



Institute  
and Faculty  
of Actuaries

# IFoA Life Conference

Documenting spreadsheets using LLMs

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# 01 Background

# What are Large Language Models (LLMs)?

LLMs are a type of neural network which is trained on a massive of text data. They are generally trained on data found online and consist of 3 main building blocks.

## Data

LLM are trained on petabytes of data including web scraping, online books, articles, etc..

## Architecture

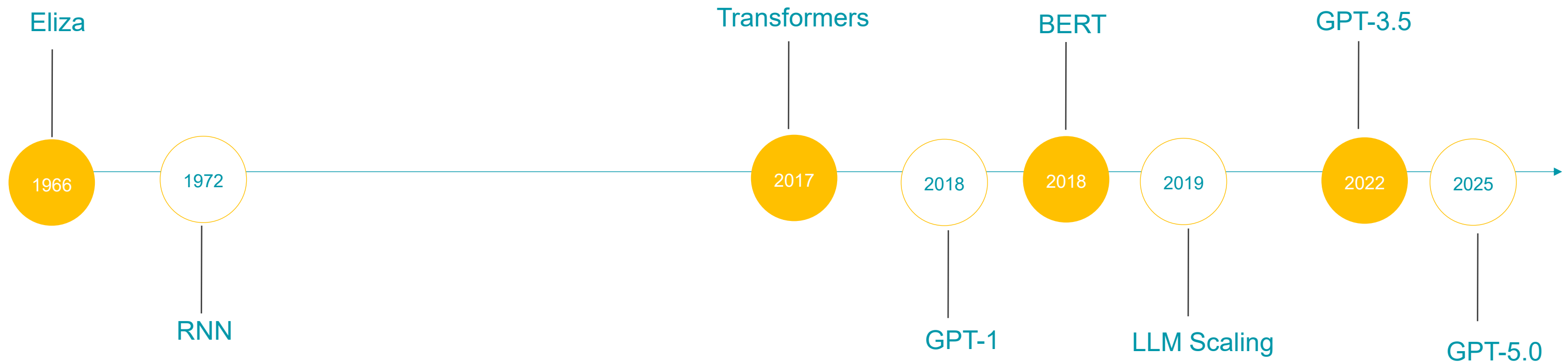
LLMs consist of a series of algorithms which try to recognise patterns of data. The algorithms are focused on understanding natural language.

## Training

Traditional programming is instructions based. In contrast, LLMs are example-based and their output relies on providing lots of examples.



# History and evolution of LLMs



## History and evolution of LLMs

- Eliza model (1966) – first Language model based on key-word.
- RNN (1972) – First model to predict the next word; the basis of an LLM.
- Attention is all you need (2017) – Breakthrough paper on Transformers.
- GPT-1 (2018) – Revolutionary model with 117 million parameters.
- BERT – 340 million parameters and bi-directionality.
- GPT-3.5-5.0 – The models we use when we use ChatGPT.

