

NLP: PROJECT PROGRESS **MATHPLOT VQA**

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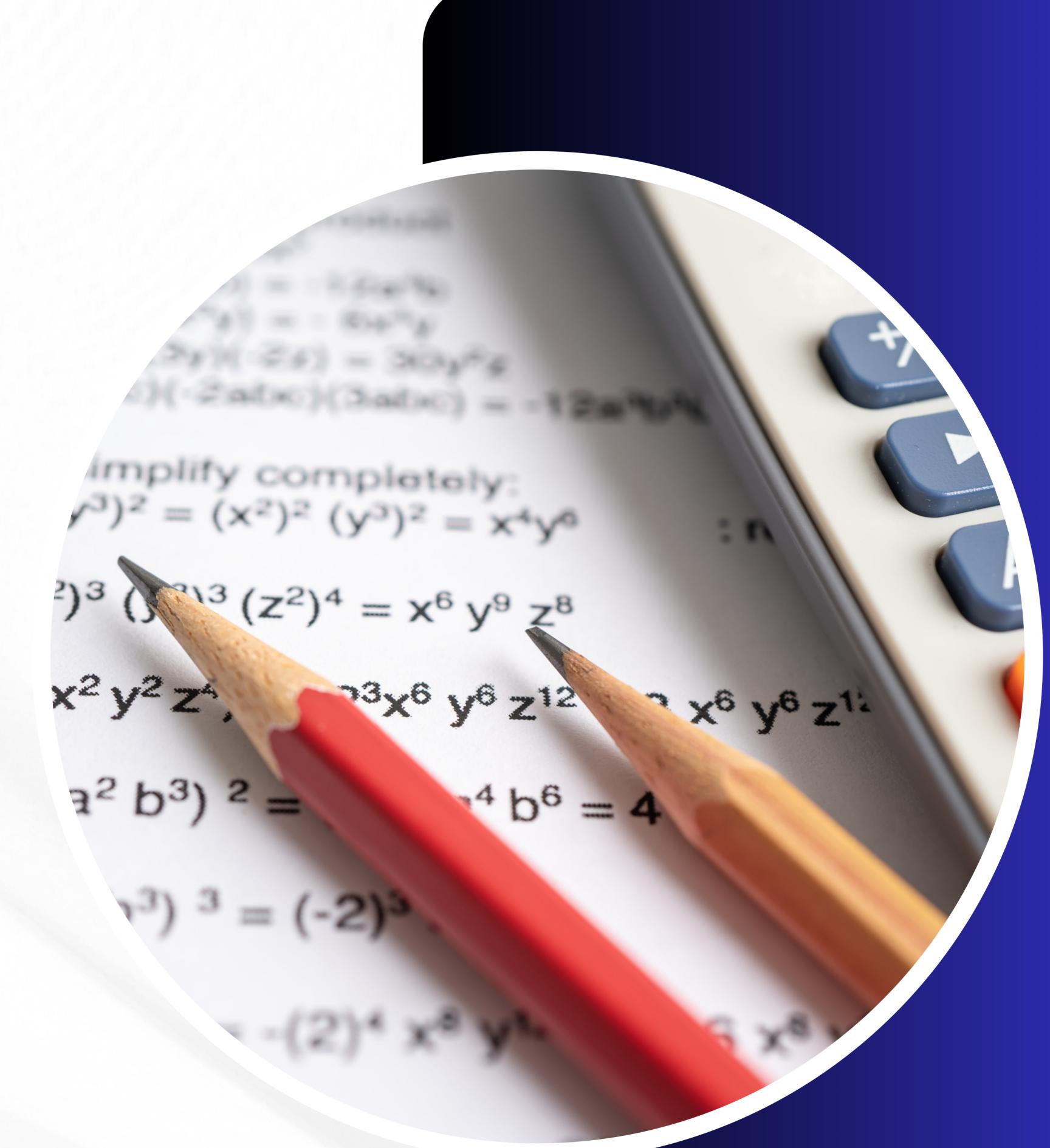


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PROJECT RECAP



- Improving current question-answering systems by creating a new system that can **understand and answer questions about graphs in math problems**.
- This new system allows users to input photos of graphs, **making math easier to understand for everyone**, especially those who find graphs difficult.

Proposed: MATHPLOT VQA

Solution Requirements:

- Graph Image Submission
- Question Input
- Math Question-solving (from graph)
- Graph Interpretation

Dataset:

