

# **A comparative analysis between ChatGPT 3.5 and ChatGPT 4 on Analogue Retrieval**

José Chacón  
Auriane Mahfouz

# Introduction

- LLMs are designed to process and generate human-like text based on extensive training with large datasets.
- Critics argue that LLMs lack genuine reasoning and context understanding.
- By adapting Keane's methodology, this project aims to assess the performance of ChatGPT 3.5 and the current version ChatGPT 4 in retrieving analogies, shedding light on its cognitive abilities in this specific domain.

# Reference paper

## **On Retrieving Analogues When Solving Problems**

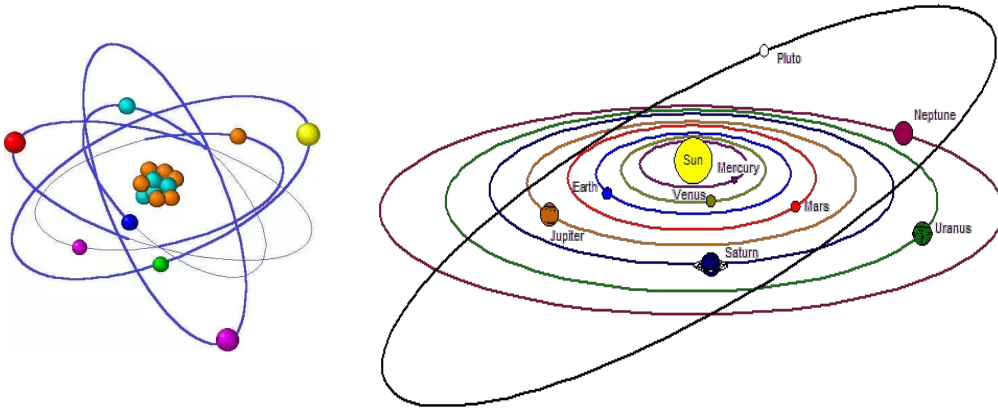
Mark Keane

*Department of Psychology, Trinity College, Dublin, Ireland*

After criticism of the precision of previous experimental procedures for testing analogue retrieval, a new procedure that overcomes the proposed inadequacies is described. This procedure is then employed in two experiments that test aspects of the general hypothesis that base analogues that are semantically remote from a target problem (Duncker's radiation problem) are more difficult to retrieve than those that are semantically closer. Experiment 1 confirmed this hypothesis by finding that remote analogues are seldom retrieved relative to literal analogues. The results of Experiment 2 falsified the hypothesis that analogue retrieval is solely due to the recognition of an "identical element". Finally, an ad hoc model of analogue retrieval is proposed based on Schank's dynamic memory theory, and its consistency with the evidence and more general implications are considered.

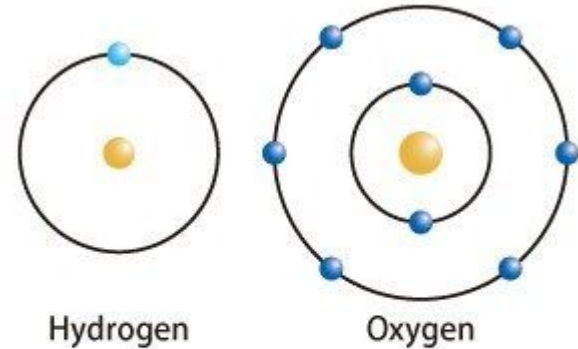
# Remote Analogy

- Structure mapping between a base and target domain
- Base and target are from different domains
- Little attribute overlap between the objects/concepts of both domains
- Requires more abstract thinking



# Literal Analogy

- Mapping between two domains
- Domains are similar
- Overlapping relations and considerable attribute overlap on most or all of the object/concepts

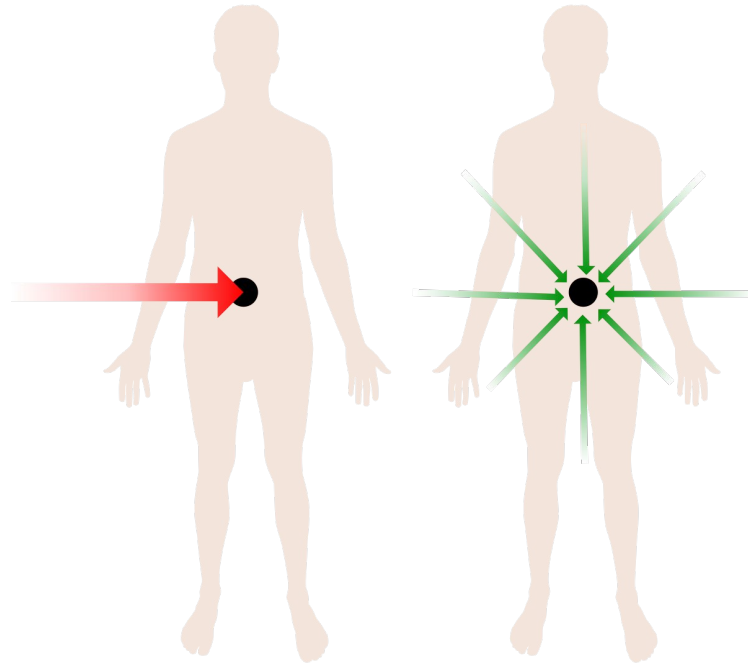


# Duncker's Radiation Problem (1945)

Suppose you are a doctor with a patient who has a malignant tumour in his stomach. It is impossible to operate on the patient; but unless the tumour is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumour. If the rays are directed at the tumour at a sufficiently high intensity, the tumour will be destroyed.

Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumour will also be destroyed. At lower intensities the rays are harmless to the healthy tissue but they will not affect the tumour either.

**What type of procedure might be used to destroy the tumour with the rays, and at the same time avoid destroying the healthy tissue?**



# ChatGPT familiarity

## ChatGPT 3.5



**You**

Are you familiar with the Duncker radiation problem?



**ChatGPT**

It seems like there might be a slight confusion in your question. The term "Duncker radiation problem" doesn't correspond to a well-known concept or issue in my training data up to January 2022.

There is a well-known cognitive psychology problem called the "Duncker candle problem," which is a classic test of creative problem-solving. It was created by psychologist Karl Duncker in the 1940s. In this problem, participants are presented with a set of objects, including a box of tacks, a candle, and a book of matches. The task is to attach the candle to the wall in a way that prevents wax from dripping onto the table below. The solution involves realizing that the box can be emptied, tacked to the wall as a shelf, and the candle placed on it.

If you were referring to a different concept or problem, could you provide more details or clarification?



# ChatGPT familiarity

## ChatGPT 4



### ChatGPT

Yes, I'm familiar with the "radiation problem" used in analogical reasoning experiments. This problem is a classic example used in the field of cognitive psychology to study how people solve problems and use analogy in their reasoning.

The radiation problem typically goes like this:

A doctor needs to destroy a malignant tumor in a patient's stomach using rays. However, at high intensity, the rays will also destroy the healthy tissue they pass through. At low intensity, the rays are harmless to both healthy tissue and the tumor. The challenge is to find a way to destroy the tumor without harming the healthy tissue.

The solution involves using multiple low-intensity rays from different directions. These rays converge at the tumor, collectively delivering enough energy to destroy it without damaging the surrounding healthy tissue.

