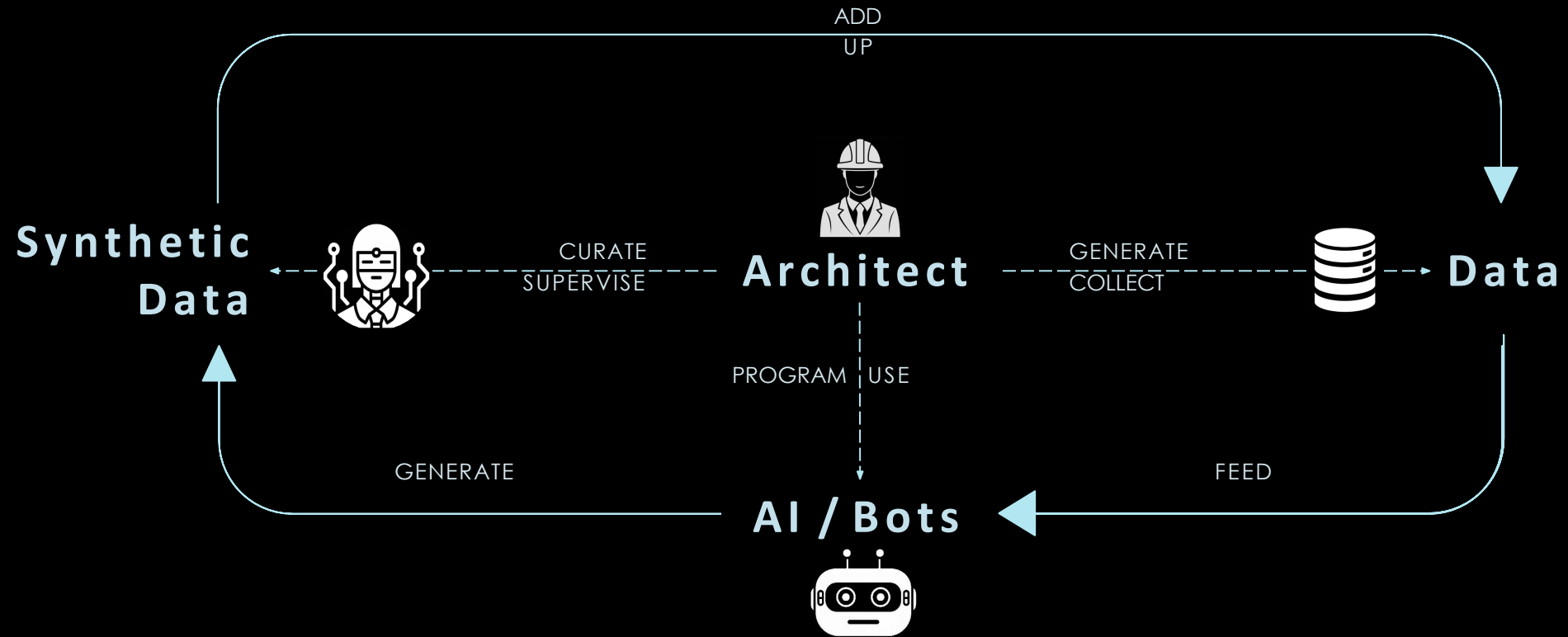


source:  
diffusionarchi  
tecture.com  
Synthetic  
Architecture  
Presentation

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# Architects Augmented



source: [diffusionarchitecture.com](https://diffusionarchitecture.com) Synthetic Architecture Presentation

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# AI Context

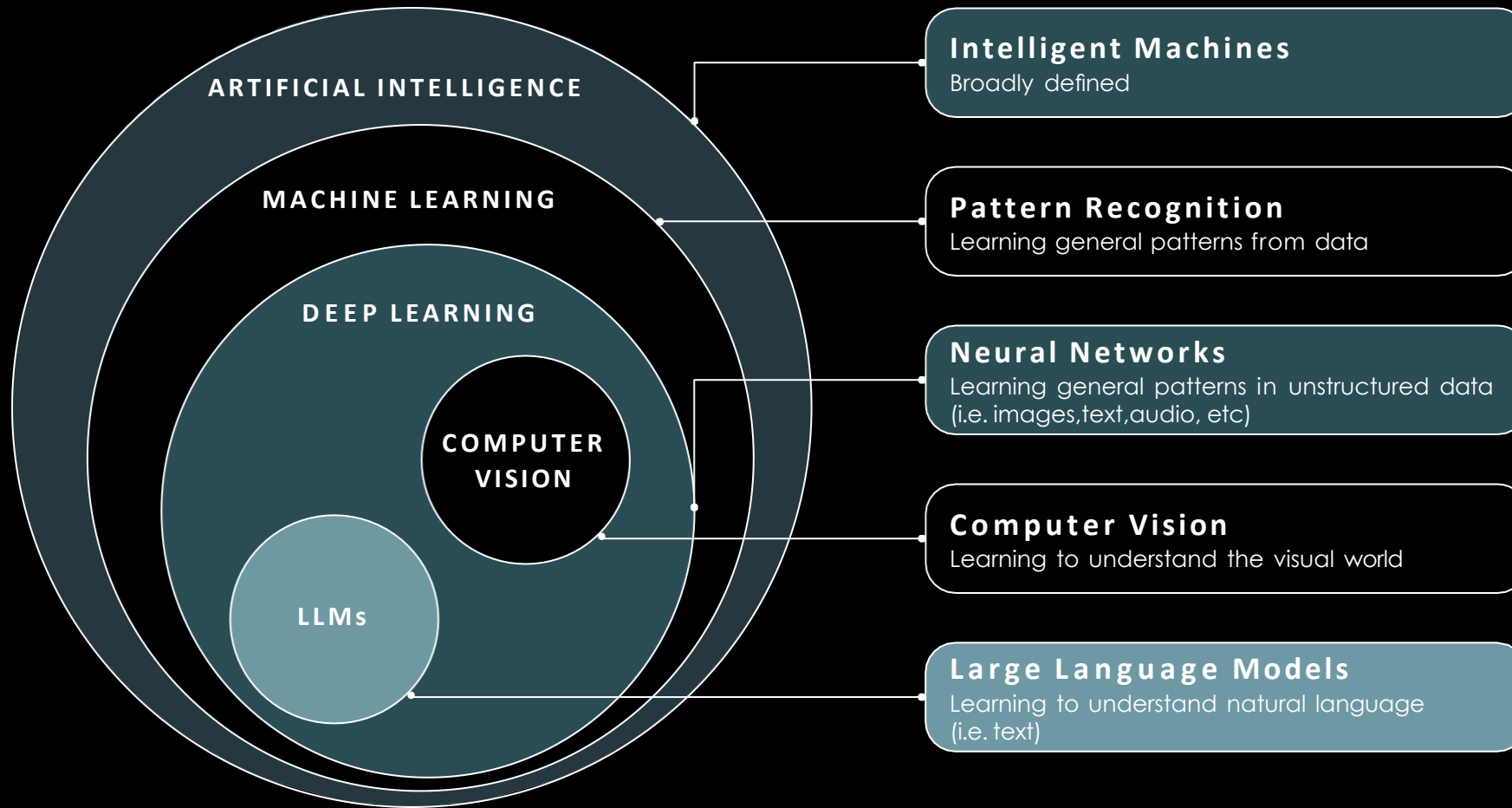
Current Events

How Large Language Models & Computer vision work?



# LLM & Computer Vision

How they work?



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# Converging Trend

Talk to any type of data

LANGUAGE



VISION



reasoning with images



**Q:** Can you explain the meme?

**A:** The meme depicts a man's reaction to the price of a computer graphics card. In the first image, the man is smiling and appears excited about the product. In the second image, he is shocked and disappointed by the high price of the graphics card, which is \$1,200. The meme is a playful representation of the contrast between the man's initial enthusiasm and his subsequent disappointment upon learning the cost of the product.



**Q:** What is unusual about this image?

**A:** The unusual aspect of this image is that a chair is flying through the air on a highway, seemingly coming out of the back of a truck.

**Q:** What should you do if you encounter this?

**A:** If you encounter this situation, you should immediately stop your vehicle and move to a safe distance from the truck and the flying chair. It is essential to avoid any potential hazards and contact the authorities to report the incident and ensure the safety of everyone involved.



**Q:** Photo 1, at 10:30 am: <img1>

Photo 2, at 12:45 pm: <img2>

Photo 3, at 3:45 pm: <img3>

What did I have for lunch, and what time was it?

**A:** I had a sandwich for lunch, and it was at 12:45 pm.



**Q:** What happens to the man after hitting the ball?

**A:** After hitting the ball, the man falls down onto the grass.

**Q:** Why does the man fall to the grass?

**A:** The man falls to the grass because he is swinging his golf club too hard, causing him to lose his balance and fall.

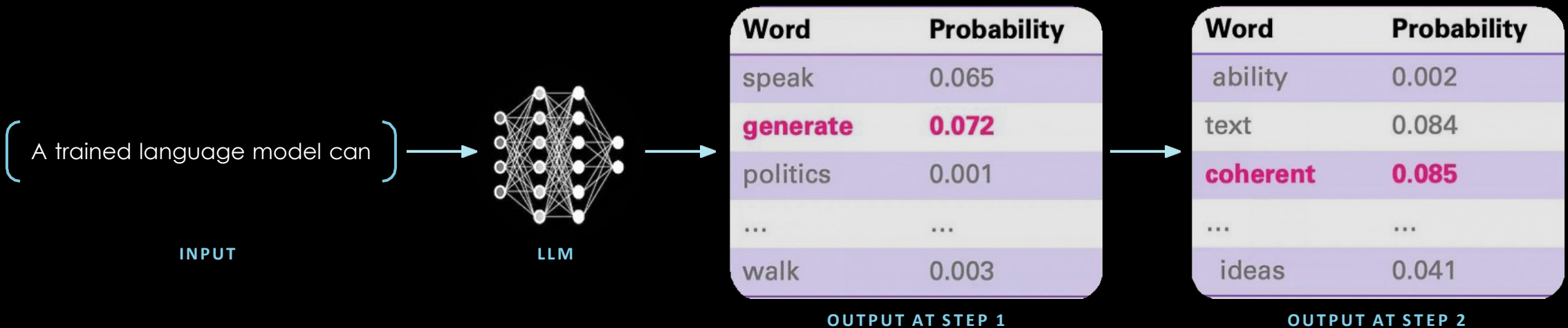
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# Natural Language Generation

Predict the next word

## After training

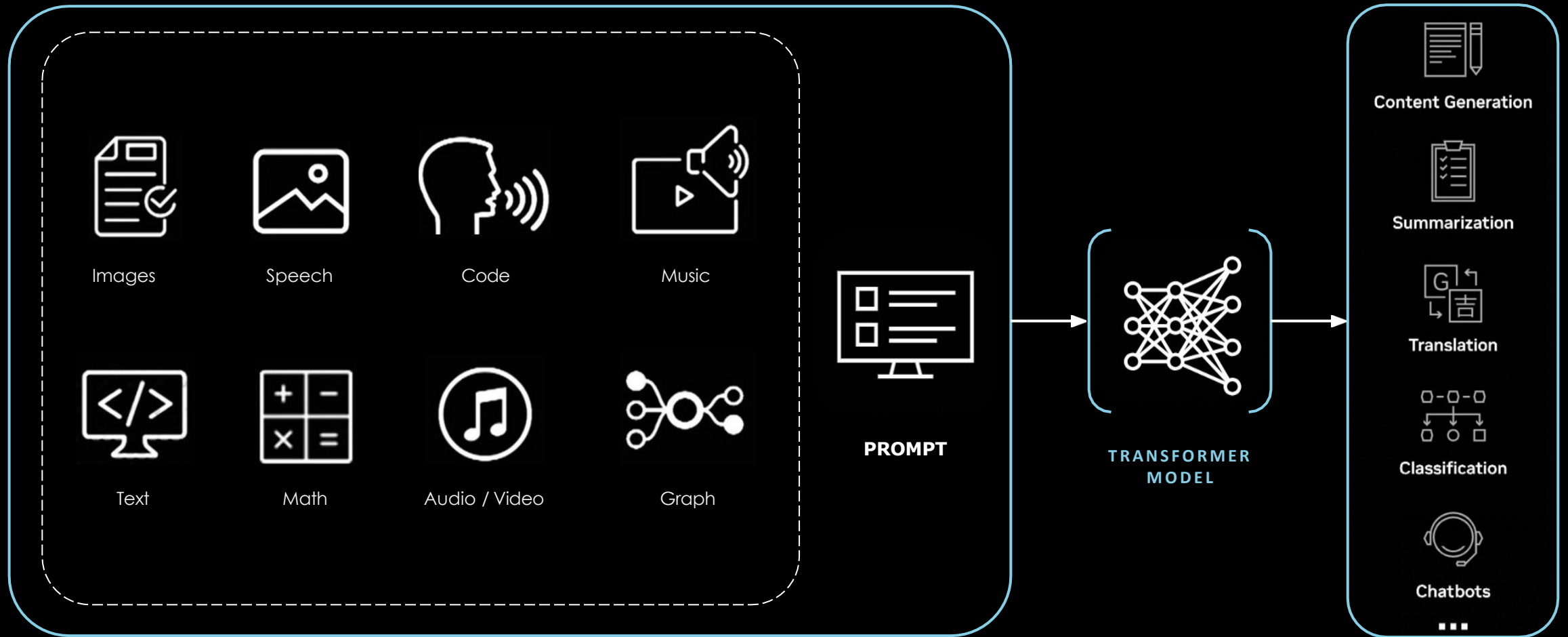
We can generate text by predicting one word at a time



\* **LLMs** are an example of what's called "**Generative AI**"

