Stochastic Energy Systems with Mechanism Choices

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01

Introductions

Energy System Fundamentals

Background

Energy systems of consumer communities

An energy system used for supplying energy to a group of energy consumer entities, all energy consumptions are in a First-In-First-Out order.

Examples of Such energy systems

e.g., power plant of an apartment, where each room requires energy supply equally.

Two parts of energy systems' cost origins

1. Energy consumption spending **(More energy consumption, more cost)**
2. Energy supply congestion spending **(More waiting supplies, most cost)**

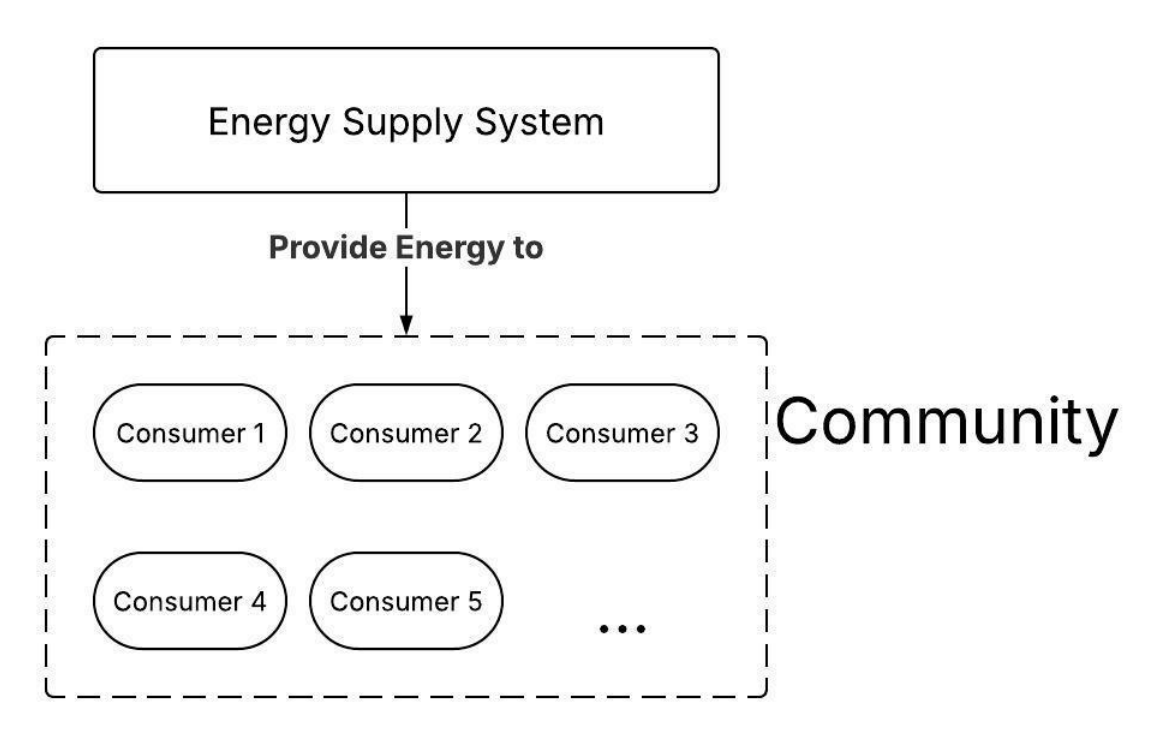


Fig 1 – Sample of Energy Systems

Engineer’s Paralleled Goals

Goal 1: To minimize energy consumption of the whole system

Goal 2: To minimize waiting in this system’s energy serving

02

Problems

Energy System Concrete Problems

On usual cases:

1. The energy system is a continuous time Markov chain (CTMC), where job arrivals are under Poisson distributions, whose parameter is a constant.
2. The energy system will not service the arrived jobs until the waiting job amount reaches k1, where k1 >= 1. Then the system will turn on with gamma (the turn-on rate).
3. When the waiting job amount < k2, the system uses the normal process rate (mu), otherwise when it >= k2, the system will use the enhanced process rate (mu_bar).

On usual cases:

4. In order to make the whole system under stable and expected performance, lambda < mu < mu_bar.
5. Alpha is the idle rate of the energy system, available on 1 of 2 conditions. (**Mentioned on slide 11**)
6. Remember gamma (the turning-on rate) and alpha (the idle rate) also exists, both are greater than 0.
7. will_turn_off represents the ability to turn off. If it is true, then alpha > 0, or it is 0. -> (the system cannot turn off)

