



# Can generative AI help us structure decision models?

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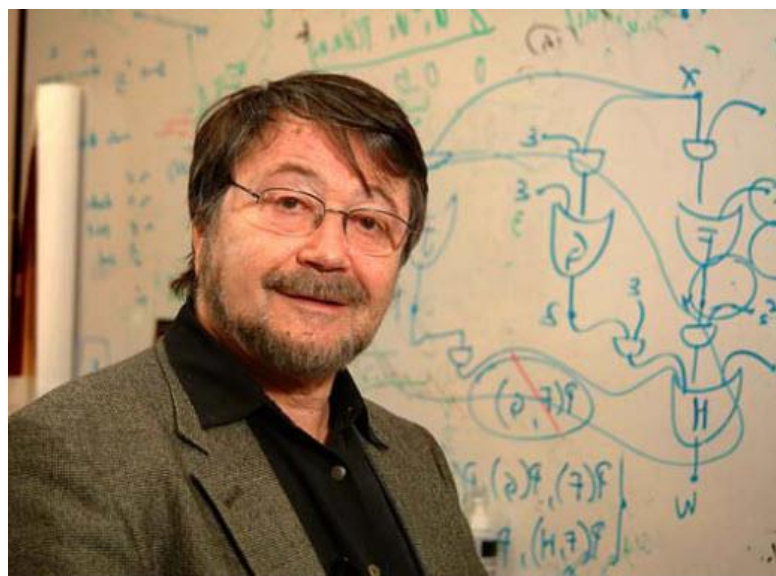
**Society for Decision Professionals**  
Arlington, VA  
April 2024



# Bayesian inference & decision theory in AI



**UAI** Conference still going strong



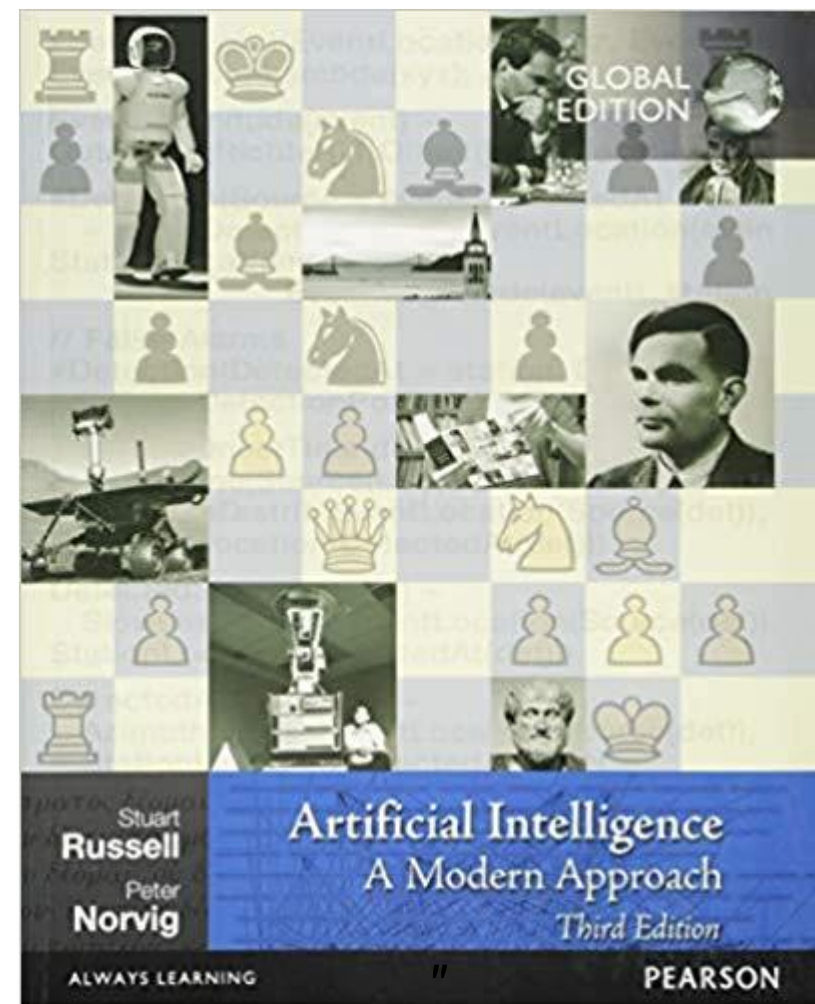
**Judea Pearl** received **ACP Turing Award** in 2011 for his work on Bayesian networks

## *Artificial Intelligence: A Modern Approach*

3<sup>rd</sup> edition,

Stuart Russell  
& Peter Norvig

*"the most popular  
AI textbook in the world"*



200 of 1000 pages on probability and decision theory



# Human vs. AI?

A trip back in time...



*MidJourney: "AI vs human"*

## **Humans = General Intelligence**

- Mastery across a broad spectrum of abilities and domains.
- Common sense
- Robust

## **A.I. = Narrow intelligence**

- Narrow domain of application
- Exceeds human capability only in narrow areas.
- Tends to be brittle.