- ChartQA

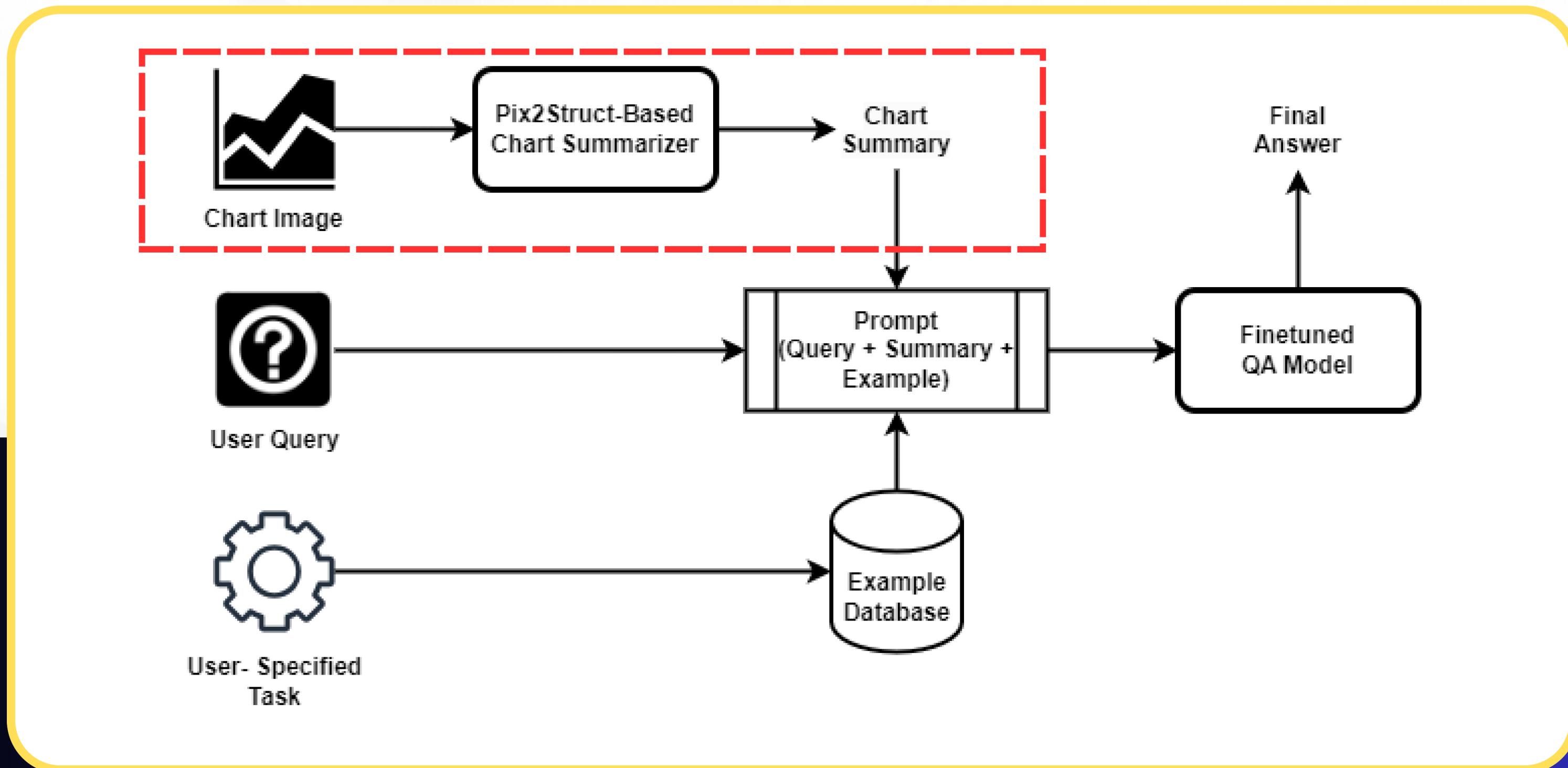
Pretrained Models:

- Matcha
- Vicuna

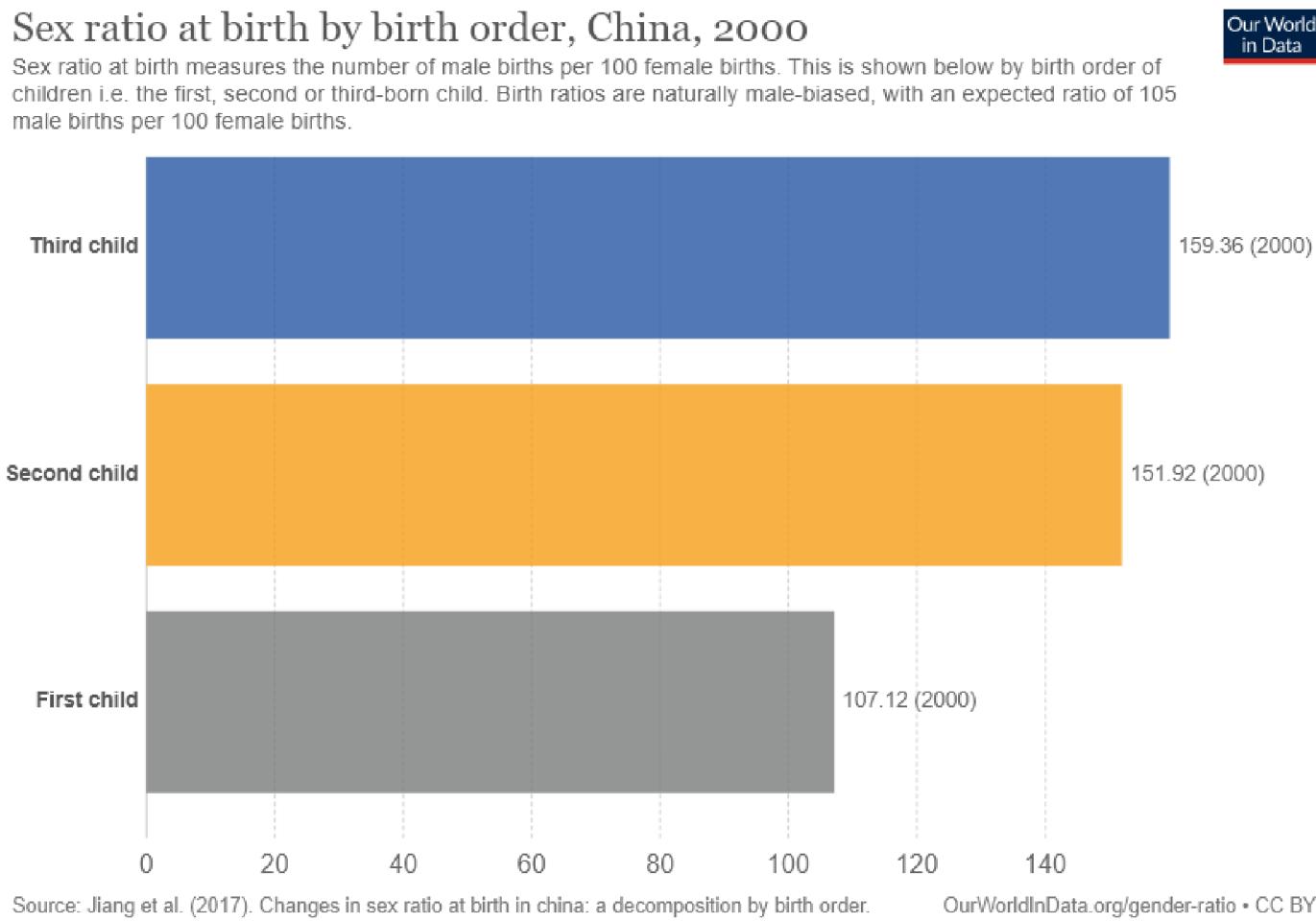
PROGRESS REPORT MATHPLOT VQA



CONDUCTED EXPERIMENTS UPDATE



Example 1



Prompt1 = "What is this chart about?"

Matcha-chart2text-pew:

This chart shows the ratio for each of **the 100 largest babies born in China (sex ratio)** based on the **March 2000 birth rate**. A **second child**, who is a **third child**, is the **first child**. **36% of births in China were born in the U.S.**, while the **second child** is a bit older. **9% of births in China were born in the U.S. at the same time**, while the **third child** is a bit older. **7% of births in China were born in the U.S. at the same time**, while the **first child** is a bit older.

Matcha-chart2text-statista:

This statistic shows the gender distribution of the population in China by birth order from 2000 to 2000. In 2000, **151.92 percent of the population in China were born in a second child**.

Prompt2 = "Translate the numerical information depicted in the chart into a comprehensive textual summary. Describe the main patterns, variations, and relationships evident in the data."

Matcha-chart2text-pew: In China, **the first childbearing birth rate (159.36|||||)** is the lowest since 1989, when the second-child immigrant population was 152 million. The 2000 rate of 63.8% of all 100 family members were born in China. Among the 100 first children, the rate was 74.2%, compared with 67.6% in 2000. (The chart below shows the ratio for 2000 among the 100 first children.)

Matcha-chart2text-statista: This statistic shows the structure of the non-960 non-900 thousand children that were born in China⁸ of 2000, by gender. In 2000, about 1600 children born in China⁸ of all ages, were born in the country.

Prompt3 = "Please generate a descriptive analysis of the quantitative data presented in the chart below. Include key statistics, trends, and insights."

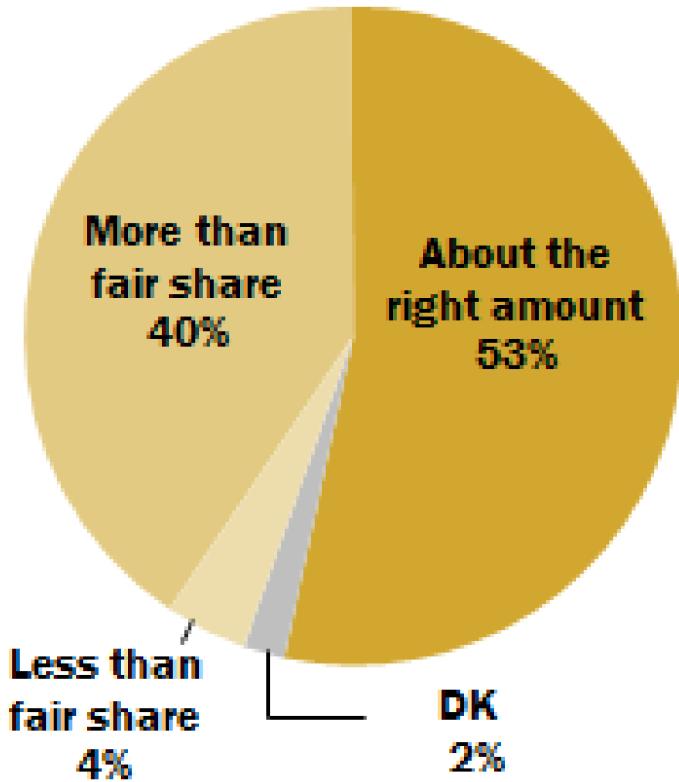
Matcha-chart2text-pew: In contrast, the|||||||.....|||||||

Matcha-chart2text-statista: This statistic shows the global sex ratio at birth by birth order, China, in 2000. In 2000, the three under three year old child had the highest gender-inclusive statistic, with 151.92 births per 100 female births.