# Large Language Model

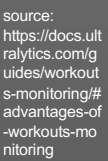
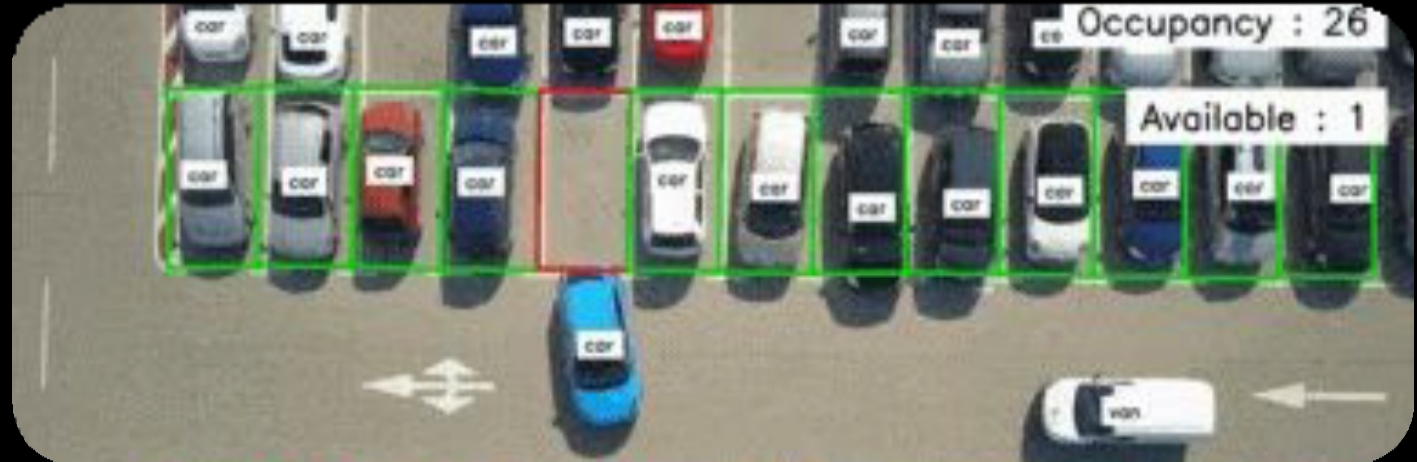
To AI everything will be a "language"



source:  
<https://www.nvidia.com/en-us/glossary/large-language-models/>



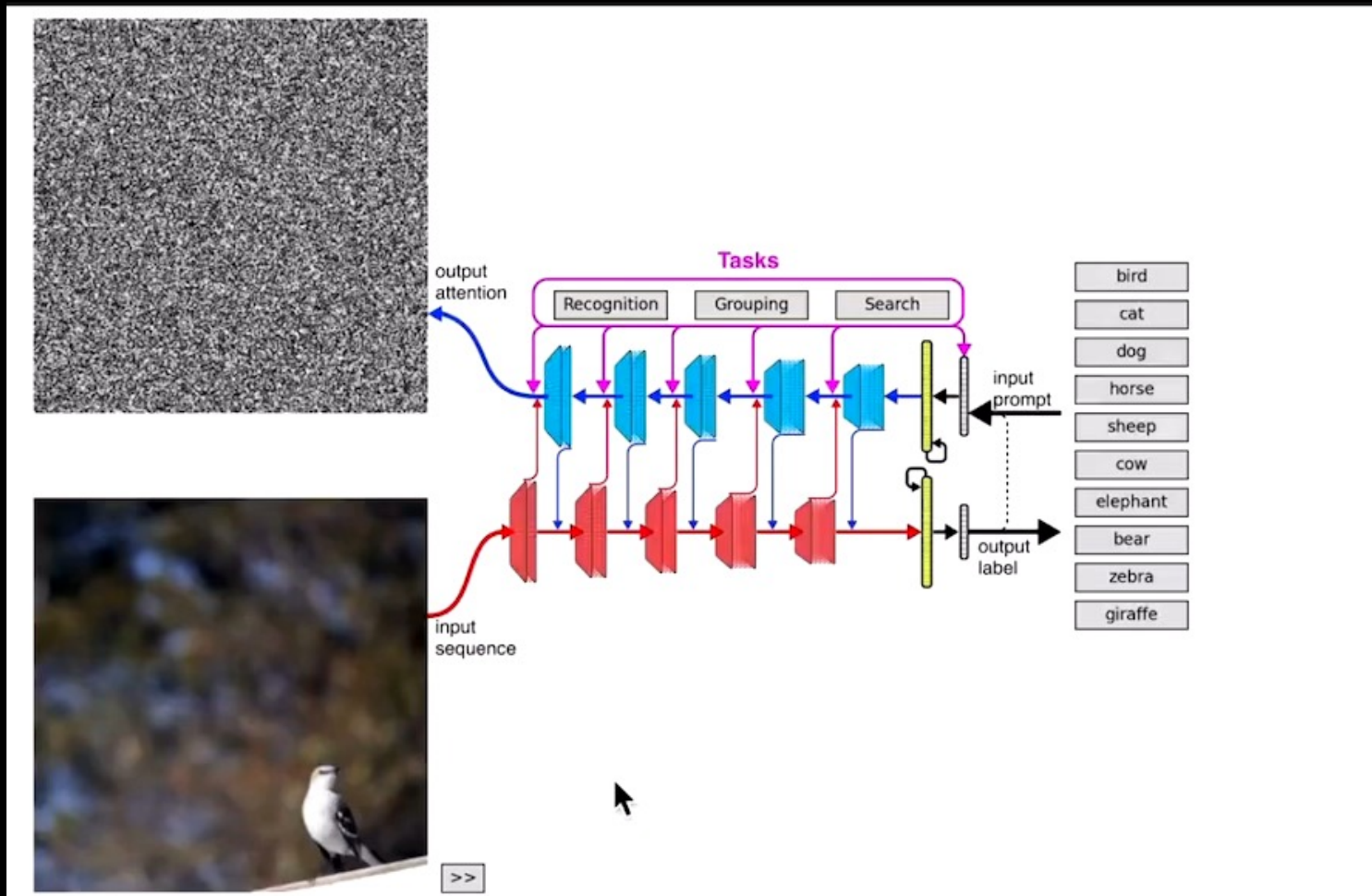
## Classification , Identification, Pose estimation



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# Computer Vision

Bundling of tasks



source:  
Modeling  
Attention and  
Binding in the  
Brain through  
Bidirectional  
Recurrent  
Gating

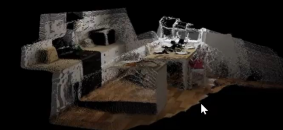


# 3D Computer Vision

reconstruction , 3D Generation



CITY SCALE



ROOM SCALE

source: <https://research.nvidia.com/labs/toronto-ai/nerfvl/>

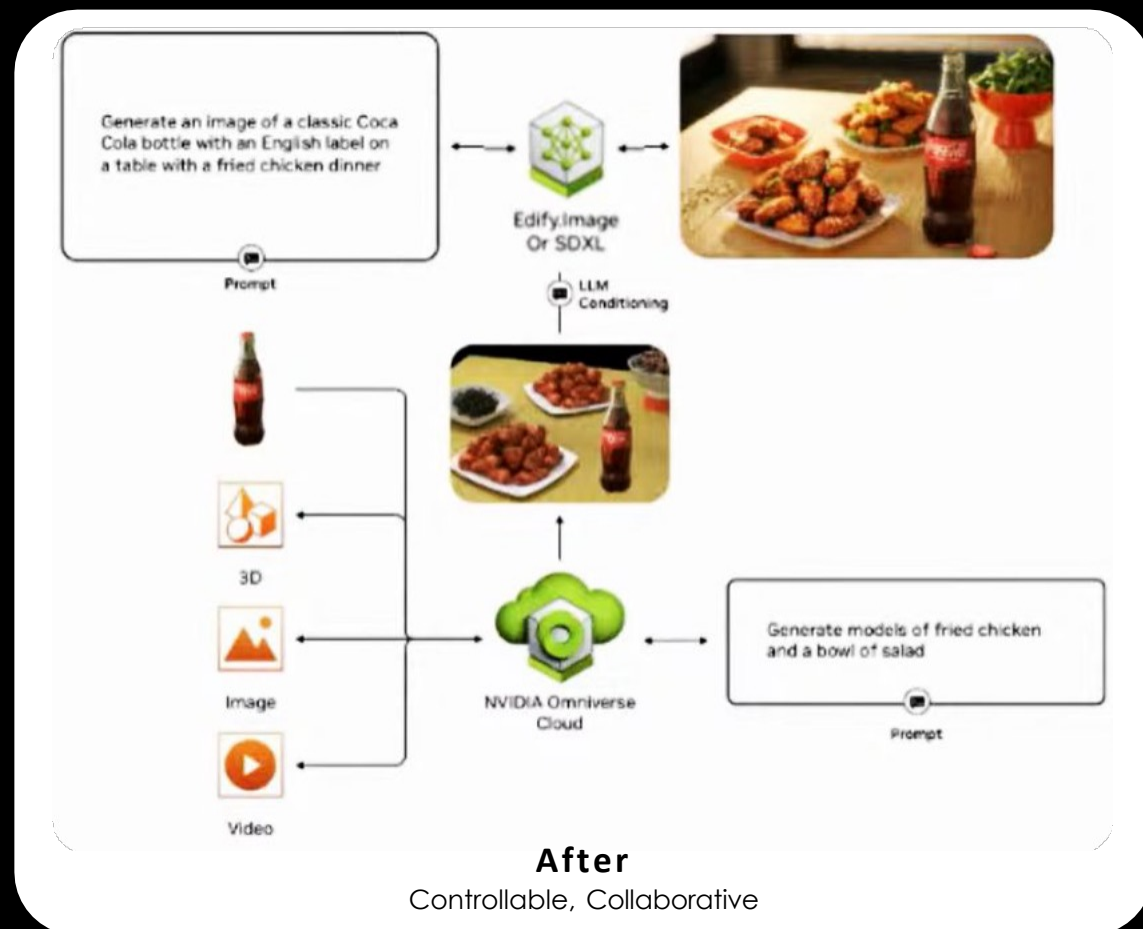
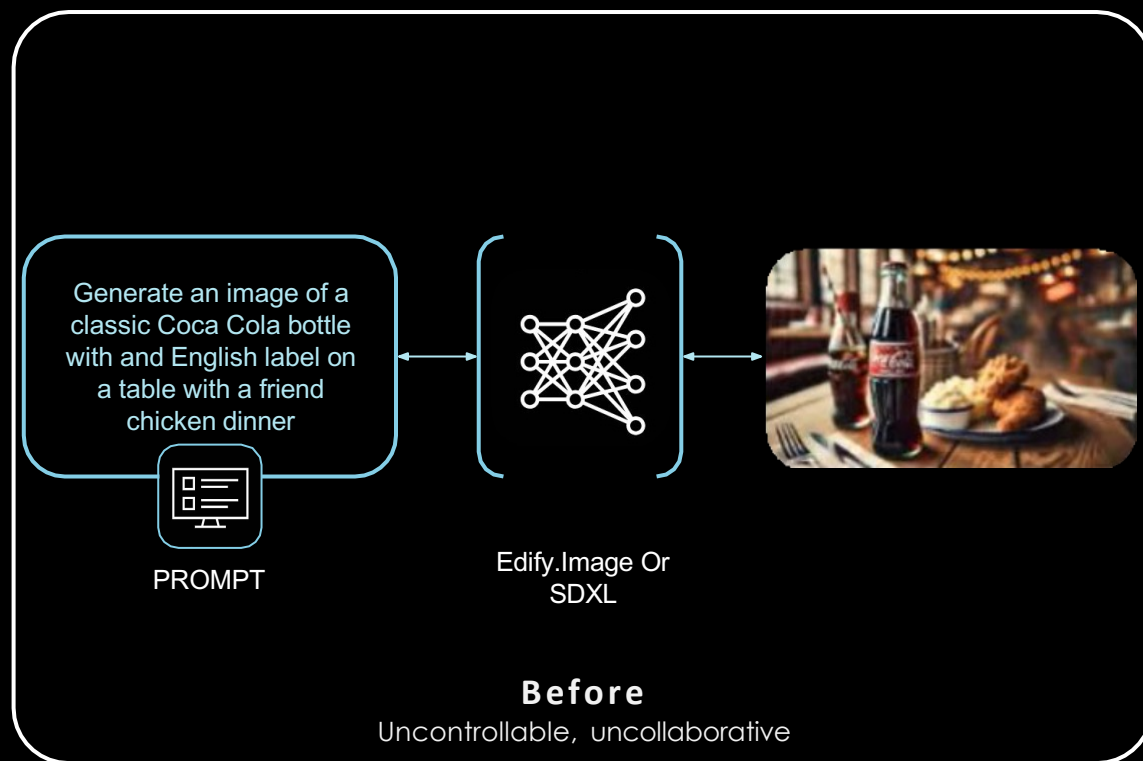
source: <https://hengyiwang.github.io/projects/spanner>

# 3D Computer Vision

Full Content Generation



**NVIDIA NIM for OpenUSD LLM, 3D, Physics and Materials Generative AI**

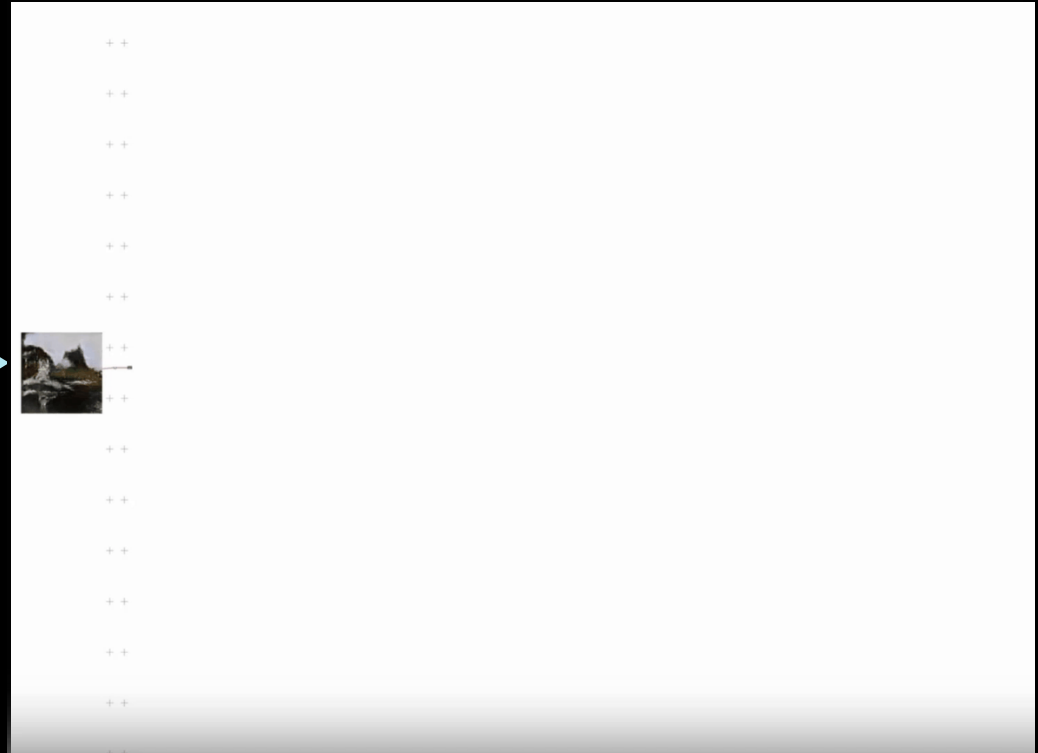


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# AI Context

Current Events

How a trend is building?