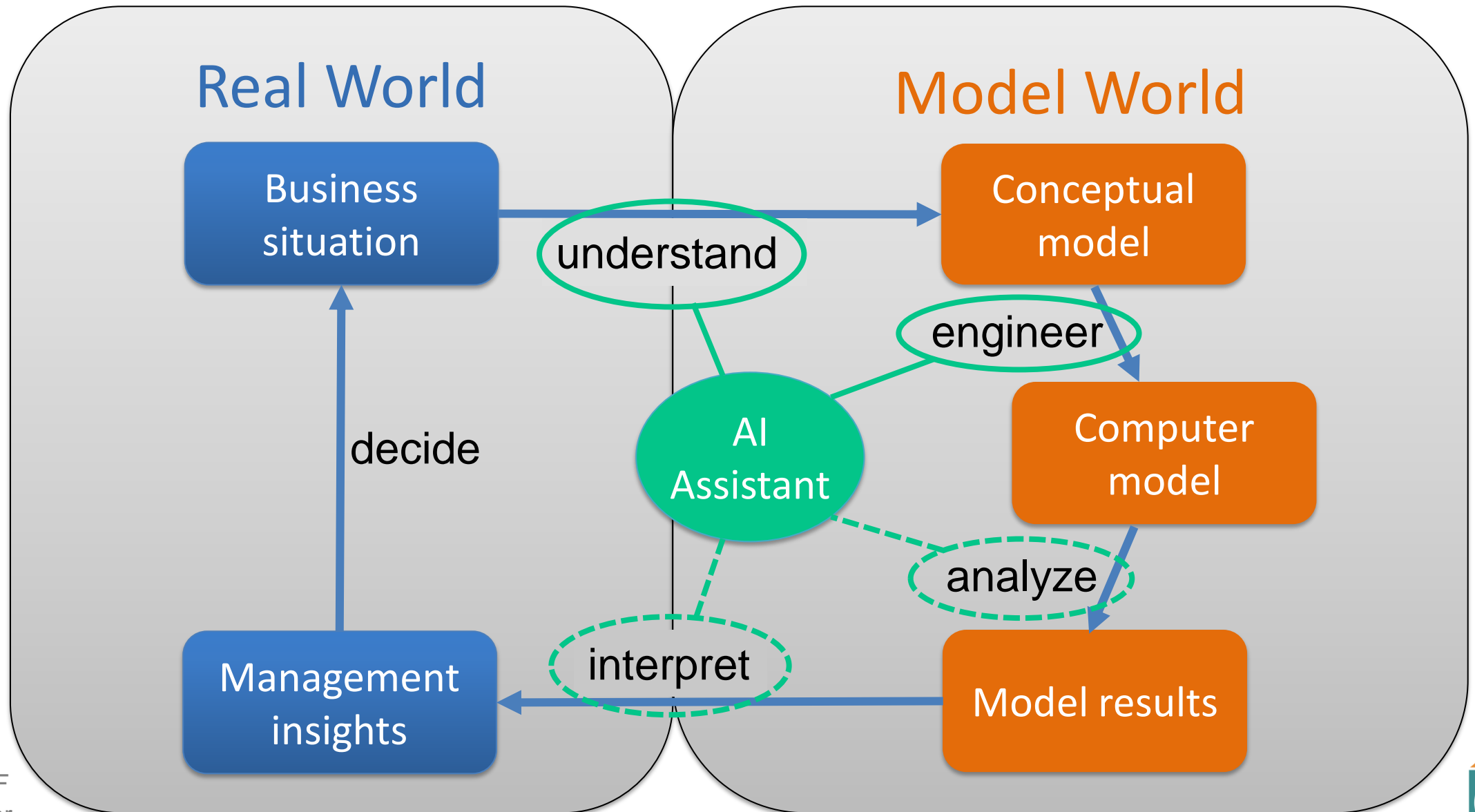


## A quick survey

- How many have played with Chat-GPT or another Large Language Model?
- How many use LLMs regularly in your work?
- How many have used one to help structure a decision problem?



