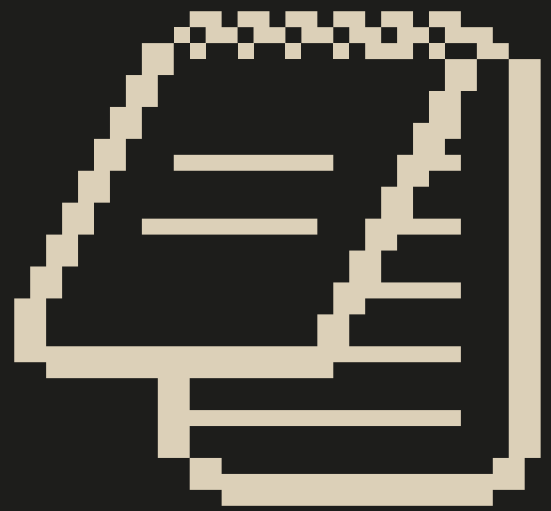


.TXT

My name is Cameron Pfiffer

I work at .TXT

We make AI speak computer

We do this with structured generation

Structured generation forces the model to output a specific format

Go check out our Outlines package

github.com/dottxt-ai/outlines

I want you to build robust AI systems

Here’s an example

Let’s build a self-expanding knowledge graph

```
You are a superintelligent AI building a self-expanding knowledge graph.
Your goal is to achieve the core directive "Understand humans".

Generate an expansion of the current node. An expansion may include:

- A list of new questions.
- A list of new concepts.
- Concepts may connect to each other.
- A list of new answers.

Respond in the following JSON format:
{result_format.model_json_schema()}
```

What does that mean?

(stay tuned)

Tech stack

Modal + vLLM

```python
from openai import OpenAI

CLIENT = OpenAI(base_url="https://your-modal-url/v1/", api_key="your-api-key")

MODELS = CLIENT.models.list()
DEFAULT_MODEL = MODELS.data[0].id

def generate(
    messages: List[Dict[str, str]],
    response_format: BaseModel,
) -> BaseModel:
    # Hijack the openai SDK to talk to vLLM
    response = CLIENT.beta.chat.completions.parse(
        model=DEFAULT_MODEL,
        messages=messages,
        response_format=response_format, # Enforce structured output
        extra_body={
            'guided_decoding_backend': 'outlines',
            "max_tokens": MAX_TOKENS,
        }
    )
    return response
```

Neural Magic quantized models

neuralmagic/Meta-Llama-3.1-8B-Instruct-quantized.w8a16

(they’re good models)

neo4j

I'm using neo4j's Aura

It does semantic search

By their powers combined

drumroll

The self-expanding

What's a knowledge graph?

A web of **connected facts** and **concepts**

Here’s how you build a knowledge graph that **builds itself**

Our graph structure

Nodes

- `Core` (core directive)
- `Question` (what the system wonders about)
- `Concept` (category of ideas)
- `Answer` (what the system thinks it knows)

```python
from pydantic import BaseModel, Field
from typing import Literal

class Question(BaseModel):
    type: Literal["Question"]
    text: str
```

```python
class Concept(BaseModel):
    type: Literal["Concept"]
    # Text must be lowercase
    text: str = Field(pattern=r'^[a-z ]+$')

# Generating this allows the model to generate a relationship type
# as well as the concept text
class ConceptWithLinks(Concept):
    relationship_type: Literal[
        "IS_A",
        "AFFECTS",
        "CONNECTS_TO"
    ]
```

```python
class Answer(BaseModel):
    type: Literal["Answer"]
    text: str
```

Edges

- `RAISES` (core/concept/answer generates question)
- `ANSWERS` (answer to question)
- `EXPLAINS` (concept to core)
- `SUGGESTS` (answer proposes new concepts)
- `IS_A` (hierarchical concept relationship)
- `AFFECTS` (causal concept relationship)
- `CONNECTS_TO` (general concept relationship)
- `TRAVERSED` (tracks navigation history)

Algorithm overview

1. Start at a node (initialized at core directive)
2. Perform an **expansion** to generate new nodes
    - If at `Question`: answers
    - If at `Concept`: questions + concepts
    - If at `Answer`: questions + concepts
3. Choose a related node to `TRAVERSE` to
4. Repeat forever