## Features of LLMs

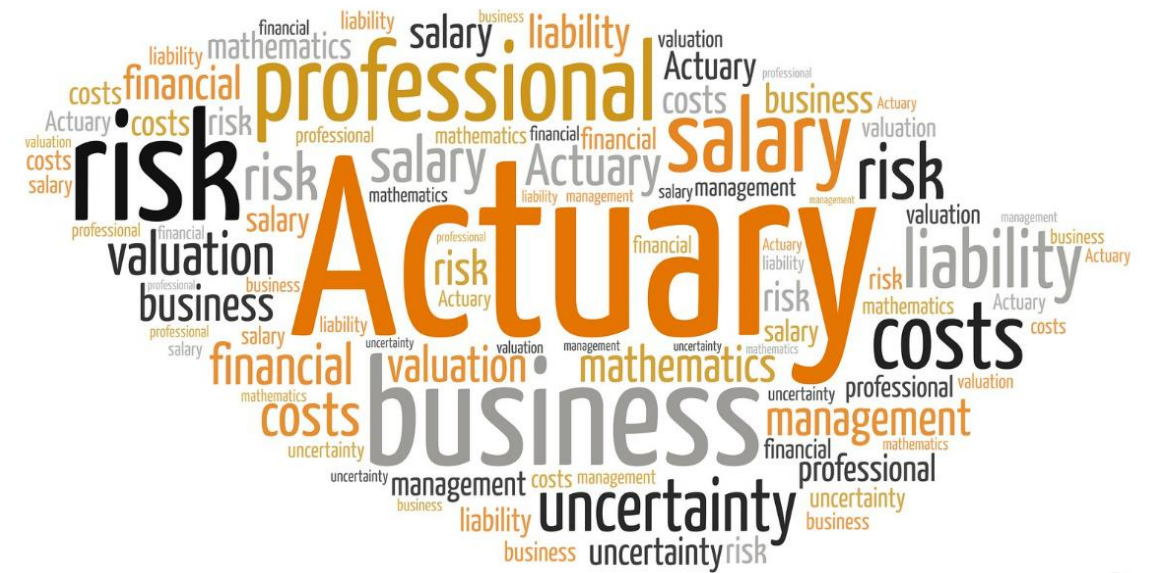
- More flexible and scalable than traditional programming
- Can be used for a wide range of tasks including summarisation, creative writing, QnA and Programming
- Rapidly evolving – we are still in the early days of LLMs and their capabilities will only continue to grow.

# How LLMs work?



Word	Vector
Cat	[0.1, 0.2, 0.3, 0.4, 0.5]
Dog	[0.1, 0.2, 0.3, 0.4, 0.6]
Ball	[0.2, 0.4, 0.6, 0.8, 1.0]
House	[0.3, 0.6, 0.9, 1.2, 1.5]

- They watched the frog **spring** (**verb**) out of the box.
- She has to replace a **spring** (**noun**) on her bicycle.



# Tuning of models

- Tuning is the process of further training a pre-trained LLM on a specific dataset or for a particular task to improve its performance in a specific area.
- It allows users to tailor the general capabilities of a pre-trained model to meet the unique needs of their application without having to train a new model from scratch.