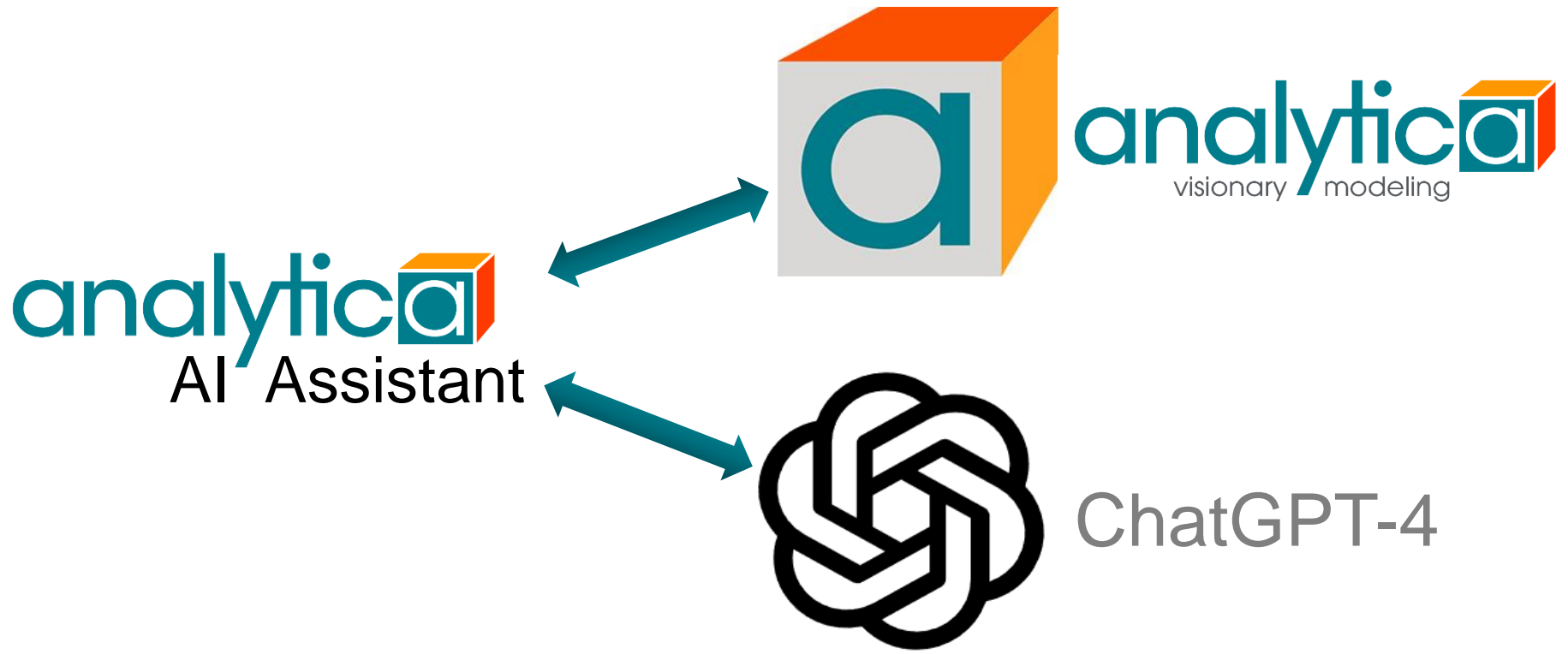
# The decision modeling cycle



# Collaborative decision modeling with Analytica AI Assistant and ChatGPT-4



Lonnie  
Chrisman  
CTO, Lumina

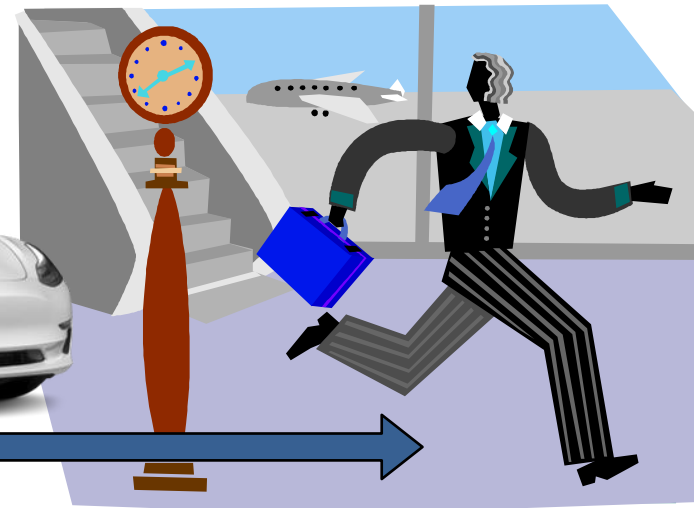


# The plane-catching decision problem

## From home

What time should I leave  
home to catch an 8am  
flight from SFO on  
Monday to attend the SDP  
2024 Conference?

**to San Francisco Airport**



# Help me decide what time to leave home for SFO to catch my flight to DC at 8am on Monday: 1

**Analytica AI Assistant:** To model the decision of what time to leave for SFO (San Francisco International Airport) to catch a flight to DC at 8 AM, we need to consider several factors that could influence your departure time.

These could include expected traffic conditions, weather implications, security wait times at the airport, the distance to the airport, and any personal preferences or constraints (like how early you prefer to be at the gate).

Let's break down the model into several variables and define them with proper Analytica syntax.

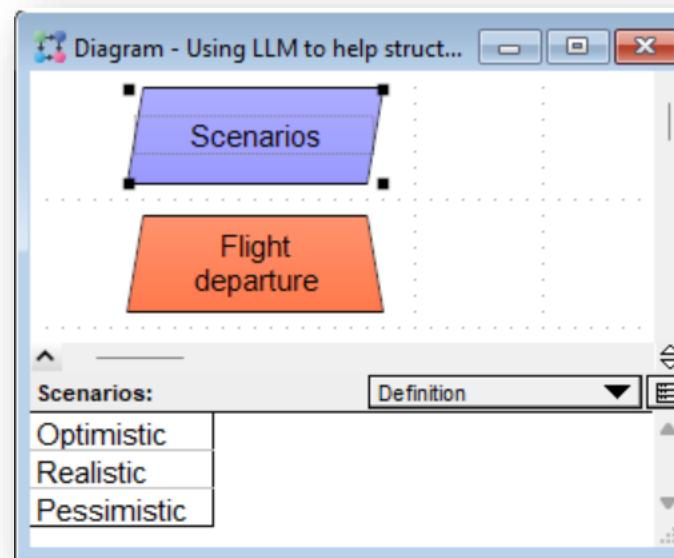
## Step 1: Define Indices and Constants

First, define any necessary indices or constants, such as an index for different scenarios or a constant for the flight time.

Index Scenarios :=

['Optimistic', 'Realistic', 'Pessimistic']

Constant Flight\_Departure := Time(8, 0, 0);





# Analytica AI Assistant presentation

- **My questions/prompts:** Exactly as given.
- **AI Assistant responses:** Extracts from the text, with formatting added (bold subheads, bullets, and indents).
- **Influence diagrams and model:** Built manually using the Analytica variables provided by the AI Assistant with some definitions (formulas) corrected for bad syntax or imaginary function names.



