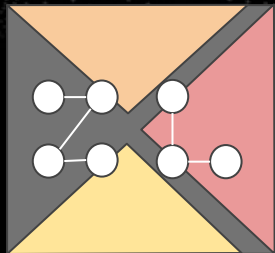


# ZONING LLM





# INITIAL PROJECT PROPOSAL

Use RAG methodologies to

1. Simplify the verbosity of various zoning documents to illustrate what can and cannot be built in a certain area.
2. Create a unified framework to compare the zoning of neighborhoods across the 7 municipalities in the Region of Waterloo
3. Extract exact details from zoning documents
4. Use classical ML techniques to correlate extracted zoning information with housing development in a given municipality.

# Research!

- Zoning research
  - Which factors in zoning codes are important?
  - How does the development process work?
- Tech stack research
  - LLMs / Vector DBs / Front End / Back End Frameworks
- Relevant papers
  - Barthik, Gupta et al 
  - Urban Institute at Cornell 
- Relevant startups:
  - trax.co
  - up.codes

## PARTNERSHIPS

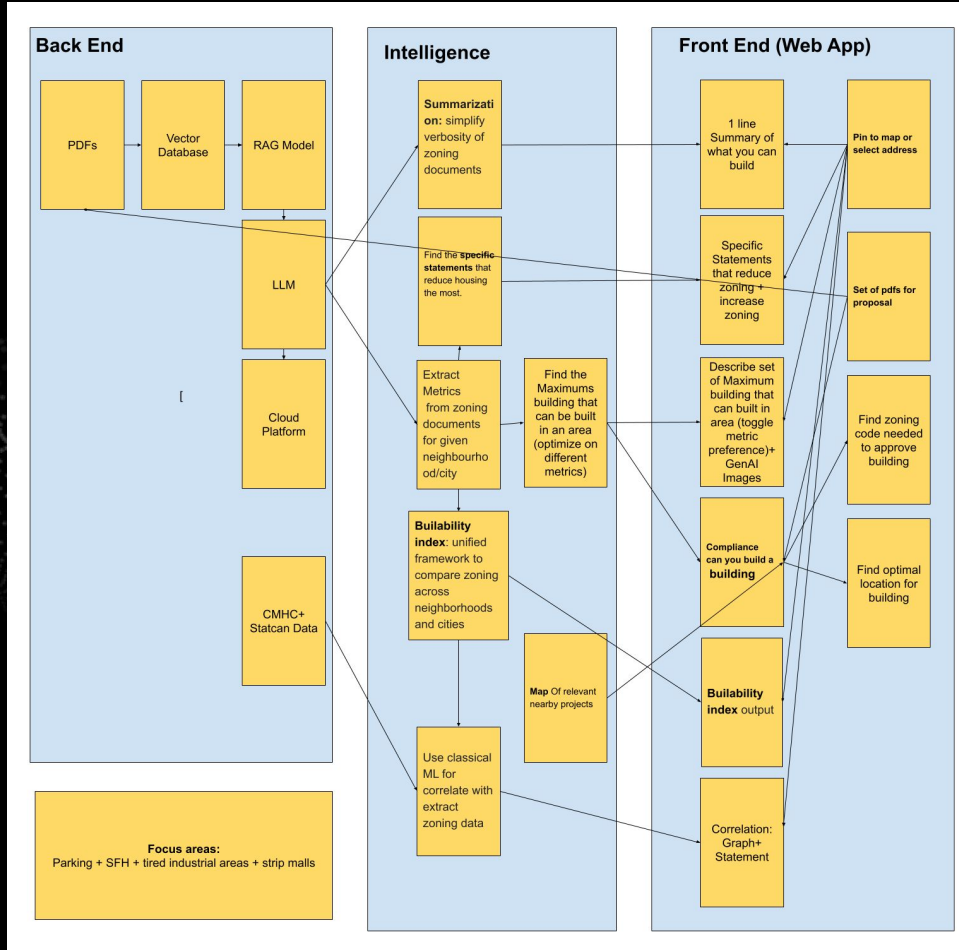
- SWIRL
  - Waterloo Region is interested in this tool
  - LLM development for policy
- Hamming
  - LLM benchmarking techniques
- Developer (s)
- Planner (s)



Perspectives on zoning development

# SYSTEM DIAGRAM

Formalizing our proposal into definite tasks





# Vector Database: Azure Cosmos DB

## LLM: GPT 3.5 Turbo

## Interface: Azure hosted Webapp

# ZONINGLLM V1

The screenshot displays the ZONINGLLM V1 web application interface. At the top right, there are links for "Clear chat" and "Developer settings". The chat history shows two interactions:

- Question:** "What is the minimum building height in R1 zone ?"
- Answer:** "The minimum building height in the R1 zone is not specified in the provided sources." This response includes a lightbulb icon and a clipboard icon.
- Question:** "whats a flankage yard as it relates to zoning"
- Answer:** "A flankage yard, as it relates to zoning, is a setback requirement that equals the existing flankage yard on the effective date of the by-law <sup>1</sup> <sup>2</sup> <sup>3</sup> ."  
**Citations:** [1. Zoning-By-law-2018-050.pdf#page=356](#) [2. Zoning-By-law-2018-050.pdf#page=354](#)  
[3. Zoning-By-law-2018-050.pdf#page=222](#)

At the bottom, there is a text input field with the placeholder text "Type a new question (e.g. What is a Two Zone Floodway)" and a blue arrow button to submit the query.