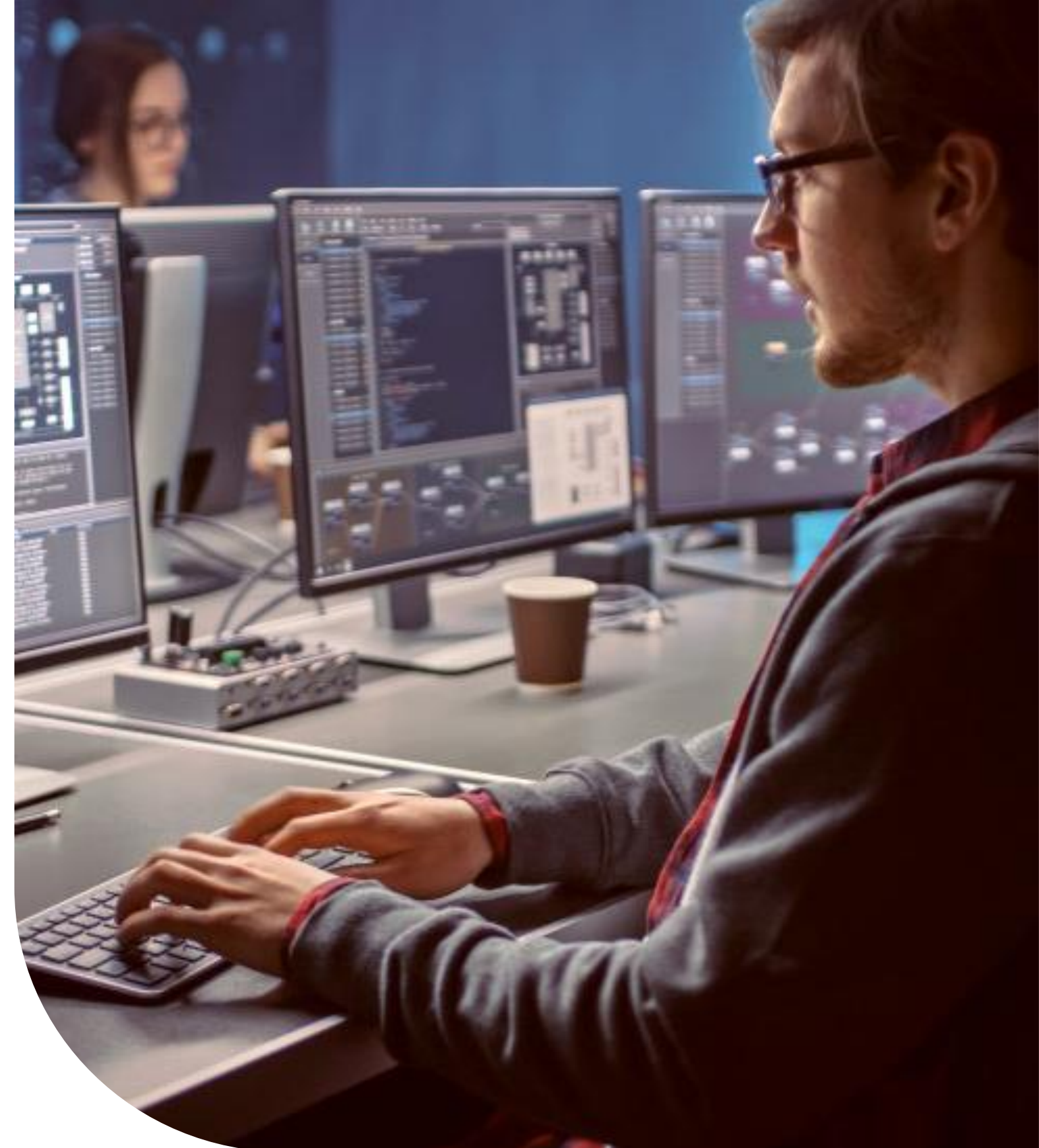
## What an off-the-shelf LLM can do

- Create a generic summary of a spreadsheet.
- Describe the general structure of a spreadsheet.
- Describe actuarial principles.
- Create Python codes based on a set of instructions.



## What an off-the-shelf LLM cannot do (yet) without tuning

- Create spreadsheet documentation based on a certain set of standards.
- Identify the inputs, calculations and output reliably.
- Describe complex spreadsheet mechanics or logic.
- Convert spreadsheets into reliable Python codes.



# 02 AI powered spreadsheet tool

# Context

Excel spreadsheets are used extensively by firms for data management, analysis, and reporting. These spreadsheets can be resource intensive to manage and prone to high-levels of control risk. Our AI-Powered spreadsheet management tool makes it easier to understand, review, audit, document and where required replace spreadsheets.



## Challenges

- Reviewing spreadsheets is resource intensive
- Dealing with legacy spreadsheets which lack documentation
- Complex spreadsheet interdependencies
- Volume of skilled resource required to move code to Python or other alternatives