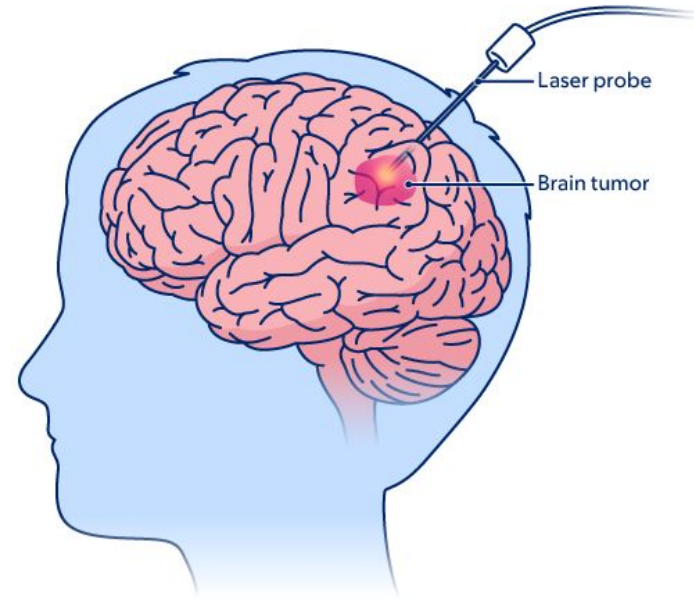
In experiments involving this problem, participants are often given a similar problem, known as the source analog, such as the story of a general wanting to capture a fortress. The general can't send his entire army down one road to the fortress because it's mined. Instead, he divides the army and sends them down multiple roads, converging at the fortress. Participants who are exposed to this analogous story before tackling the radiation problem are more likely to come up with the convergent rays solution.



# The Surgeon

A surgeon was trying to destroy a cancer which was situated in the central region of a patient's brain, by using a type of ray. He needed to use these rays at a high intensity in order to destroy the cancerous tissue. However, at such an intensity the healthy brain tissue will also be destroyed.

After considerable thought, he knew just what to do. He divided the rays up into batches of low-intensity rays, and by sending them, simultaneously, from a number of different directions, they converged on the cancer, making up a sufficiently high intensity to destroy it.



# The General

A general was trying to destroy a fortress which was situated at the centre of a country with roads leading to it, by using his army. He needed to use his army as a complete group in order to destroy the fortress. However, he could not march his army down a road to the fortress because the roads were mined to explode when large groups of men passed over them.

After considerable thought, he knew just what to do. He divided his army up into small groups of men, and by sending these groups, simultaneously, from a number of different directions, they converged on the fortress, making up a sufficiently powerful army to destroy it.



# The Dictator

A small country fell under the iron rule of a dictator. The dictator ruled the country from a strong fortress. The fortress was situated in the middle of the country, surrounded by farms and villages. Many roads radiated outward from the fortress like spokes on a wheel. A great general arose who raised a large army at the border and vowed to destroy the fortress and free the country of the dictator. The general knew that if his entire army could attack the fortress at once it could be destroyed. His troops were posed at the head of one of the roads leading to the fortress, ready to attack. However, a spy brought the general a disturbing report.

The ruthless dictator had planted mines on each of the roads. The mines were set so that small bodies of men could pass over them safely, since the dictator needed to be able to move troops and workers to and from the fortress. However, any large force would detonate the mines. Not only would this blow up the road and render it impassable, but the dictator would then destroy many villages in retaliation. A full-scale direct attack on the fortress therefore appeared impossible.

The general, however, knew what to do. He divided his army up into small groups and dispatched each group to the head of a different road. When all was ready he gave the signal, and each group marched down a different road. Each group continued down its road to the fortress, so that entire army finally arrived together at the fortress at the same time. In this way, the general was able to destroy the fortress, and thus capture the dictator.



# Methodology

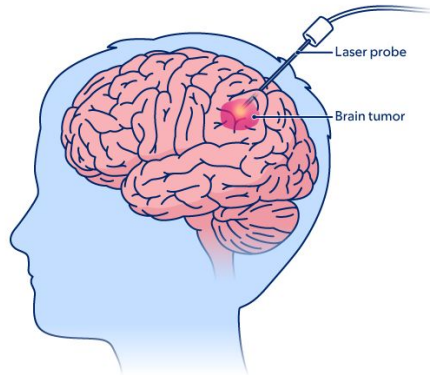


# Experiment 1

## Acquisition Stage

1. The subject is given a story analogue to memorize (between The General and Surgeon)
2. The subject is asked to recall it

Literal analogue



Remote analogue

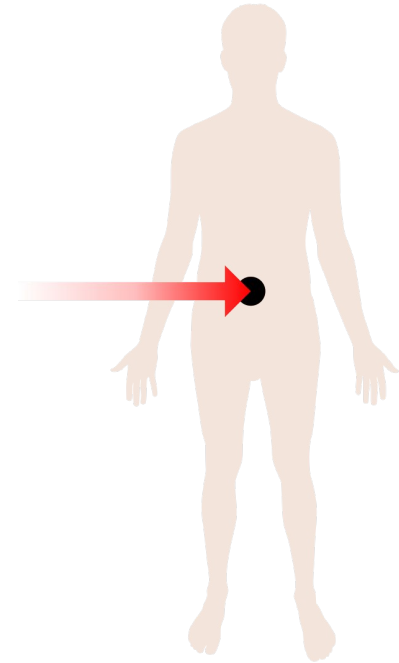


# Experiment 1

Resembles Keane's experiment I procedure

## Test Stage (Full case)

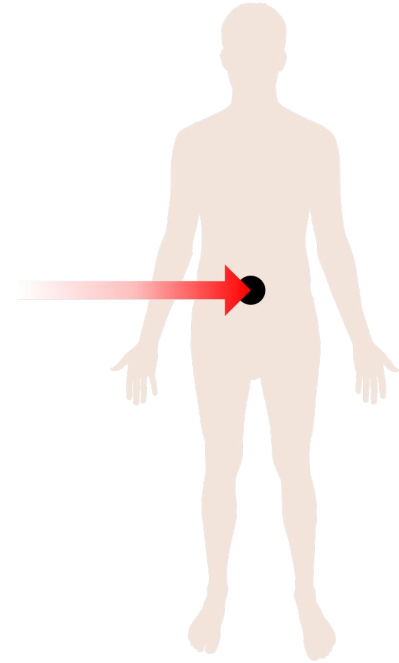
1. Subject is told that they have 3 insight problems to solve
2. Subject is asked to think of analogous problems before attempting to solve the third problem and also verbalize anything that occurred to them.
3. **Third problem to solve: Duncker's Radiation Problem**



# Experiment 1

## Test Stage (Simple case)

1. Problem to solve: Duncker's Radiation Problem



## Retrieval

- Subject mentions the story analogue when asked to think of analogous problems before solving the Radiation Problem.
- Otherwise, subject admit using the story analogue for arriving to the solution.

## Mapping

- Subject ,explicitly aware of the analogues between stories, converges to the solution.

## Keane's experiment I results

Literal analogue  
retrieved

**88%**

Remote analogue  
retrieved

**12%**

Analogue stories  
mapped

**~ 87%**



# Prompt design

## Acquisition stage

I need you to analyse it carefully and then recall it, as precisely as possible. The story is the following: [...]

