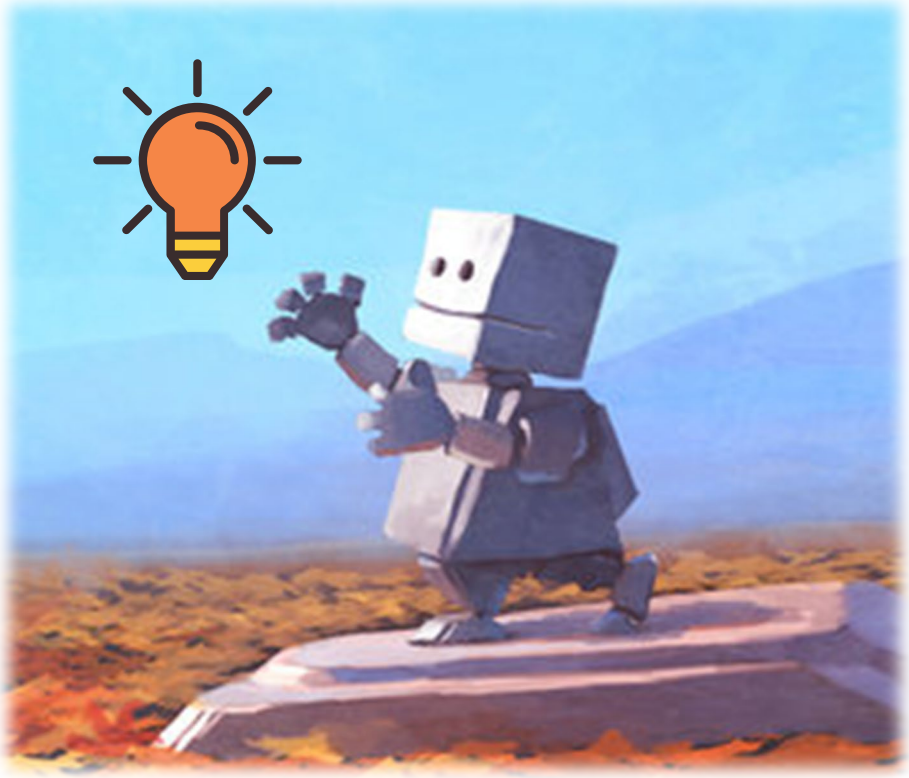
# InnoVAET: Generative AI for Mapping Patents and Firm Innovation