## Our approach

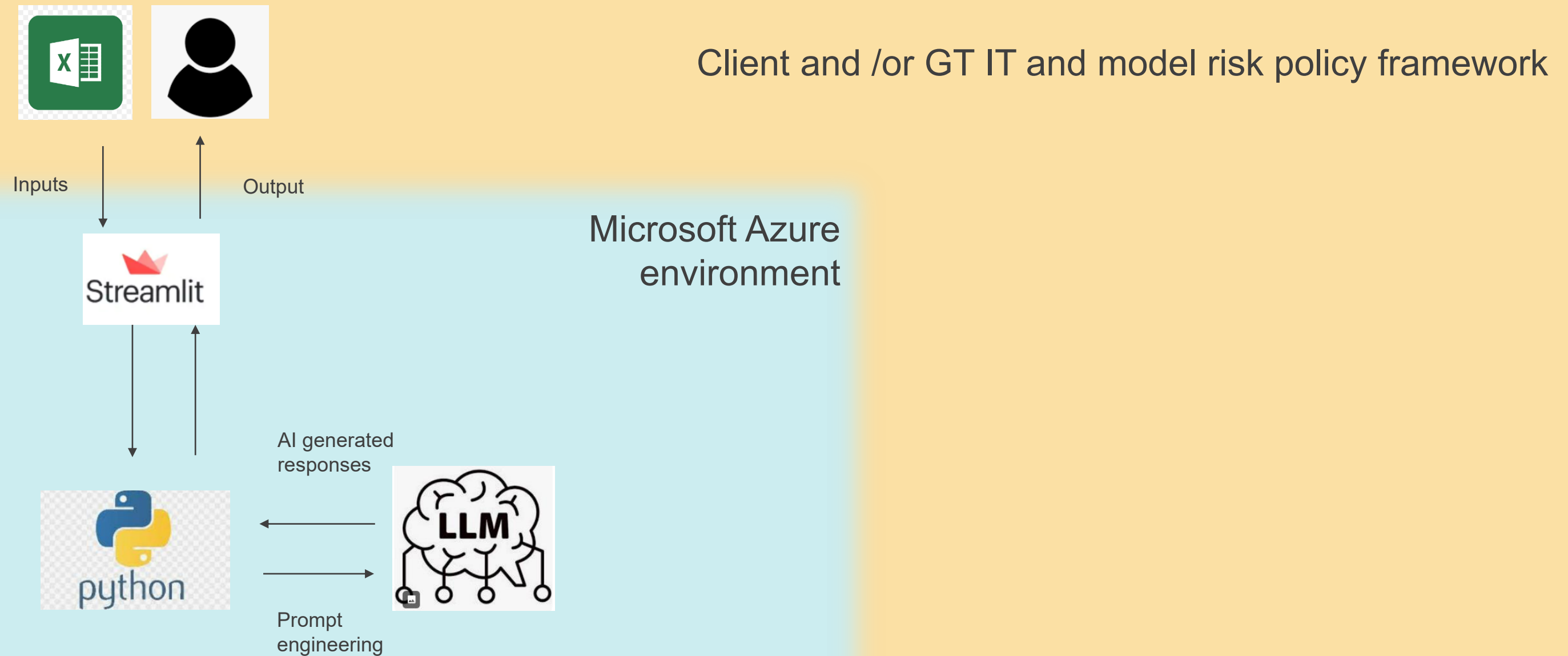
To create a bespoke AI-powered app to streamline spreadsheet:

- Analysis
- Documentation
- Validation
- Translation to programming codes (eg Python, R, Julia)

## Benefits

- Auditability: Ensures transparency by automatically documenting spreadsheet structures and dependencies, making it easier to track data flows and formula logic.
- Cost Efficiency: Reduces the need for manual review and extensive consulting time, leading to significant cost savings.
- Speed: Automates spreadsheet analysis, cutting down time spent on documentation and dependency.
- Control: Provides users with an intuitive interface to review AI-generated documentation, allowing them to verify and refine the insights before implementation.