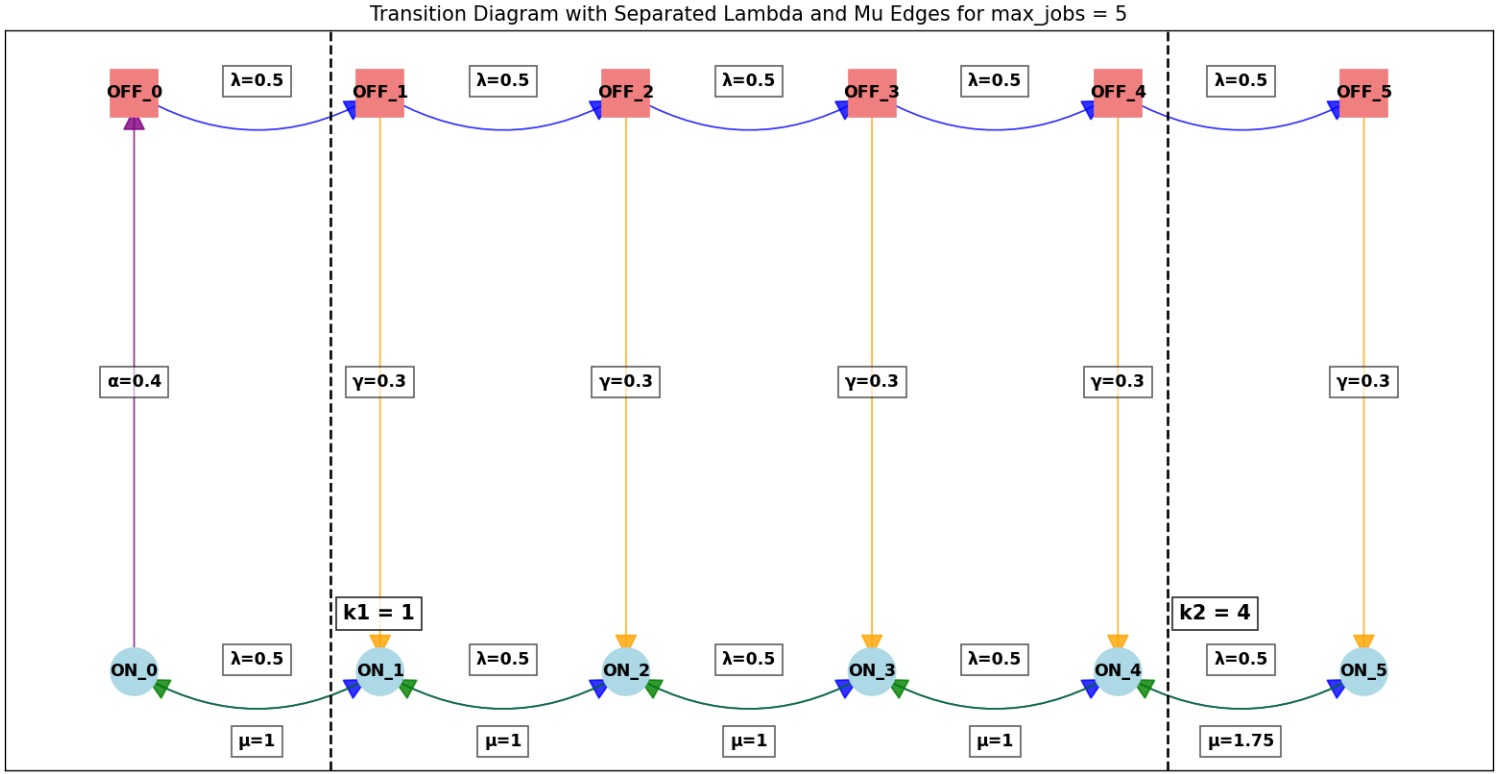
On usual cases:

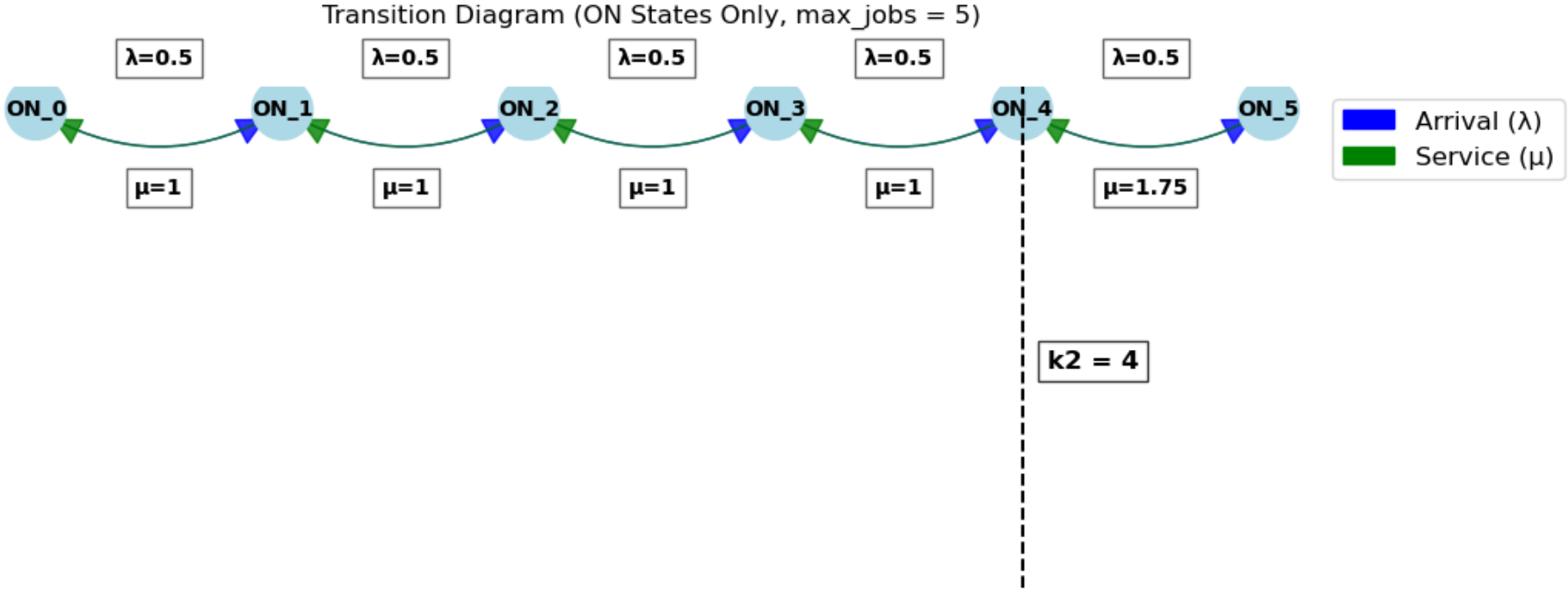
8. 1 <= k1 <= k2, as the enhanced service rate only occurs after normal service rate (represents overload).
- Note that both k1 and k2 can reach indefinity.

9. **Important**: parameters k1, k2, and will_turn_off are variables (can be adjusted by system controls), while others are all constant (cannot be changed).

will_turn_off determines distinctions

1. When will_turn_off = False, the energy system will never go back to OFF states (to become idle), so we can ignore all states without service processing. This results in a **variant M/M/1 queue** (**Two service rates**).
2. When will_turn_off = True, the energy system will go back to idle when there is no waiting job. This has more complicated structures, and it **does not belong to any special CTMC cases** (e.g., M/M/1).