# Help me decide what time to leave home for SFO to catch my flight to DC at 8am on Monday: 2

## AI Assistant: Variables to Consider-

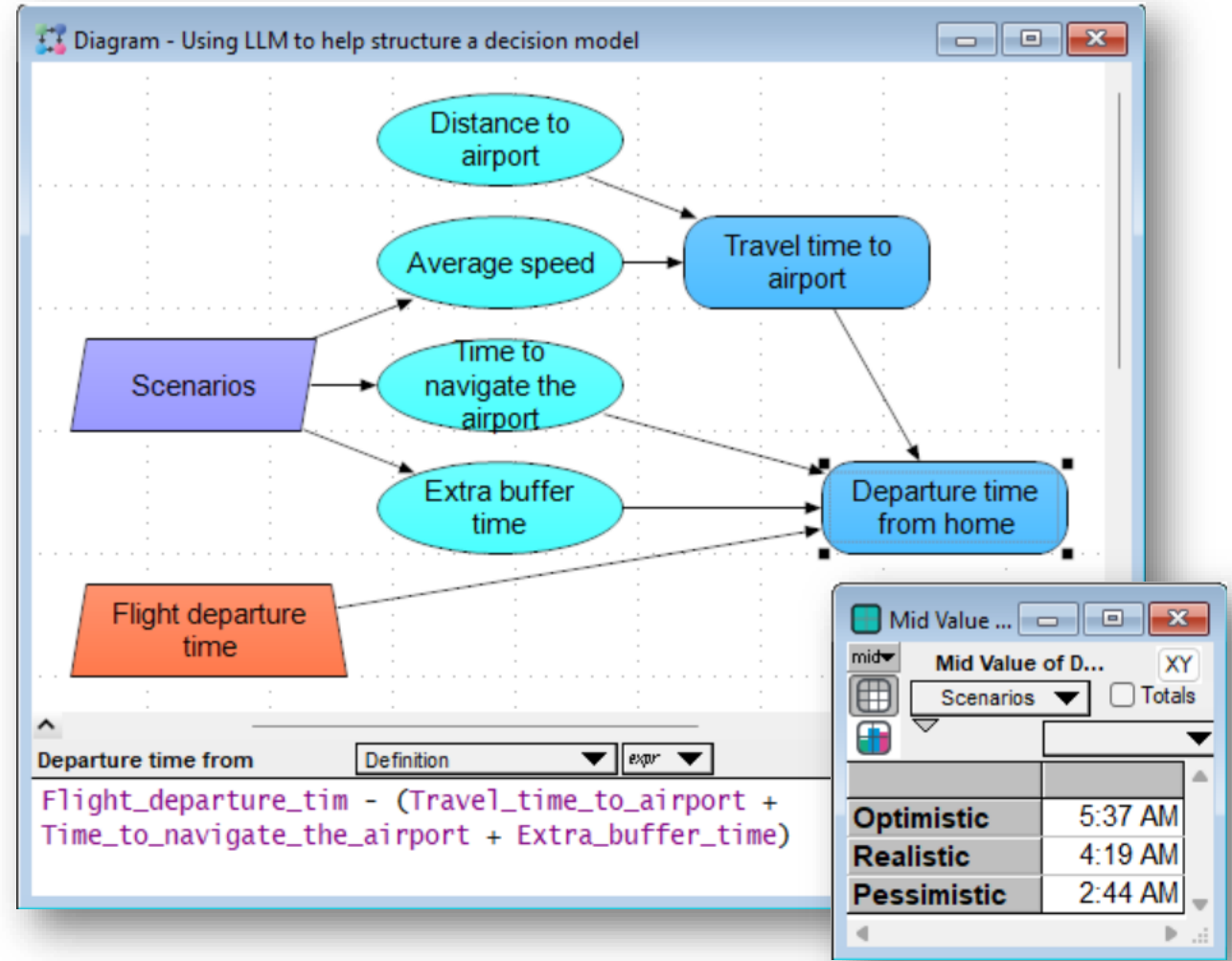
- Distance to Airport (miles)
- Average Speed (miles per hour) based on scenarios
- Time to Navigate Airport (hours) including check-in and security, based on scenarios
- Extra Buffer Time (hours) to account for unexpected delays

Calculate the travel time to the airport, based on distance and average speed under each scenario.

Variable `Travel_Time_to_Airport` :=  
 $\text{Distance\_to\_Airport} / \text{Average\_Speed}$ ;

## Decide Departure Time

Variable `Departure_Time_From_Home` :=  
 $\text{Flight\_Departure} - (\text{Travel\_Time\_to\_Airport} + \text{Time\_to\_Navigate\_Airport} + \text{Extra\_Buffer\_Time})$



# What is the probability that I will miss the plane if I leave at 5am?

## AI Assistant:

To calculate the probability of missing your flight if you leave at 5 AM, you'll need to model the uncertainties involved in getting to the airport and through the airport processes, leading up to the flight at 8 AM. This type of model falls under the category of a Monte Carlo simulation because it inherently involves dealing with uncertainties and calculating probabilities based on those uncertainties.

This involves defining various uncertainties like traffic conditions, parking and shuttle times to the terminal, and security wait times. Then, you will combine these to determine if the total time required exceeds the available time before your flight's departure.

First, identify all the variables that could influence whether you'll make it to your flight on time and categorize them as chance variables.