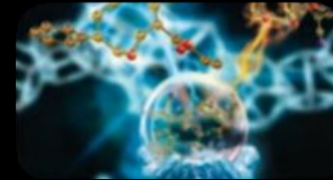
# Foundation Models

Compressing "Knowledge"



## Healthcare

Images, a/b matches large data  
Future pandemic response



## Science (generally)

Research  
Applied science  
Space

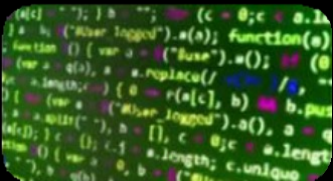


## Speed of Drug Discovery Molecular level Genetic level (CRISP)



## Industrial Facilities

Warehouse automation  
digital twins of manufacturing  
facilities



## Coding and Development

+20% - 30% in speed of code  
development  
Upleveling entire enterprises  
System Integration



## Material Development

Solar panels  
Lithography for chip making  
Unlocking industries that have not  
been touched by software



## Supply Chain

Optimization using foundation  
models



## Creator community

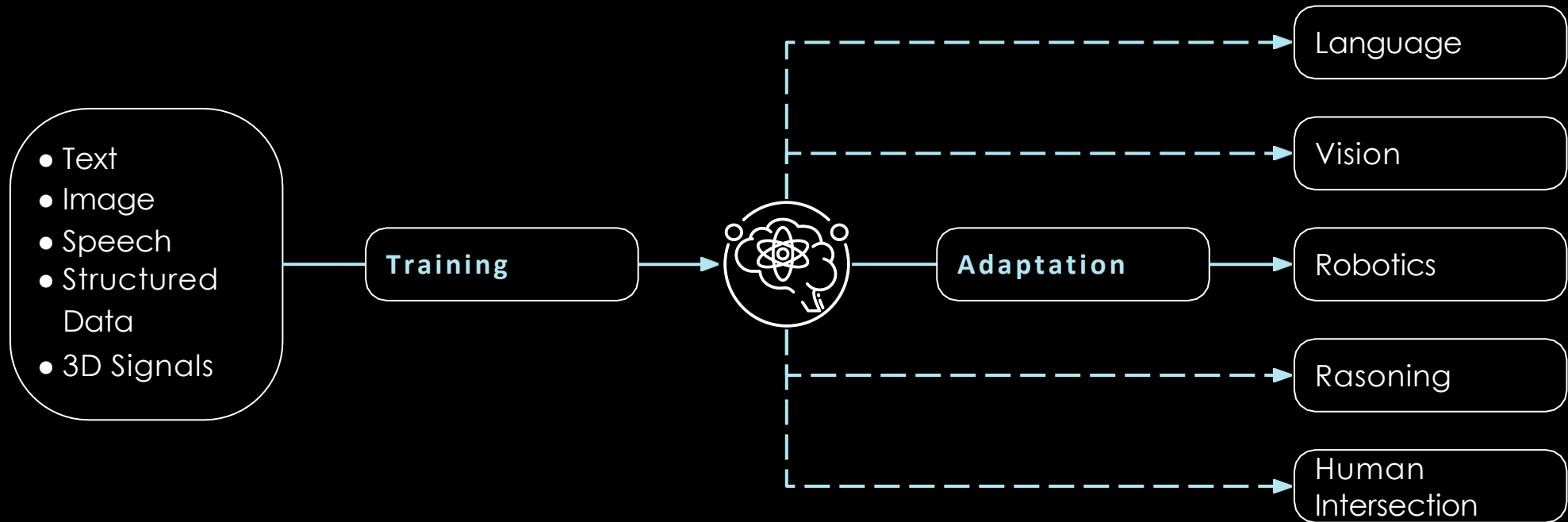
Marketing  
Media  
Image and video generation

source:  
Barry  
McGeough

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# Foundation Models

Useful to build on top



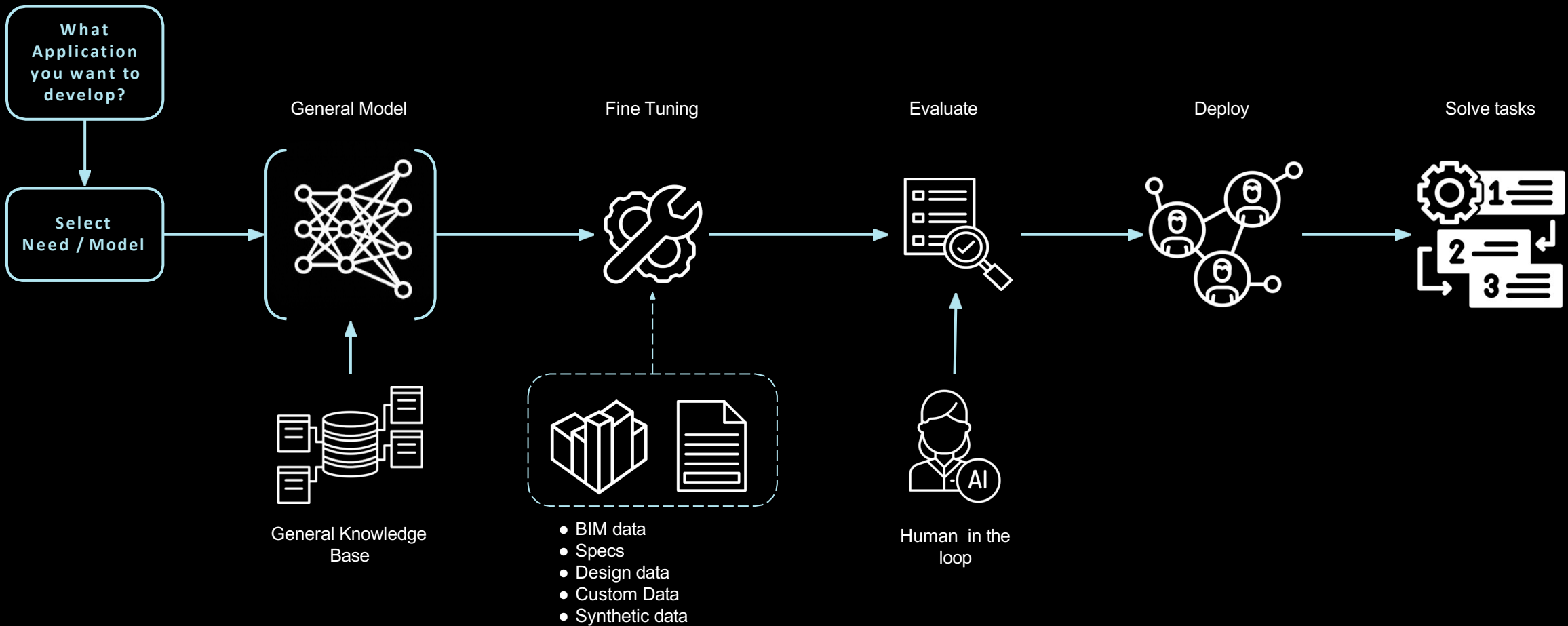
\*

## Foundation Model

Large models that are pre-trained on vast amounts of data. Foundation models provide a base, or foundation, on which more specific models can be built, and trained on large sets of broad and general data.

# Foundation Models

Application in Practice



source:  
Opportunities and Challenges of Generative AI in Construction Industry: Focusing on Adoption of Text-Based Models

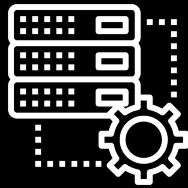
# Current Challenges

Understanding Limits



## Accuracy

Hallucination  
90% vs 99%  
precision



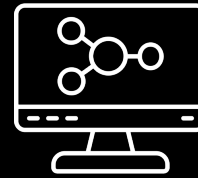
## Data Context

Domain expert data  
high quality dataset



## Cost Efficiency

deployment costs  
maintaining data



## Computational Resources

speed of integration  
infrastructure for  
automation



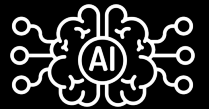
## Interpretability

understanding bias  
understanding how it  
predicts  
how can it reason?



## Safety

avoid harmful  
content  
mitigating data  
leakage or privacy

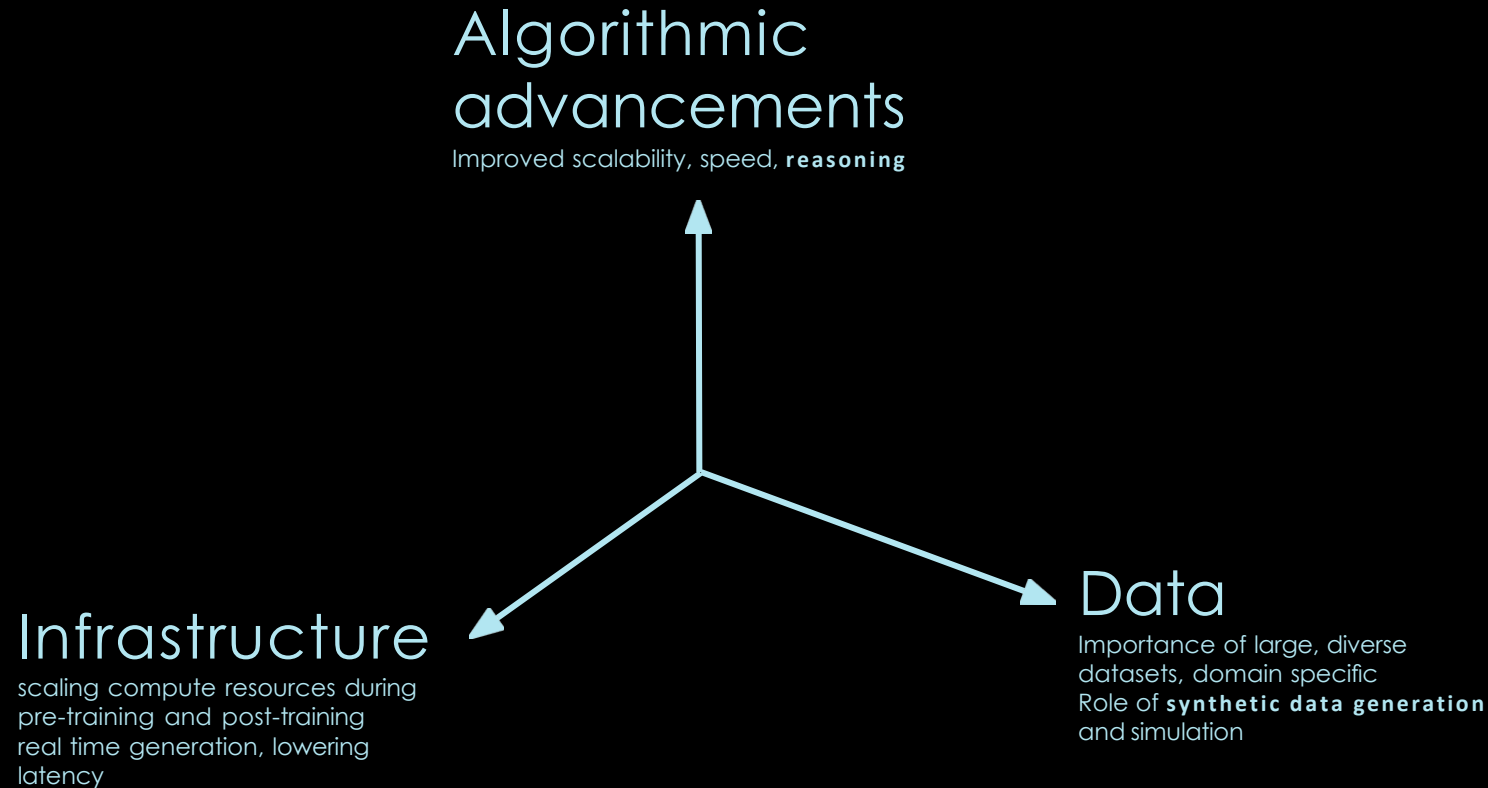


## Open-Ended Learning

can it learn by itself?  
self improvement?