Transition Diagram with Separated Lambda and Mu Edges for max_jobs = 5
Arrival (λ)
Service (μ
Turn On (γ
Idle (α)
OFF_0
OFF_1
OFF_2
OFF_3
OFF_4
OFF_5
ON_0
ON_1
ON_2
ON_3
ON_4
ON_5
λ=0.5
α=0.4
γ=0.3
μ=1
μ=1.75
k1 = 1
k2 = 4


Transition Diagram (ON States Only, max_jobs = 5)
λ=0.5
λ=0.5
λ=0.5
λ=0.5
λ=0.5
ON_0
ON_1
ON_2
ON_3
ON_4
ON_5
μ=1
μ=1
μ=1
μ=1
μ=1.75
k2 = 4
Arrival (λ)
Service (μ)

Power Consumption and Total Cost

1. Power consumption =

A picture always reinforces the concept

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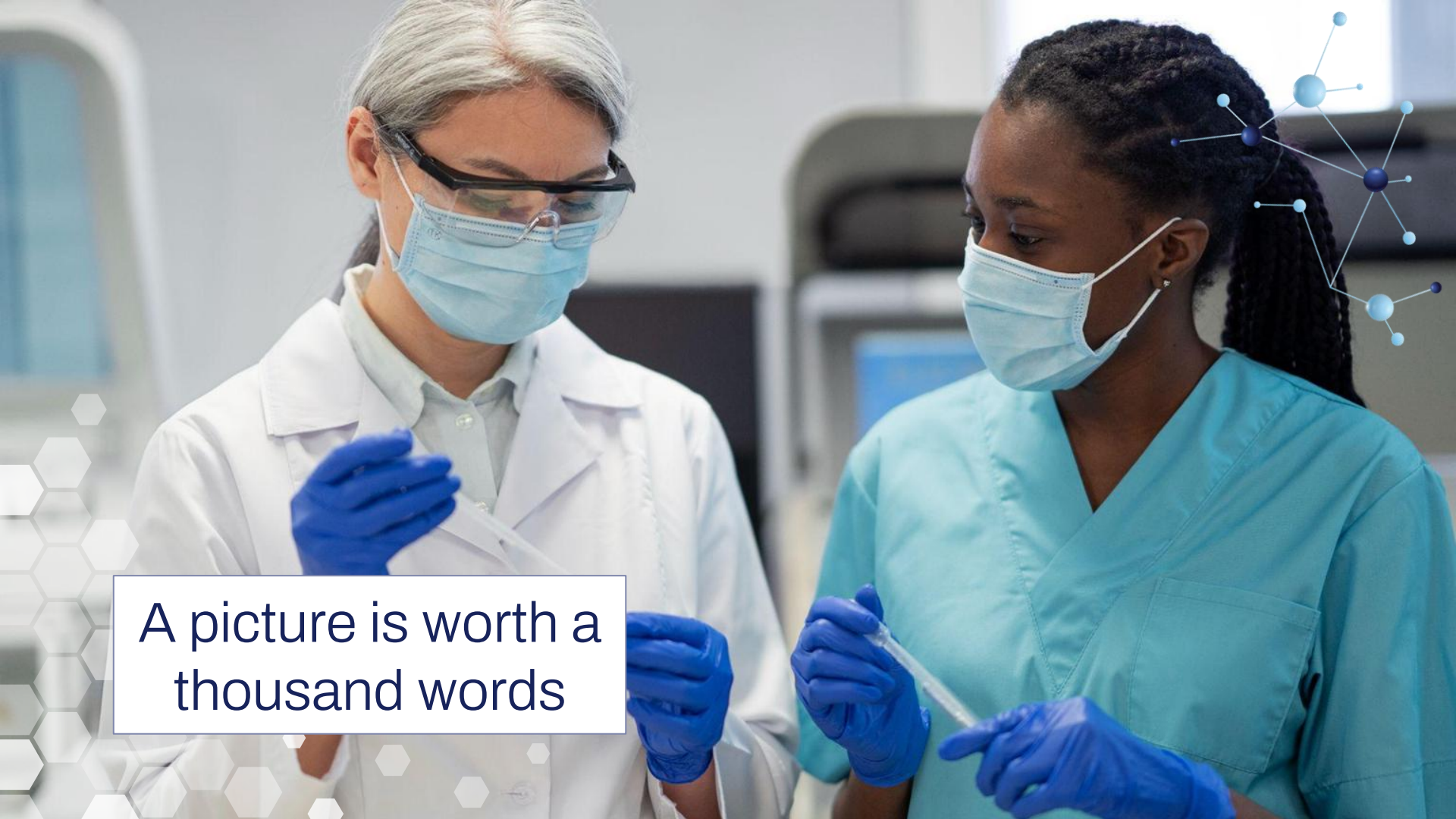
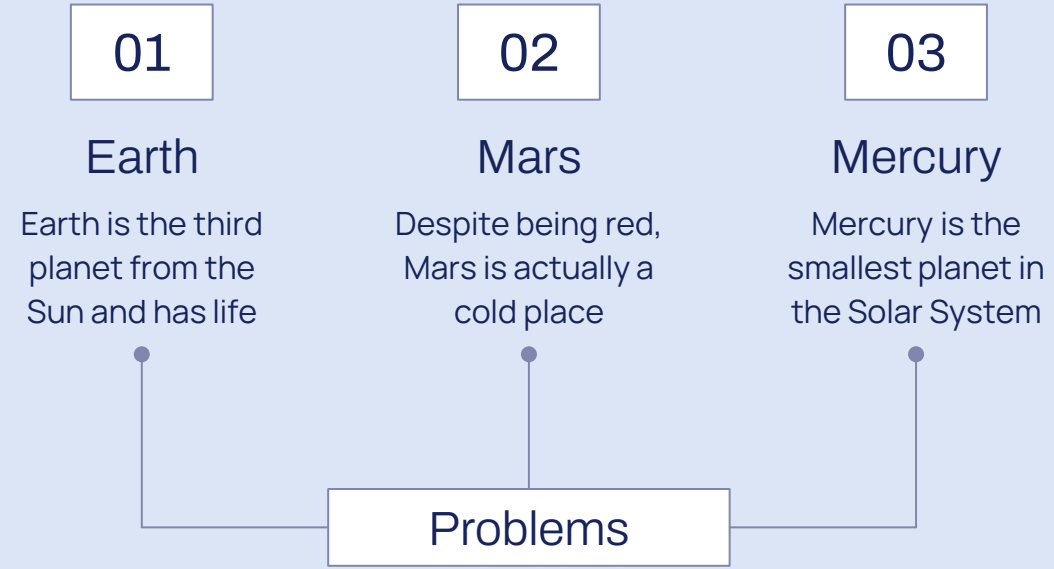