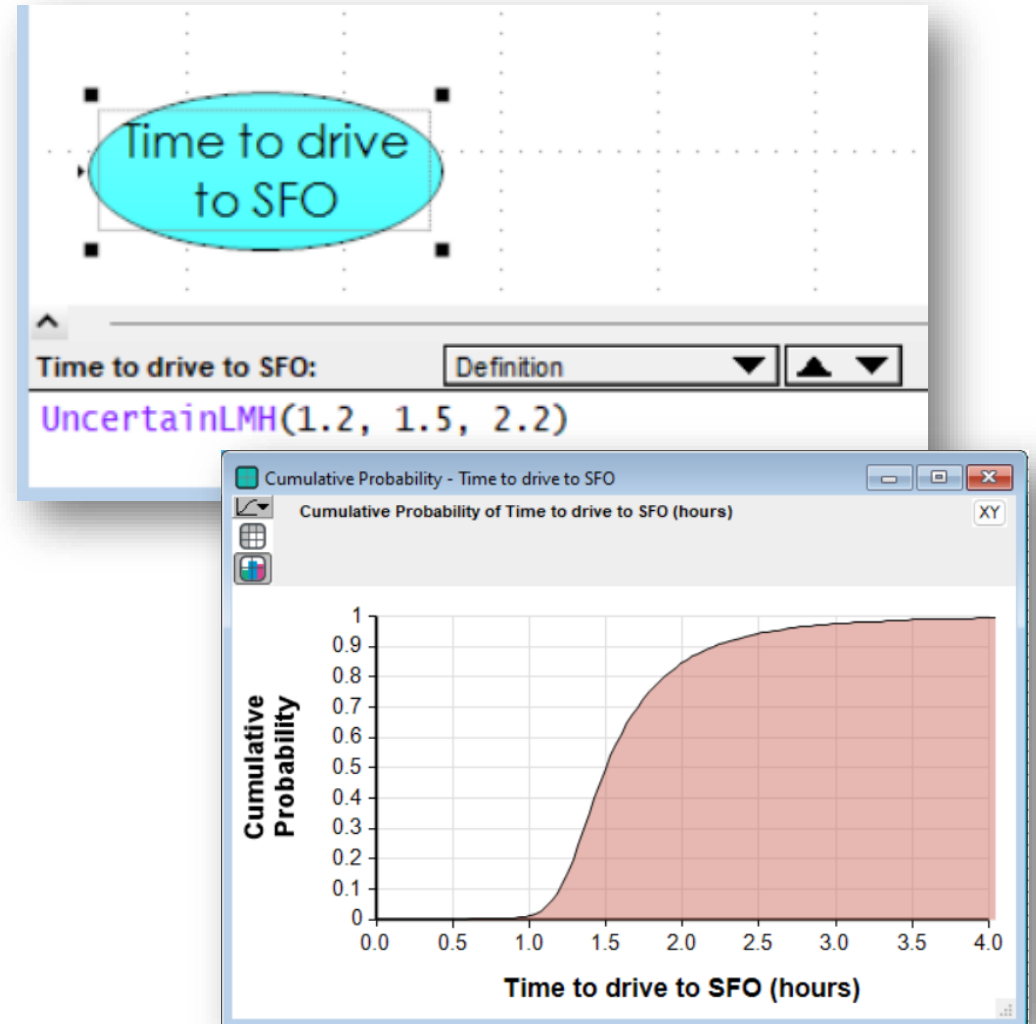


# How can I assess a probability distribution using percentiles to express my uncertainty about how long it will take to drive to SFO?

**AI Assistant:** To assess your uncertainty about the time it will take to drive to the San Francisco International Airport (SFO) using percentiles, you can use the `UncertainLMH` function in Analytica. This function allows you to specify a smooth continuous distribution based on three percentile estimates:

- a low estimate (often the 10th percentile) under optimistic conditions,
- a median estimate (the 50th percentile) the most likely time, and
- a high estimate (90th percentile), the time under heavy traffic or pessimistic conditions.

Variable `Time_to_drive_to_SFO` :=  
`UncertainLMH(xLow, xMedian, xHigh)`



# What it is the probability that I will miss the plane if I leave at 5am?

Your decision is when to leave:

~~Variable Departure\_Time := 5; // 5 AM~~

Decision

Determine how much time you have from leaving your house to the flight departure

Variable Time\_to\_Flight :=

Flight\_Departure - Departure\_Time

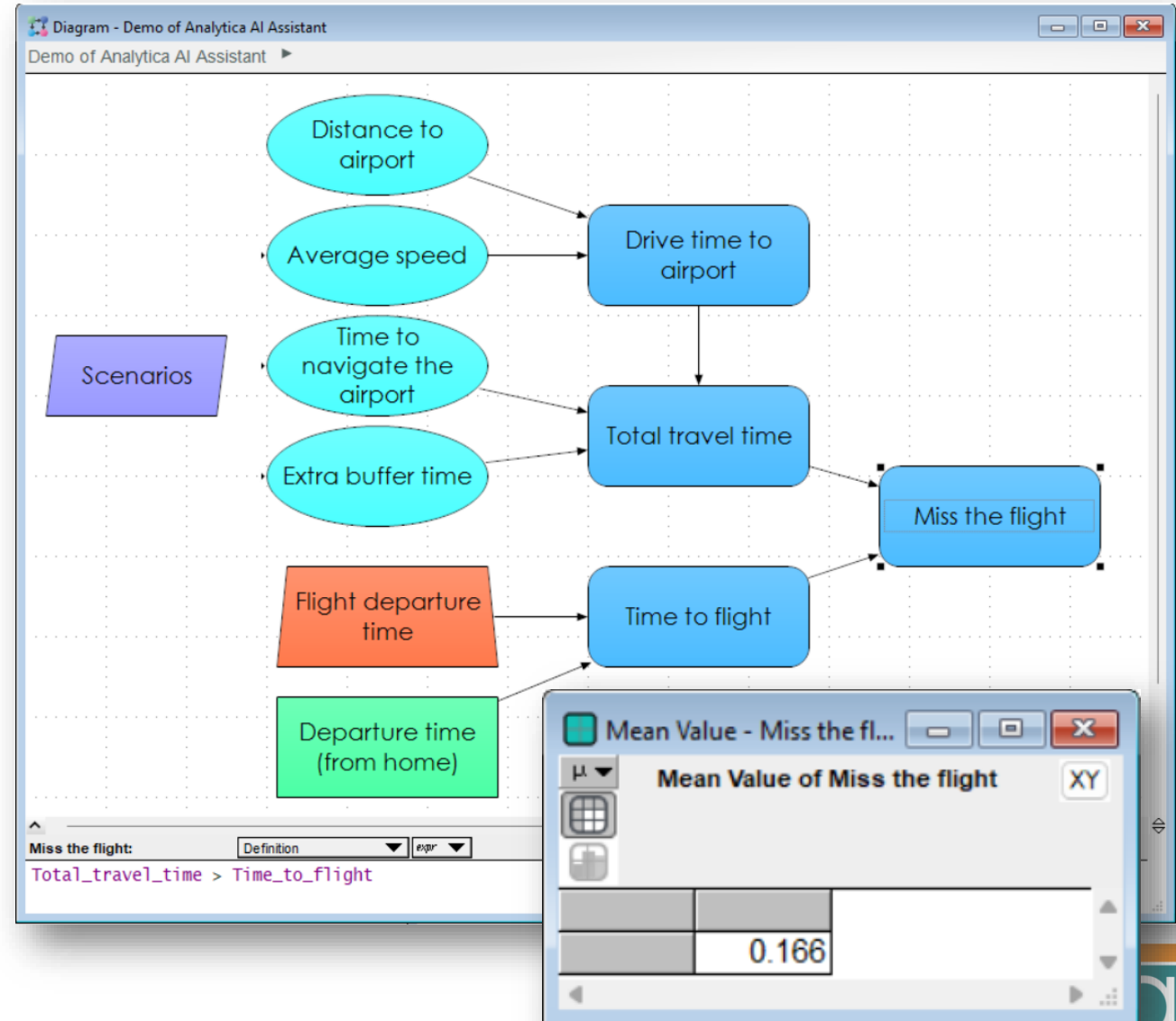
Determine if the `Total\_Travel\_Time` exceeds `Time\_to\_Flight`, and calculate the probability of this event:

Variable Miss\_Flight :=

~~If Total\_Travel\_Time > 2 Then 1 Else 0~~

~~// Assuming you need to be 2 hours ahead~~

Total\_Travel\_Time > Time\_to\_Flight



# What time should I leave to reduce the probability of missing my flight to 5%?

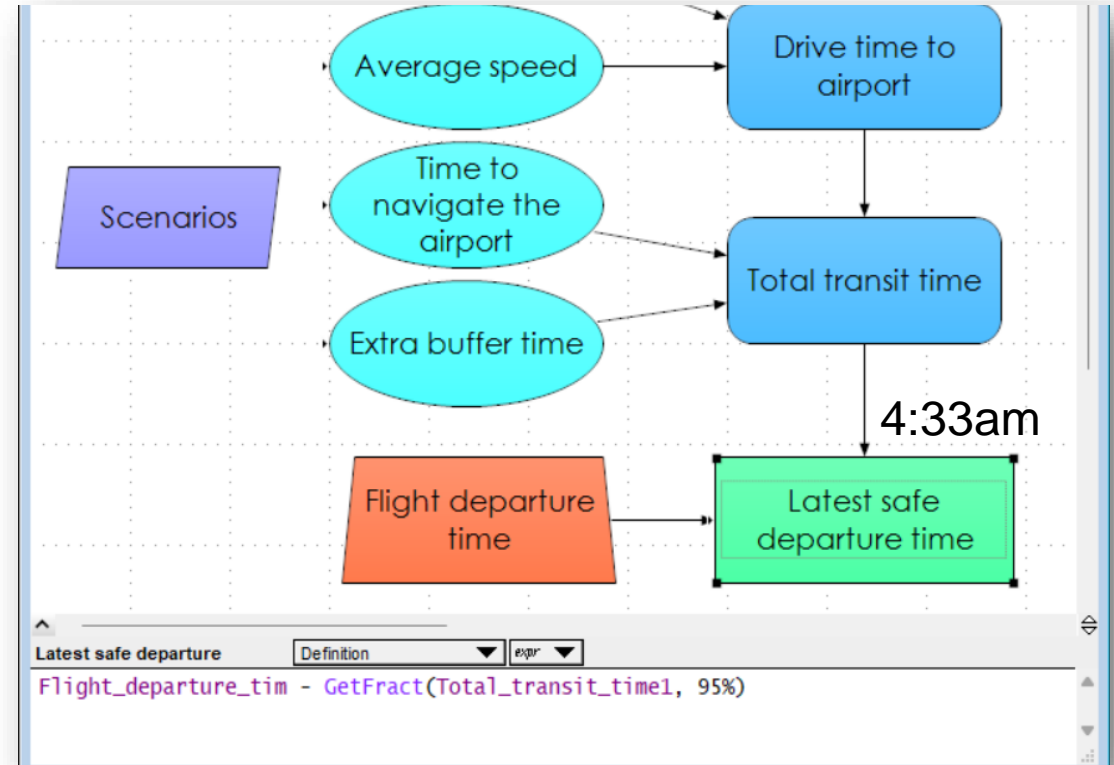
**AI Assistant:** To establish a time to leave that reduces the probability of missing your flight to San Francisco International Airport (SFO) to 1%, it is essential to model the uncertainties and variabilities in the factors affecting your trip to the airport. This includes traffic conditions, security wait times, distance to the airport, and your speed of travel. By incorporating chance variables for these components, we can simulate the variability and calculate a departure time that aims to limit the probability of missing your flight to 5%.

## Determine Safe Departure Time

To achieve a 5% risk of missing your flight, you'll need to analyze the total travel time distribution and find a departure time that ensures you're at the airport within your risk tolerance.

Variable Latest\_Safe\_Departure\_Time :=

Flight\_Departure - ~~Percentile(Total\_Travel\_Time, 99)~~  
GetFract(Total\_Travel\_Time, 95%)



# AI Assistant's final comments

## **Additional Steps for Improved Accuracy**

- Consider including more detailed scenarios or distributions for each time delay component, which could give a more accurate range of outcomes.
- Incorporate real data from traffic reports, airport statistics on security wait times, etc., to refine the distributions of your chance variables.