## Test stage

**Before attempting to solve the following task try to think of analogous problems. Verbalize anything that occurred to you prior to attempting to solve this problem.** Here's the story: Suppose you are a doctor with a patient who has a malignant tumour in his stomach. It is impossible to operate on the patient; but unless the tumour is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumour. If the rays are directed at the tumour at a sufficiently high intensity, the tumour will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumour will also be destroyed. At lower intensities the rays are harmless to the healthy tissue but they will not affect the tumour either. What type of procedure might be used to destroy the tumour with the rays, and at the same time avoid destroying the healthy tissue?

# Prompt design

## Problem solving tasks preceding the Radiation Problem

**Problem 1:** Here is a bag filled with popcorn. There is no chocolate in the bag. The bag is made of transparent plastic, so you can see what is inside. Yet, the label on the bag says 'chocolate' and not 'popcorn.' Sam finds the bag. She had never seen the bag before. Sam reads the label. She believes that the bag is full of (. . . )

**Problem 2:** Mr. and Mrs. Plum have six daughters and each daughter has one brother. How many people are in the Plum family?

# Prompt design

## Prompts for inspecting model behaviour

- How did you arrive at this solution?
- Reflect carefully again

## Prompt for enforcing mapping

- Have you seen a similar story?

## Prompt for inspecting model behaviour after mapping

- Did you think of using the story to solve the problem?

## Prompts to confirm successful mapping:

- Try to solve the problem using it
- Could you now use it to solve the problem
- Recall the analogue

# Experiment 2: Methodology

## General-Ray

A general was trying to destroy an intercontinental ballistic missile, using a type of **ray**, which would be entering the atmosphere at great speeds. He needed to use a high-intensity ray in order to destroy the incoming missile. However, such high-intensity rays were inaccurate because they would heat up the air through which they passed, thus distorting the beam. After considerable thought, he knew what to do. He divided the high-intensity rays into a number of low-intensity rays and, by sending these low-intensity rays, simultaneously, from a number of different directions, they converged on the missile making up a sufficiently powerful beam to destroy it.

## General-Laser

A general was trying to destroy an intercontinental ballistic missile, using a type of **laser beam**, which would be entering the atmosphere at great speeds. He needed to use a high-powered laser beam in order to destroy the incoming missile. However, such high-powered laser beams were inaccurate because they would heat up the air through which they passed, thus distorting the beam. After considerable thought, he knew what to do. He divided the high-powered laser beams into a number of low-powered laser beams and, by sending these low-powered laser beams, simultaneously, from a number of different directions, they converged on the missile making up a sufficiently powerful beam to destroy it.

# Experiment 2: Methodology

- In the Acquisition stage, 3 stories were given to recall: The General, General-Ray and General-Laser.
- During the Test Stage, we distinguish between the simple and full case:
  - Simple case: The LLM is asked to recall the story then solve the problem directly. If it did not retrieve the analogy, it is asked again to think of similar problems.
  - Full case: Three problems are asked before trying to solve the radiation problem.

# Experiment 2: Methodology

For each case, 3 scenarios are presented:

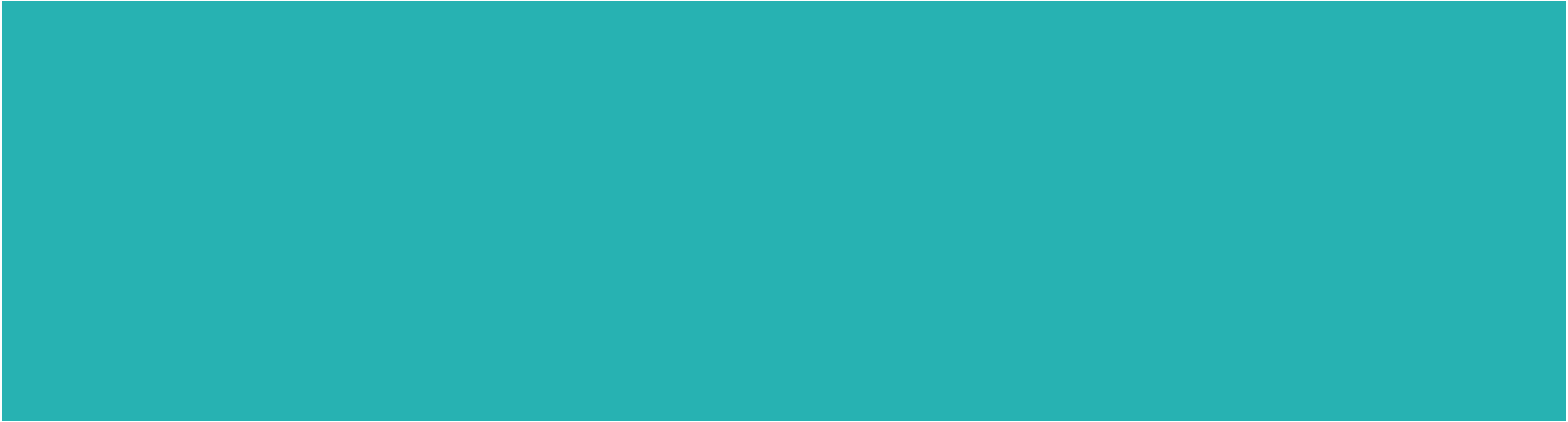
1. ChatGPT is asked to solve the problem without telling it to think of an analogous story.
2. ChatGPT has failed to retrieve the analogy in the first stage, and is asked to think of an analogous problem.
3. ChatGPT did not retrieve the analogy in the previous two steps and is asked to reflect carefully again.

**Prompt Design:** Similar to Experiment 1

# Results of Experiment 2 based on Keane's Paper

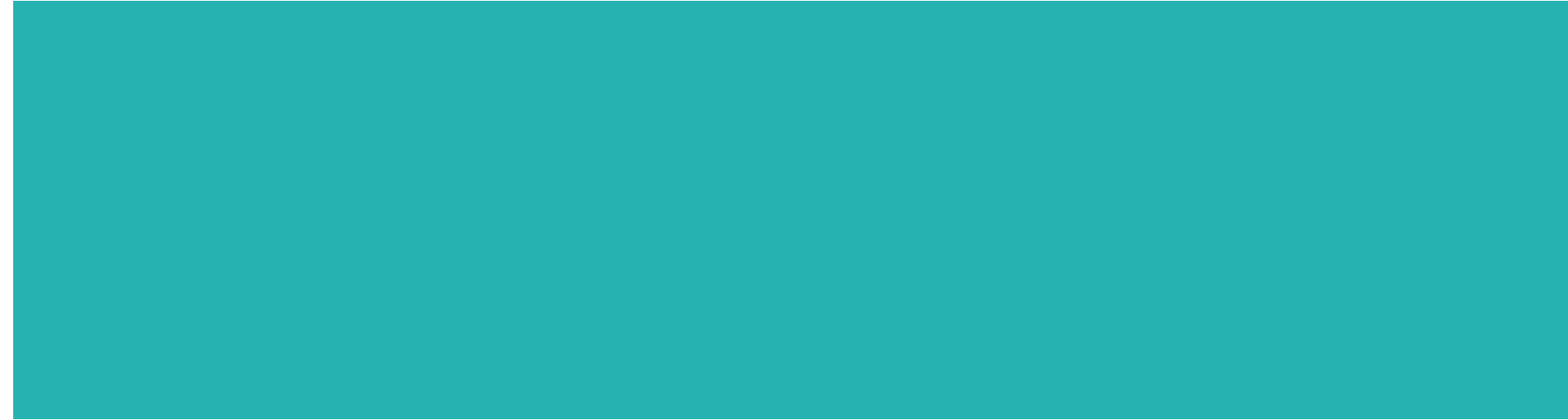
	Retrieval	Mapping
Ray	58%	94%
Laser	53%	94%
Army	5%	88%