A picture is worth a thousand words

Awesome words

Current situation & problems statement

Current situation

Jupiter is a gas giant and the biggest planet in the Solar System. It's the fourth-brightest object in the night sky. It was named after the Roman god of the skies and lightning



Hypotheses

01

Hypothesis 1

Jupiter is a gas giant and the biggest planet in the Solar System. It's the fourth-brightest object in the night sky

02

Hypothesis 2

Neptune is the farthest planet from the Sun. It's also the fourth-largest planet by diameter in the Solar System

03

Hypothesis 3

Earth is the third planet from the Sun and the only one that harbors life in the Solar System. All humans live on this planet

Study objectives

Mercury

Mercury is the closest planet to the Sun and the smallest of them all

Venus

Venus has a beautiful name and is the second planet from the Sun

Mars

Despite being red, Mars is actually a cold place. It’s full of iron oxide dust

Reviewing concepts is a good idea

Mars

Mars is actually a very cold place

Neptune

Neptune is the farthest planet from the Sun

Mercury

Mercury is the closest planet to the Sun

Saturn

Saturn is a gas giant with several rings

Venus

Venus has extremely high temperatures

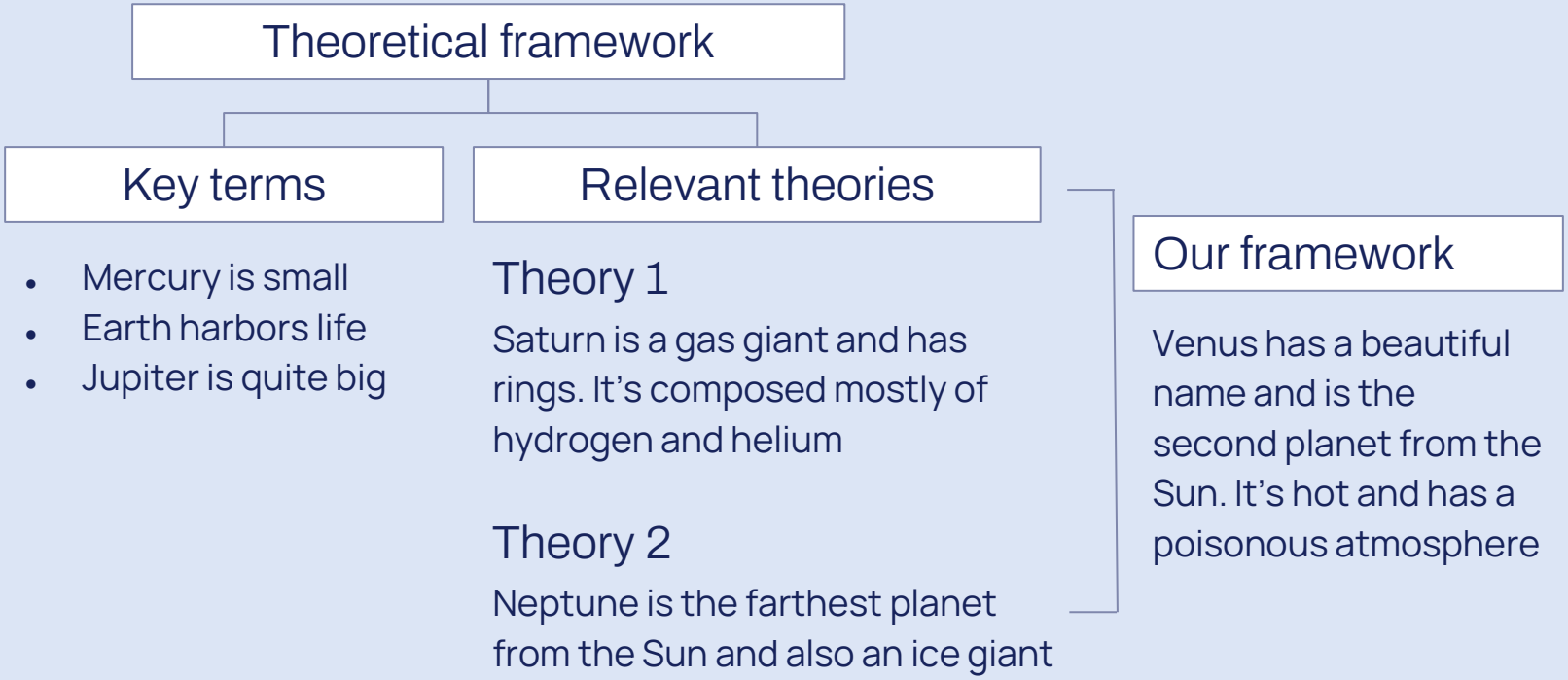
Jupiter

Jupiter is the biggest planet of them all

Literature review

- AUTHOR. (YEAR). *Title of the publication*. Publisher
  - Mercury is the closest planet to the Sun and the smallest one in the Solar System
- AUTHOR. (YEAR). *Title of the publication*. Publisher
  - Mars is full of iron oxide dust, which gives the planet its reddish cast
- AUTHOR. (YEAR). *Title of the publication*. Publisher
  - Jupiter is a gas giant and the biggest planet in the Solar System
- AUTHOR. (YEAR). *Title of the publication*. Publisher
  - Venus has a beautiful name and is the second planet from the Sun
- AUTHOR. (YEAR). *Title of the publication*. Publisher
  - Earth is the third planet from the Sun and harbors life