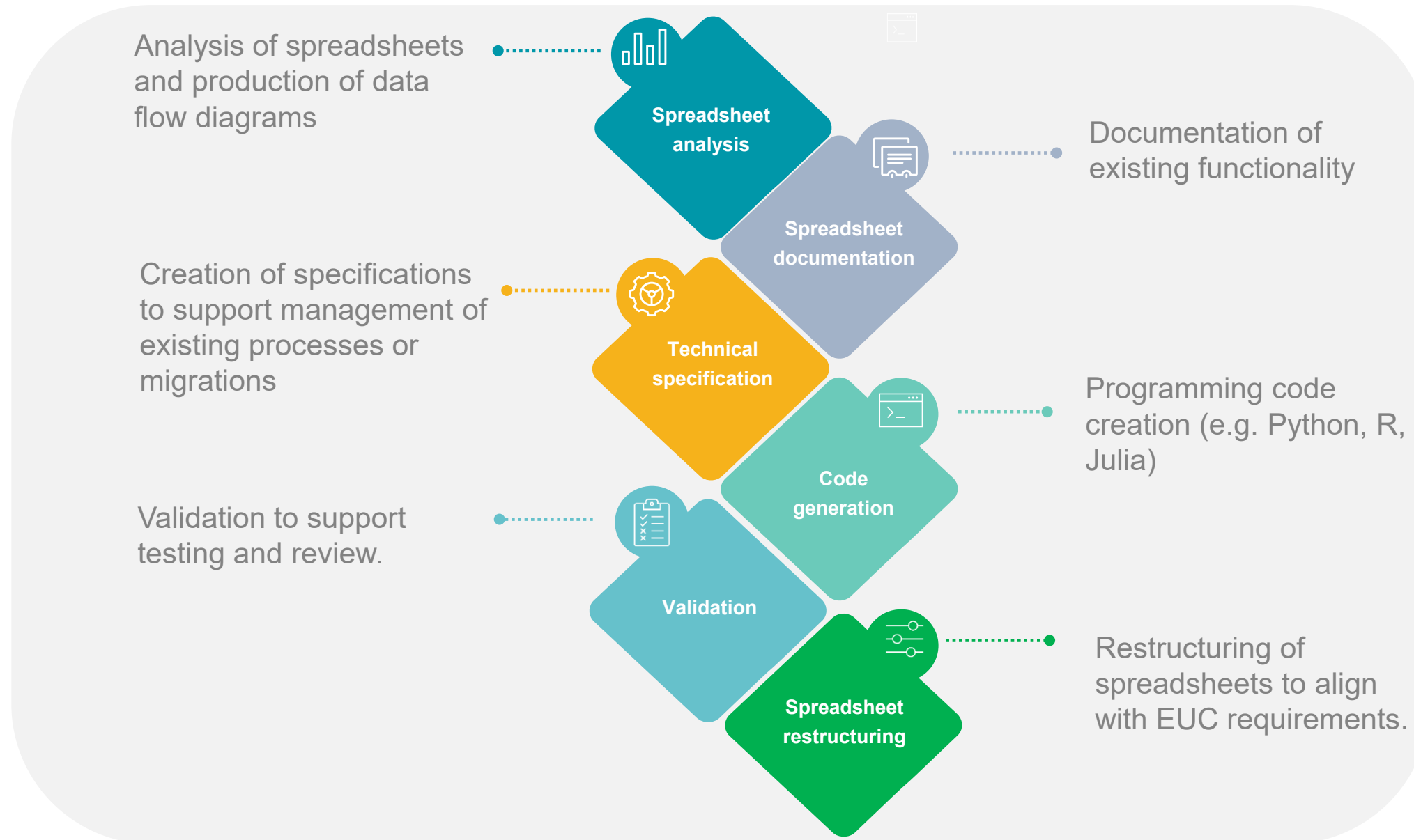
# So how does it work?