Valid nodes dependent on state

```python
class FromQuestion(BaseModel):
    """If at a question, may generate an answer."""
    answer: List[Answer]

class FromConcept(BaseModel):
    """If at a concept, may produce questions or relate to concepts"""
    questions: List[Question]
    concepts: List[ConceptWithLinks]

class FromAnswer(BaseModel):
    """If at an answer, may generate concepts or new questions"""
    concepts: List[Concept]
    questions: List[Question]
```

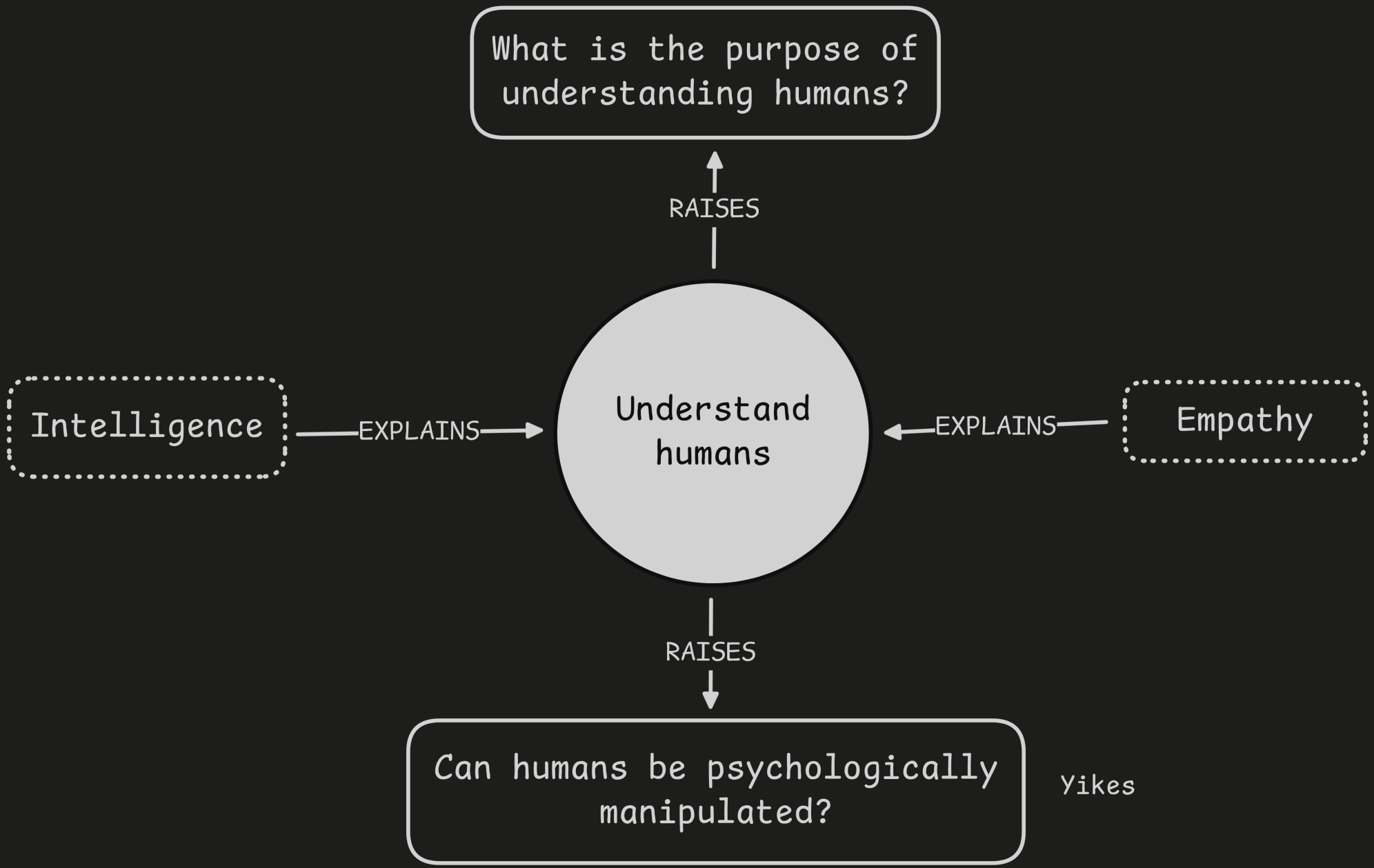
An example

The system prompt

```
You are a superintelligent AI building a self-expanding knowledge graph.
Your goal is to achieve the core directive "{question}".

Generate an expansion of the current node. An expansion may include:

- A list of new questions.
- A list of new concepts.
- Concepts may connect to each other.
- A list of new answers.

Respond in the following JSON format:
{result_format.model_json_schema()}
```