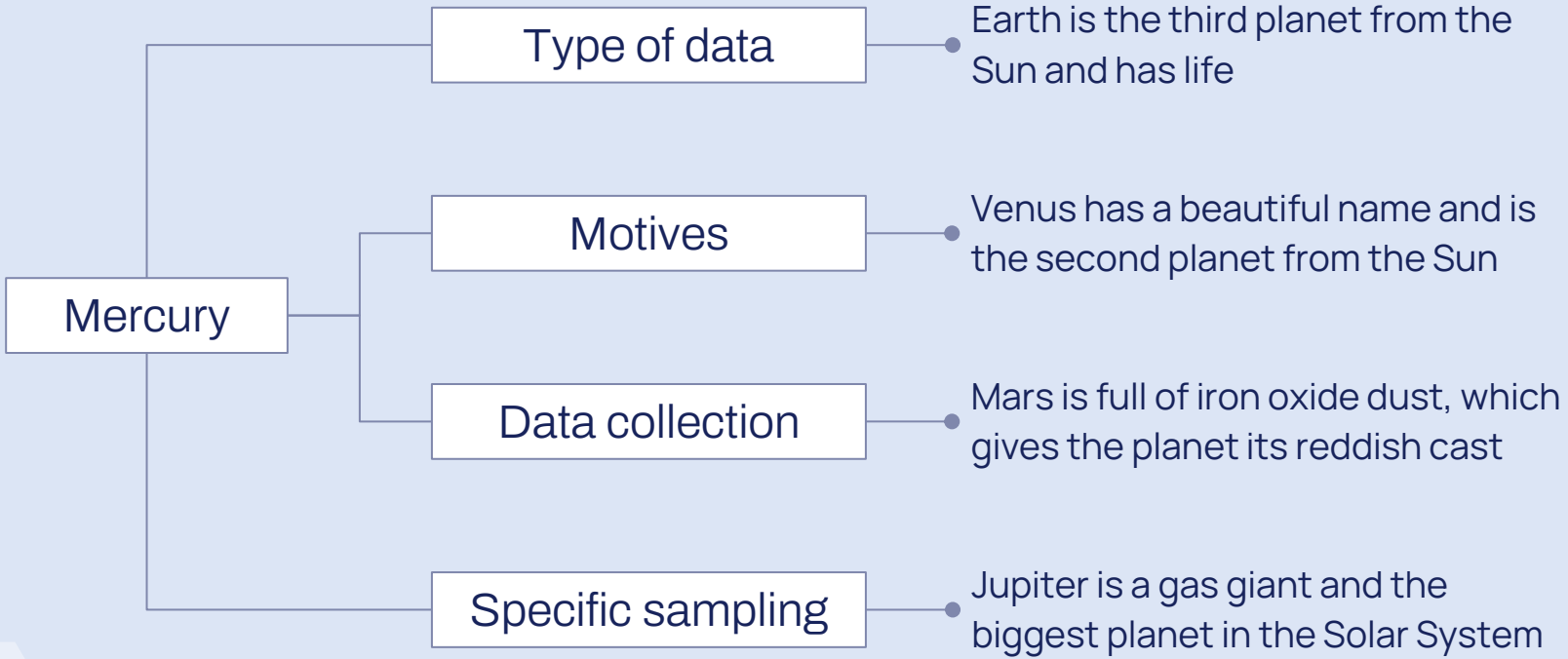
Theoretical framework



Schedule

Task	Description	Date	J	F	M	A	M	J	Status
Task 1	Despite being red, Mars is cold	Jan 1 - Feb 15							Completed
Task 2	Earth is the planet with life	Feb 1 - Apr 30							In progress
Task 3	Venus has a beautiful name	Mar 15 - Apr 30							Delayed
Task 4	Neptune is far away from us	Apr 20 - May 15							Not started
Task 5	Jupiter is a huge gas giant	May 1 - Jun 30							Not started

Methodology



Analysis & development

Phase 01

- Mercury is the closest planet to the Sun and the smallest one in the Solar System—it's a bit larger than the Moon
- Jupiter is a gas giant, the biggest planet in the Solar System and the fourth-brightest object in the night sky
- Neptune is the farthest planet from the Sun. It's also the fourth-largest planet by diameter in the Solar System

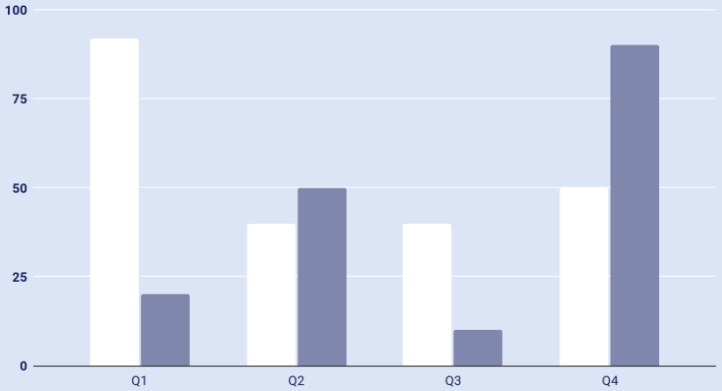
Phase 02

- Venus has a beautiful name and is the second planet from the Sun. It's terribly hot—even hotter than Mercury
- Saturn is a gas giant and has several rings. This planet is composed mostly of hydrogen and helium
- Earth is the third planet from the Sun and the only one that harbors life in the Solar System. We all live on this planet

Analysis & development

Mercury is the closest planet to the Sun and the smallest one in the Solar System. This planet's name has nothing to do with the liquid metal

- The Sun is the star at the center of the Solar System
- Jupiter is the biggest planet in the entire Solar System
- Saturn is composed mostly of hydrogen and helium



Venus

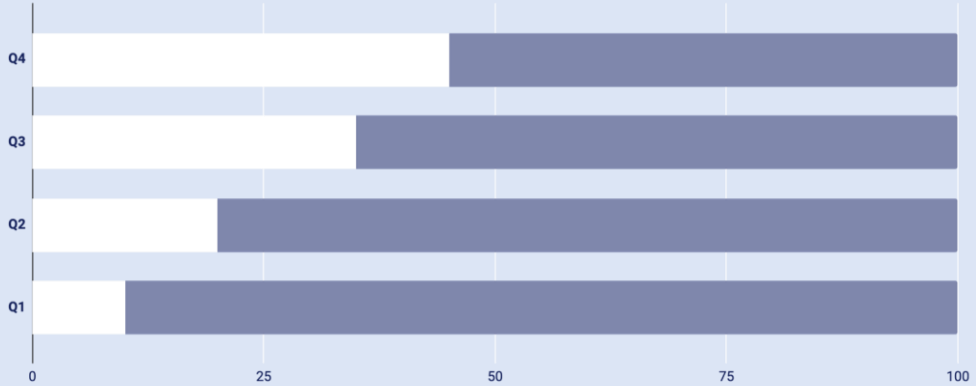
Venus has a beautiful name

Mercury

Mercury is quite a small planet

Follow the link in the graph to modify its data and then paste the new one here. **For more info, click here**

