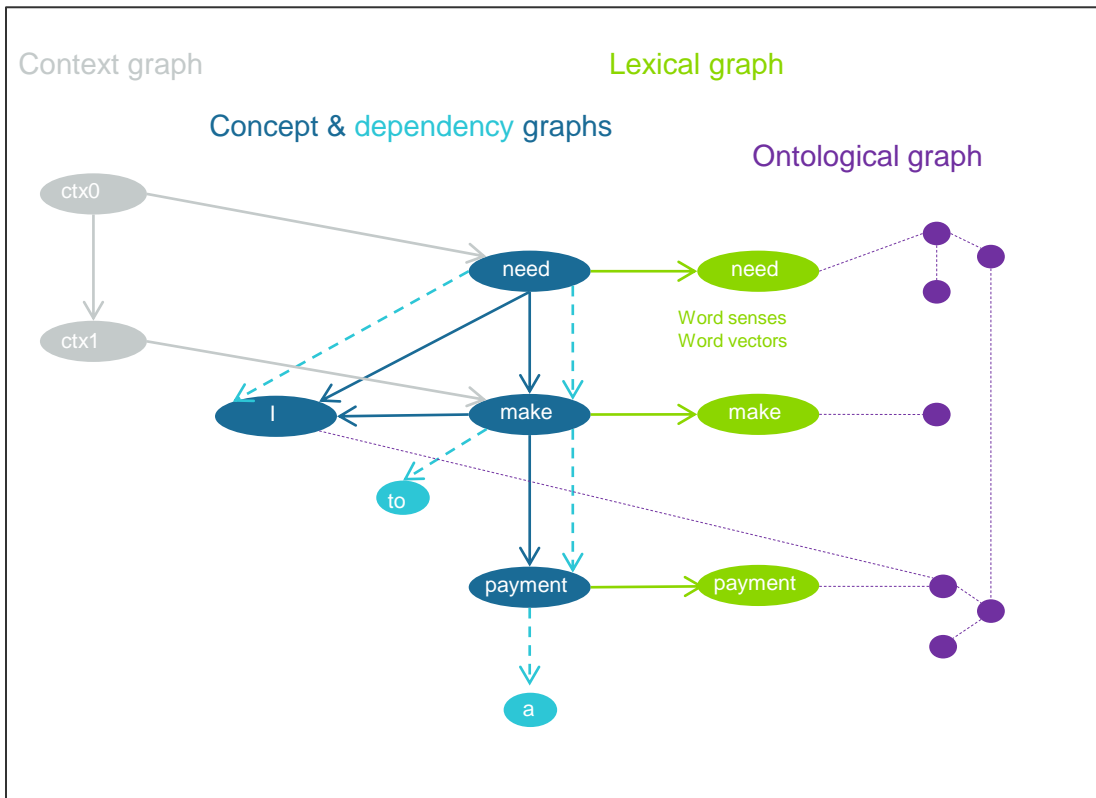


# Graphical AKR

- AKR (Abstract Knowledge Representation)
  - Developed at PARC
  - Sharp separation of conceptual, contextual, and other structures
- Graphical AKR
  - Socialize AKR with computer scientists
  - Comprises conceptual, contextual, and other graphs
    - Separate but linked and interacting graphs
  - Readily extendible to incorporate other sub-graphs of information
    - E.g. task models, frames, dialog states
  - Easy to ignore certain levels of information
- Grand vision
  - A semantic representation that bridges natural language inference and formal knowledge-based reasoning