**Paper at: tiny.cc/innovaet**


| | |
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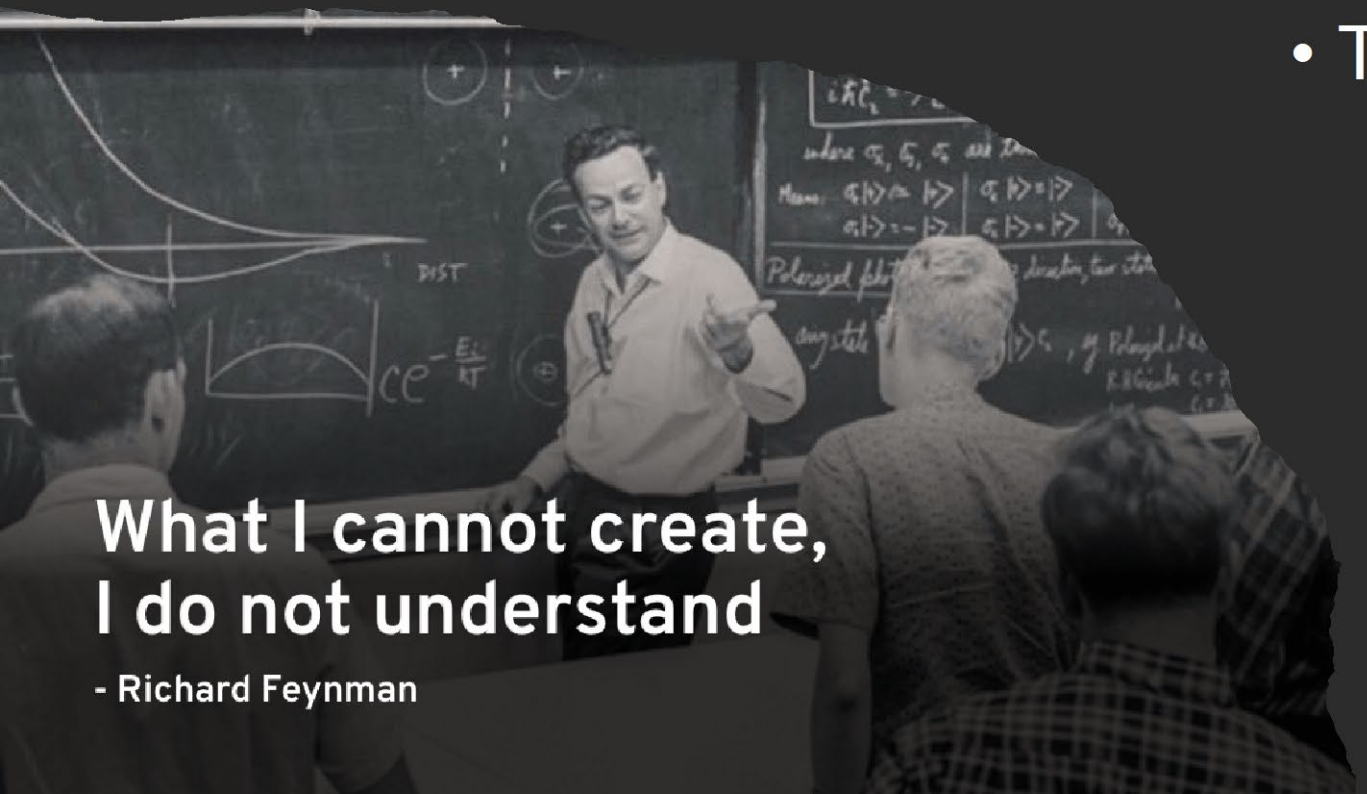
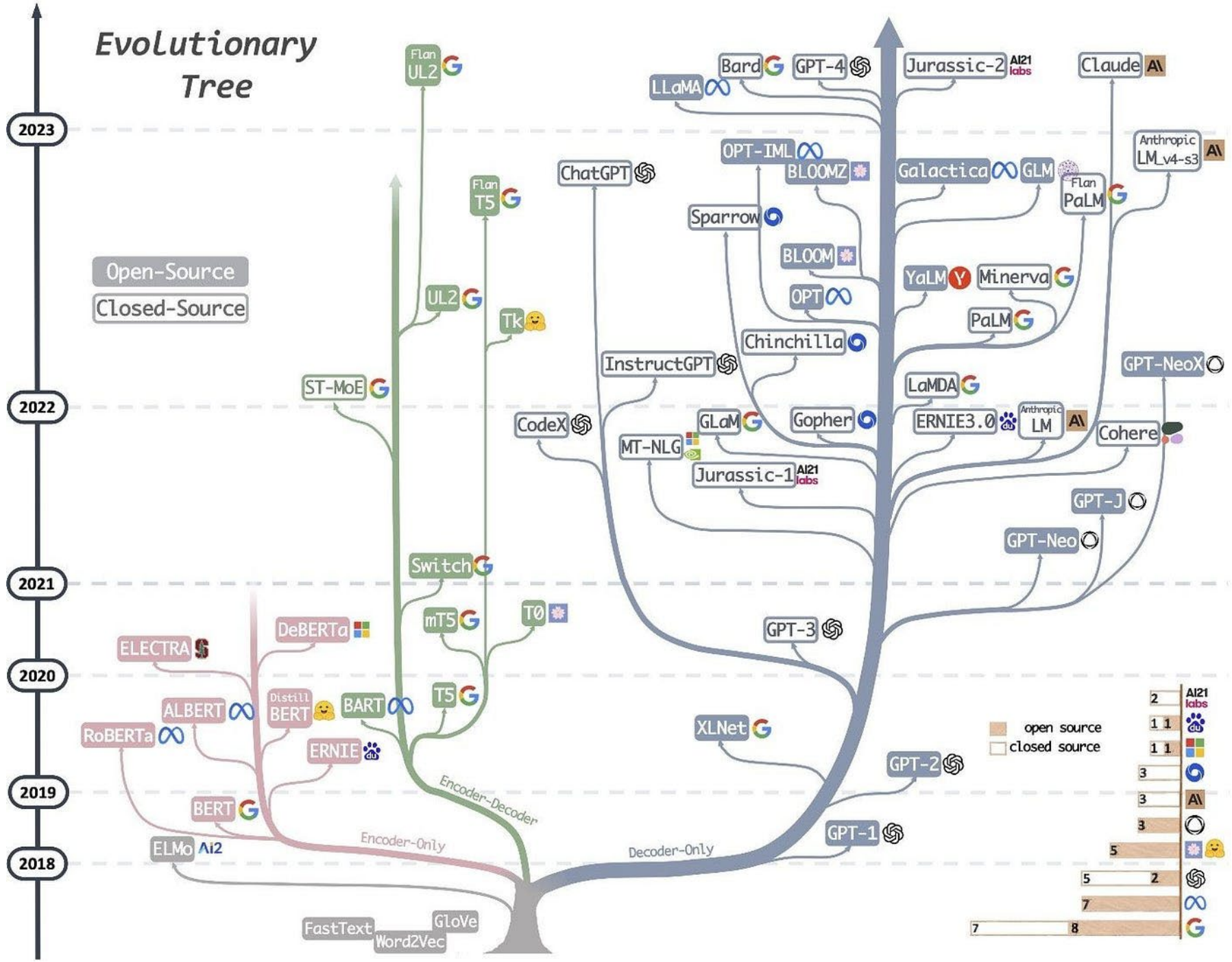
# Generative AI's Powerful Capability **Summarized**