Analysis of the results

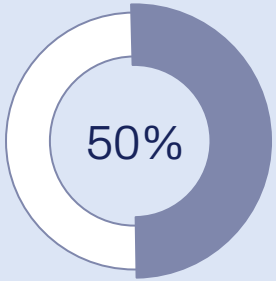


Mercury

Mercury is quite a small planet

Venus

Venus has a beautiful name

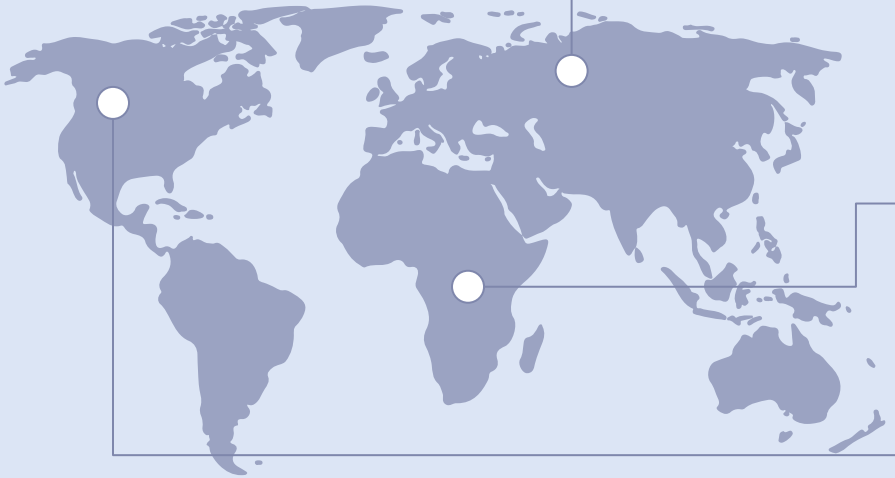


Mars

Despite being red, Mars is actually a cold place

Follow the link in the graph to modify its data and then paste the new one here. **For more info, click here**

This is a map



Mars

Despite being red, Mars is a very cold place

Mercury

Mercury is the closest planet to the Sun

Venus

Venus is the second planet from the Sun

Discussion

Mars & Earth

Despite being red, Mars is actually a cold place. It's full of iron oxide dust, which gives the planet its reddish cast. Earth is the third planet from the Sun and the only one that harbors life in the Solar System. We all live on this planet:

- Ceres is located in the main asteroid belt
- The Moon is Earth's natural satellite
- Neptune is very far from the Sun
- Pluto is now considered a dwarf planet

01

Discussion 1

Mercury is the closest planet to the Sun and the smallest one in the Solar System—it's only a bit larger than the Moon

02

Discussion 2

Venus has a beautiful name and is the second planet from the Sun. It's terribly hot—even hotter than Mercury

Conclusions

01

Mars

Despite being red, Mars is actually a cold place. It’s full of iron oxide dust

02

Saturn

Saturn is a gas giant and has several rings. It’s composed mostly of hydrogen and helium

03

Venus

Venus has a very beautiful name and is the second planet from the Sun. It’s terribly hot

04

Neptune

Neptune is the farthest planet from the Sun and the fourth-largest of them all

Bibliographical references

Surname, A. (YEAR). *Name of the source*. Publisher
Surname, A. (YEAR). *Name of the source*. Publisher
Surname, A. (YEAR). *Name of the source*. Publisher
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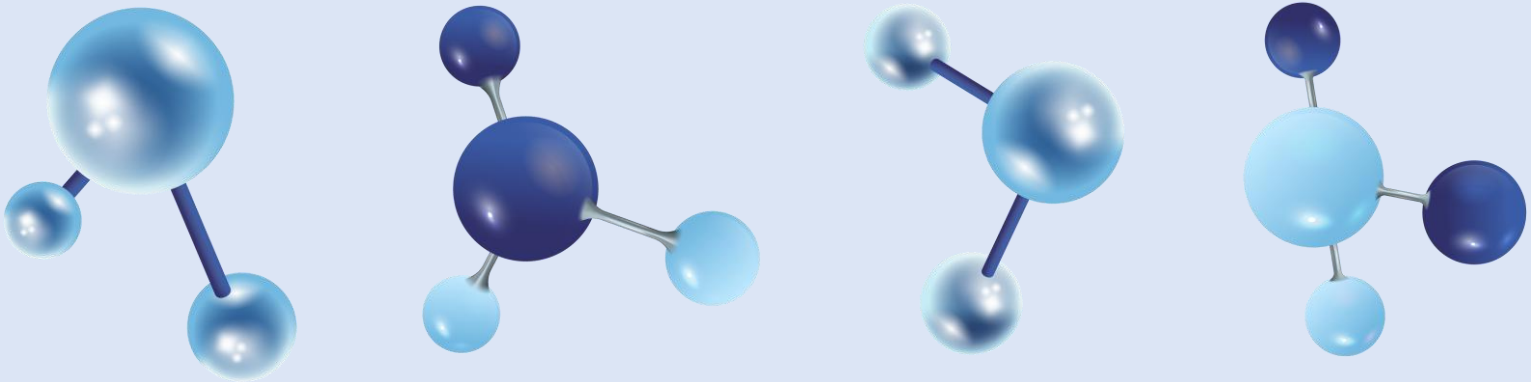