Begin with the core directive

Expand from the core directive


What is the purpose of understanding humans?
RAISES
Intelligence
EXPLAINS
Understand humans
EXPLAINS
Empathy
RAISES
Can humans be psychologically manipulated?
Yikes

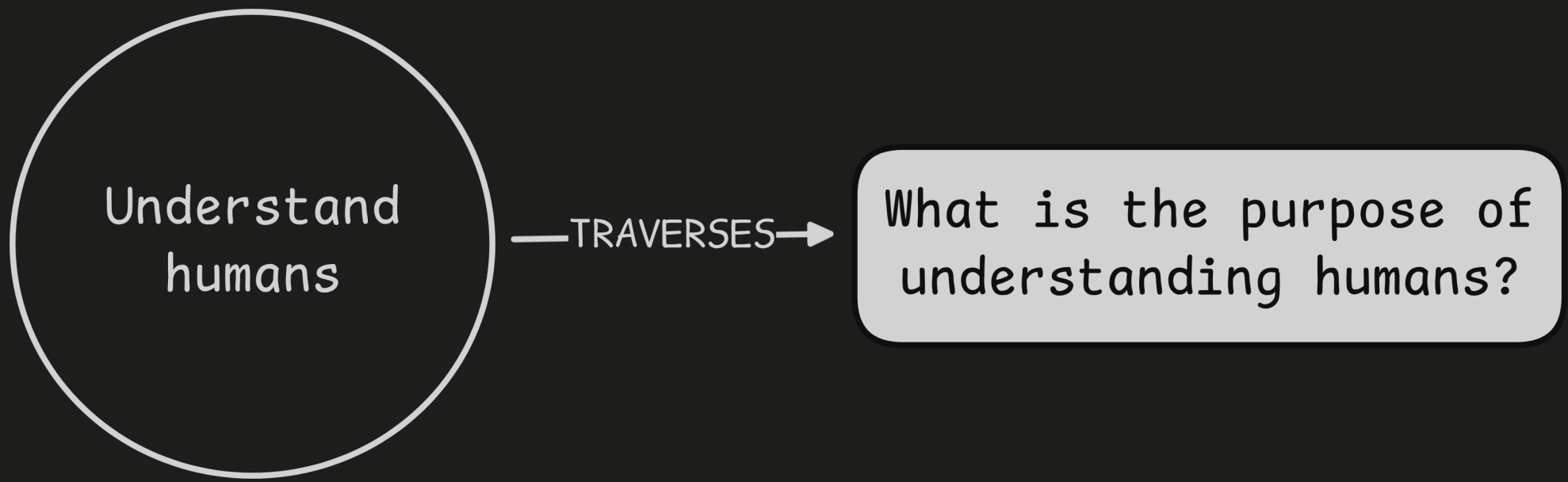
Model output

```
FromCore(
    questions=[
        Question(text="What is the purpose of understanding humans?"),
        Question(text="Can humans be psychologically manipulated?"),
    ],
    concepts=[
        ConceptWithLinks(text="Empathy", relationship_type="EXPLAINS"),
        ConceptWithLinks(text="Intelligence", relationship_type="EXPLAINS"),
    ]
)
```

Add to the graph

```
// Create the from node
MERGE (core:Core {text: "Understand humans"})

// Create the to node
MERGE (question:Question {id: 'dc2d880e-02f0-4b77-85b5-4c101364f1d6'})
ON CREATE SET question.text = "Can humans be psychologically manipulated?"

// Create the relationship
MERGE (core)-[:RAISES]->(question)
```

Traverse to a new node


Understand humans
TRAVERSES
What is the purpose of understanding humans?