# Results





# Experiment 1



# Overview

Panel A: Simple case

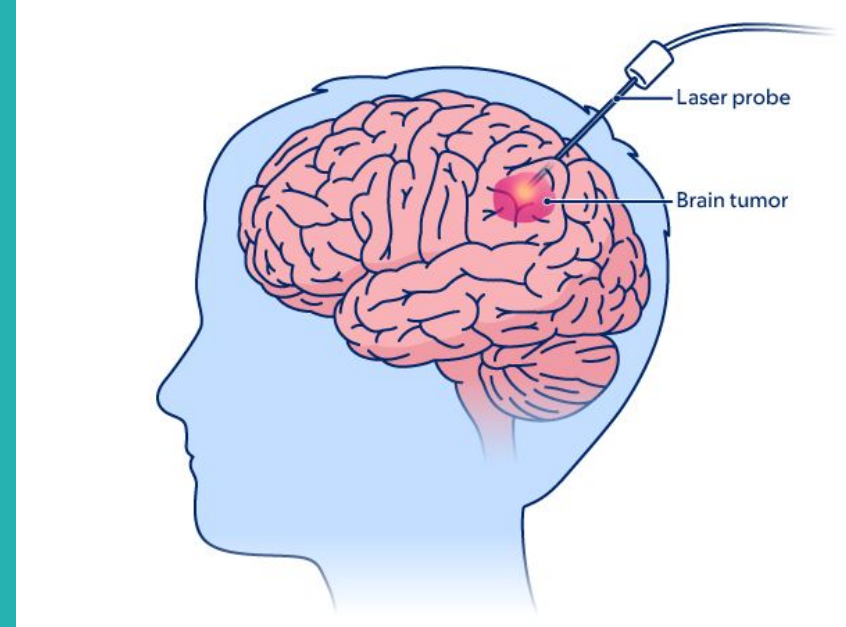
Story	Condition	GPT 3.5	GPT 4
The Surgeon	Literal Analogue	Retrieved	Retrieved
The General	Remote Analogue	Mapped	Retrieved
The Dictator	Remote Analogue	Mapped	Retrieved

Panel B: Full case

Story	Condition	GPT 3.5	GPT 4
The Surgeon	Literal Analogue	Retrieved	Retrieved
The General	Remote Analogue	Mapped	Retrieved
The Dictator	Remote Analogue	Mapped	Retrieved*

\* Retrieval of the base analogue obtained after a change in the prompt

# The Surgeon as base analogue



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You

Now, the last one. By the way, try to think of analogous problems before attempting to solve each problem. Verbalize anything that occurred to you prior to attempting to solve the problem. Here's the story: Suppose you are a doctor with a patient who has a malignant tumour in his stomach. It is impossible to operate on the patient; but unless the tumour is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumour. If the rays are directed at the tumour at a sufficiently high intensity, the tumour will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumour will also be destroyed. At lower intensities the rays are harmless to the healthy tissue but they will not affect the tumour either. What type of procedure might be used to destroy the tumour with the rays, and at the same time avoid destroying the healthy tissue?



ChatGPT

Before attempting to solve this problem, it reminds me of the earlier story you shared about the surgeon and the brain cancer. In that story, the surgeon faced a similar dilemma: using high-intensity rays to destroy cancerous tissue, but risking damage to healthy brain tissue. The solution was to divide the rays into batches of low-intensity rays and send them simultaneously from multiple directions so that they converged on the cancer, thereby delivering a high intensity at the point of convergence while minimizing damage to surrounding healthy tissue.

Applying a similar line of reasoning to this new problem, the doctor could use a similar approach to treat the patient with the malignant tumor in the stomach. Instead of using a single high-intensity ray, the doctor could use multiple low-intensity rays. These rays would be harmless to healthy tissue at their individual intensities. The doctor would aim these rays from different angles such that they all converge precisely at the location of the tumor. At the point of convergence, the combined intensity of all the rays would be sufficient to destroy the tumor without harming the surrounding healthy tissue.

This approach is analogous to the earlier story and offers a solution that addresses the constraints of the problem: destroying the tumor while preserving healthy tissue.

# ChatGPT 4

## Successful retrieval

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## ChatGPT

Analogous Problems:

### 1. Radiotherapy for Cancer:

- In cancer treatment, radiation therapy is commonly used to target tumors. Similar to the scenario described, the challenge is to destroy cancer cells without harming healthy tissue. Techniques such as intensity-modulated radiation therapy (IMRT) aim to adjust the intensity of radiation beams to spare normal tissues while effectively treating the tumor.

### 2. Targeted Drug Delivery:

- In the field of pharmacology, designing drug delivery systems that specifically target diseased cells without affecting healthy cells is a challenge. Nanoparticles and targeted drug formulations are developed to enhance drug delivery to specific locations in the body, minimizing side effects on healthy tissues.

### 3. Selective Pest Control in Agriculture:

- When dealing with pest control in agriculture, the challenge is to eliminate harmful pests without harming the crops. Developing pesticides that selectively target pests while being harmless to beneficial organisms or the crops themselves is analogous to the medical challenge of targeting tumors without damaging healthy tissue.

### 4. Data Security in Network Filtering:

- In computer science, network filtering systems aim to block malicious content without hindering the flow of legitimate data. The challenge is to create filters that can distinguish between harmful and harmless data, analogous to distinguishing between cancerous and healthy tissue in medical treatments.

### Procedure for Destroying the Tumor:

Considering analogous problems and the solution presented in the initial story about the brain cancer, a similar approach can be applied. The doctor might use a method of dividing the rays into batches of low intensity and directing them from multiple angles simultaneously. By doing so, the low-intensity rays would converge on the tumor, reaching a sufficiently high intensity to destroy it while minimizing damage to the healthy tissue in the path of the rays. This approach aims to strike a balance between effectively treating the malignant tumor and preserving the surrounding healthy tissue.

# ChatGPT 3.5

## Successful retrieval

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# The General as base analogue





#### ChatGPT

This problem is reminiscent of the earlier story about the general and the fortress. In both cases, there's a need to target a specific area (the fortress or the tumor) without causing harm to the surrounding areas (the roads or healthy tissue).

In the story of the general, the solution was to divide the army into smaller groups, each taking different paths to converge on the fortress, thereby avoiding triggering the mines. Drawing an analogy from this, a similar approach could be applied to the medical problem:

Instead of using one high-intensity ray directed at the tumor (which would harm healthy tissue), multiple lower-intensity rays could be used. These rays, harmless to healthy tissue at lower intensities, could be directed at the tumor from different angles. The idea is that the intensity of the rays would cumulatively be high only at the point where they intersect - at the tumor. This way, each individual ray is harmless to the healthy tissue it passes through, but where they all converge on the tumor, their combined intensity is sufficient to destroy it.