Example 2

53% Say They Pay 'About Right Amount' in Taxes

Considering what you get from fed. govt, do you pay ___ of taxes?



Survey conducted Feb. 18-22, 2015.
Figures may not add to 100% because of rounding.

PEW RESEARCH CENTER

Prompt1 = "What is this chart about?"

Matcha-chart2text-pew:

A majority of Americans (53%) say they pay more than their fair share considering what they get from the federal government, while 40% say they pay more than their fair share. Opinion varies considerably based on annual family income. Among those making \$100,000 or more, 53% think they pay more than their fair share; 44% say they pay less than their fair share.

Matcha-chart2text-statista:

This statistic shows the results of a survey among Americans on the question if they pay about the right amount of money to make a tax return or not, if they pay 53 percent of the tax return. 40 percent of respondents stated they pay less than fair share.

Prompt2 = "Translate the numerical information depicted in the chart into a comprehensive textual summary. Describe the main patterns, variations, and relationships evident in the data."

Matcha-chart2text-pew: In a Pew Research Center survey conducted in February, 53% of Americans said they pay more than their fair share considering what they get from the federal government, while 40% said they pay more than their fair share.

Matcha-chart2text-statista: This statistic shows the 53 percent of Americans who have not added any value to the tax revenue during the 2015 survey in the United States. The survey was conducted by Gallup via a telephone interview. During the survey, 40 percent of Americans who have not added any value to the tax revenue during the last 30 days.

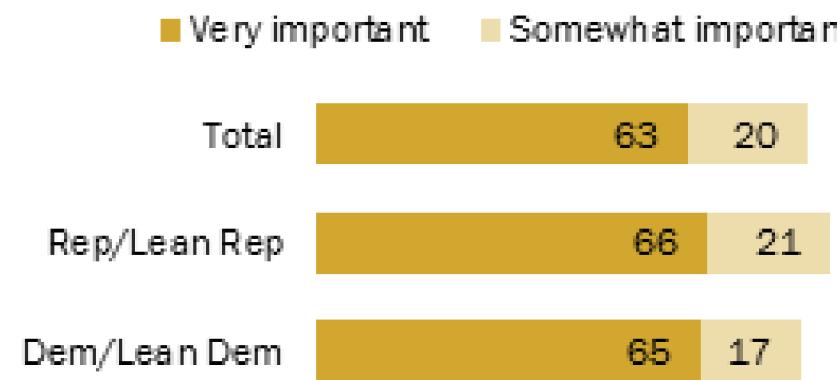
Prompt3 = "Please generate a descriptive analysis of the quantitative data presented in the chart below. Include key statistics, trends, and insights."

Matcha-chart2text-pew: In a Pew Research Center survey conducted in February, 53% of Americans said they pay more than fair share of taxes (40%) and about the right amount (53%). Just 4% said they pay less than fair share of taxes.

Matcha-chart2text-statista: This statistic shows the share of Americans who expect that the 53 percent of Americans think that they pay about the fair share of taxes, if they pay '||| the right amount'.

No partisan gap in views of importance of choice of next Supreme Court justice

% who say the choice of the next Supreme Court justice is to them personally



Source: Survey of U.S. adults conducted July 11-15, 2018.

PEW RESEARCH CENTER

Prompt2 = "Translate the numerical information depicted in the chart into a comprehensive textual summary. Describe the main patterns, variations, and relationships evident in the data."

Matcha-chart2text-pew: A large majority of Americans (83%) say the choice of the next Supreme Court justice is either very or somewhat important to them personally, with 63% saying it is very important. Just 16% say it is not too important or not at all important. Similar majorities of Republicans and Republican leaners and Democrats and Democratic leaners say the choice of the next Supreme Court justice is very important to them personally (66% and 65%, respectively).

Matcha-chart2text-statista: This statistic shows the statistic shows the statistic and statistic | the most important | the | number of people who have | or what seem to be the most important | the text of the post-Supreme Court justice. During the survey, 63 percent of respondents stated that the most important text of the post-Supreme Court justice is ``very important ''.

Example 3

Prompt1 = "What is this chart about?"

Matcha-chart2text-pew:

The public is divided over the importance of the choice of the next Supreme Court justice: 63% say it is very important, while 20% say it is somewhat important. About half of Republicans and Republican leaners (66%) say the choice of the next Supreme Court justice is very important to them personally, with 21% saying it is somewhat important. Democrats and Democratic leaners are far more likely than Republicans and GOP leaners to say the choice of the next Supreme Court justice is very important to them personally (65% vs. 17%).