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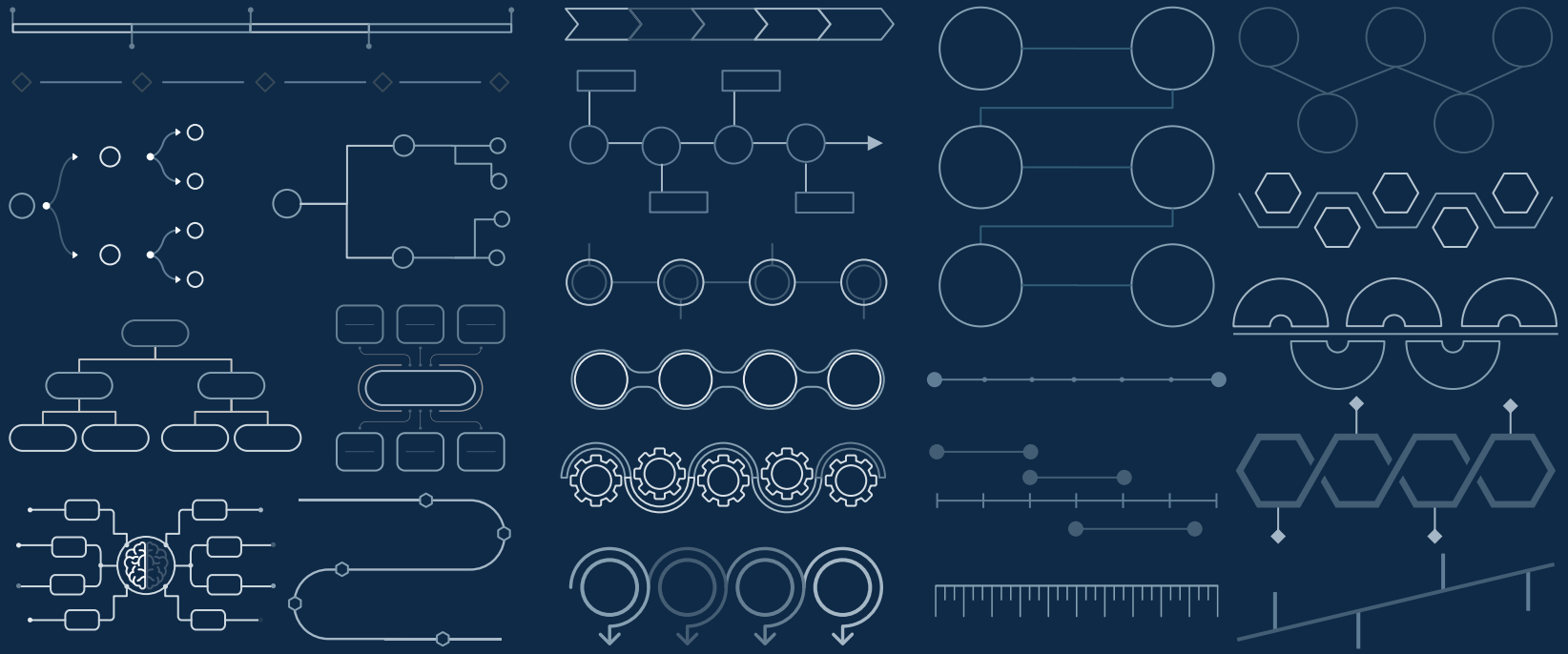

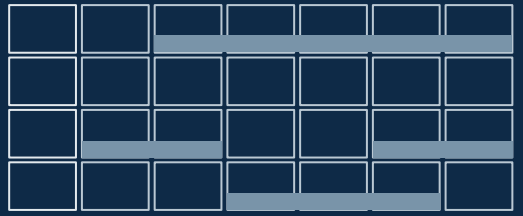

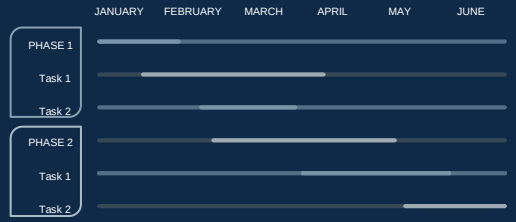
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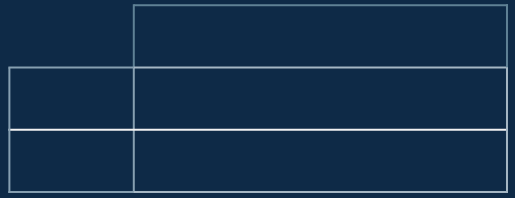