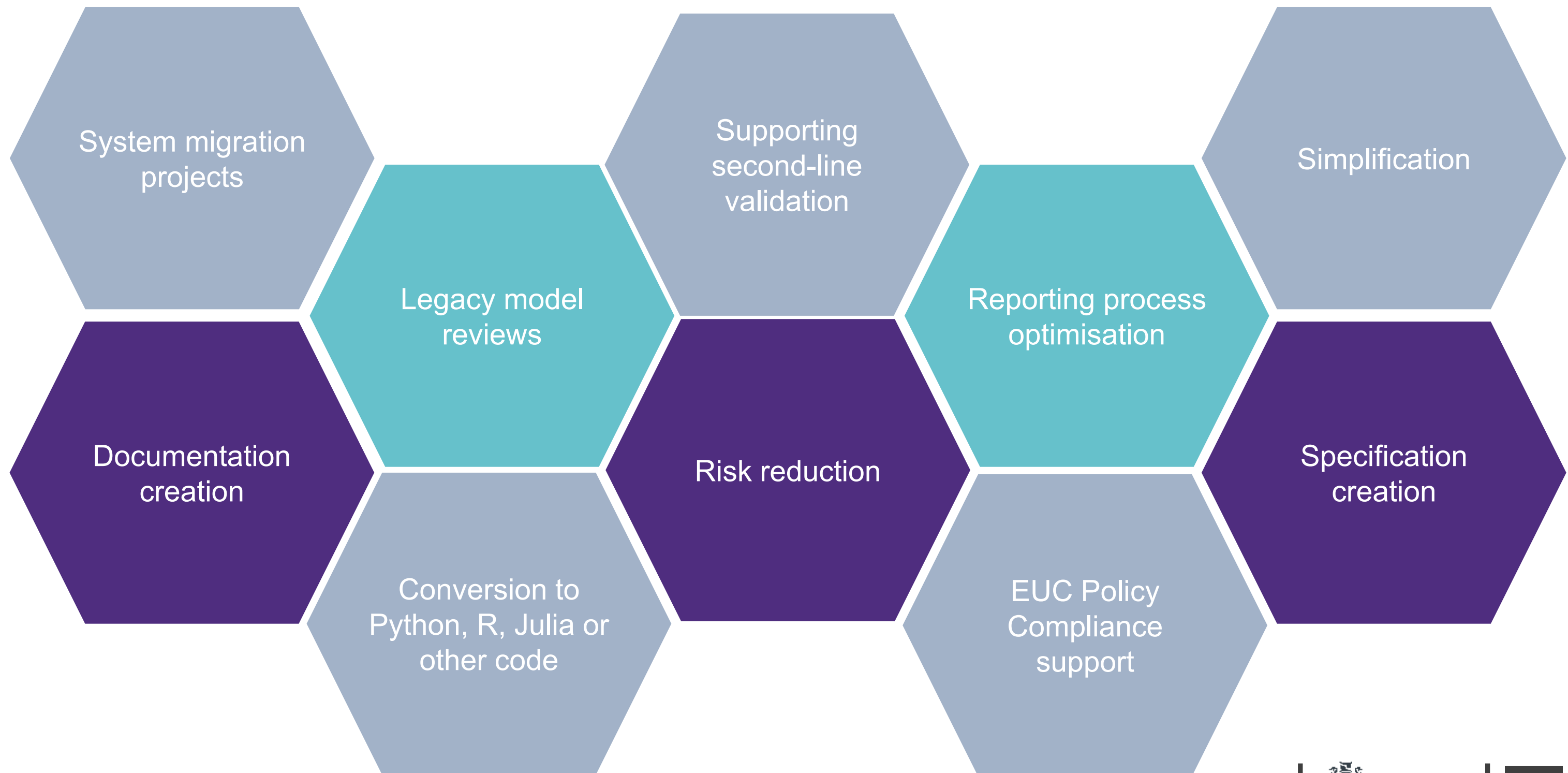
# 03 Live example

# Our concept

Our analysis, combined with feedback from clients, has led us to take a building block approach to enable bespoke solutions to client needs



# Supporting the business



# Model performance

Item	Positive Features	Can still be improved
General description of model	<ul style="list-style-type: none"> <li>Clearly states the model framework the calculations are based on.</li> <li>Describes both inputs, calculations and outputs.</li> </ul>	<ul style="list-style-type: none"> <li>Can be overly generic when describing application for actuaries.</li> </ul>
Describing inputs and their purpose	<ul style="list-style-type: none"> <li>Each input is listed with its name, type, source, and a detailed explanation.</li> <li>Descriptions link inputs to their role in the model.</li> </ul>	<ul style="list-style-type: none"> <li>Can be more concise.</li> <li>Complex technical inputs may be incorrect.</li> </ul>
Describing calculations logic	<ul style="list-style-type: none"> <li>Each logic step is clearly numbered and named.</li> <li>Descriptions explain dependencies between steps and how inputs are transformed.</li> </ul>	<ul style="list-style-type: none"> <li>Some steps are overly detailed and could be summarised more concisely.</li> <li>Could benefit from grouping steps into thematic blocks (e.g., trend projection, volatility, final output).</li> </ul>
Describing output	<ul style="list-style-type: none"> <li>Output is clearly defined with its location and structure.</li> </ul>	<ul style="list-style-type: none"> <li>Complex output may be incorrect.</li> </ul>

## Techniques to improve model performance

### Prompt Engineering

Avoid vague prompts - *"Kim, can you get me something to drink?"*

Chain-of-thought prompting - *"Kim, could you please go to the kitchen, open the fridge, and bring me a cold can of cola? If there's no cola, a glass of chilled water would be fine."*