Matcha-chart2text-statista:

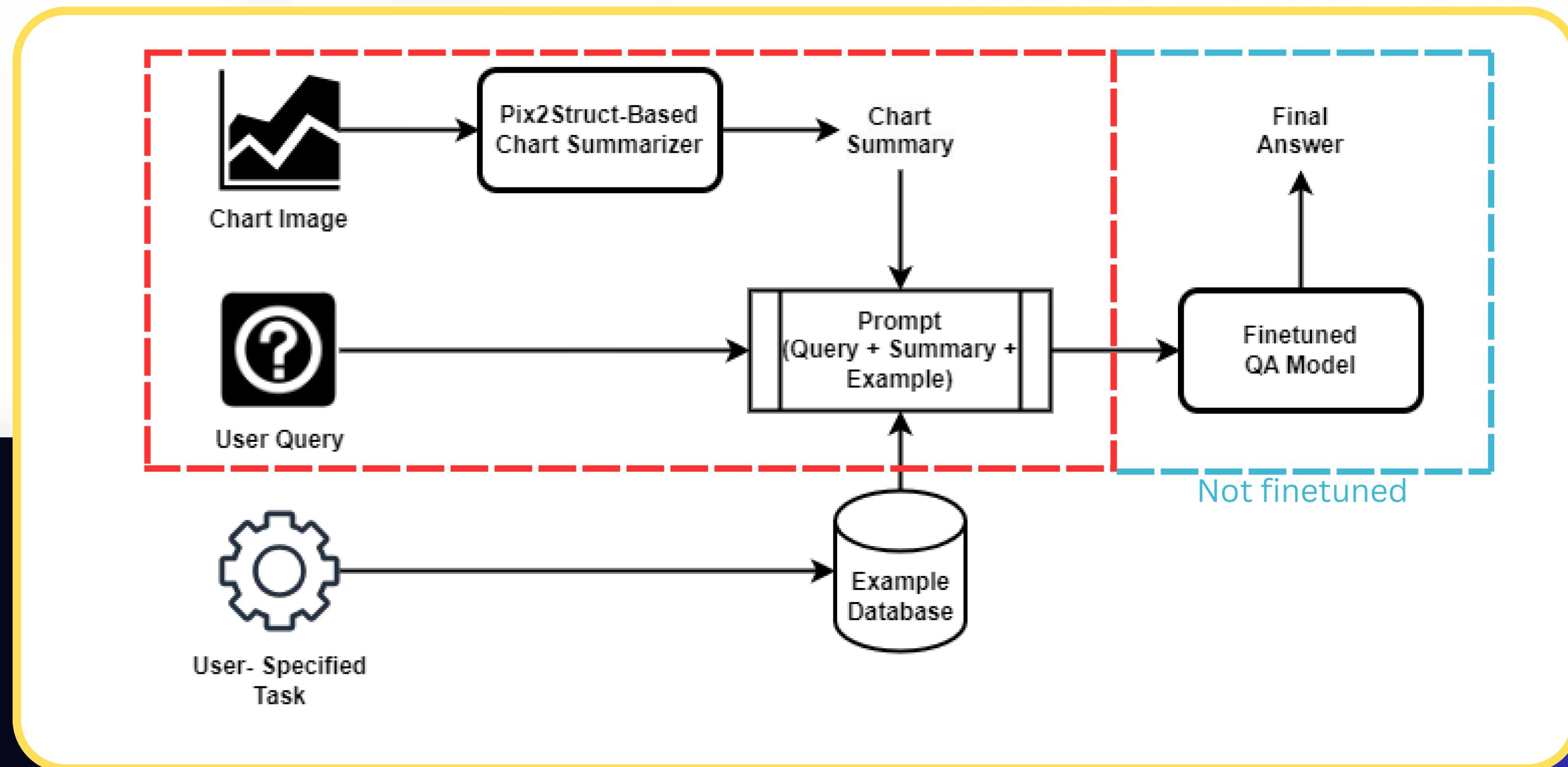
This statistic shows the results of a survey conducted in July 2018 and July 2018 on the importance of the choice of next Supreme Court justice. 63 percent of respondents stated that the total was very important.

Prompt3 = "Please generate a descriptive analysis of the quantitative data presented in the chart below. Include key statistics, trends, and insights."

Matcha-chart2text-pew: A large majority of Americans (83%) say the choice of the next Supreme Court justice is either very or somewhat important to them personally, with 63% saying it is very important. Just 16% say it is not too important or not at all important. Similar majorities of Republicans and Republican leaners and Democrats and Democratic leaners say the choice of the next Supreme Court justice is very important to them personally (66% and 65%, respectively).

Matcha-chart2text-statista: This statistic shows the results of a survey conducted in July 2018 and July 2019, asking Americans to rate the importance of the choice of the next Supreme Court justice. According to the source, 63 percent of respondents rated the rate as very important.