# Axes of Improvement

Towards frictionless Ai interaction



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# AI in Architecture

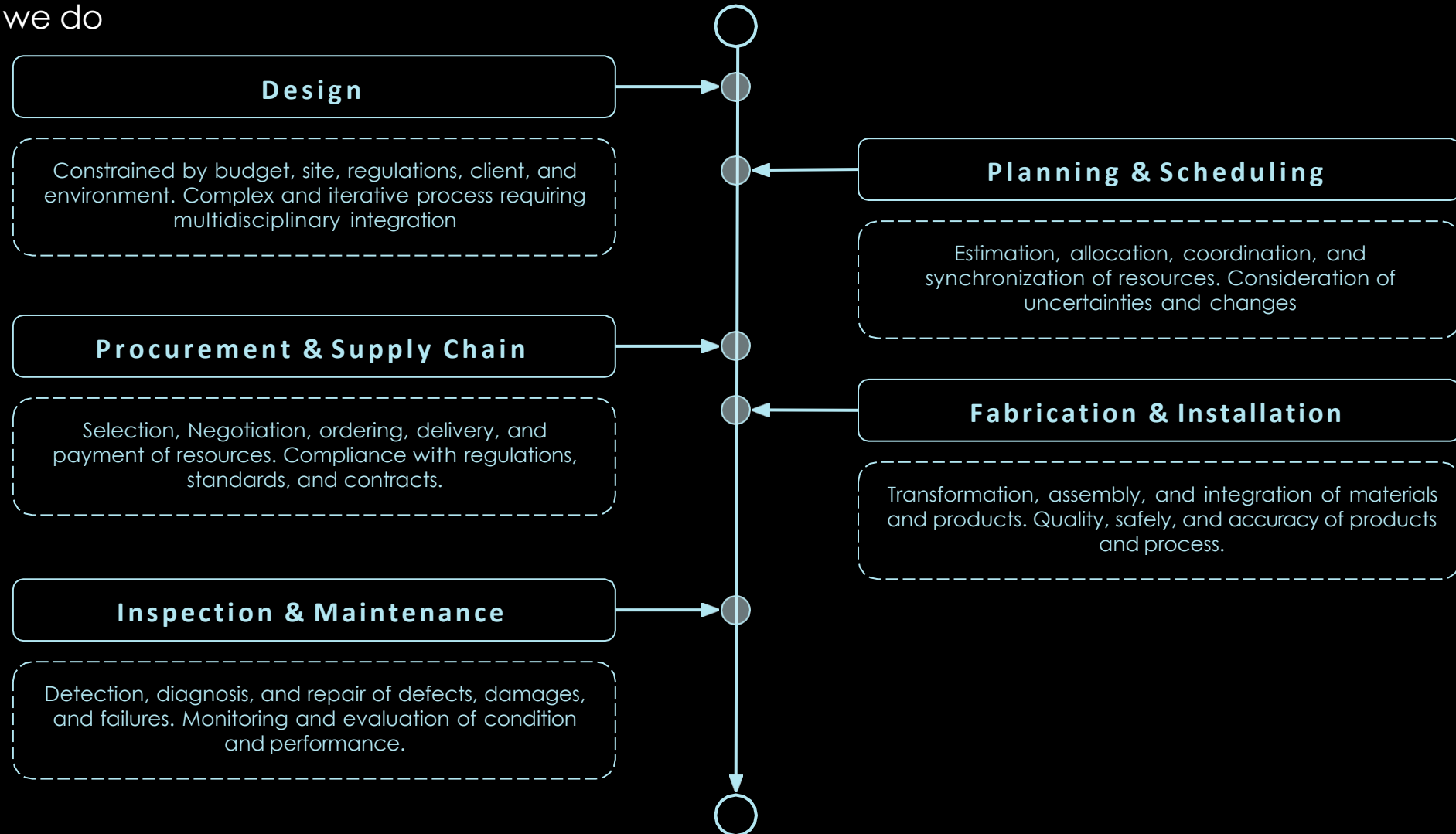
## Healthcare

How do we use our data?



# Architecture

What do we do

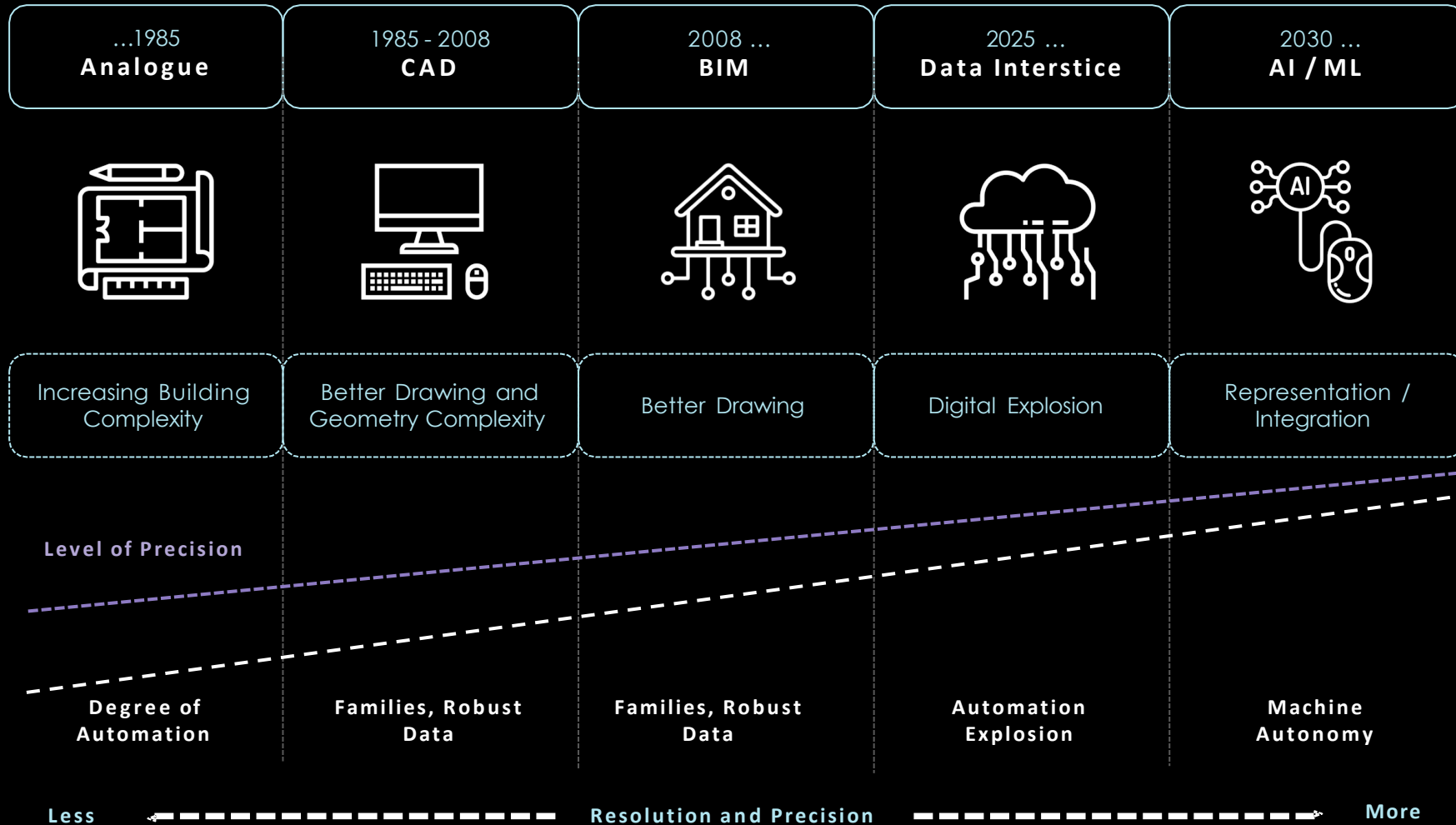


source:  
Generative  
AI in the  
Construction  
Industry: A  
State-of-the-  
art Analysis

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# Digitalization

Tech in Architecture

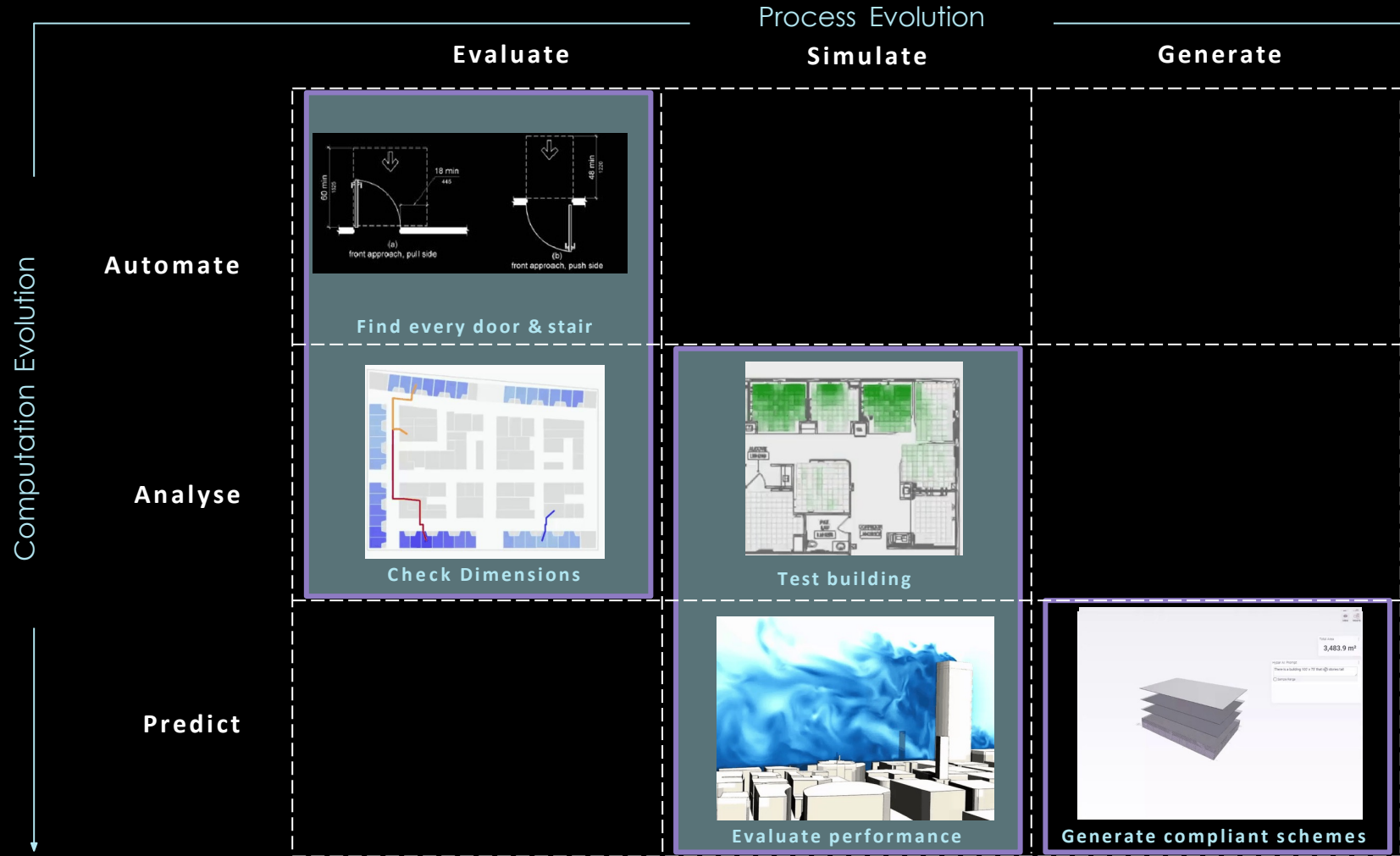


source: Phil Bernstein and Sam Omans: Machine Learning: Architecture in the age of Artificial Intelligence