## **Final Note**

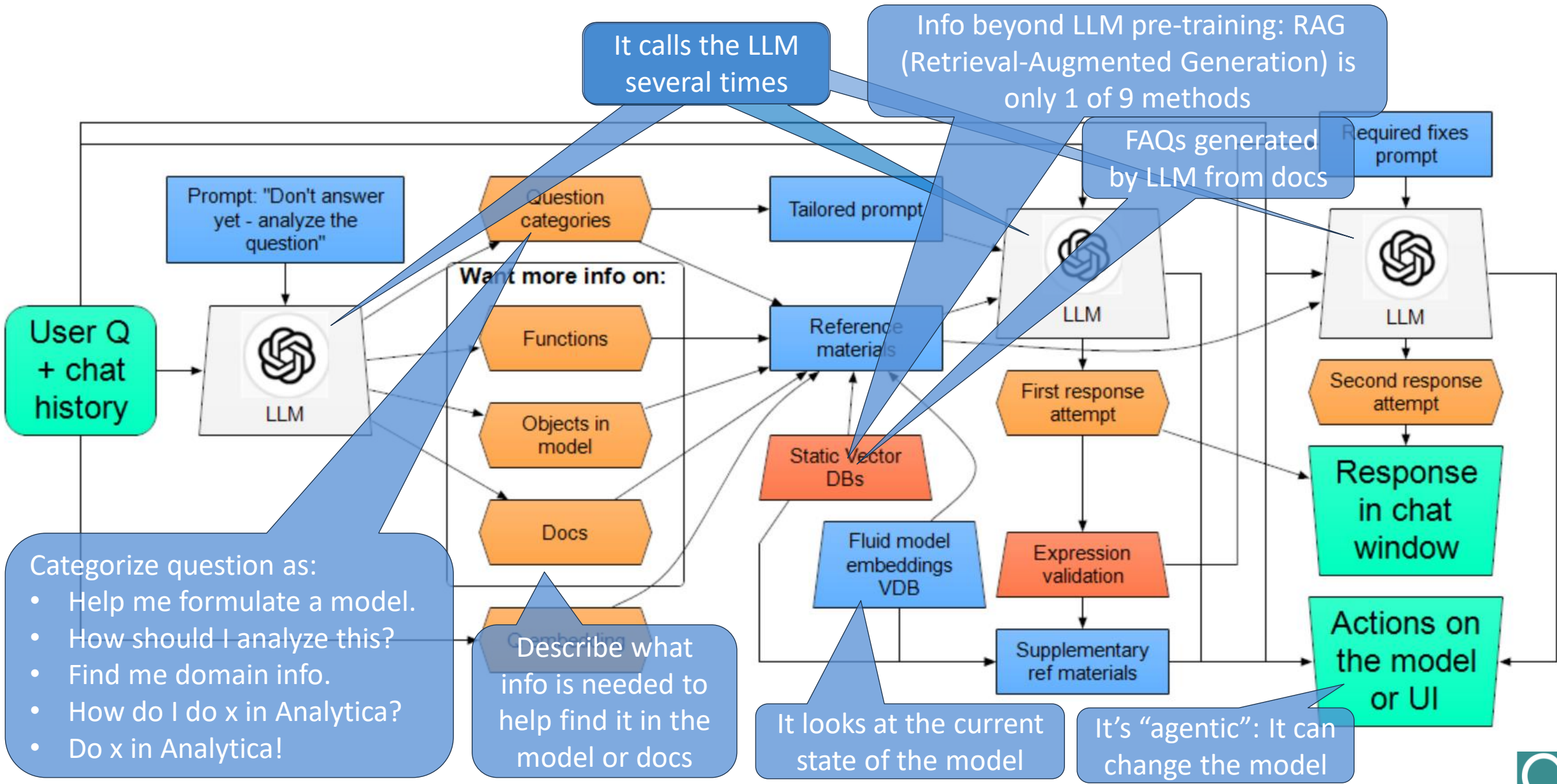
This framework provides a basic structure. In a real-world scenario, you would likely need to replace the distributions with more accurate data specific to the day, time, and even the season of your travel.

Moreover, this model assumes a simple additive relationship between the different time components. Depending on your situation, you might need to consider more complex interactions or dependencies between variables.

Analytica's Monte Carlo simulation capabilities will allow you to run this model numerous times, each with randomly selected values for the chance variables within their specified distributions. The result is a probability distribution of different outcomes, from which you can calculate the probability of missing your flight.



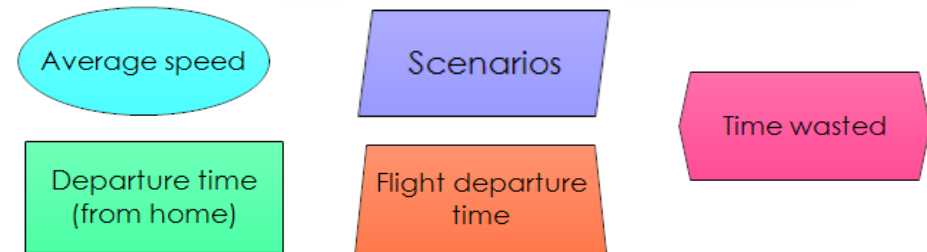
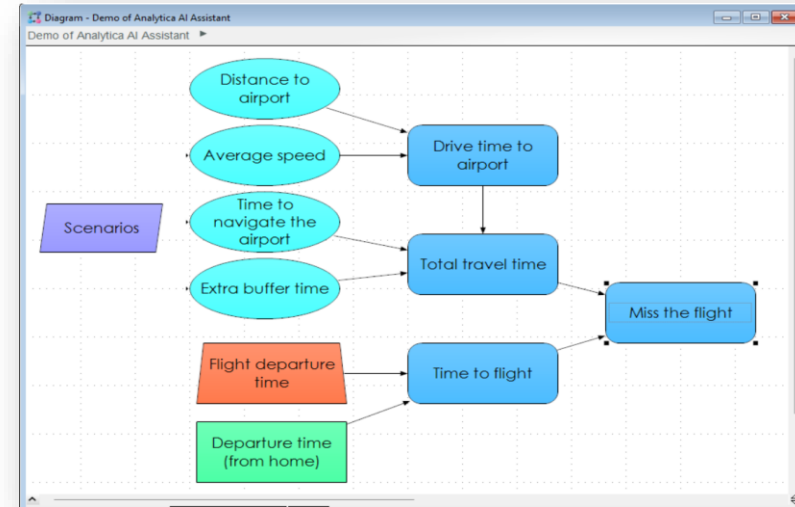
# Architecture of the Analytica AI Assistant