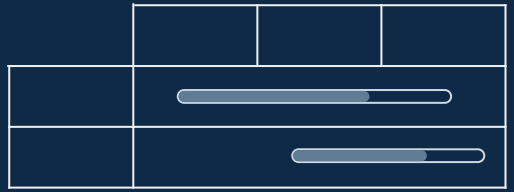

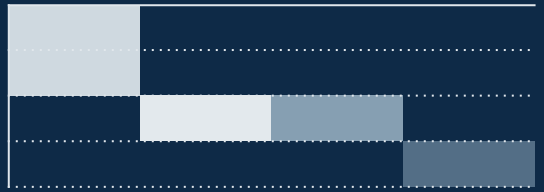

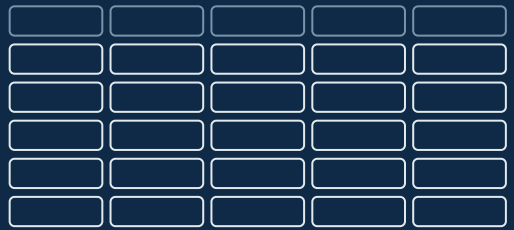

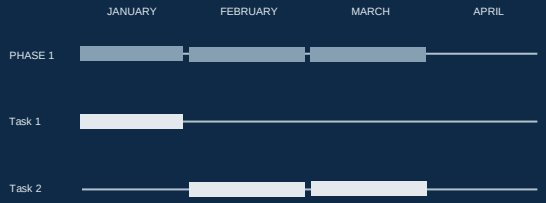
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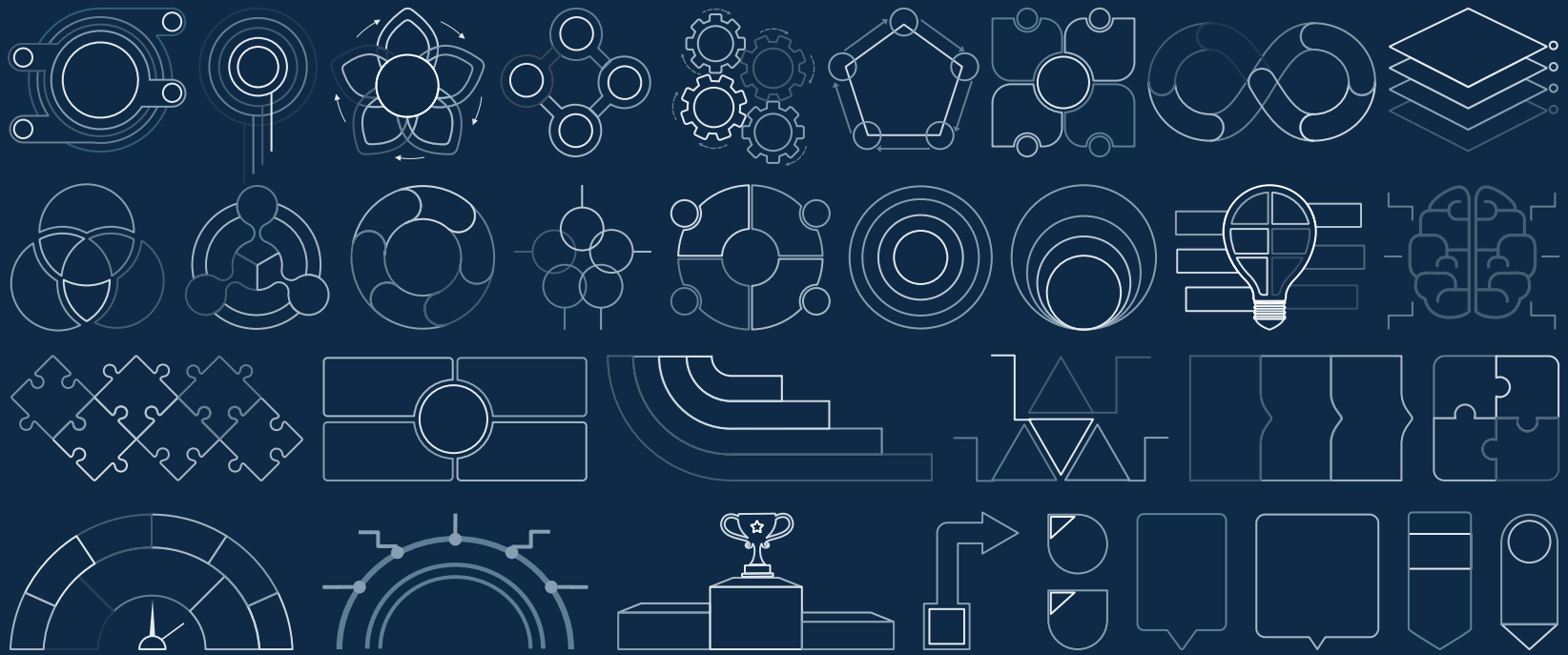

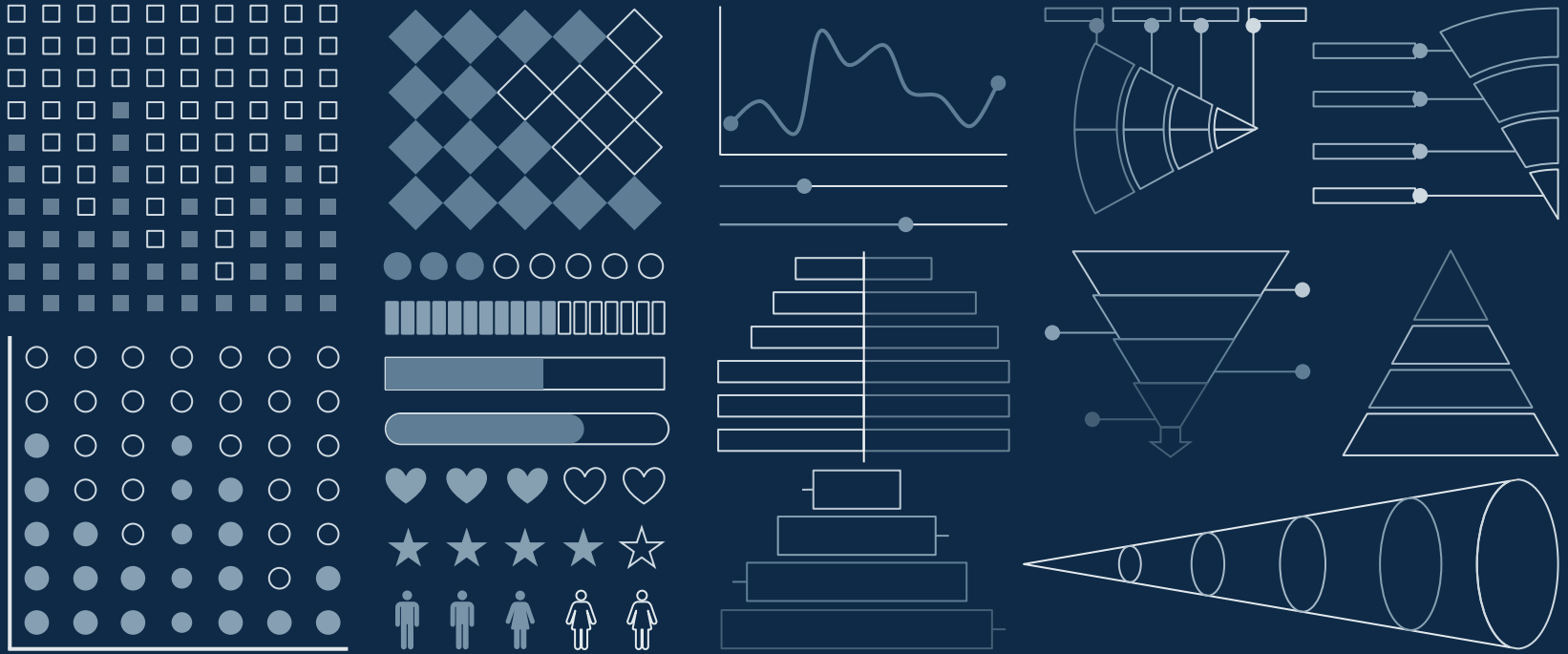

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