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# Digitalization

Tech in Architecture

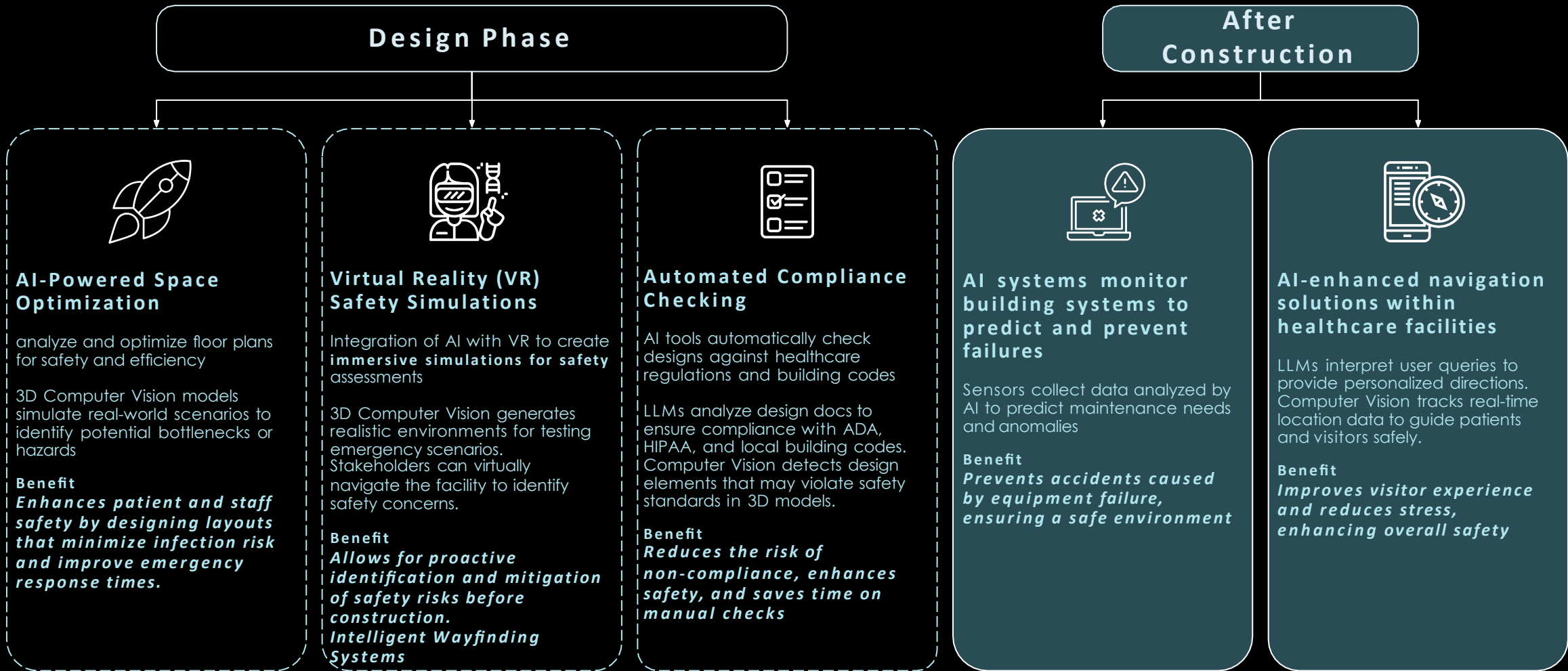


source:Phil  
Bernstein

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# Integration

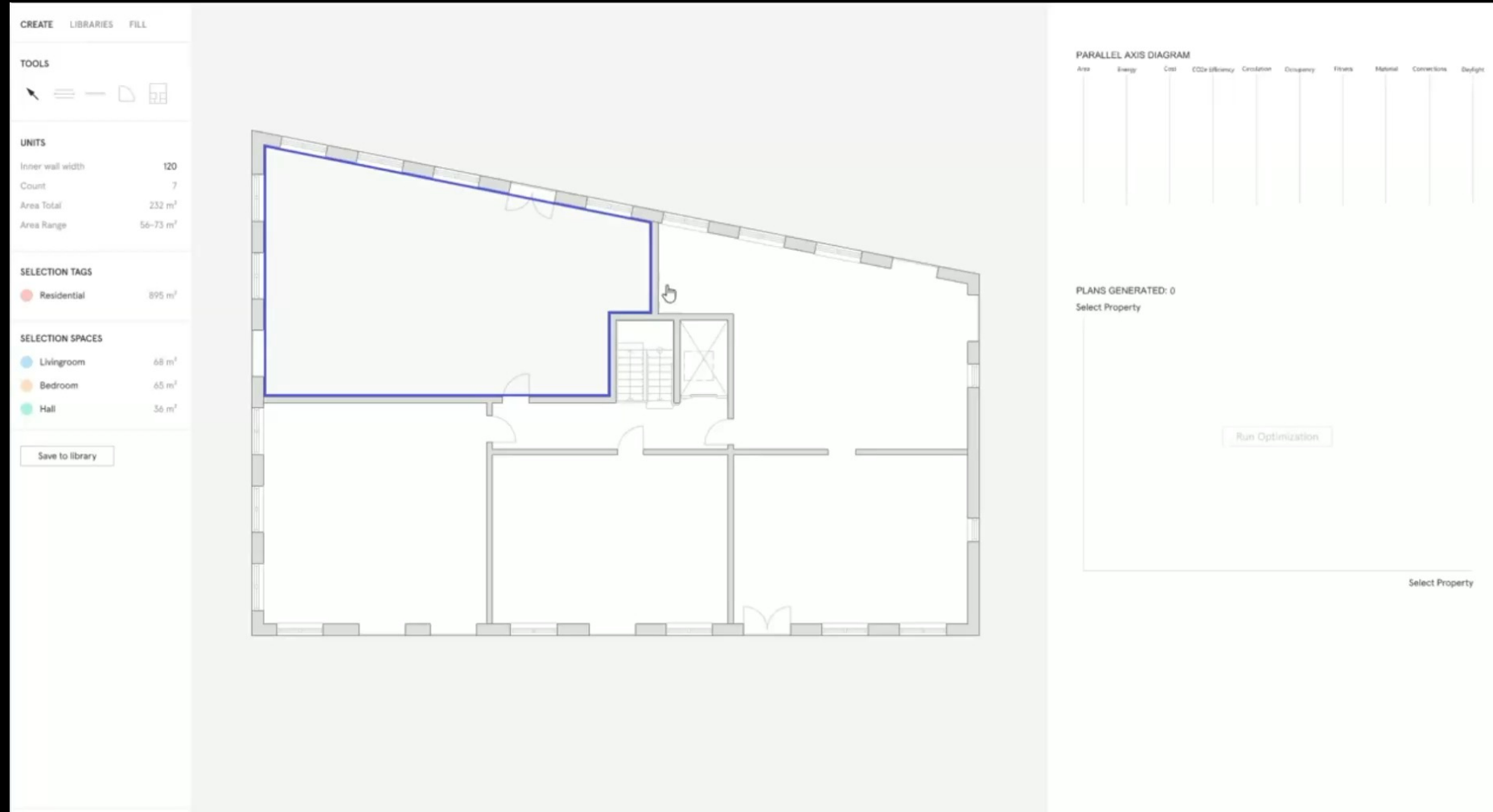
Ai in healthcare design



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# Case studies

## Floorplan Generation and Optimization



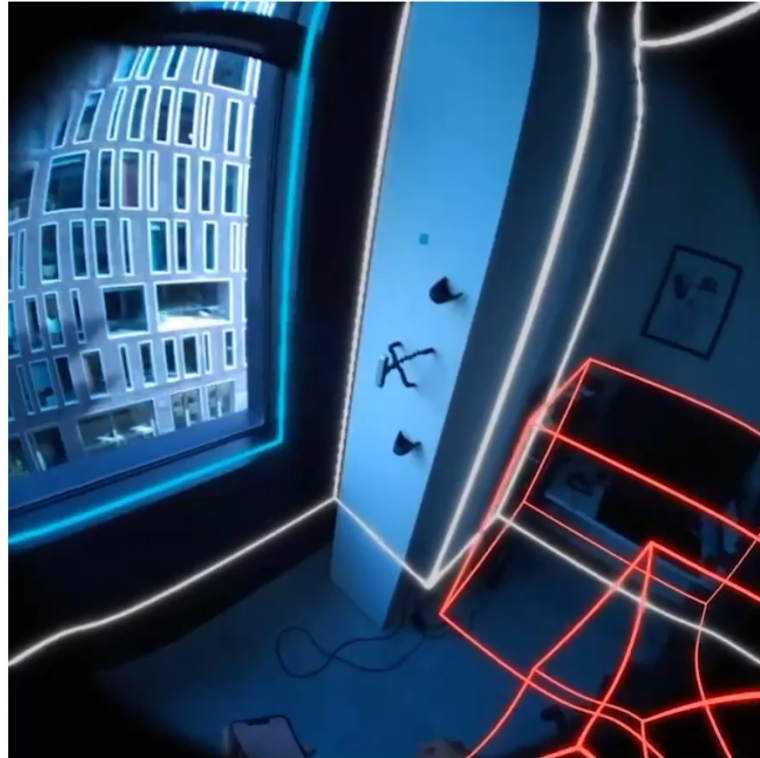
“Where architects  
and AI design  
together”

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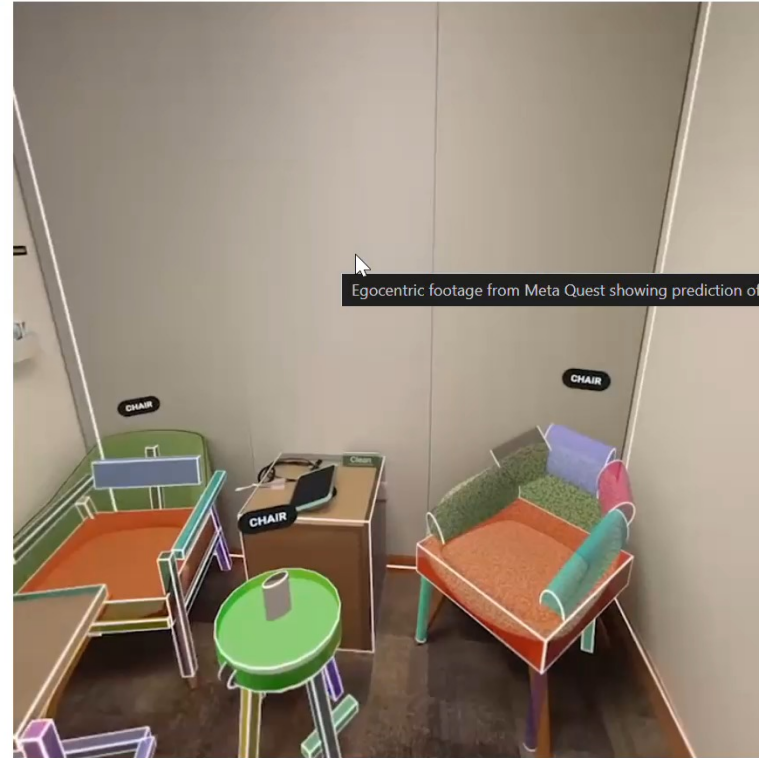


# Case studies

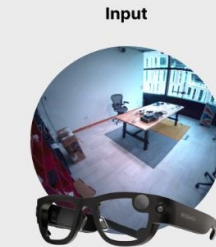
Smart AR/VR



Shown on footage captured by Aria glasses, SceneScript can take visual input and estimate scene elements, such as walls, doors, or windows.

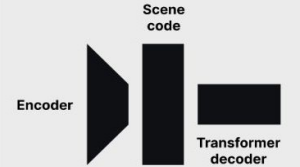


Shown on Meta Quest, scene elements predicted by SceneScript can be arbitrarily extended to include new architectural features, objects, and even object decompositions.



Egocentric video + point cloud

SceneScript is provided visual information in the form of images or point cloud from an egocentric device.

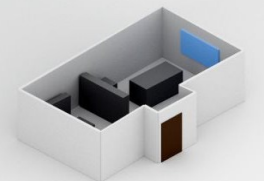


SceneScript CODEC network

SceneScript encodes the visual information into a latent representation, which describes the physical space.

```
1 make_wall,
2   (id = 0),
3   (a_x = -5.518),
4   (a_y = 7.228),
5   (a_z = 0.0),
6   (b_x = -0.91),
7   (b_y = 7.228),
8   (height = 3.089)
9 ...
10 make_door,
11  (id = 1000),
12  (wall_id = 0),
13  (position_x = -3.428),
14  (position_y = 7.228),
15  (size_x = 2.533),
16  (size_y = 1.991)
17 make_window,
18  (id = 2001),
```

SceneScript decodes the latent representation to a concise, parametric, and interpretable language, similar to CAD.



Rendered 3D SceneScript layout

A 3D interpreter can convert the language to a geometric representation of the physical space.

“SceneScript allows AR & AI devices to understand the geometry of physical spaces”

# Case studies

Automate compliance check

NC

In a Group B office, can the bathroom be ventilated only by a window?

No, the bathroom in a Group B office cannot be ventilated only by a window. According to the New York City Building Code 2022, rooms containing bathtubs, showers, spas, and...

NYC BC Ventilation ('22)

NYC BC 1203.5.1.3 Bathrooms and Toilet

NYC BC Ventilation ('22)

[↗](#) [🔗](#)

The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space.



source:  
[https://up.c  
odes/](https://up.codes/)

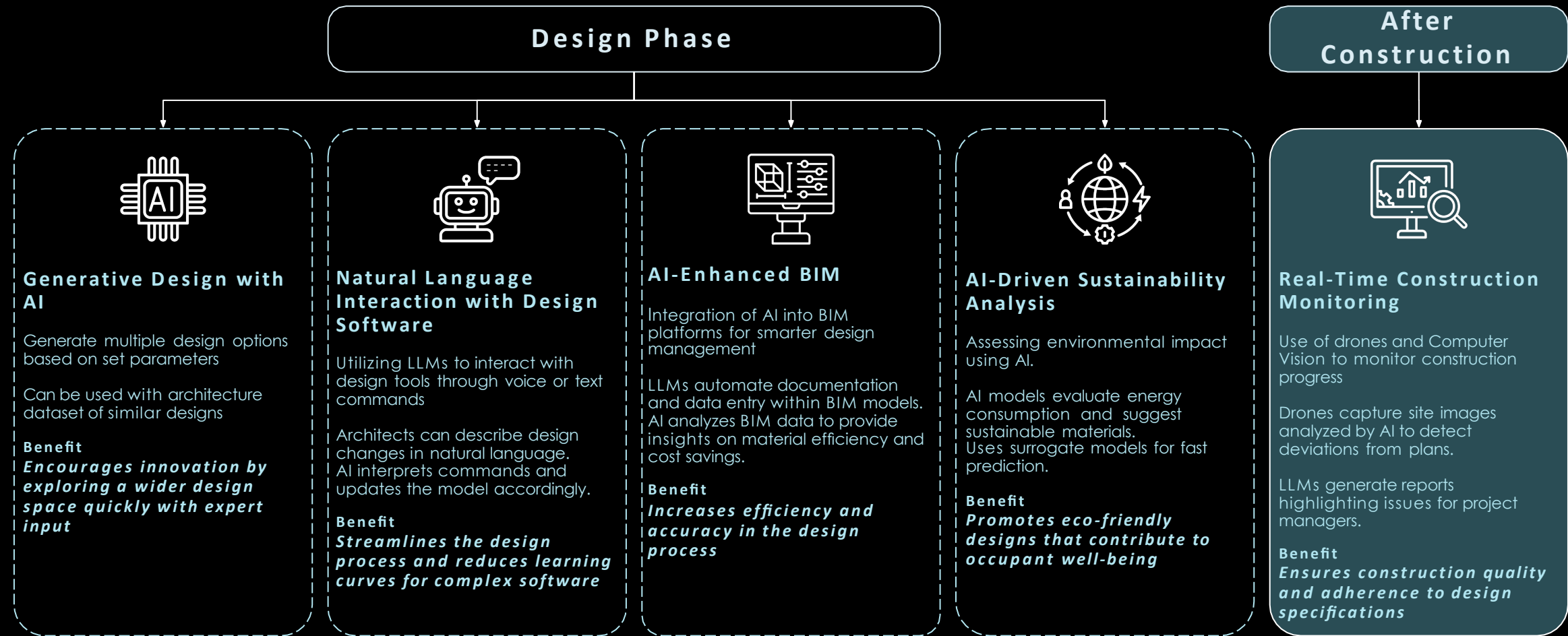
“Leverage Copilot to understand, interpret, and apply compliance requirements consistently and accurately.”

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# Advancements

applications in design



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## AI-enhanced BIM

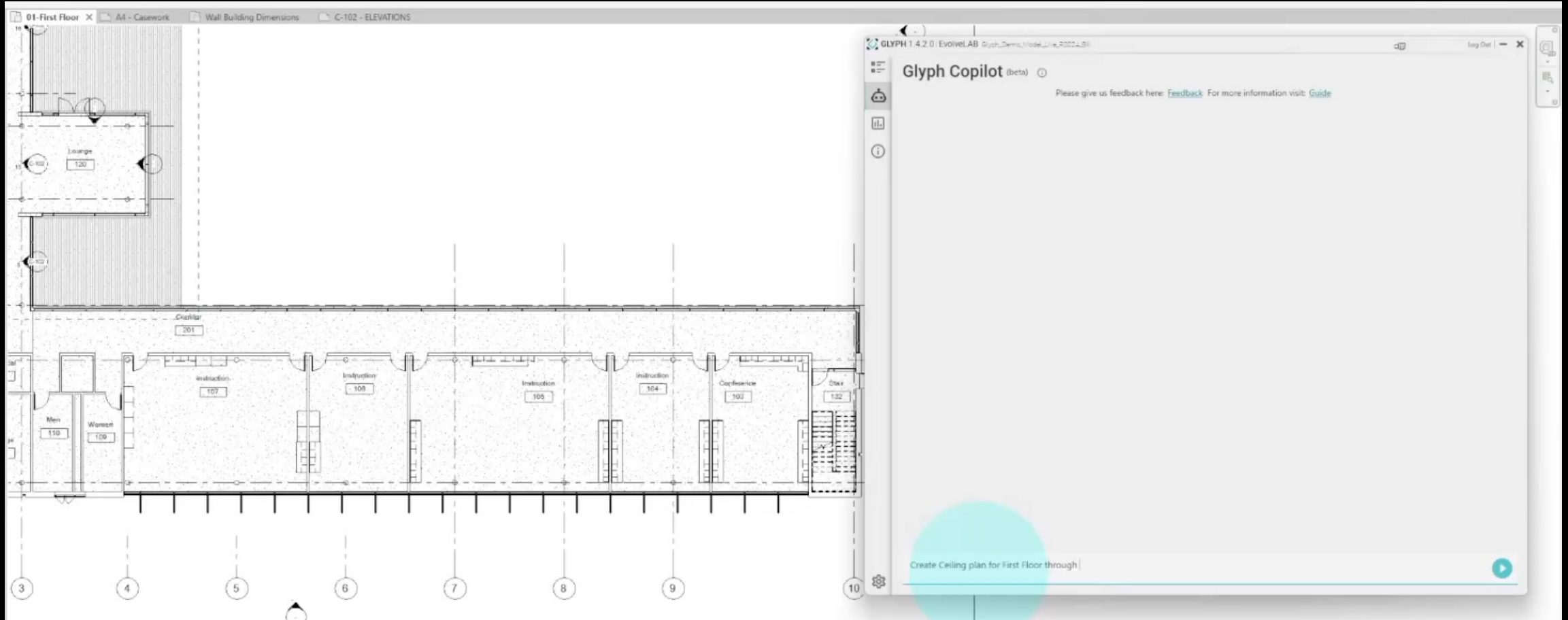
## AI-enhanced BIM

# "Howie - the AI copilot for architects"



# Case studies

## AI-enhanced BIM



"Glyph® is a Revit® plugin that automates and standardizes multiple documentation tasks like view and sheet creation, tagging, dimensioning, and sheet packing."