- Learn to generate any complex object (e.g., images, documents, patents, jobs, firms, portfolios, consumers, digital twin of anything)
- Doing so, learns object space and compositions in scale
- Trained model can then:
  1. Map out the object space and provide deeper insights (compare & contrast)
  2. Augment purposeful synthesis of a new and creative object
  3. Do 1 and 2 at incredible scale and speed



- Many mainstream LLMs (ChatGPT) are decoder only model
- Works by learning to predict the next words in long word context
- Not appropriate for mapping & representation that can provide comparisons and insights.




Visual Source

Harnessing the Power of LLMs in Practice: A Survey on ChatGPT and Beyond

## Research Questions

- Can we harness generative AI for meaningful representation of business objects to aid exploration, understanding, action?
- And how is the representation useful?

## Answer

Disentangled Representation Learning Via VAE transformer enables managerial action that otherwise wouldn't be possible as they provide

**Granular and Uncorrelated** dimensions that

1) Define the problem and business object space
2) More importantly, **each dimension is constrained so that variations within it affect only specific properties of the underlying business object attribute, while all other properties remain unaffected**.

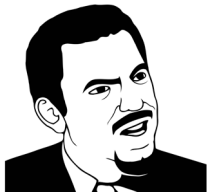
# Disentangled Representation Learning (DRL)

Here are 1 million sample of cylinders..
Find me the disentangled representation space so I can manipulate each dimensions to create different cylinders I like

Disentangled Representation Learning Algorithm

I see that Radius and Height are the only two dimensions you need to represent and generate all kinds of cylinders to your taste!

Volume and Surface Area are something I like. Much representation. Wow.