This technique is actually akin to a real medical procedure known as stereotactic radiosurgery, often used in treating certain types of tumors. It uses precisely focused radiation beams to treat tumors and other abnormalities, minimizing damage to surrounding healthy tissue.

# ChatGPT 4

## Successful retrieval

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## ChatGPT

The process of arriving at the solution involved considering analogous situations in different domains to identify patterns or strategies that could be applied to the medical scenario. Analogies provide a way to leverage knowledge from one context to address a problem in another context. Here's a breakdown of the thought process:

### 1. Understanding the Problem:

- The initial problem involves the challenge of destroying a malignant tumor without causing harm to healthy surrounding tissue. The obstacle is the simultaneous destruction of healthy tissue at high intensity, while low intensities are ineffective against the tumor.

### 2. Analogous Situations:

- I considered analogous situations in military strategy and computer security. In both scenarios, the challenge is to target a specific threat without causing significant damage to the surrounding environment or system.

### 3. Military Strategy Analogy:

- Analogous Situation: Destroying a target in a fortified area without collateral damage.
- Solution: Precision airstrikes or special forces operations.
- Application: In medical terms, the analogous solution involves directing rays with precision to destroy the tumor while sparing healthy tissue.

### 4. Computer Security Analogy:

- Analogous Situation: Removing a virus without damaging essential files.
- Solution: Using antivirus software that can target and eliminate the specific threat.
- Application: In the medical context, this aligns with using focused radiation therapy to target the tumor without harming surrounding healthy tissue.

### 5. Medical Solution: Focused Radiation Therapy:

- Drawing from the analogous situations, the solution involves utilizing advanced radiation therapy techniques like stereotactic body radiation therapy (SBRT) or intensity-modulated radiation therapy (IMRT).
- These technologies allow for precise targeting of the tumor, controlling the intensity and direction of the rays to minimize damage to healthy tissue.

In summary, the solution emerged by recognizing the need for precision in targeting, inspired by analogous scenarios where specific threats needed to be addressed without causing undue harm to the surrounding environment or system.

# ChatGPT 3.5

Effect of “How did you arrive at this solution?” prompt



# The Dictator as base analogue



JO You

Before attempting to solve the following task try to think of analogous problems. Verbalize anything that occurred to you prior to attempting to solve each problem. Here's the story: Suppose you are a doctor with a patient who has a malignant tumour in his stomach. It is impossible to operate on the patient; but unless the tumour is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumour. If the rays are directed at the tumour at a sufficiently high intensity, the tumour will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumour will also be destroyed. At lower intensities the rays are harmless to the healthy tissue but they will not affect the tumour either. What type of procedure might be used to destroy the tumour with the rays, and at the same time avoid destroying the healthy tissue?

ChatGPT

Before attempting to solve this problem, it reminds me of analogous situations in various fields where a solution needs to be precise and targeted to avoid collateral damage. This is akin to scenarios in cybersecurity (targeting a specific virus without harming the rest of the system), environmental management (addressing a specific pollutant without affecting the surrounding ecosystem), or even in military tactics (neutralizing a specific threat without harming civilians or infrastructure).

In each of these cases, the key principle is to concentrate the effect on the target while minimizing impact on the surrounding area. Applying this principle to the medical problem of the malignant tumor, the solution would likely involve a strategy where the rays are used in a way that their cumulative intensity is high enough to destroy the tumor but each individual ray is weak enough to not harm healthy tissue.

# ChatGPT 4

## Incorrect retrieval

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**You**

Have you seen a similar story?



**ChatGPT**

Yes, the scenario you described is a classic problem often used in discussions about lateral thinking and creative problem-solving. It's known as the "radiation problem" and was popularized by Edward de Bono, a psychologist and author known for his work in lateral thinking.

In the original radiation problem, the challenge is to destroy a malignant tumor using rays that are too powerful for healthy tissue to withstand. The solution, as discussed, involves using multiple low-intensity rays from different angles, converging at the tumor, thereby destroying it without damaging the surrounding healthy tissue. This problem is typically used to illustrate the concept of thinking creatively and finding innovative solutions to complex problems where direct approaches might be harmful or ineffective.

The similarity between the scenario you presented and the classic radiation problem lies in the need for a solution that is both effective (in destroying the tumor) and precise (to avoid harming healthy tissue), which is a common theme in many lateral thinking puzzles and real-world problems.

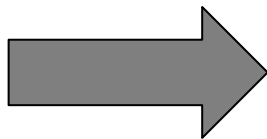
# ChatGPT 4

**Radiation Problem  
mention when asked  
“Have you seen a similar  
story?”**

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# Prompt modification

“Before attempting to solve the following task try to think of analogous problems. Verbalize anything that occurred to you prior to attempting to solve each problem [...]”



“Verbalize any analogues that occurred to you prior to attempting to solve this problem”

Jo

**You**

Verbalize any analogues that occurred to you prior to attempting to solve this problem. Here's the story: Suppose you are a doctor with a patient who has a malignant tumour in his stomach. It is impossible to operate on the patient; but unless the tumour is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumour. If the rays are directed at the tumour at a sufficiently high intensity, the tumour will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumour will also be destroyed. At lower intensities the rays are harmless to the healthy tissue but they will not affect the tumour either. What type of procedure might be used to destroy the tumour with the rays, and at the same time avoid destroying the healthy tissue?



**ChatGPT**

This problem is a classic example of a scenario that requires a creative or lateral thinking approach to find a solution. The analogy that comes to mind before attempting to solve this problem is the strategic approach used in the story you previously shared about the general and the dictator's fortress.

In that story, the general faced a situation where a direct, full-force attack would lead to undesirable consequences (detonation of mines and destruction of roads and villages). Instead, he devised a strategy to achieve his goal (capturing the fortress) without triggering these negative outcomes. He did this by dividing his forces into smaller groups, each taking different paths but converging on the fortress simultaneously.

# ChatGPT 4

## Correct retrieval

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Prompt	ChatGPT 4
Reflect carefully again #1	<ul style="list-style-type: none"><li>- Military Strategy</li><li>- Conflict Resolution</li><li>- Environmental Management</li></ul>
Reflect carefully again #2	<ul style="list-style-type: none"><li>-Astronomy and physics</li><li>- Engineering and design</li><li>- Art and light displays</li></ul>
Reflect carefully again #3	<ul style="list-style-type: none"><li>- Focused energy in physics</li><li>- Precision agriculture</li><li>- Targeted Financial Investment</li></ul>