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# Case studies

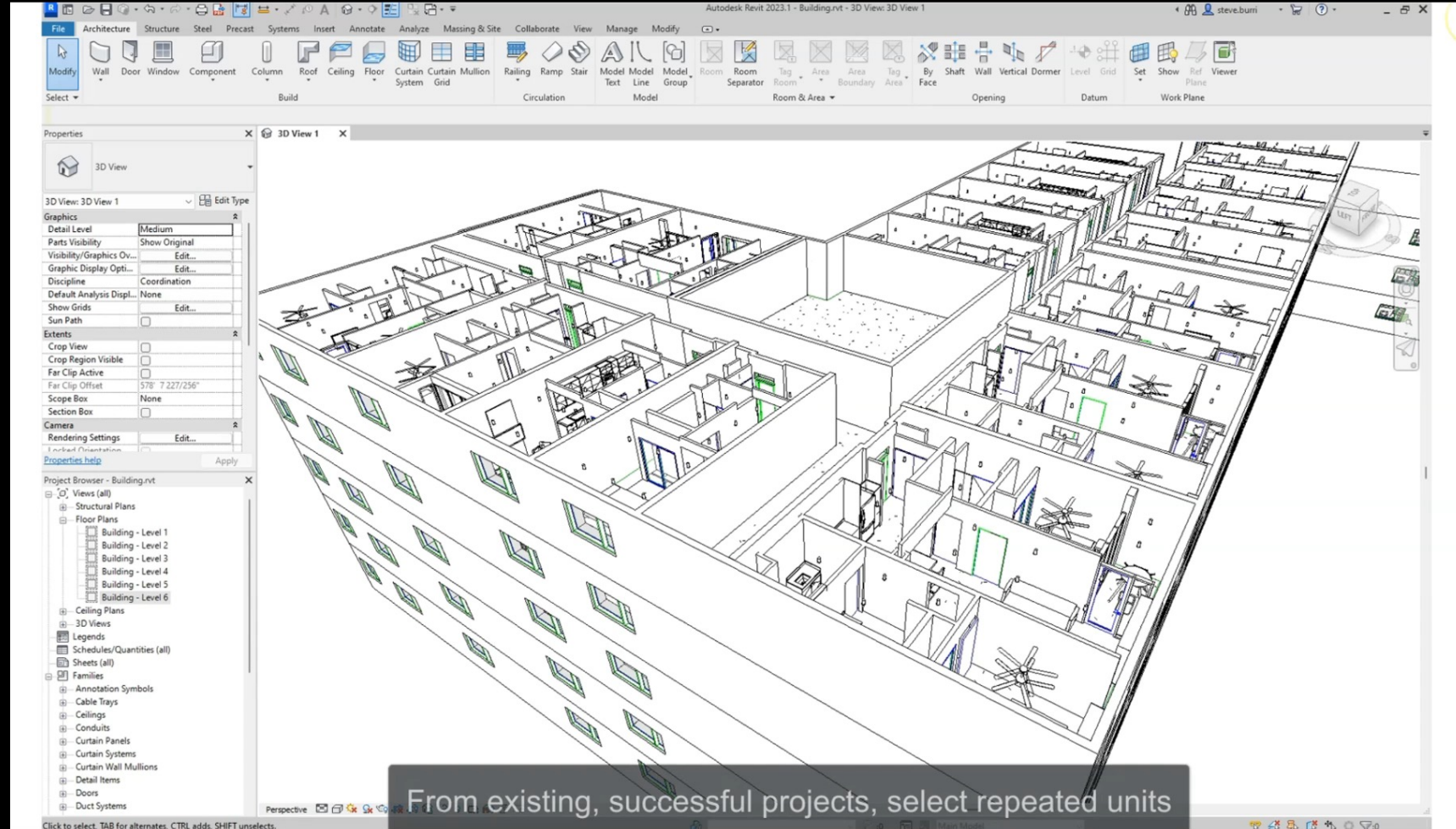
## AI-enhanced BIM



### Skema for **HEALTHCARE**

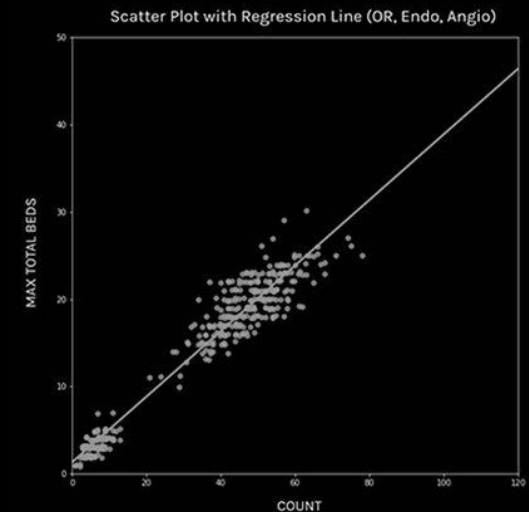
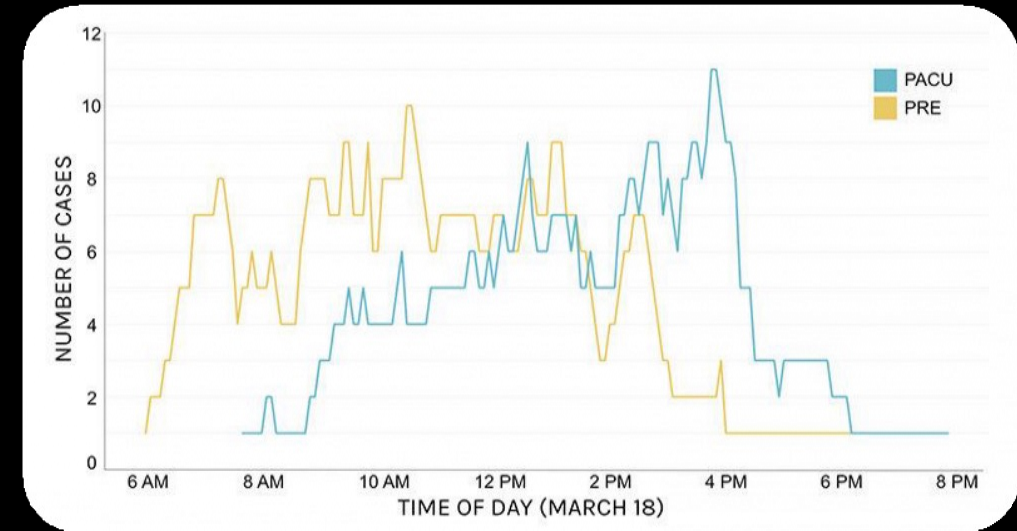
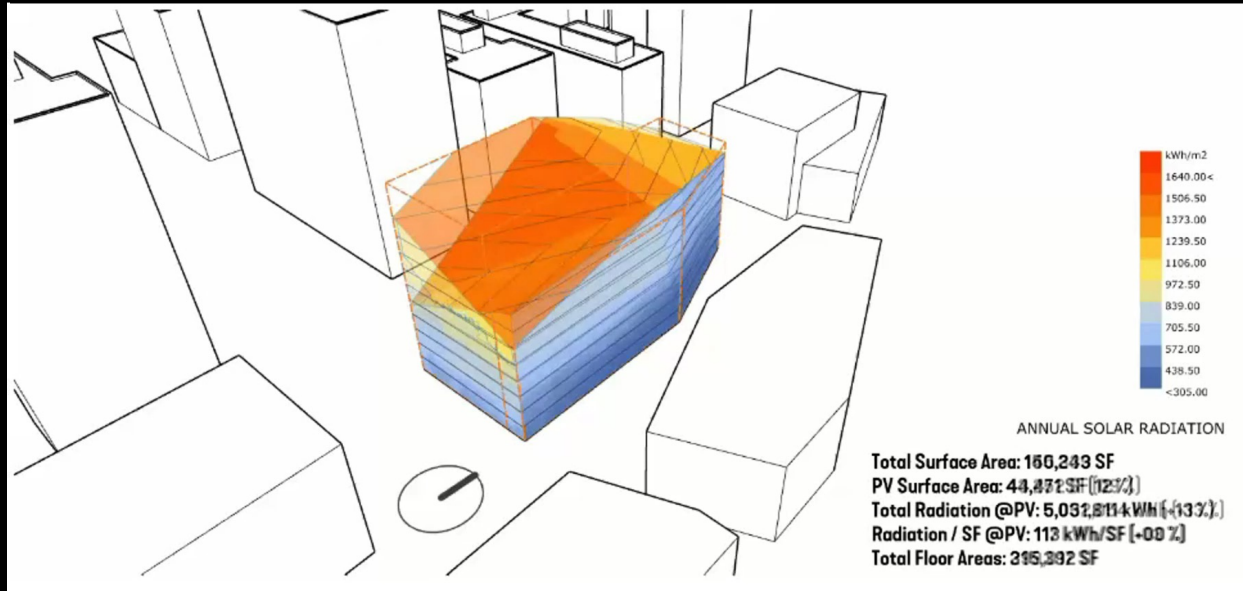
From medical office buildings (MOBs) to advanced research facilities, modern healthcare facility design is challenging and complex. Skema captures the design knowledge and best design work from your previous projects, harnessing your proven solutions for surgery suites, nursing stations, exam rooms and more. Skema maintains your design standards across projects and project teams. With Skema, deliver schematics and BIM deliverables earlier, giving you more time to focus on the high value design work that differentiates your firm.

“Create new projects informed by actual projects you've done before”

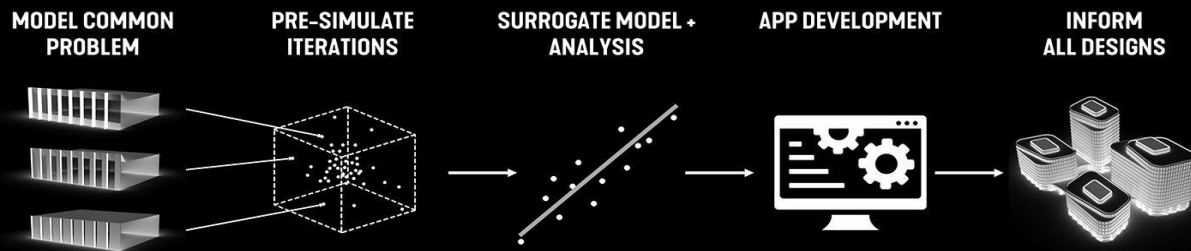


# Case studies

## AI-driven Sustainability



"SmithGroup applied machine learning to better predict future hospital program requirements based on a large body of past-patient room occupancy data."



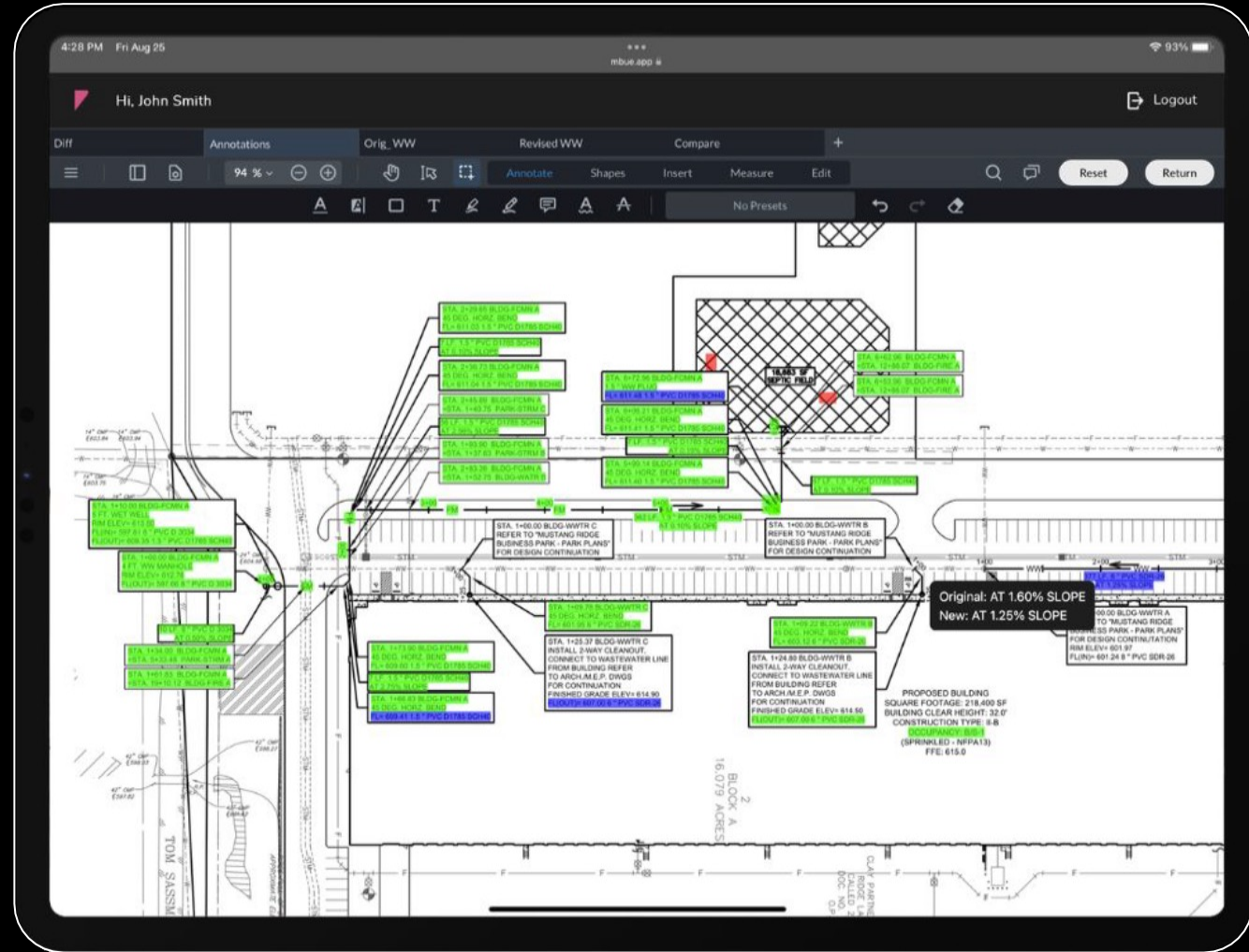


# Case studies

QA/QC enhanced

“AI-First vertical SaaS company automating architectural review. mbue is a web-based application that utilizes artificial intelligence to instantly review architectural drawings. Think “autocorrect” for construction documents. It saves significant time and money, while reducing liability exposure.”