### Custom Instructions

Decomposition prompting - *solve part of the problem for the AI.*

Few shot prompting - *show the AI what good looks like.*

### RAG

*Giving more context to the AI*

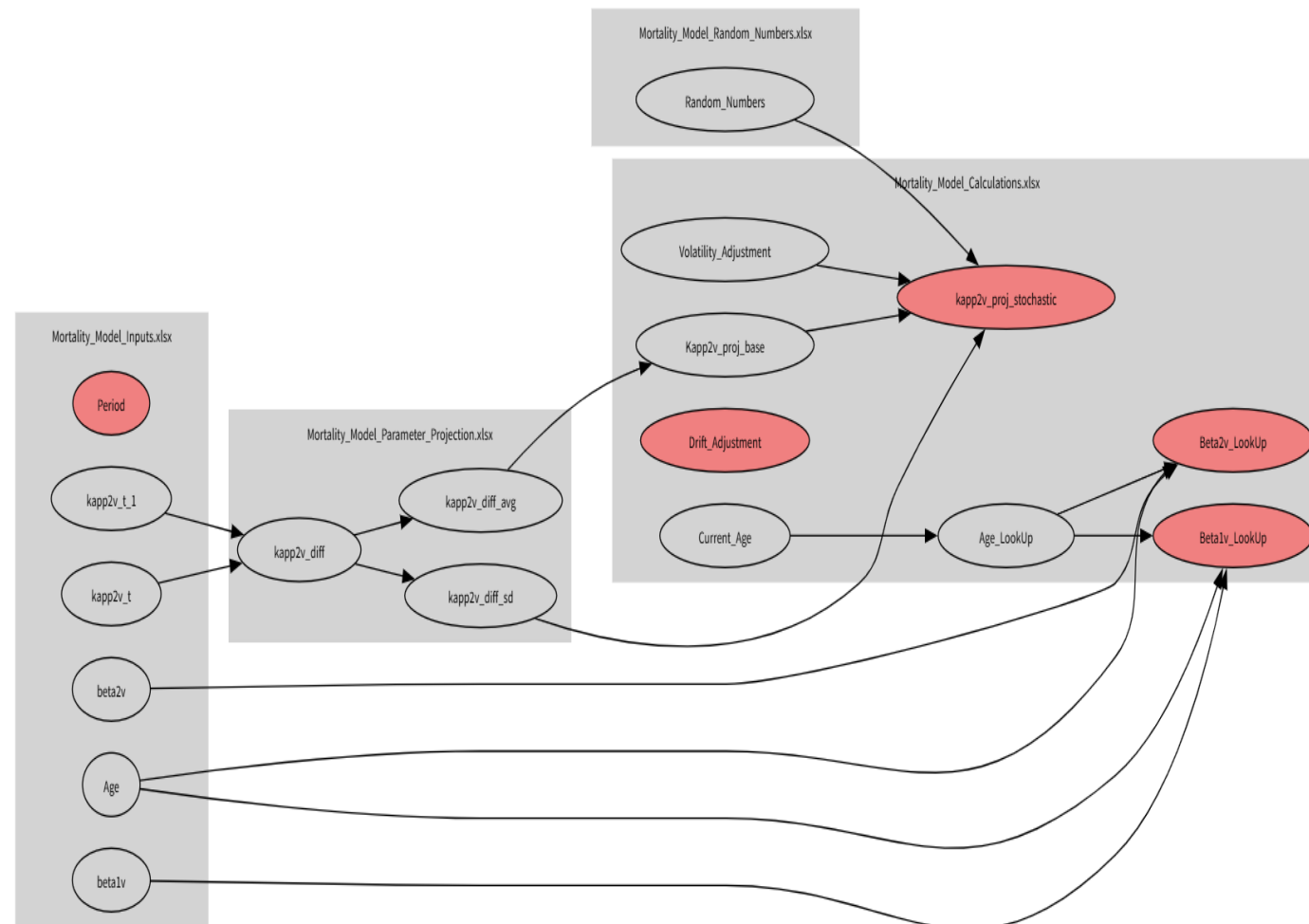
### Model Selection

GPT-4, GPT-5o, Claude 3, LLaMA 3

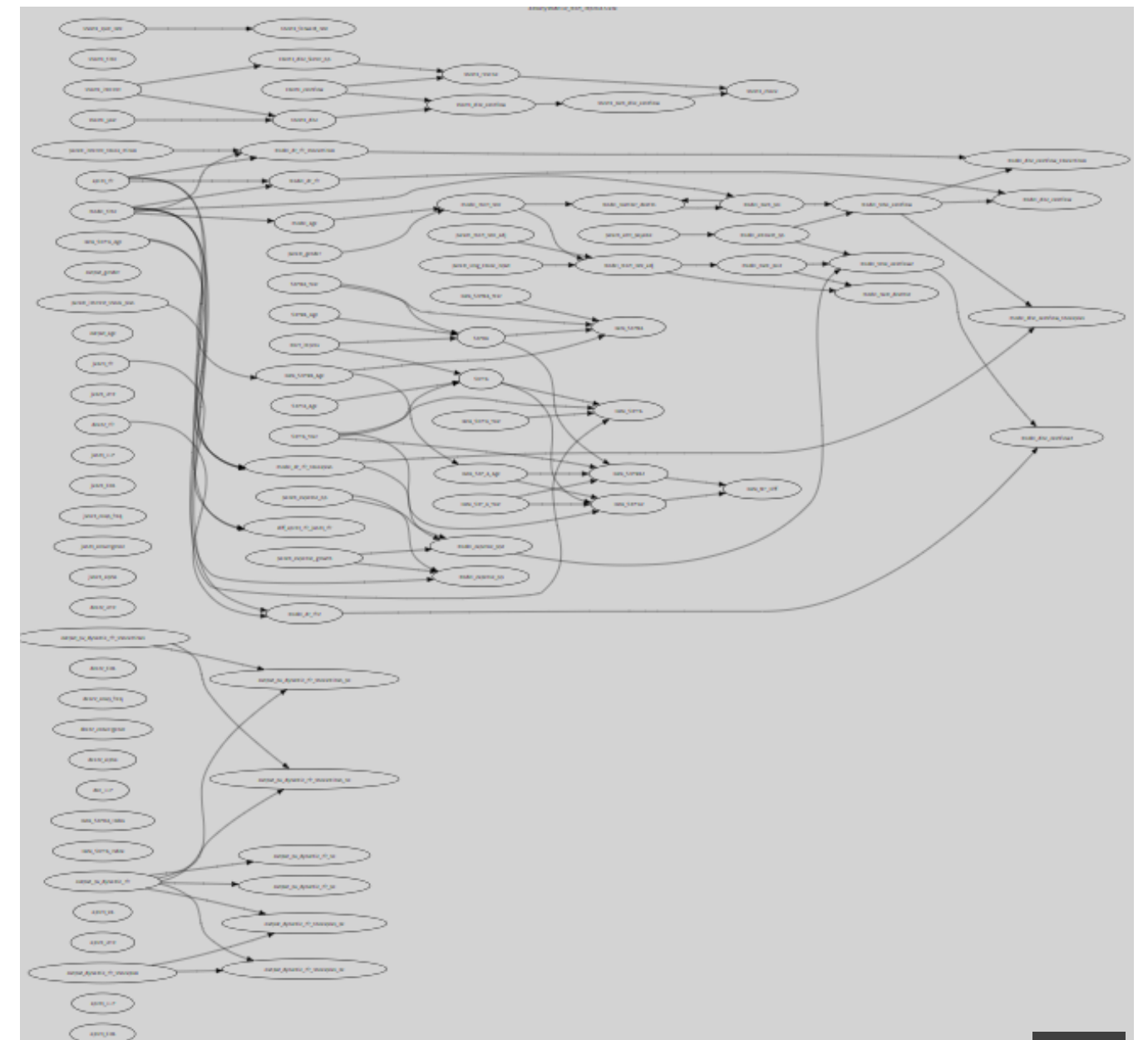
# Test cases

We have tested the tool suite on multiple interconnected spreadsheets and on very large spreadsheets

## Multiple spreadsheets



## Large spreadsheet



# Q&A



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# Thank you

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