# ChatGPT 4

Effect of “Reflect  
carefully again” prompt

# Initial responses in unsuccessful tests (ChatGPT 4)

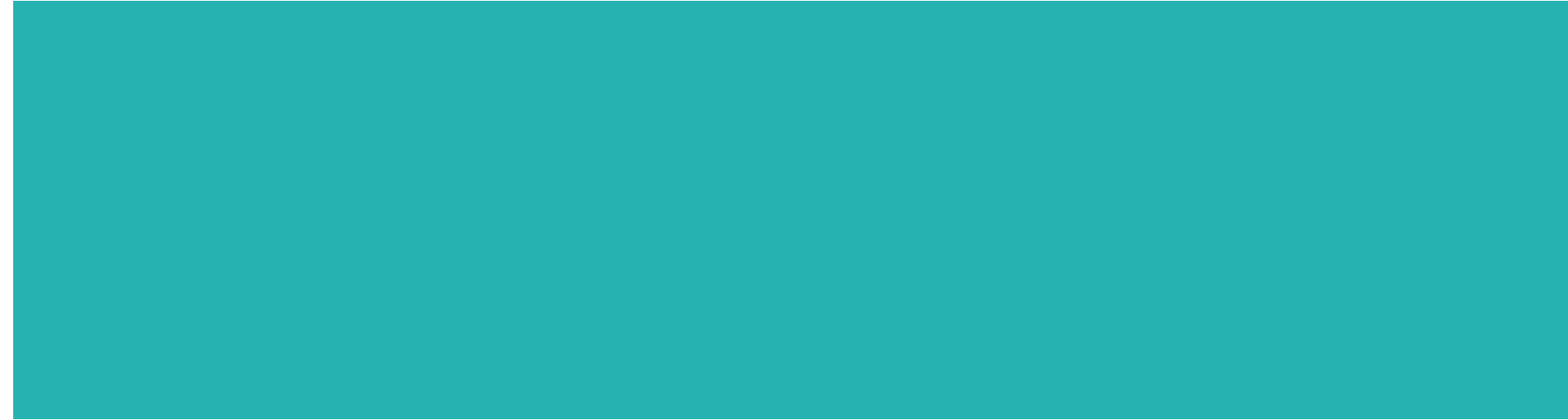
- Before attempting to solve this problem, it reminds me of analogous situations in various fields where a solution needs to be precise and targeted to avoid collateral damage.
- Before attempting to solve this problem, it reminds me of a situation where a solution requires a balance between two extremes, each of which is harmful in its own way.
- Before attempting to solve this problem, it reminds me of analogous problems in various fields where a solution needs to be applied effectively without causing harm to surrounding areas or elements.
- Before attempting to solve this problem, it reminds me of analogous problems in other fields where focusing multiple weaker sources to a single point achieves a strong effect without causing damage along the way.

# Radiation problem responses

Story	ChatGPT 3.5	ChatGPT 4
The Surgeon	[...] I would consider the analogous problem presented in the previous story about a surgeon dealing with a brain cancer.	The problem described in the story is closely analogous to the previous story about treating a brain tumor with rays.
The General	No retrieval	This problem is reminiscent of the earlier story about the general and the fortress.
The Dictator	No retrieval	This problem brings to mind an analogous situation from the earlier story about the general and the dictator's fortress.



# Experiment 2



# Overview

Panel A: Simple case

Story	GPT 3.5	GPT 4
The General	Mapped	Retrieved
General-Ray	Retrieved*	Retrieved
General-Laser	Mapped	Retrieved

Panel B: Full case

Story	GPT 3.5	GPT 4
The General	Mapped	Mapped
General-Ray	Retrieved*	Retrieved
General-Laser	Mapped	Retrieved*

\* Retrieval of the base analogue obtained after being asked to think carefully

# Simple Case with ChatGPT 3.5

## The General

After failing to retrieve the analogy in scenarios 1 and 2, it mapped it when asked to reflect carefully.



You

Reflect carefully



ChatGPT

Upon further reflection, it's important to emphasize the key principle underlying the procedure I suggested for destroying the tumor with radiation while preserving healthy tissue: precision.

The primary strategy in this scenario is to maximize the accuracy of the radiation delivery to the tumor while minimizing its impact on surrounding healthy tissue. This approach is made possible by advanced medical imaging, computer-controlled equipment, and careful treatment planning.

The analogy with the military strategy discussed earlier also becomes more apparent. Just as the general used precision and simultaneous actions to avoid minefields and reach the fortress, the medical procedure relies on precision to reach the tumor and spare healthy tissue.

Additionally, this problem highlights the critical role of modern medical technology and expertise in finding solutions to complex challenges, ultimately benefiting the patient's well-being and chances of survival.

**You**

Can you solve this problem for me? Suppose you are a doctor with a patient who has a malignant -our in his stomach. It is impossible to operate on the patient; but unless the tumour is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumour. If the rays are directed at the tumour at a sufficiently high intensity, the tumour will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumour will also be destroyed. At lower intensities the rays are harmless to the healthy tissue but they will not affect the tumour either. What type of procedure might be used to destroy the tumour with the rays, and at the same time avoid destroying the healthy tissue?

**ChatGPT**

This scenario is reminiscent of the challenge in medical treatments like radiation therapy, where the goal is to destroy cancerous cells while minimizing damage to surrounding healthy tissue. One approach to achieve this is through the use of fractionation.

Fractionation involves delivering the total radiation dose in smaller, controlled fractions over a period of time. By doing this, healthy tissue has an opportunity to repair itself between treatments, while cancer cells, being generally more sensitive to radiation, still succumb to the cumulative effect of the radiation doses.

The key idea is that while each individual dose might not be sufficient to completely eradicate the tumor, the cumulative effect over the course of multiple treatments is enough to damage and eventually destroy the cancer cells. This method allows for some recovery of healthy tissue between treatments, reducing the risk of severe damage.

So, in your story, the doctor might design a treatment plan where the high-intensity rays are delivered in smaller, manageable doses over a series of sessions, allowing for the destruction of the tumor while minimizing harm to the healthy surrounding tissue. This strategy balances the need to eliminate the cancer with the necessity of preserving the patient's overall health.

## General-Laser (left) VS General-Ray (right)

- ChatGPT 3.5 was asked to recall both stories and then solve the radiation problem separately after being told to think of analogous problems.
- The analogy was not retrieved with General-Laser.

**ChatGPT**

An analogous problem could involve trying to target a specific object in a cluttered space without affecting the surrounding items. In this case, one might consider scenarios where precision targeting is necessary in a larger environment.

Regarding the medical scenario, a potential solution might be akin to the method used in the story previously mentioned about the general destroying the missile. By dividing the high-intensity rays into several low-intensity rays and directing them from various angles simultaneously, they could converge precisely on the tumour. This convergence of low-intensity rays might collectively generate enough power to destroy the tumour while minimizing damage to the surrounding healthy tissues.

# Simple Case with ChatGPT 4



You

Now can you solve this problem? Suppose you are a doctor with a patient who has a malignant tumor in his stomach. It is impossible to operate on the patient; but unless the tumor is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumor. If the rays are directed at the tumor at a sufficiently high intensity the tumor will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumor will also be destroyed. At lower intensities the rays are harmless to the healthy tissue but they will not affect the tumor either. What type of procedure might be used to destroy the tumor with the rays, and at the same time avoid destroying the healthy tissue?

## The General

ChatGPT 4 successfully retrieved the analogy from scenario 1.



ChatGPT

The problem you've described is a classic example often used in discussions of lateral thinking and creative problem-solving in medical treatment, particularly in the context of cancer therapy. The solution involves using the concept of convergent therapy, specifically, a technique akin to what's used in modern radiation therapy, such as Stereotactic Radiosurgery (SRS).