# Example: *I need to make a payment*



## Concept Graph

- Predicate-argument structure

## Context Graph

- Scope & modality

## Lexical Graph

- Word senses/vectors

## Property Graph

- Determiners, tense

## Link Graph

- Coreference

# Basic Graph Semantics

Concept graph is a description logic restriction structure

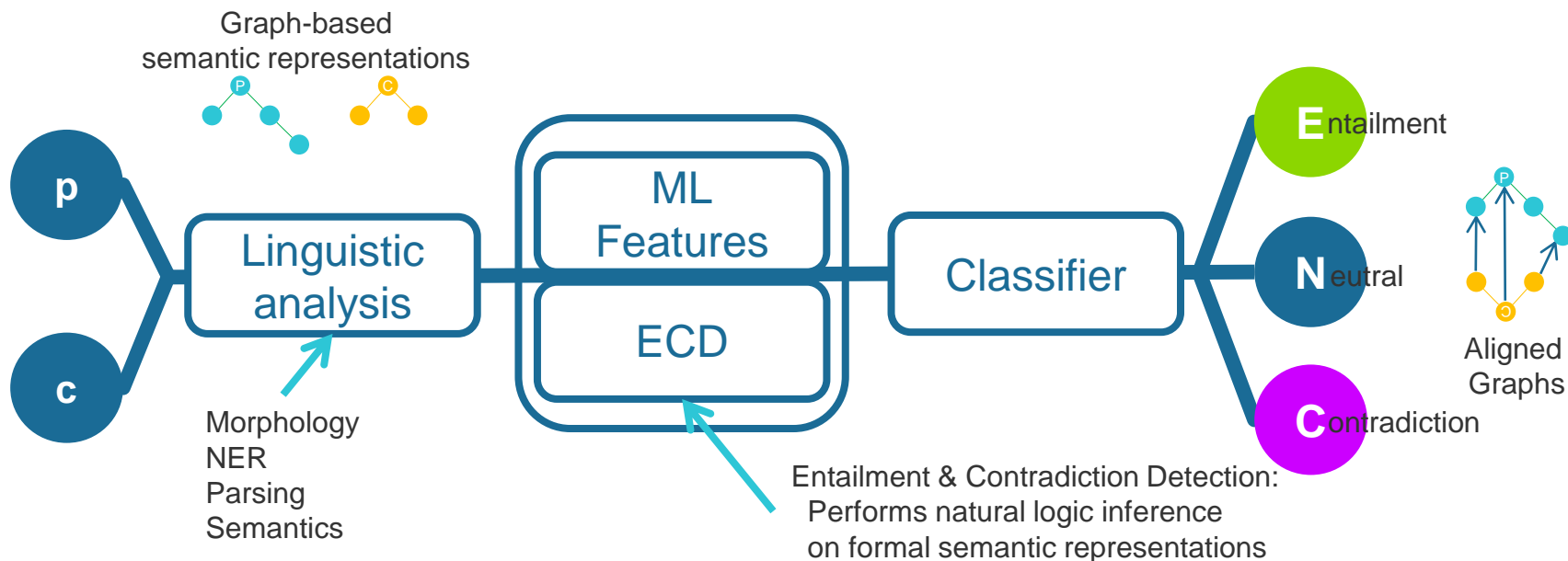
- Graph carries no existential commitment
- Nodes denote concepts (not individuals)
- Arcs represent concept restrictions
- Property graph arcs (to determiners, tense) represent further restrictions

Context graph

- Imposes existential commitment by saying whether head concepts are instantiable
- Context structure induced by
  - Connectives (not, or, if)
  - Mood & modals
  - Clausal complements
  - Distributivity (aka quantifier scope)

# Approach to NL Inference

- Uses deep linguistic structures
- Output is weighted classification **plus** structure alignment



# Natural Logic Inference for ECD

- Determine specificity relations between words
  - then phrases
  - then sentences
- More specific implies less specific
  - more specific than
  - ~ incompatible

## Words

*plane* □ *vehicle*  
*man* □ *person*  
*no ~ a*

## Phrases

*flew a plane* □ *flew a vehicle*  
*jet plane* □ *plane*  
*every person* □ *every man*  
*no man ~ a man*

## Sentences

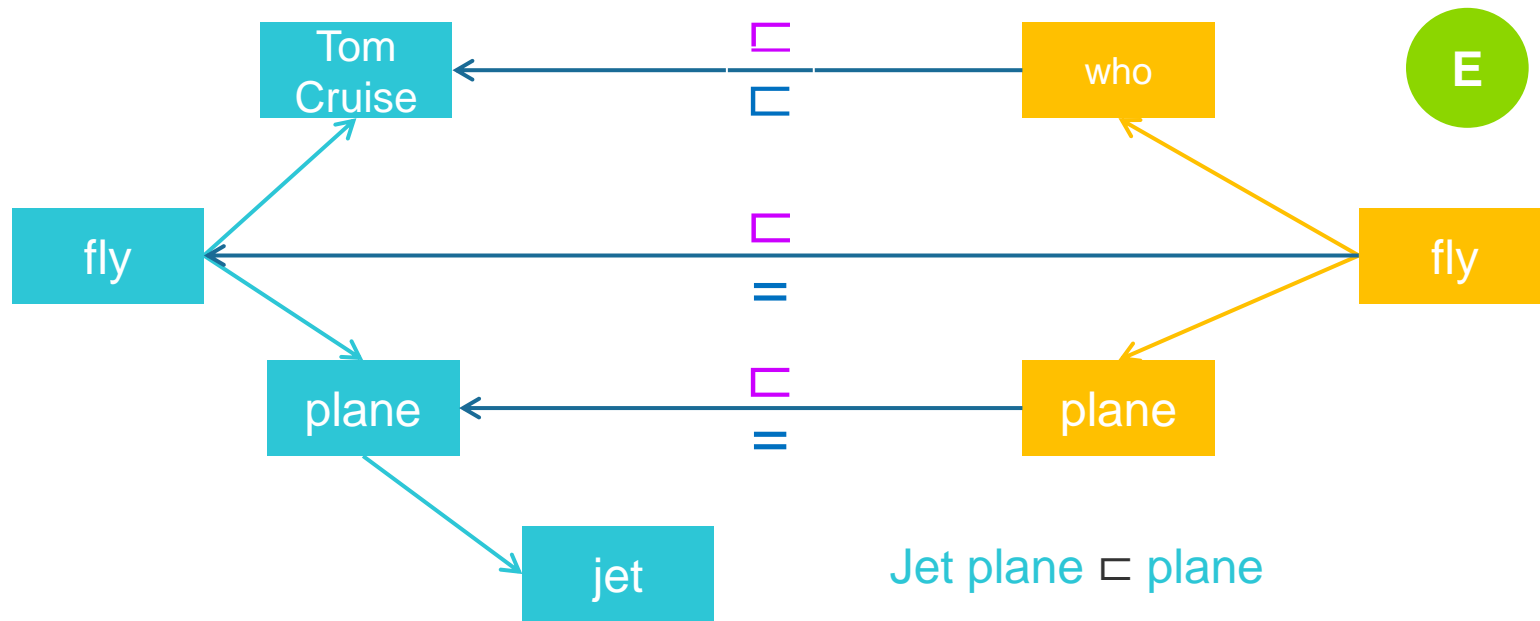
*A man flew a plane* □ *A man flew a vehicle*  
*Every person flew a plane* □ *Every man flew a plane*  
*No man flew a plane ~ A man flew a plane*