# ZONING LLM V1

## Pros:

- It works?!
- Easy to set up
- Decent with small queries

## Cons:

- Can't really adjust Hyperparameters
- Not great for more complicated queries (tends to give up)




# ZONINGLLM V2

**Vector Database:** PG Vector Database


**LLM:** GPT 3.5 Turbo/GPT 4 Turbo (others undergoing testing)


**Interface:** Streamlit front end - currently locally hosted


## Zoning Chatbot


 How can I help you?


 Hello

 Hello! How can I assist you today?

 What is the minimum building height in R1 - Residential One Zone?

 The minimum building height in R1 - Residential One Zone is 10 meters.

 What is a flankage yard as it relates to zoning?

 A flankage yard is a yard that extends across the full width of a lot between the facade (exterior wall) of the principal building or buildings and the flankage lot line. It jointly comprises part of the front yard and rear yard where such yards coincide with the flankage yard as described in the zoning regulations.



# HYPERPARAMETER TESTING

Evaluating Several thousands of test cases across various parameter settings

```
hyper_params = {  
  'chunk_size': [100, 200, 500, 1000, 2000],  
  'chunk_overlap': [10, 20, 50, 100, 200],  
  'temparature': [0.05, 0.1, 0.2, 0.3],  
  'models': ['GPT 4 turbo', 'gpt-3.5-turbo'],  
  'zones': ['R1 - Residential One Zone', 'R3 - Residential  
  'questions': ['What is the min building height', 'What is  
    'What is the min density', 'What is the max  
    'Are apartments above commercial (mixed use  
    'Are attached single family houses (townho  
    'Is cluster development, planned unit deve  
  'time': [5]  
}
```

Iteration	Question	Residential Ci Answer	Model	Chunk Size	Chunk Ov
0	What is the minimum building	R1 - Residential One Zone	The minimum building height in the Residential One (R1) Zone is 4.5 metres for buildings located	gpt-4-turbo	100
1	What is the minimum building	R1 - Residential One Zone	The minimum building height in the Residential One (R1) Zone is 4.5 metres for buildings located	gpt-4-turbo	100
2	What is the minimum building	R1 - Residential One Zone	The minimum building height in the Residential One (R1) Zone is 4.5 metres for buildings located	gpt-4-turbo	100
3	What is the minimum building	R1 - Residential One Zone	The minimum building height in the Residential One (R1) Zone is 4.5 metres for buildings located	gpt-4-turbo	100
4	What is the minimum building	R1 - Residential One Zone	The minimum building height in the Residential One (R1) Zone is 4.5 metres for buildings located	gpt-4-turbo	100
0	What is the max building heig	R1 - Residential One Zone	In the Residential One Zone, the maximum building height is 10 metres.	gpt-4-turbo	100
1	What is the max building heig	R1 - Residential One Zone	In the Residential One Zone, the maximum building height is 10 metres.	gpt-4-turbo	100
2	What is the max building heig	R1 - Residential One Zone	In the Residential One Zone, the maximum building height is 10 metres.	gpt-4-turbo	100
3	What is the max building heig	R1 - Residential One Zone	In the Residential One Zone, the maximum building height is 10 metres.	gpt-4-turbo	100
4	What is the max building heig	R1 - Residential One Zone	In the Residential One Zone, the maximum building height is 10 metres.	gpt-4-turbo	100
0	What is the min street line se	R1 - Residential One Zone	I don't have the specific information regarding the minimum street line setback for the Residential One (R1) Zone	gpt-4-turbo	100
1	What is the min street line se	R1 - Residential One Zone	I don't have the specific information regarding the minimum street line setback for the Residential One (R1) Zone	gpt-4-turbo	100
2	What is the min street line se	R1 - Residential One Zone	I don't have the specific information regarding the minimum street line setback for the Residential One (R1) Zone	gpt-4-turbo	100
3	What is the min street line se	R1 - Residential One Zone	I don't have the specific information regarding the minimum street line setback for the Residential One (R1) Zone	gpt-4-turbo	100
4	What is the min street line se	R1 - Residential One Zone	I don't have the specific information regarding the minimum street line setback for the Residential One (R1) Zone	gpt-4-turbo	100
0	What is the max street line se	R1 - Residential One Zone	The information provided does not include specific details about the Residential One (R1) Zone	gpt-4-turbo	100
1	What is the max street line se	R1 - Residential One Zone	The information provided does not include specific details about the Residential One (R1) Zone	gpt-4-turbo	100
2	What is the max street line se	R1 - Residential One Zone	The information provided does not include specific details about the Residential One (R1) Zone	gpt-4-turbo	100
3	What is the max street line se	R1 - Residential One Zone	The information provided does not include specific details about the Residential One (R1) Zone	gpt-4-turbo	100
4	What is the max street line se	R1 - Residential One Zone	The information provided does not include specific details about the Residential One (R1) Zone	gpt-4-turbo	100
0	What is the max density	R1 - Residential One Zone	The information provided does not specify the maximum density for the Residential One (R1) Zone	gpt-4-turbo	100
1	What is the max density	R1 - Residential One Zone	The information provided does not specify the maximum density for the Residential One (R1) Zone	gpt-4-turbo	100
2	What is the max density	R1 - Residential One Zone	The information provided does not specify the maximum density for the Residential One (R1) Zone	gpt-4-turbo	100
3	What is the max density	R1 - Residential One Zone	The information provided does not specify the maximum density for the Residential One (R1) Zone	gpt-4-turbo	100

# FUTURE WORK

- Continue Hyperparameter Testing
- Write and publish paper
- Present Findings to
  - Region of Waterloo
  - CUCAI
- Continue on Phase 2
  - Additional features (DB of data, compliance, summaries)
  - Multimodality (geographic data, Image production)