**NOT** Disentangled Representation Learning Algorithm

# So what if we don't have DRL? The Sauce Jar Problem

Say a resourceful cook named Tim just made a avant-garde  dish with just

- Peanut Butter (Sweet and Salty)
- Vinaigrette (Sour and Salty)

Upon tasting, Tim finds **sweetness** and **sourness** at the perfect level. But it needs to be **saltier**.

I GOT NO SALT.

ಠ_ಠ

# With DRL

Tim’s dish is now perfect.

I got salt ☺

# DRL for Business Action – Resource Allocation Problem by Tim Cook

We will enter the healthcare market. Upon applying InnoVAET, we see that we need to spend more R&D on “Diagnostics” capabilities to catch up to potential competitors like Abbott and Medtronics

# InnoVAET: a Variational AutoEncoder Transformer for Patents

## InnoVAET estimates disentangled representations of patents

- Map patent text (e.g., claims) into an interpretable, spatial representation of firms' innovative activities.
- Innovation Space (IS) – enable explorations into patents, innovation, and firms

Here are samples of computing patents (x-vars and claims text)

Disentangled Representation Learning Algorithm

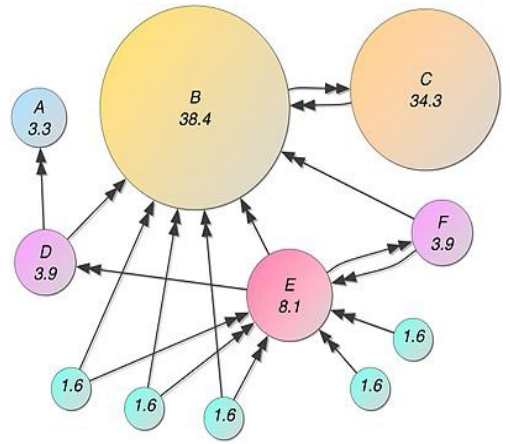
Factors of Innovations that comprise these group of patents are: Security, Human-Computer Interaction, etc

## Good disentangled representation (Innovation Space) enables you to ask and explore:

1. What could you get if you combine patent A and B? (automate combinational creativity)
2. How unusual is a patent (e.g., iPod interface) with respect to specific technological factor (e.g., user-interface)?
3. What innovation factors inc/dec over time?
4. Rank companies in technological factor X (extracted from claims by the algo)
5. If I am firm A, what innovation do I need to boost up to be more like Firm B?
6. How do firms move in Innovation Space over time and how does that correlate to some performance?
7. What happens to innovation activity in specific technological region after event X (i.e., acquisition, mergers)
8. etc

# Data Context

- US Patents on AI & computing systems
- 583,841 patents between 1976 to 2019

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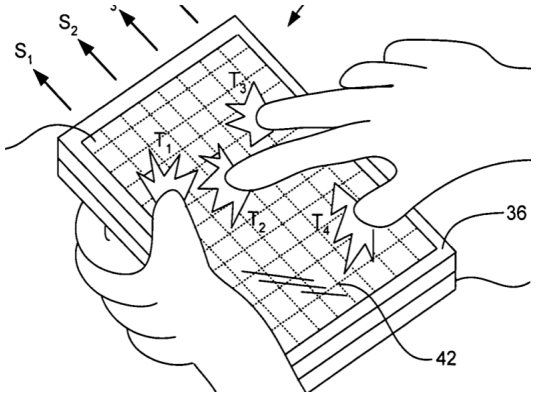



Multipoint
Touch
by Apple
(US# 7663607)

Examples of patents under G06 group

## Example Innovation Factors (Disentangled Axis)

- Pictorial Communication
- Controlling Combustion Engines
- IT for Administration & Management
- Healthcare Informatics
- Diagnostics and Surgery
- Electric Data Processing
- Etc