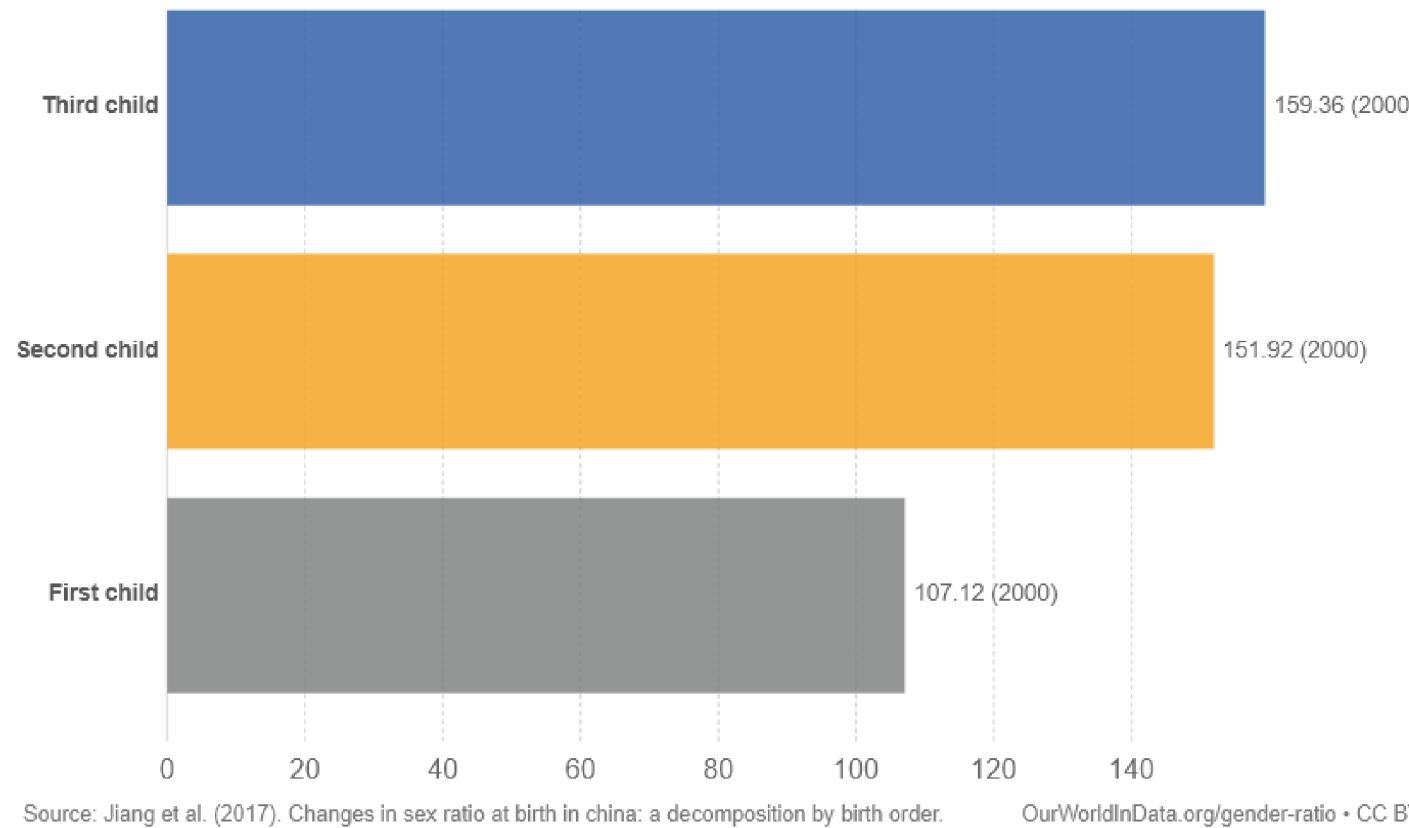
CONDUCTED EXPERIMENTS UPDATE



Bad Example

Sex ratio at birth by birth order, China, 2000

Sex ratio at birth measures the number of male births per 100 female births. This is shown below by birth order of children i.e. the first, second or third-born child. Birth ratios are naturally male-biased, with an expected ratio of 105 male births per 100 female births.



Source: Jiang et al. (2017). Changes in sex ratio at birth in china: a decomposition by birth order.

OurWorldInData.org/gender-ratio • CC BY

Chart summarizer prompt: What is this chart about?

Result:

Matcha-chart2text-pew + Minichat-3B:

The male birth ratio is 105.66.

Matcha-chart2text-statista + Minichat-3B:

The male birth ratio of a third child is 104.13 percent.

Math QA using summaries generated from chart summarizers

Question: What is the male vs. female birth ratio of a third child?

Prompt template for QA model:

Below is a summary that describes a chart, paired with a question the user has about the chart. Write a response that appropriately answer the question.

Summary:

{summary}

Question:

{question}

Response:

Chart summarizer prompt: Translate the numerical information depicted in the chart into a comprehensive textual summary. Describe the main patterns, variations, and relationships evident in the data.

Result:

Matcha-chart2text-pew + Minichat-3B:

The birth ratio of a third child varies for each gender. In the case of the U.S., the birth ratio of a third child was 103% males and 97% females

Matcha-chart2text-statista + Minichat-3B:

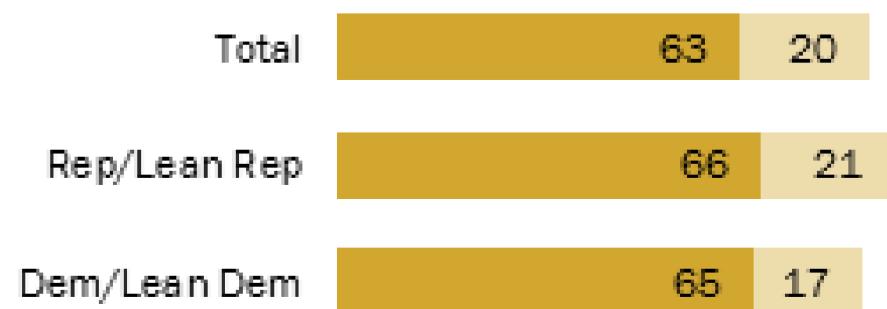
The male vs. female birth ratio of a third child is not provided in the data provided.