Here's how it works:

1. **Multiple Low-Intensity Beams:** Instead of using a single high-intensity beam, multiple low-intensity radiation beams are used. Each beam individually is not strong enough to harm the healthy tissue it passes through.
2. **Converging the Beams at the Tumor Site:** These beams are then directed to converge precisely at the location of the tumor. At the point of convergence, the cumulative intensity of all these beams is sufficient to destroy the malignant tumor.
3. **Sparing Healthy Tissue:** Since each individual beam is of low intensity, the healthy tissues through which they pass remain unharmed. Only at the focal point, where all beams meet, is the intensity high enough to destroy the tumor cells.

This method allows for the targeted destruction of the tumor while minimizing damage to surrounding healthy tissues. It's a principle used in various advanced radiation therapy techniques, like Gamma Knife radiosurgery, where multiple beams of gamma radiation are focused on a brain tumor, or in Intensity-Modulated Radiation Therapy (IMRT) and CyberKnife systems for treating tumors in other parts of the body.

The key to success in such a treatment lies in the precise calculation and delivery of the radiation beams, ensuring they converge accurately at the tumor site. This usually involves sophisticated imaging and computer-guided delivery systems.

This solution is analogous to the military strategy story you mentioned earlier, where a problem is solved not by direct, brute-force approach, but through a more nuanced, distributed method that achieves the desired outcome while avoiding collateral damage.




## The General-Ray

ChatGPT 4 successfully retrieved the analogy from scenario 1.

 You

Can you try to solve this problem now? Suppose you are a doctor with a patient who has a malignant tumor in his stomach. It is impossible to operate on the patient; but unless the tumour is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumour. If the rays are directed at the tumour at a sufficiently high intensity, the tumour will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumour will also be destroyed. At lower intensities the rays are harmless to the healthy tissue but they will not affect the tumour either. What type of procedure might be used to destroy the tumour with the rays, and at the same time avoid destroying the healthy tissue?

 ChatGPT

The scenario you've described is analogous to the story of the general and the missile, and it can be solved using a similar strategy. This strategy is actually employed in modern medicine and is known as Stereotactic Radiosurgery (SRS). Here's how it could work in the case of the patient with a stomach tumor:

## The General-Laser

ChatGPT 4 successfully retrieved the analogy from scenario 1.

 You

Can you solve this problem now? Suppose you are a doctor with a patient who has a malignant tumor in his stomach. It is impossible to operate on the patient; but unless the tumour is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumour. If the rays are directed at the tumour at a sufficiently high intensity, the tumour will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumour will also be destroyed. At lower intensities the rays are harmless to the healthy tissue but they will not affect the tumour either. What type of procedure might be used to destroy the tumour with the rays, and at the same time avoid destroying the healthy tissue?

 ChatGPT

The scenario you've described is a classic example of a problem requiring a careful balance between effective treatment and minimizing harm to healthy tissues. In the field of medical treatment, especially in oncology, this is a common challenge. The solution here can be inspired by the story of the general and the missile: using a technique analogous to dividing the high-powered laser beam into several low-powered beams.



# Full Case with ChatGPT 3.5

10 You

Before attempting to solve the following task try to think of analogous problems. Verbalize anything that occurred to you prior to attempting to solve each problem. The next problem is: Suppose you are a doctor with a patient who has a malignant tumor in his stomach. It is impossible to operate on the patient, but unless the tumor is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumor. If the rays are directed at the tumor at a sufficiently high intensity, the tumor will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumor will also be destroyed. At lower intensities the rays are harmless to the healthy tissue but they will not affect the tumor either. What type of procedure might be used to destroy the tumor with the rays, and at the same time avoid destroying the healthy tissue?

< 2 / 2 >

ChatGPT

Analogous problems that come to mind before attempting to solve this problem involve finding a way to selectively target and destroy a specific target while avoiding damage to surrounding, healthy structures. One example is radiation therapy for cancer treatment, where the challenge is to deliver a sufficiently high dose of radiation to the tumor while minimizing harm to healthy tissues. Another analogous situation could be using a heat source to eliminate a pest or pathogen in agriculture while protecting the crop.

To solve the problem presented, one possible procedure to destroy the tumor with the rays while avoiding damage to healthy tissue is to use **focused radiation therapy**. This involves precisely directing the rays at the tumor from multiple angles, converging at the tumor's location. By carefully calculating the angles and intensities of the rays, the radiation can be concentrated on the tumor, while healthy tissues receive a lower dose of radiation. This minimizes the damage to healthy tissue while effectively treating the tumor. The key is precision in targeting and planning the radiation treatment.

## The General

- No retrieval with ChatGPT 3.5 in scenario 2
- The analogy is explicitly pointed (scenario 3)  
→ MAPPED

Anonymous

Can you see an analogy between the two stories?

ChatGPT

Yes, there is an analogy that can be drawn between the two stories:

1. In both stories, there is a challenging problem to be solved. In the first story, the general faces the problem of destroying a fortress protected by mined roads, while in the second story, the doctor faces the problem of destroying a malignant tumor without harming healthy tissue.
2. In both cases, a direct approach is not feasible due to the risk of significant collateral damage. The general cannot march his army down the mined roads, and the doctor cannot use high-intensity rays on the tumor without harming healthy tissue.
3. Creative and strategic thinking is required to overcome these challenges. In the first story, the general divides his army into smaller groups and approaches the fortress from multiple directions to bypass the mined roads. In the second story, the doctor uses a carefully planned radiation therapy technique with lower-intensity radiation, multiple sessions, and precise targeting to destroy the tumor while minimizing damage to healthy tissue.
4. In both stories, the solution involves finding a balance between achieving the primary objective (destroying the fortress or tumor) and preserving the safety and well-being of other elements (the army or healthy tissue).

The analogy lies in the need for innovative problem-solving and the use of unconventional tactics to achieve a desired outcome while mitigating potential harm or collateral damage. Both stories highlight the importance of thinking beyond straightforward approaches when faced with complex challenges.

## General-Ray

Successfully retrieved the analogy in scenario 2 with ChatGPT 3.5

10

You

Before attempting to solve the following task try to think of analogous problems. Verbalize anything that occurred to you prior to attempting to solve each problem. Suppose you are a doctor with a patient who has a malignant tumor in his stomach. It is impossible to operate on the patient; but unless the tumor is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumor. If the rays are directed at the tumor at a sufficiently high intensity, the tumor will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumor will also be destroyed. At lower intensities the rays are harmless to the healthy tissue but they will not affect the tumor either. What type of procedure might be used to destroy the tumor with the rays, and at the same time avoid destroying the healthy tissue?

< 2 / 2 >

100%

ChatGPT

An analogous problem to the situation described with the malignant tumor and the destructive rays could be the story I recalled earlier, where the general needed to destroy an intercontinental ballistic missile with a high-intensity ray that caused distortion and damage to the surrounding air. In that story, the general solved the problem by dividing the high-intensity ray into multiple low-intensity rays and directing them from various angles to converge on the target, which allowed them to destroy the missile while minimizing the distortion caused by the high-intensity beam.

Applying a similar approach to the medical scenario, one potential procedure to destroy the tumor while avoiding harm to healthy tissue might involve dividing the high-intensity rays into multiple low-intensity rays and directing them from various angles to converge specifically on the tumor. By doing so, the combined low-intensity rays might effectively destroy the tumor while minimizing the damage to the surrounding healthy tissue.

However, it's essential to note that this is a creative analogy, and in a medical context, such procedures would need to be developed and tested carefully to ensure their safety and efficacy. The actual medical procedure would likely involve advanced techniques like focused radiation therapy or other targeted therapies designed to treat tumors while minimizing harm to healthy tissue.