# Semantic structure of latent space (Patent Fusion)

$$\mathbf{z}^{(\text{fused})} = \mathbf{z}^{(a)} + \mathbf{z}^{(b)}$$

#5873080 Using multiple search engines to search multimedia data

#7689506 System and method for rapid updating of credit information

$\mathbf{z}^{(a)}$

$\mathbf{z}^{(b)}$

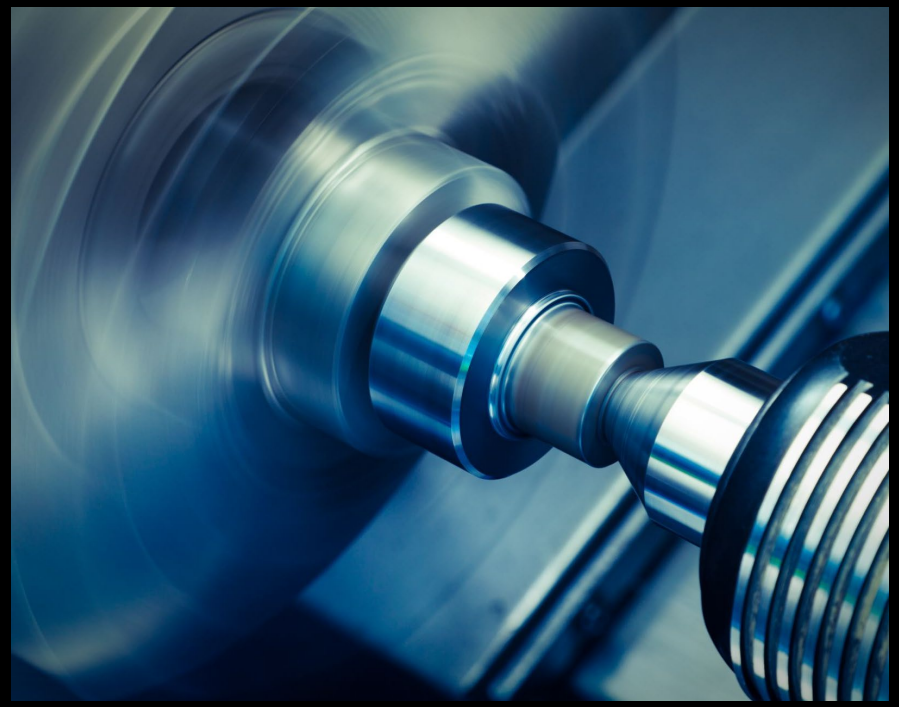
#5162638 Process for protection against fraudulent use of smart cards, and device for use of the process

$\mathbf{z}^{(\text{fused})}$

| Innovation Factor | Top 3 Firms | 4-digit NAICS Code | Innovation Index |
|---|---|---|---|
| Pictorial Communication | TDK Corp | 3344 (Semiconductor and Electronic Components) | 1.5016 |
| | Canon Inc | 3333 (Commercial and Service Industry Machinery) | 1.3388 |
| | Fujifilm Hldgs Corp | 3259 (Other Chemical Product and Preparation) | 1.2873 |
| Controlling Combustion Engines | Nissan Motor Co Ltd | 3361 (Motor Vehicle Manufacturing) | 0.7622 |
| | Toyota Motor Corp | 3361 (Motor Vehicle Manufacturing) | 0.6439 |
| | Cummins Inc | 3336 (Engine, Turbine, and Power Transmission) | 0.5601 |
| IT for Administration & Management | Booking Holdings Inc | 5191 (Other Information Services) | 1.7784 |
| | Convergys Corp | 5614 (Business Support Services) | 1.5458 |
| | MCI Inc | 5171 (Wired Telecommunications Carriers) | 1.4633 |
| Healthcare Informatics | Masimo Corp | 3345 (Navigational, Measuring, Electromedical) | 0.5326 |
| | Dexcom Inc | 3345 (Navigational, Measuring, Electromedical) | 0.5239 |
| | Checkfree Corp | 5619 (Other Support Services) | 0.5043 |
| Diagnosis & Surgery | Fresenius Medical Care | 6214 (Outpatient Care Centers) | 1.0033 |
| | St Jude Medical Inc | 3345 (Navigational, Measuring, Electromedical) | 0.8583 |
| | Zoll Medical Corp | 3345 (Navigational, Measuring, Electromedical) | 0.7693 |
| Electric Digital Data Processing | Western Digital Corp | 3341 (Computer and Peripheral Equipment) | 1.4727 |
| | Netlogic Microsystems Inc | 3344 (Semiconductor and Electronic Components) | 1.4395 |
| | Cavium Inc | 3342 (Communications Equipment) | 1.3723 |