Good Example

No partisan gap in views of importance of choice of next Supreme Court justice

% who say the choice of the next Supreme Court justice is
— to them personally

■ Very important ■ Somewhat important



Source: Survey of U.S. adults conducted July 11-15, 2018.

PEW RESEARCH CENTER

Chart summarizer prompt: What is this chart about?

Result:

Matcha-chart2text-pew + Minichat-3B:

Yes, the choice of the next Supreme Court justice is important for Democrats. Democrats and Democratic leaners are far more likely than Republicans and GOP leaners to say the choice of the next Supreme Court justice is very important to them personally (65% vs. 17%)

<Note: The graph is not about probability but actual opinions collected from the survey so “far more likely” is not a correct term to use>

Math QA using summaries generated from chart summarizers

Question: Is the choice of next supreme court justice important for the democrats?

Prompt template for QA model:

Below is a summary that describes a chart, paired with a question the user has about the chart. Write a response that appropriately answer the question.

Summary:

{summary}

Question:

{question}

Response:

Chart summarizer prompt: Translate the numerical information depicted in the chart into a comprehensive textual summary. Describe the main patterns, variations, and relationships evident in the data.

Result:

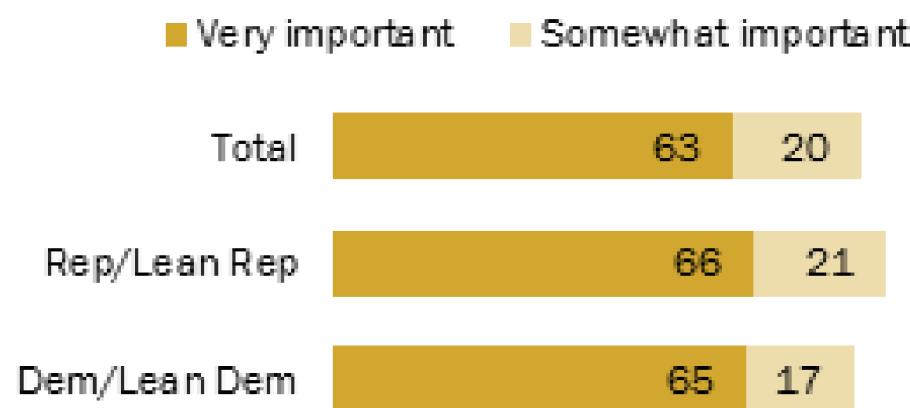
Matcha-chart2text-pew + Minichat-3B:

The choice of the next Supreme Court justicee is important for Democrats as well as Republicans. According to the chart, 65% of Democrats and Democratic leaners see the choice of the next Supreme Court justice as very important to them personally. This is a close match to the 66% of Republicans and Republican leaners who also see the choice of the next Supreme Court justice as very important to them personally.

Good Example

No partisan gap in views of importance of choice of next Supreme Court justice

% who say the choice of the next Supreme Court justice is
____ to them personally



Source: Survey of U.S. adults conducted July 11-15, 2018.

PEW RESEARCH CENTER

Chart summarizer prompt: What is this chart about?

Result:

Matcha-chart2text-statista + Minichat-3B:

The data from the survey suggests that the majority of respondents (63%) believe that the choice of the next Supreme Court justice is very important. However, it is not necessarily representative of the entire Democratic party as the survey was conducted among a specific group of people. The importance of the Supreme Court is a matter of debate and can vary depending on one's political ideology and views on the role of the judiciary in society.

Math QA using summaries generated from chart summarizers

Question: Is the choice of next supreme court justice important for the democrats?

Prompt template for QA model:

Below is a summary that describes a chart, paired with an question the user has about the chart. Write a response that appropriately answer the question.

Summary:

{summary}

Question:

{question}

Response:

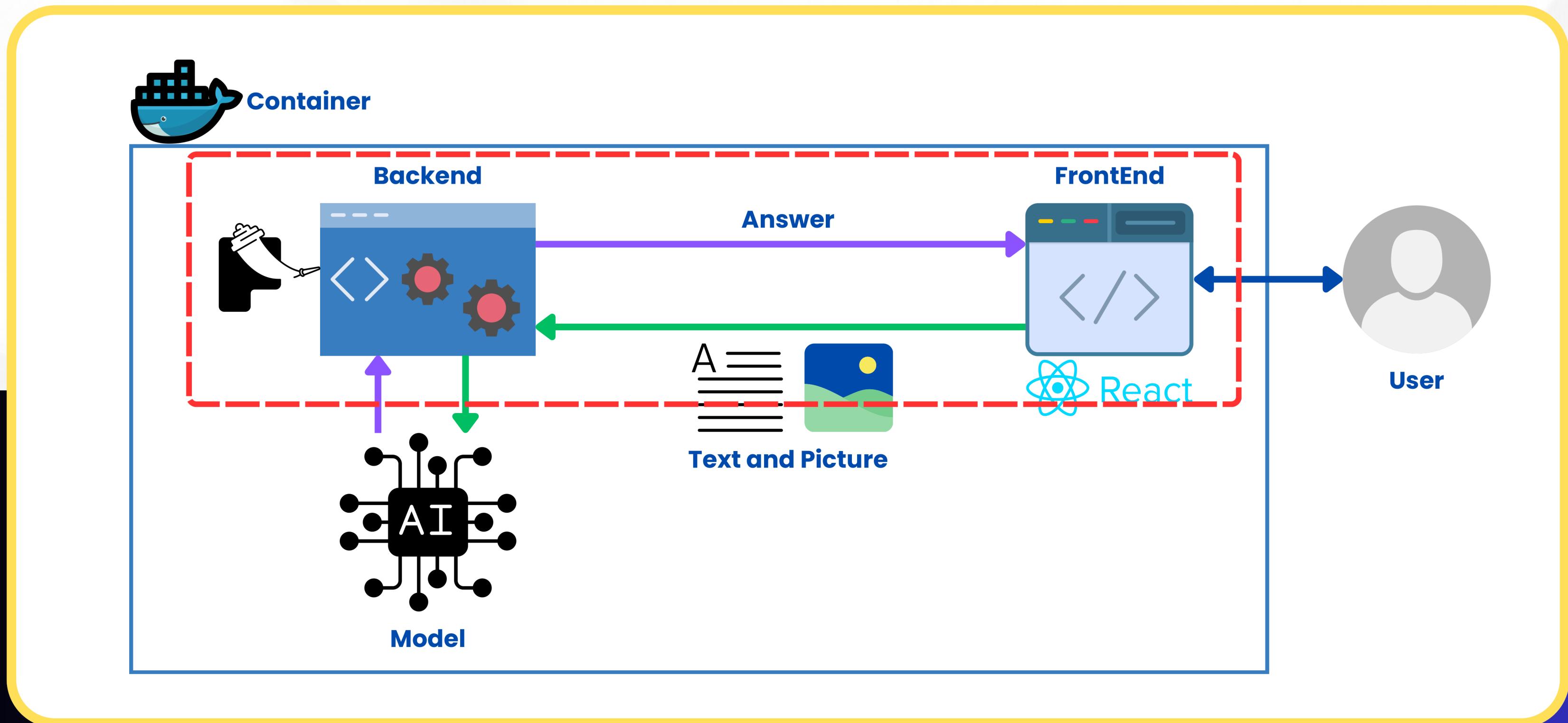
Chart summarizer prompt: Translate the numerical information depicted in the chart into a comprehensive textual summary. Describe the main patterns, variations, and relationships evident in the data.

Result:

Matcha-chart2text-statista + Minichat-3B:

The choice of the next Supreme Court justice is important for all branches of government and for the American people. The views of the public, and those of the Democratic Party in particular, are worth considering when deciding who should be appointed to this position. The preferences and priorities of the Democratic Party do not necessarily reflect the views of the American people as a whole. It is important for the American people to have a voice in this decision, and for the Democratic Party to take the opinions of its constituents into account when making this important decision.

WEB APPLICATION DEVELOPMENT UPDATE



MATH APP

Text Input:

What's this graph about ?

Image Input:

Choose File graph.png

Process

Output:

This is an example of texts generated



**WEB
APPLICATION
(v.1.0)**

DEMO VIDEO

MATH APP

Text Input:

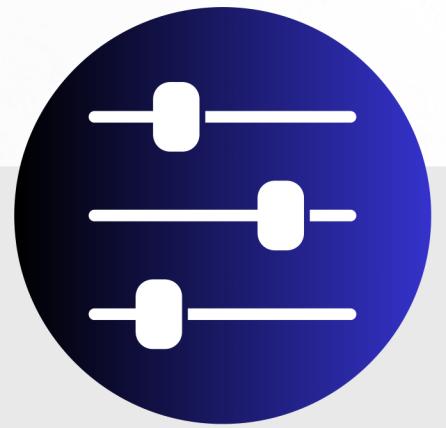
Image Input:

Choose File graph.png

Process

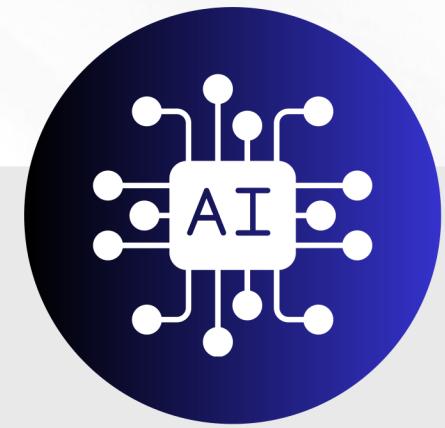
Output:

NEXT STEPS



FINE-TUNING CHART SUMMARIZER

Fine-tuning the chart summarizer since the main issue actually lies there, not with the QA model.



RAG + USER-SPECIFIED TASK

Incorporate the RAG technique using user-specified task input into the model pipeline.



PERFORMANCE BENCHMARK

Conduct a performance benchmark using appropriate metrics on baseline and finetuned models.



MODEL PIPELINE + WEB APPLICATION

Integrate the model pipeline with the web application through Flask backend.

THANK YOU

Question and Answer section