# Observations

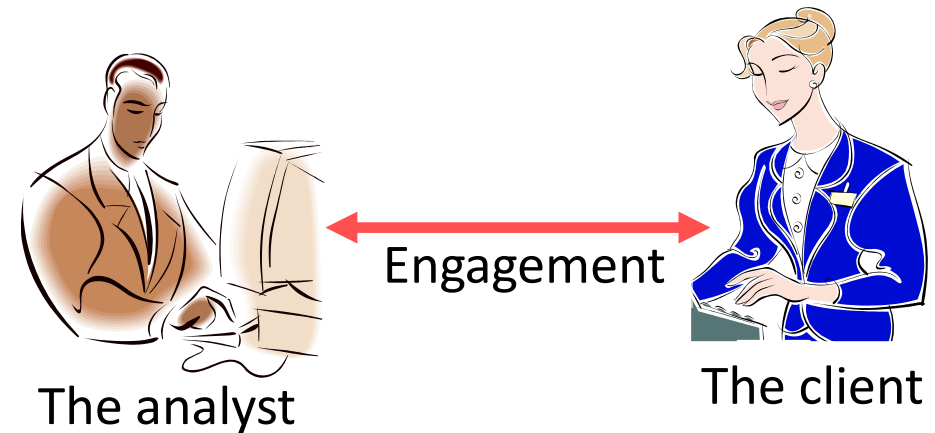
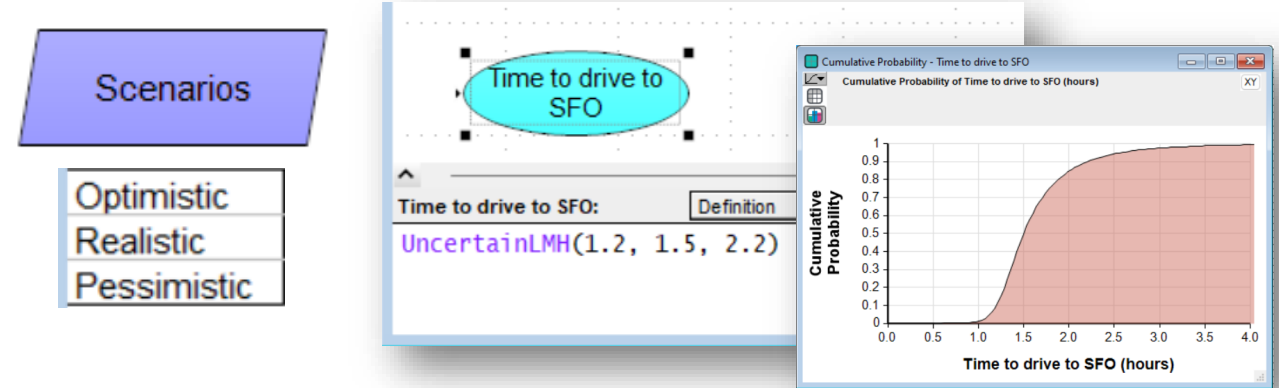
- **Model structuring:** It's good at identifying an approach and suggesting an appropriate model structure
- **Influence diagrams:** It generates variables and influences as text but doesn't yet pass them into Analytica as influence diagrams.
- **Node types:** It identifies **chance** variables (and **indexes** and **constants**), but often misses **decisions** and **objectives**.
- **Formulas:** It usually (~80%) generates correct Analytica definitions/code, but syntax and function names are sometimes contaminated with Python and other languages.



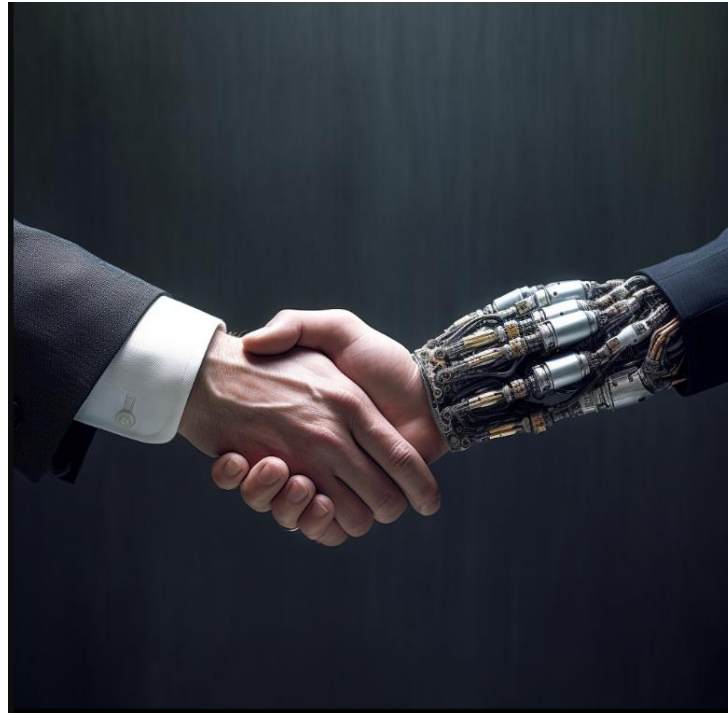
~~If Total\_Travel\_Time > 2 Then 1 Else 0~~  
 Total\_Travel\_Time > Time\_to\_Flight

# More observations

- **Uncertainty:** It often starts with scenarios. It is good with probability distributions and Monte Carlo, with occasional mistakes.
- **Interpreting results:** Not yet.
- **Cautions:** It's great at advising of limitations.
- **Refinements:** It's good at suggesting ways to expand and improve the analysis
- **Interactions:** It doesn't ask the user (or stakeholders) questions, a key skill for model structuring.



# Q & A



*Concept: GPT-4,  
Design: MidJourney*