| Entrant | Incumbent | Factors of Technology Gap | Technology Gap |
|---|---|---|---|
| Apple | Medtronic | Diagnosis; Surgery; Identification | 0.3875 |
| | | Electro, Magnetic, Radiation and Ultrasound Therapy | 0.2849 |
| | | Measuring Electric and Magnetic Variables | 0.2562 |
| | Johnson & Johnson | Diagnosis; Surgery; Identification | 0.4531 |
| | | Healthcare Informatics | 0.1408 |
| | | Controlling Non-Electric Variables | 0.1197 |
| | Abbott | Diagnosis; Surgery; Identification | 0.3113 |
| | | Radio Navigation | 0.2181 |
| | | Healthcare Informatics | 0.0994 |
| Google | Medtronic | Diagnosis; Surgery; Identification | 0.3766 |
| | | Measuring Electric and Magnetic Variables | 0.3247 |
| | | Electro, Magnetic, Radiation and Ultrasound Therapy | 0.2333 |
| | Johnson & Johnson | Diagnosis; Surgery; Identification | 0.4422 |
| | | Controlling Non-Electric Variables | 0.1635 |
| | | Healthcare Informatics | 0.1310 |
| | Abbott | Radio Navigation | 0.3502 |
| | | Diagnosis; Surgery; Identification | 0.3004 |
| | | Healthcare Informatics | 0.0896 |

(b) Healthcare market



# Patent Level Exploration

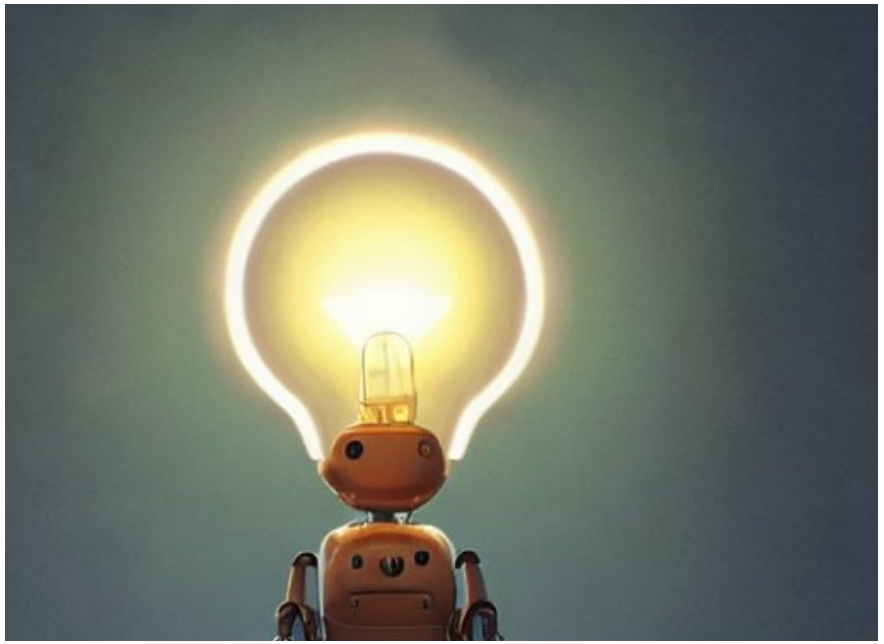
**We can use geometric analyses of patents in innovation space to categorize, patents into combinational vs transformative patents.**