source:  
<https://www.mbue.ai/>

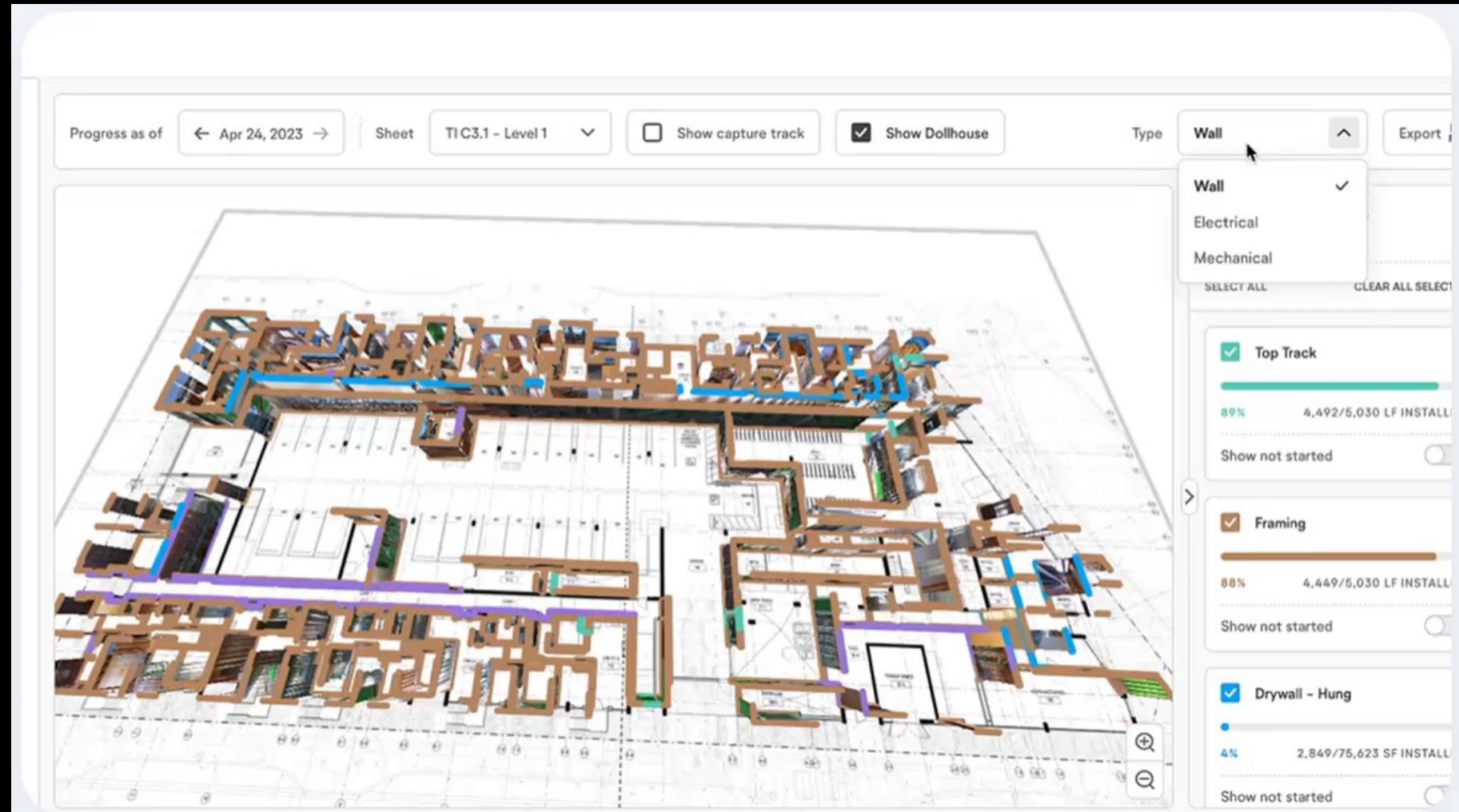




# Case studies

Real time construction monitoring

“Reality capture and AI-powered analytics for builders—from pre construction to operations.”

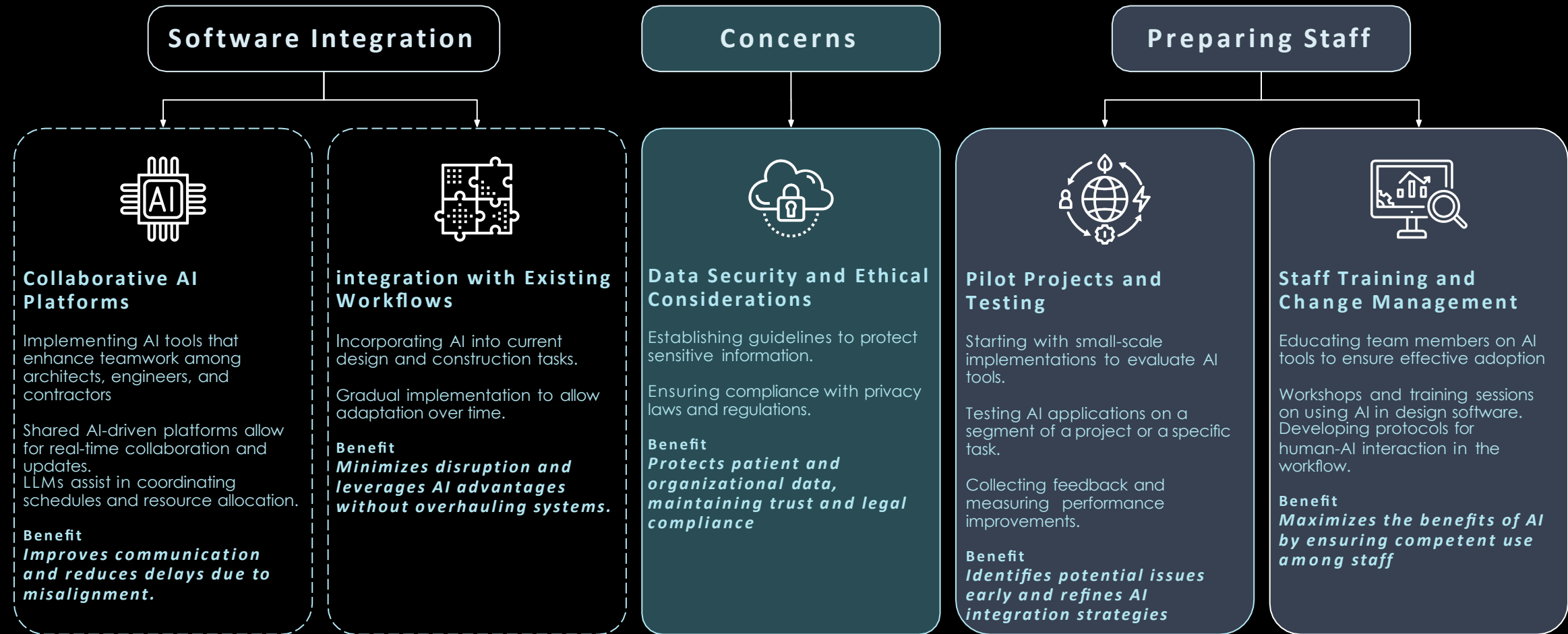


source:  
[https://www.  
openspace.a  
i/](https://www.openspace.ai/)

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# AI and Automation

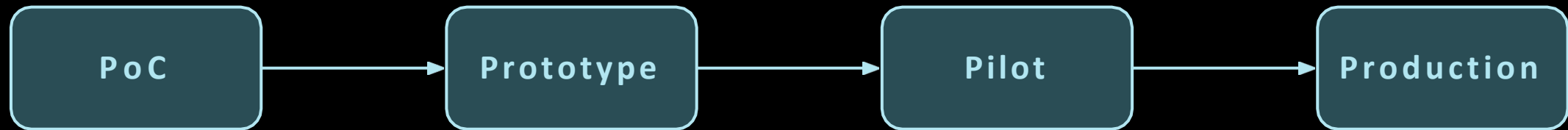
Integrating in design



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# AI and Automation

How to deploy



- Define the scope
- Does the internal customer want this?
- Can your organization do this?
- Should your organization do this?

- Evaluate the use of GenAI
- Understand accuracy
- Intellectual property
- Disruption of common workflows

\*

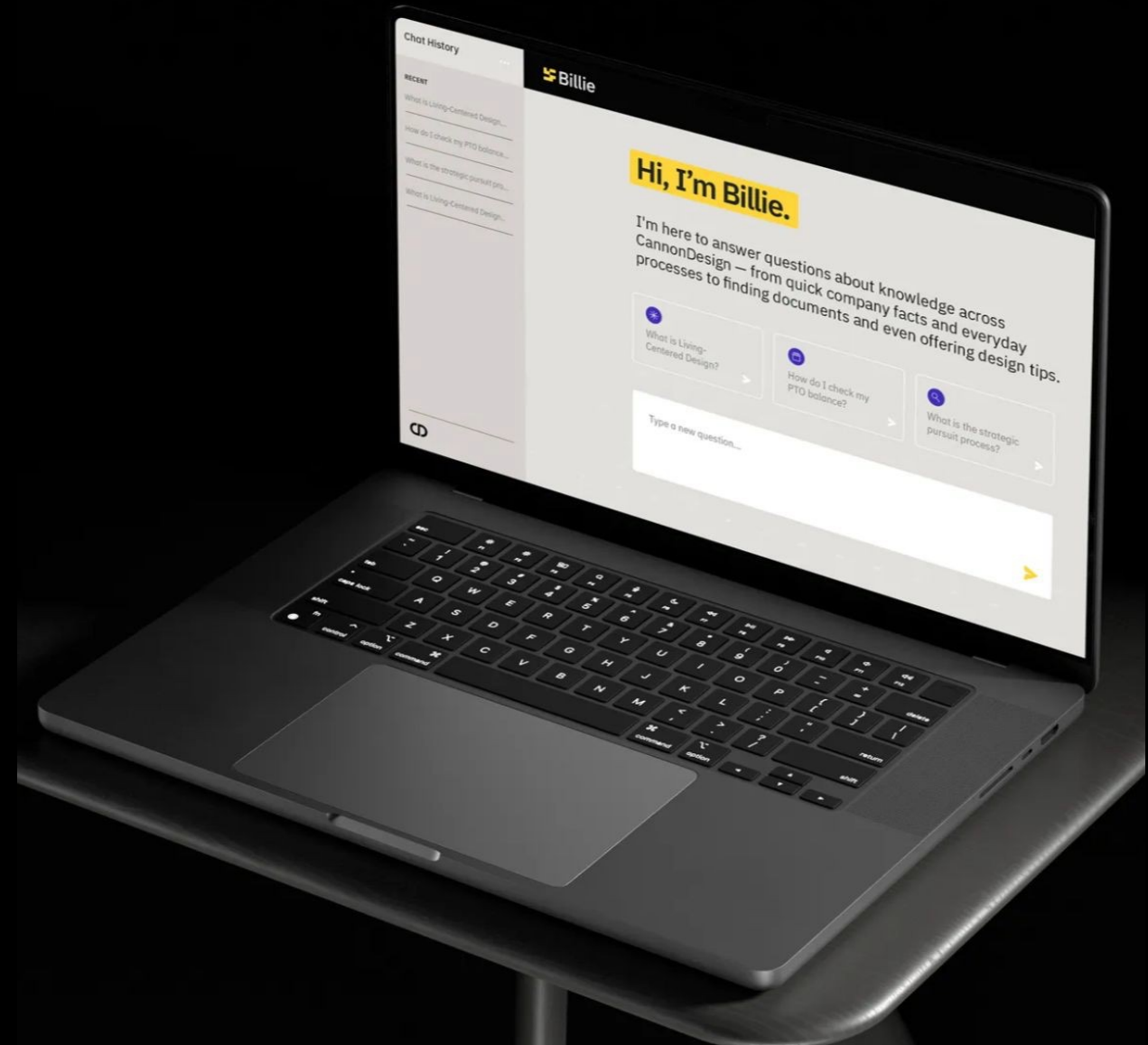
**Proof of Concept**



# Case studies

## Firmwide LLM integration

“Billie is an internal tool that leverages advanced technologies, including ChatGPT, to effortlessly search, retrieve and summarize essential documents and data within our firm.”



source:  
<https://www.cannondesign.com/news/say-hello-billie-generative-ai-companion>

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## Collaborative Ai based platform