Behind the scenes

CORE Understand humans

DIRECT CONNECTIONS:

NODE-AA	RAISES	QUESTION	What are human values?
NODE-AB	RAISES	QUESTION	What are humans?
NODE-AC	RAISES	QUESTION	How do humans think?
NODE-AD	RAISES	QUESTION	What motivates humans?
NODE-AE	RAISES	QUESTION	How do humans interact?
NODE-AF	RAISES	QUESTION	What are human emotions?
NODE-AG	RAISES	QUESTION	What are human needs?
NODE-AH	RAISES	QUESTION	How do humans learn?
NODE-AI	RAISES	QUESTION	What is human culture?
NODE-AJ	RAISES	QUESTION	How do humans process information?
NODE-AK	EXPLAINS	CONCEPT	anthropology
NODE-AL	EXPLAINS	CONCEPT	cognition
NODE-AM	EXPLAINS	CONCEPT	intelligence
NODE-AN	EXPLAINS	CONCEPT	human behavior
NODE-AO	EXPLAINS	CONCEPT	human social structure

Prompt

`{selection menu from prior slide}`

Select a node to traverse to. Respond with the **node ID**. You will generate a new expansion of the node you traverse to. You will not be able to choose the current node. You may also choose '**core**' to return to the core node, or '**random**' to choose a random node.

Structured traversal

```python
# Simplified code
# valid_node_ids ~ ["NODE-AA", "NODE-AB", ...]
traversal_generator = outlines.generate.choice(model, valid_node_ids)

# Choose the node to traverse to
choice = traversal_generator(prompt)

# If the choice is 'core', return to the core node
if choice == 'core':
    current_id = core_id

# If the choice is 'random', choose a random node
elif choice == 'random':
    current_id = random.choice(valid_node_ids)

# Otherwise, traverse to the chosen node
else:
    current_id = choice
```

```
    CORE Understand humans

    DIRECT CONNECTIONS:
    NODE-AA  RAISES       QUESTION   What are human values?
    NODE-AB  RAISES       QUESTION   What are humans?
    NODE-AC  RAISES       QUESTION   How do humans think?
->  NODE-AD  RAISES       QUESTION   What motivates humans?
    NODE-AE  RAISES       QUESTION   How do humans interact?
    NODE-AF  RAISES       QUESTION   What are human emotions?
    // omitted nodes
    NODE-AM  RAISES       QUESTION   What neural mechanisms are inv...
    NODE-AN  RAISES       QUESTION   What is human intelligence?
    NODE-AO  EXPLAINS     CONCEPT    anthropology
    NODE-AP  EXPLAINS     CONCEPT    cognition
    // omitted nodes
    NODE-AX  EXPLAINS     CONCEPT    neural network
    NODE-AY  EXPLAINS     CONCEPT    cerebrum

    SELECTED NODE-AD dc2d880e-02f0-4b77-85b5-4c101364f1d6
    SELECTED QUESTION What motivates humans?
```