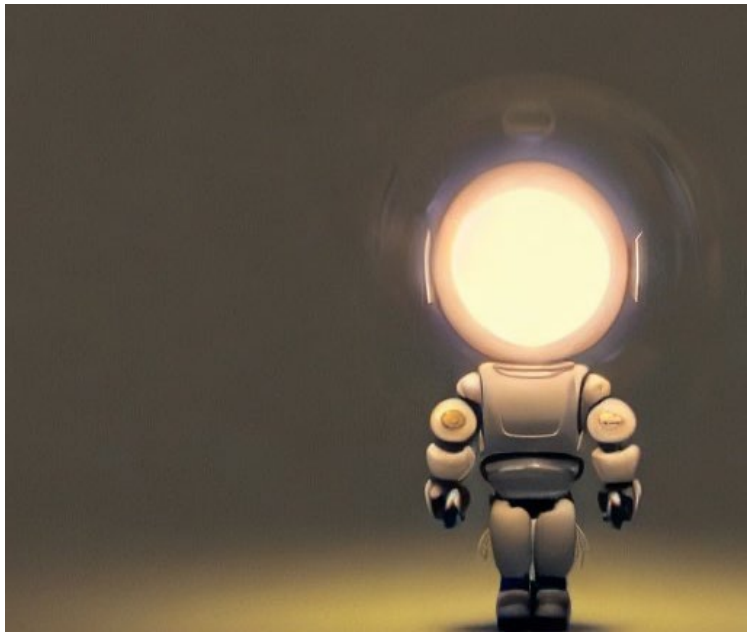
# Why Not

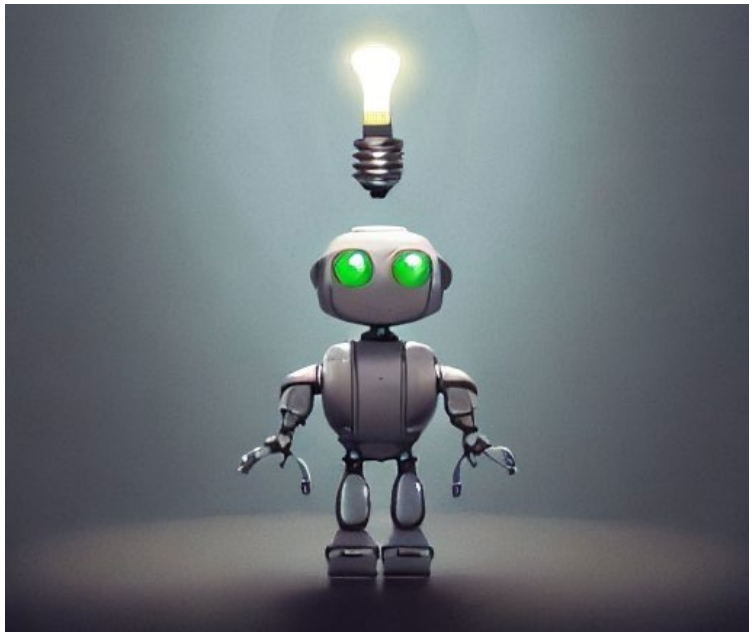
- **Products** in Feature Spaces (Customer Reviews)
- **Products** in Wish-Feature Spaces (Customer Feedback, Complaints)
- **Brands** in Personality Spaces (Social Media Data)
- **Assets** in Risk Spaces (10K, earnings report, analyst report)
- **Jobs** in Skill Spaces (Job Description Data)
- **Firms** in Business Strategy Spaces (Pitchbook, 10K, etc)
- Etc…

# Takeaways

- InnoVAET is an **exploratory tool**
- This approach enables interpretation, comparison, visualization, and augmented creation of any multi-modal business object
- Generative AI can be used to map out a competitive landscape for strategic action







Thank you!

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