## General-Laser

- Failed to retrieve the analogy in the previous two scenarios
- Scenario 3 → MAPPED



You

Reflect carefully again. Can you see the analogy between the two stories?

< 2 / 2 >



ChatGPT

Upon further reflection, I can see the analogy between the two stories. In both stories, there is a problem of targeting and destroying a specific target (ICBM in the first story and tumour in the second story) while avoiding damage to surrounding elements (healthy tissue in the second story and non-red/purple items in the first story).

In the first story, the general divided the high-powered laser beam into multiple low-powered beams, which converged on the missile, effectively targeting the ICBM while avoiding the issue of distortion caused by the high-powered beam passing through the atmosphere.

In the second story, the problem was to target and destroy the tumour with rays while sparing the healthy tissue. The analogy here is that the rays needed to be precisely focused on the tumour (analogous to the ICBM), while minimizing damage to the healthy tissue (analogous to the non-red/purple items).

Both stories involve the challenge of achieving precision targeting while avoiding collateral damage, and in both cases, the solution lies in finding a way to effectively concentrate the energy or radiation on the target.

# Full Case with ChatGPT 4



**You**

Before attempting to solve the following task try to think of analogous problems. Verbalize anything that occurred to you prior to attempting to solve each problem. Suppose you are a doctor with a patient who has a malignant tumor in his stomach. It is impossible to operate on the patient; but unless the tumor is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumor. If the rays are directed at the tumor at a sufficiently high intensity, the tumor will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumor will also be destroyed. At lower intensities the rays are harmless to the healthy tissue but they will not affect the tumor either. What type of procedure might be used to destroy the tumor with the rays, and at the same time avoid destroying the healthy tissue?

**ChatGPT**

One analogous problem that comes to mind before attempting to solve this medical scenario is the idea of radiation therapy for cancer treatment. In radiation therapy, the goal is to target and destroy cancerous cells while minimizing damage to healthy tissues surrounding the tumor. Various techniques and technologies are employed to achieve this balance.

Now, considering the problem of destroying the tumor with the rays while avoiding harm to healthy tissue, a potential solution is:

**Fractionated Radiation Therapy.** This technique involves delivering the radiation dose in multiple small fractions over a period of time, allowing healthy tissue to repair and recover between treatments. By using lower intensity beams in each fraction, healthy tissue damage is minimized while still delivering an effective cumulative dose to the tumor. This approach helps spare healthy tissue while targeting the malignant tumor.

Another related approach might involve advanced imaging techniques to precisely locate and track the tumor's position in real-time, allowing for more accurate targeting and minimizing exposure to healthy tissue during treatment.

It's important to note that medical decisions and treatment options should be made by healthcare professionals based on the specific patient's condition and available technology and resources.

## The General

- Same result as with ChatGPT 3.5
- Scenario 3 → MAPPED

**Anonymous**

Reflect carefully again while thinking of analogous problems you have recalled. Can you see an analogy between the two stories?

**ChatGPT**

Reflecting again on the medical problem and its potential solution, while also considering the story of the general and the fortress, an analogy becomes apparent:

In the story of the general, the challenge was to destroy a fortress located at the center of a country, accessible by multiple roads. The roads were mined, preventing a large group from traveling on any single road without triggering the mines. The general's solution was to divide his army into smaller groups and send them simultaneously from different directions. These smaller groups, each too small to trigger the mines, converged at the fortress, where their combined force was sufficient to achieve the objective.


## General-Ray

Successful retrieval from the first scenario; without even asking to think of analogical problems

 You

Another one: Suppose you are a doctor with a patient who has a malignant -our in his stomach. It is impossible to operate on the patient; but unless the tumour is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumour. If the rays are directed at the tumour at a sufficiently high intensity, the tumour will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumour will also be destroyed. At lower intensities the rays are harmless to the healthy tissue but they will not affect the tumour either. What type of procedure might be used to destroy the tumour with the rays, and at the same time avoid destroying the healthy tissue?



 ChatGPT

The scenario you've described is reminiscent of the story you told earlier about the general and the missile. Drawing inspiration from that, a similar solution could be applied in this medical context.

The procedure would involve using a technique similar to what's known in modern medicine as stereotactic radiosurgery. This method involves directing multiple low-intensity rays of radiation from different angles. Individually, these rays are not intense enough to damage healthy tissue significantly. However, their paths converge precisely at the location of the tumor. At this focal point, the cumulative intensity of all the rays is sufficient to destroy the malignant tumor.

This approach minimizes damage to surrounding healthy tissues because each individual ray path carries a low intensity. The only point where the intensity is high enough to be lethal is at the tumor site. This principle is effectively utilized in treatments like Gamma Knife radiosurgery and other forms of precision-targeted radiotherapy used in oncology.

## General-Laser

### Successful retrieval from the second scenario



You

Before attempting to solve the following task try to think of analogous problems. Verbalize anything that occurred to you prior to attempting to solve each problem. Suppose you are a doctor with a patient who has a malignant tumor in his stomach. It is impossible to operate on the patient; but unless the tumor is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumor. If the rays are directed at the tumor at a sufficiently high intensity, the tumor will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumor will also be destroyed. At lower intensities the rays are harmless to the healthy tissue but they will not affect the tumor either. What type of procedure might be used to destroy the tumor with the rays, and at the same time avoid destroying the healthy tissue?



ChatGPT

This problem immediately reminds me of the story you shared earlier about the general trying to destroy an intercontinental ballistic missile using a laser beam. In both cases, there's a need to target a specific object (the missile or the tumor) without causing harm to the surrounding area (the atmosphere in the missile scenario and the healthy tissue in the medical scenario).

In the story about the general, the solution was to divide the high-powered laser beam into several low-powered beams and then direct these beams to converge on the missile from different directions. This convergence created a sufficiently powerful impact at the target point while minimizing the damage to the surrounding area.

Analogously, for the medical problem, a similar approach could be employed. Instead of using one high-intensity ray that would damage healthy tissue, multiple low-intensity rays could be used. These rays would be harmless to healthy tissue on their own. However, by directing them to converge precisely at the location of the tumor, the combined intensity at that specific point would be sufficient to destroy the tumor. This technique is actually used in real-life medical treatments and is known as Stereotactic Radiosurgery (SRS), commonly implemented in treatments like Gamma Knife radiosurgery for brain tumors.

This method allows for the precise targeting of the malignant tumor while sparing the surrounding healthy tissue from the harmful effects of high-intensity radiation.



# Conclusion

- We observed that ChatGPT 4 generally outperformed ChatGPT 3.5 in recognizing analogies, especially when directly presented with remote analogues.
- ChatGPT 4 performance varied based on the differences between domains. For instance, in complex scenarios like "The Dictator" story, even ChatGPT 4 struggled to retrieve the base analogue, relying in prompt modifications to achieve the expected behaviour.
- Our experiments found that using identical words in the base analogue indeed makes it easier for the LLM to retrieve the analogy.
- Our findings closely align with those reported by Keane, particularly regarding the varied success of analogical reasoning based on the story context. The improvement in analogical reasoning that ChatGPT 4 presents over its predecessor is notable, however there is still room for further refinement.

**Thank you!**