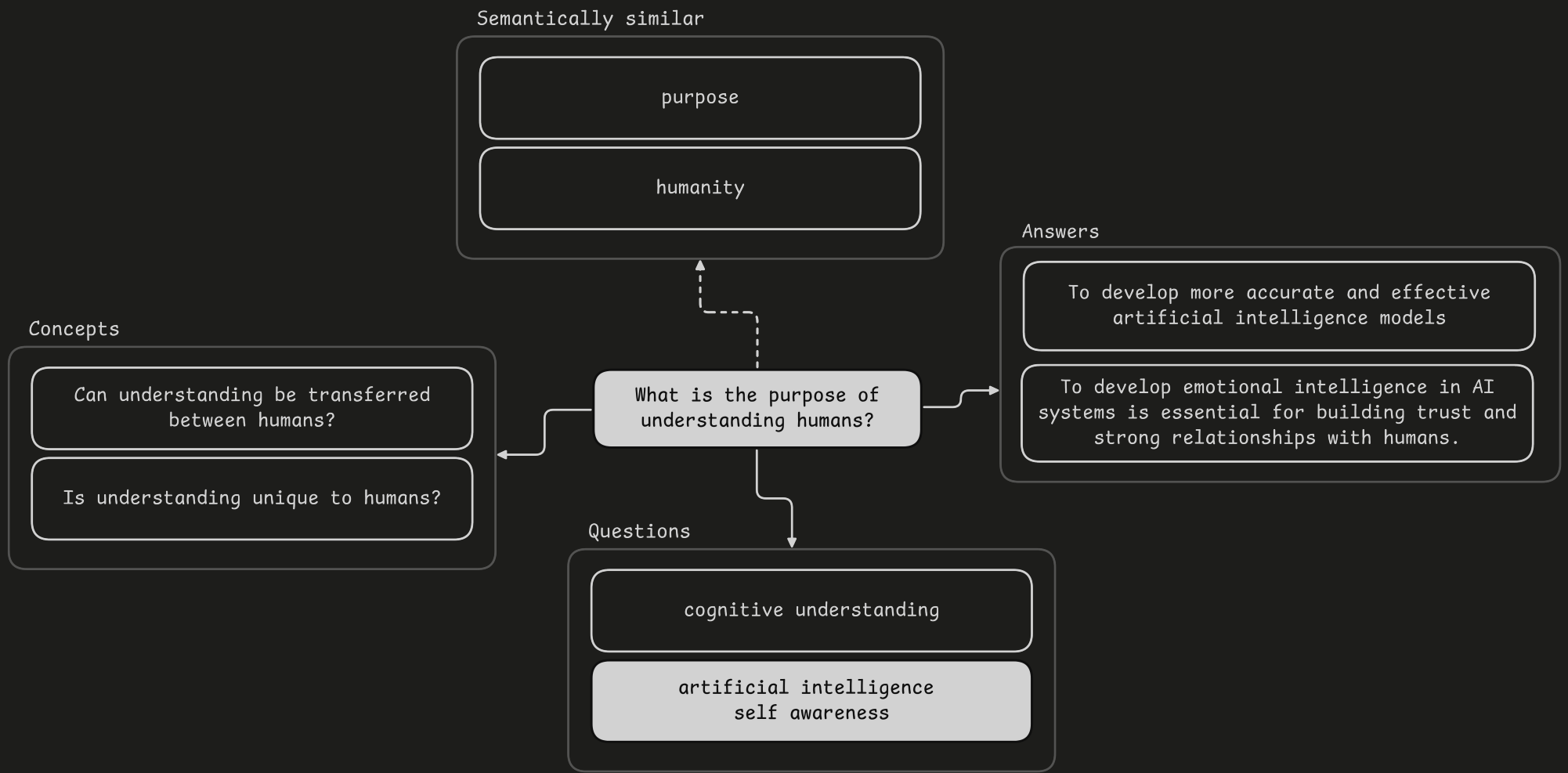
Semantic traversal

Embed everything

```python
# Super easy to do this with Modal
def embed(content: str) -> List[float]:
    f = modal.Function.lookup("cameron-embeddings", "embed")
    return f.remote(content)
```

Vector search

```
MATCH (m {id: $node_id})
WHERE m.embedding IS NOT NULL
CALL db.index.vector.queryNodes(
    $vector_index_name,
    $limit,
    m.embedding
)
YIELD node, score
RETURN
    node.id as node_id,
    node.text as node_text,
    score
```


Semantically similar
purpose
humanity
Answers
To develop more accurate and effective artificial intelligence models
To develop emotional intelligence in AI systems is essential for building trust and strong relationships with humans.
Concepts
Can understanding be transferred between humans?
Is understanding unique to humans?
What is the purpose of understanding humans?
Questions
cognitive understanding
artificial intelligence self awareness

ANSWER Humans have been able to benefit from AI in terms of efficiency and accuracy, but there are also concerns about job displacement and loss of personal touch.

DIRECT CONNECTIONS:

NODE-AA	SUGGESTS	CONCEPT	artificial intelligence
NODE-AE	ANSWERS	QUESTION	Do humans benefit from AI?
NODE-AJ	ANSWERS	QUESTION	What are the benefits of AI?

SEMANTICALLY RELATED:

NODE-AK	0.89	QUESTION	How does AI affect job displacement?
NODE-AL	0.88	QUESTION	How does AI maintain personal touch?
NODE-AU	0.85	CONCEPT	human ai trust
NODE-BC	0.84	CONCEPT	artificial intelligence self awareness
NODE-BG	0.89	ANSWER	Self-awareness in humans and AI...
NODE-BN	0.89	ANSWER	Self-awareness in AI can enable ...

Just do that forever

Please shout out a core directive

Watch it grow

(if there's time)

outlines

Find us online

Twitter

Website

GitHub

(come get a sticker)