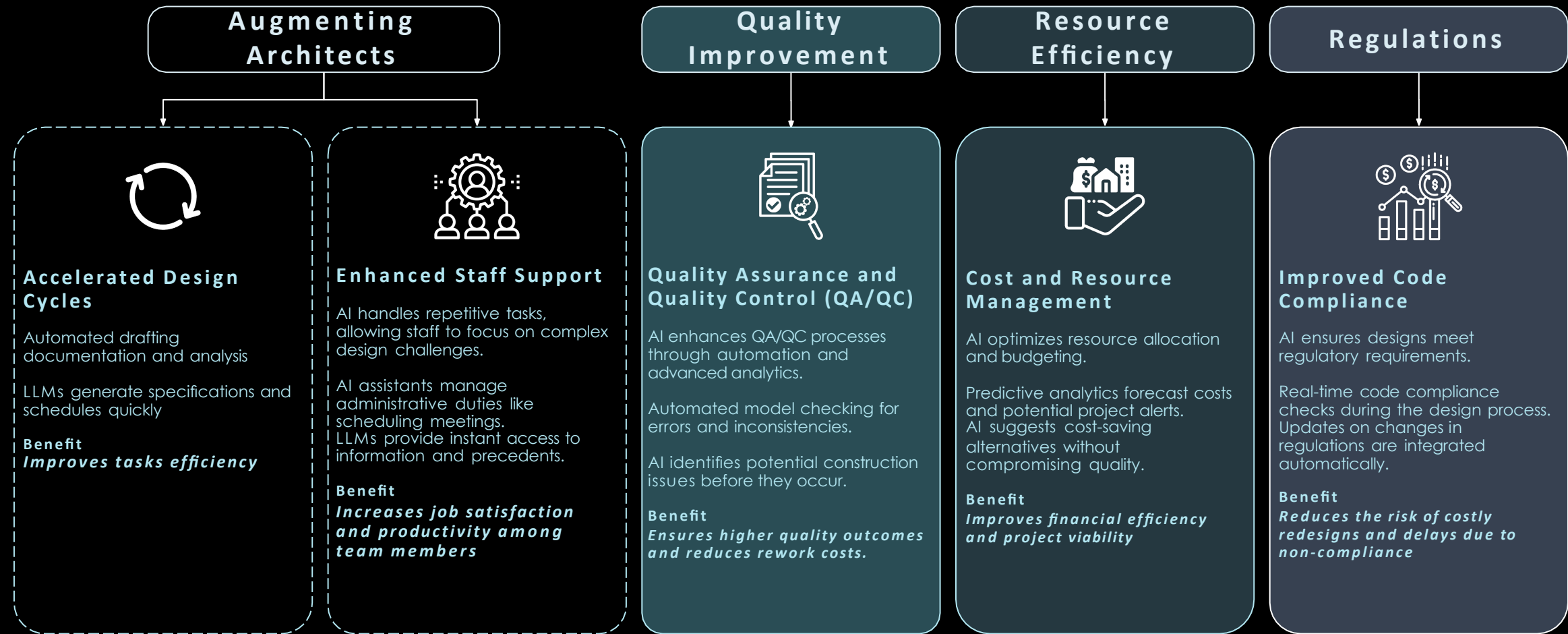
## Collaborative Ai based platform

source:<http://twinklknowledge.com/why-twin-knowledge>  
-1

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# Potential

Benefits and considerations



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# Case studies

Staff support with Agents

“Autonomous Healthcare Agents for Patient-facing Voice Conversations”



Hippocratic AI

— Do No Harm —

## Call Agenda

- ☐ Introduction
- ☐ Patient Verification
- ☐ Gets To Know Patient
- ☐ Medication Review
- ☐ Diet Review
- ☐ CHF Symptom Self-Assessment
- ☐ Physical Activity Check-in
- ☐ Call Summary



Linda



## Fictional Patient Info

- Patient Name: Albert
- Gender: Male
- Age: 74

## Health History

- Patient discharged from the hospital 3 days ago following an acute CHF exacerbation.

## Medication List

- Lasix
- Lisinopril

Hi, this is Linda calling from Memorial Hospital

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# Case studies

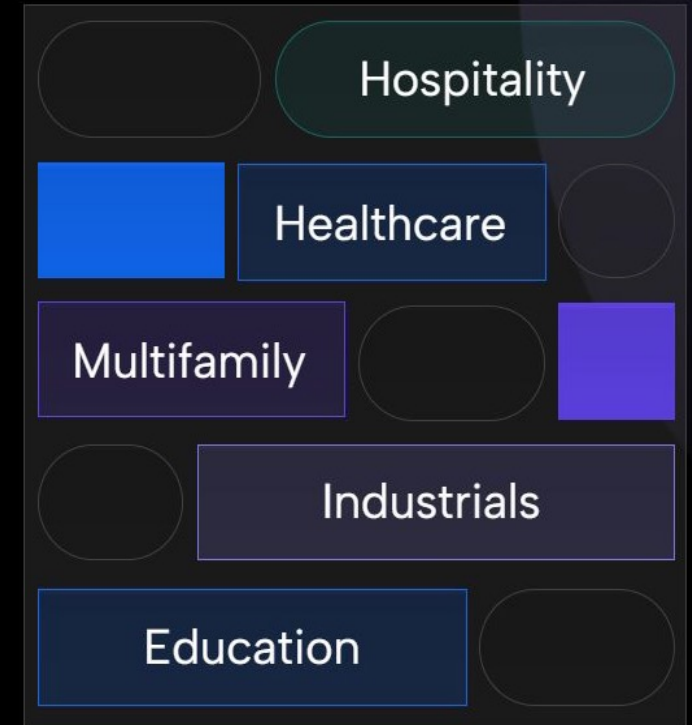
Documentation enhanced

"SWAPP harvests value from your firm's previous projects and takes it forward to boost your architecture teams' performance.

SWAPP analyzes your project portfolio, extracts your documentation design habits and annotation practices. Your data is used to develop and maintain bespoke rule sets and algorithms, which are then used by our systems to automate the creation and annotation of architectural documentation for your new projects at the most detailed level."

## Diverse Project Experience

SWAPP has a proven track record of over 200 projects across a spectrum of sectors, including multifamily, education, hospitality, industrials, and healthcare facilities.



# Case studies

Robotics on site

“Facade panels are only as good as the brackets they’re attached to – our robot is specialized in tackling this task, completing the layout, installation, and inspection in a fraction of the time”



source:  
<https://raise-robotics.ai/>

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# Potential Solutions

over 1000 new Startups

## AI in AEC: Zero To Power User CHEAT SHEET

### KEY TERMS

<b>AI</b>	Artificial Intelligence is, simply put, a way of making machines to solve problems in a more human-like way. Within AEC, frequent AI forms are ML, GenAI, and MO.
<b>ML</b>	Machine Learning focuses on understanding existing data and making accurate predictions. It also focuses on teaching the machine how to solve a problem.
<b>GENAI</b>	Generative AI is a type of AI that can create a wide variety of data, such as images, videos, and 3D models. It can create new data, unlike many traditional ML forms.
<b>MO</b>	Unlike GenAI, Mathematical Optimization (MO) works to select the best element (the best solution), with regard to some criterion, from a set of available alternatives.

### THE IMPACT

- Within AEC, AI's possible impact could be:
- Time to design is lowered substantially.
  - The scope of design is increased considerably.
  - Innovation and Ideation are positively impacted.
  - Current AEC processes are significantly changed due to AI automatization and possibilities.
  - Reassessment of educational curriculums.
  - Data-driven design, resulting in safer projects, better decisions, and less rote work.
  - Lower risk, as AI can help find the best solution.

*"We're still early in the AI revolution, but AI is promising a better future for AEC - there are many useful tools! In the near term, I expect to see firms investing heavily in R&D, and companies starting to test AI tools on pilot projects. In the medium term, I expect companies to start integrating AI into their existing workflows. In the long term, I expect AI to change our current processes, and companies investing heavily in AI-related education."*

Stjepan Mikulic

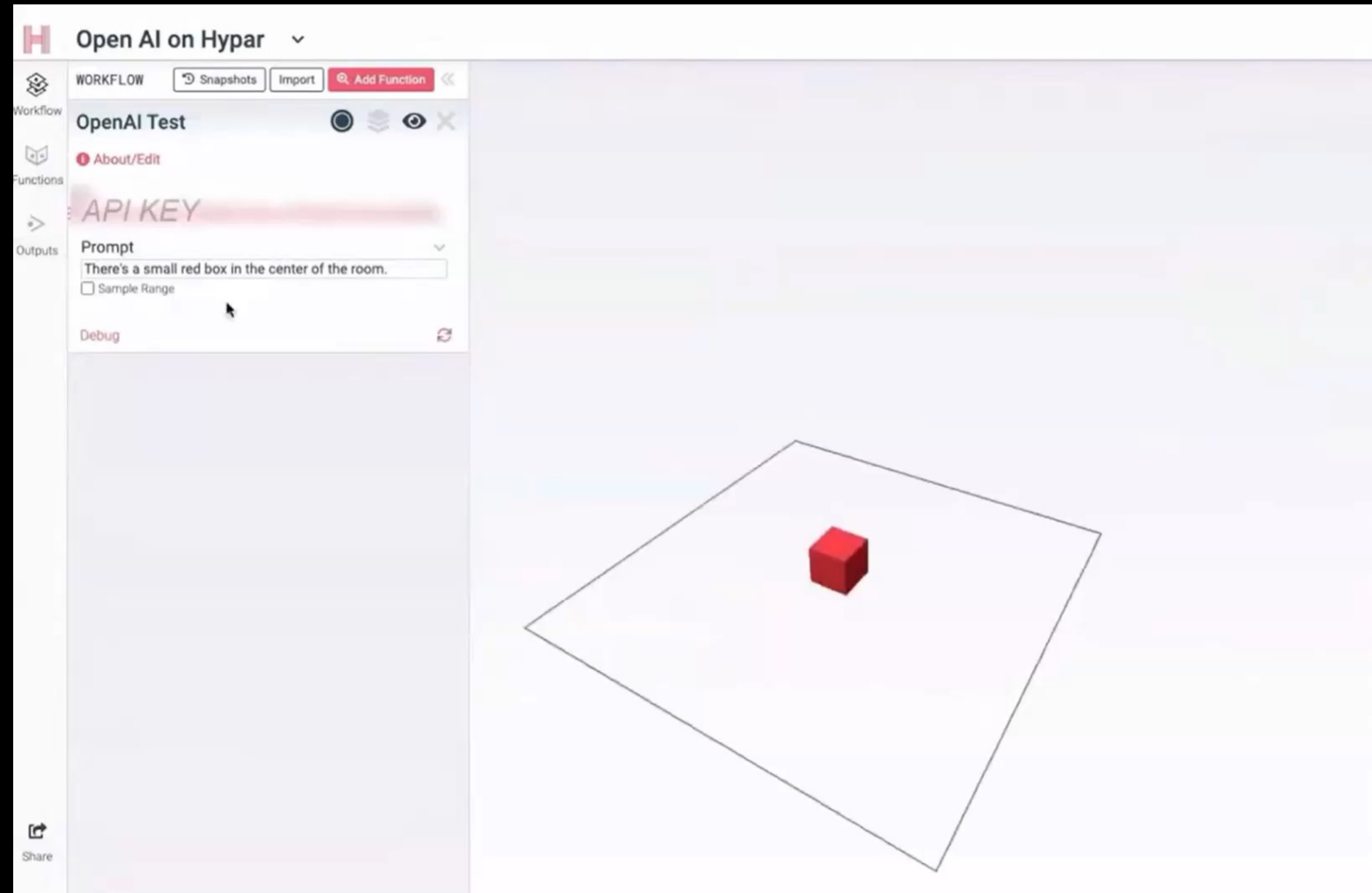
source:  
<https://stjepanmikulic.com/site/AI-in-AEC-AEC-AI-Hub-b6e6e8e88094e0e9b4995da38e96768>

CONCEPT	USE CASES	KEY AI TOOLS
<b>TEXT-TO-2D</b>	Ideation, Art & Design Creation, Rendering, Inspiration, Realistic Edits, Scaling Images (Up or Down)	Adobe Firefly, Midjourney, Canva AI, Stable Diffusion, DALL-E 2
<b>TEXT-TO-3D</b>	Animation Creation, Gaming (Object Creation), Space Visualization, Video & 3D Point Cloud Creation	Shap-E & Point-E, Magic3D, DreamFusion, Spline AI
<b>SKETCH-TO-3D</b>	Create Artwork, Animate Characters, Build Products Quickly, Rough Sketches to Refined Images	AutoDraw, Animated Drawings, Plasmio, Scribble Diffusion
<b>IMAGE EDITING</b>	Rendering, Design Creation & Iteration, Digital Landscaping, Background Replacement & A Lot More	Super Resolution API, Mokker, Canvas, VERAS, Segment Anything
<b>GENERATIVE MODELING</b>	Site Analysis Automation, Building Data Assessment, Real Estate Feasibility, Sun & Wind Analyses, Parking Layouts, Urban Planning, Environmental & Financial Analysis, Walking Accessibility, Buyer/Seller Connection	Forma, TestFit, Parafin3D, Omrt, Digital Blue Foam, Architectures, CityBlDr, CITYPLAIN, Build Flow AI
<b>BIM + AI</b>	Automated Building Design or Generation of Floor Plans, Text-to-BIM, Construction Documentation Automation	Augmenta, Finch3D, Hypar, SWAPP, BricsCAD BIM
<b>STRUCTURAL DESIGN</b>	Low Carbon Design, Timber Design, Steel Structures, Automated & Optimized Concrete Design	AECforward, Daisy, Pathw.ai, PrePlan, Structure Plus
<b>CONSTRUCTION</b>	Building Site Data Capture, Construction Management, Language Barrier Elimination, Information Management, Procurement & Material Management	Disperse, Imerso, Need2Say, Sparkel, StructShare
<b>DATA ANALYSIS (PLATFORMS)</b>	Scan-to-BIM, Quantity Takeoffs, Auto-Annotation, Project & Resource Planning, Better Decision Making	Aurivus, Kreo, Archilyse, Slate AI, Buildots, Mosaic

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# Interfaces

Text to BIM



source:  
<https://blog.hypar.io/>

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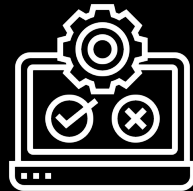
# Summary

over 1000 new Startups



## Design

- Get insights from previous data
- Create and improve designs
- Ensure compliance with building codes



## Testing

- Experiment and try out on your tasks
- Plan an internal hackathon
- Pilot test



## Environment, Health, Safety

- Extract insights
- Predict environmental impacts on comfort
- Analyze and predict potential safety issues
- Monitor and report automation



## Finding Solutions

- How unique is your problem?
- Can you scope it?
- Is there a solution?

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**Thank you for your attention!**