# ECD Processing (for QA)

- Construct semantic graphs
- Initial term matches
- Revise specificity relations

Tom Cruise flew a jet plane

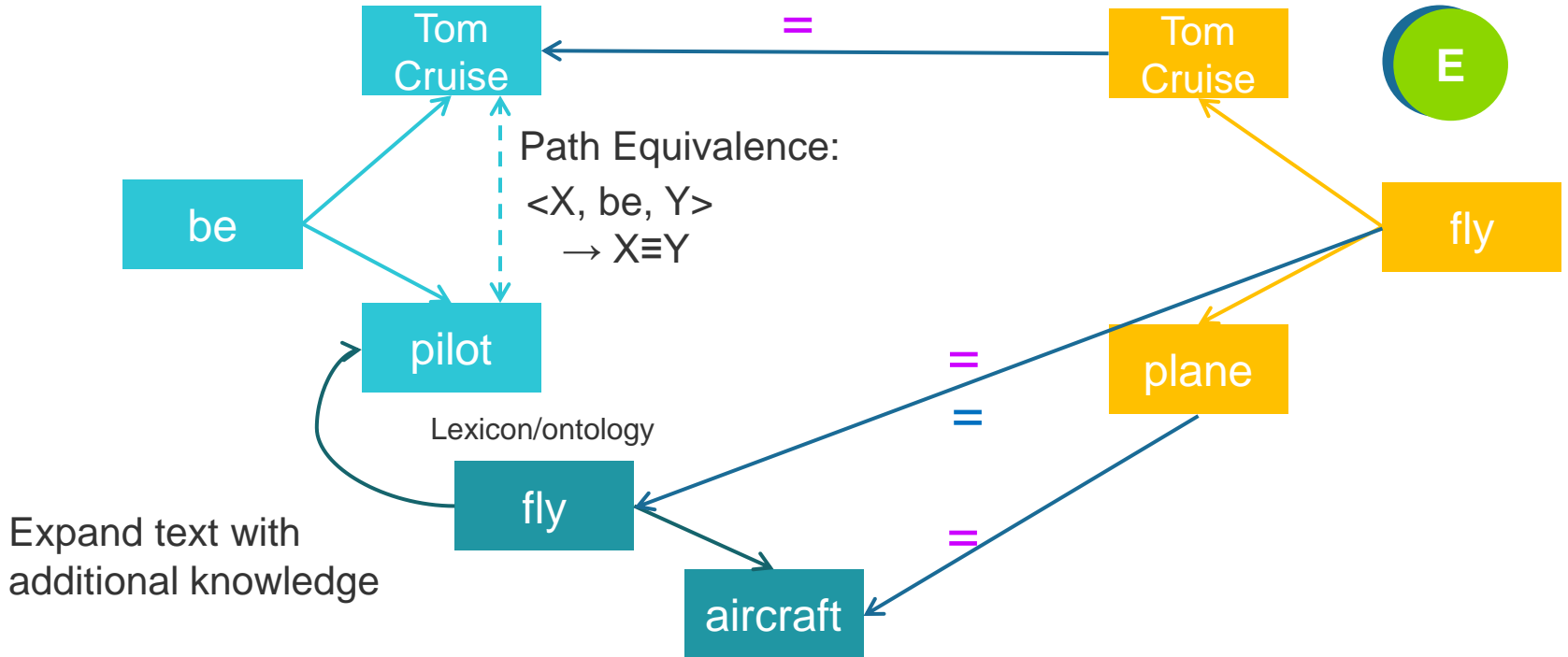
Who flew a plane?



# Adding more Knowledge

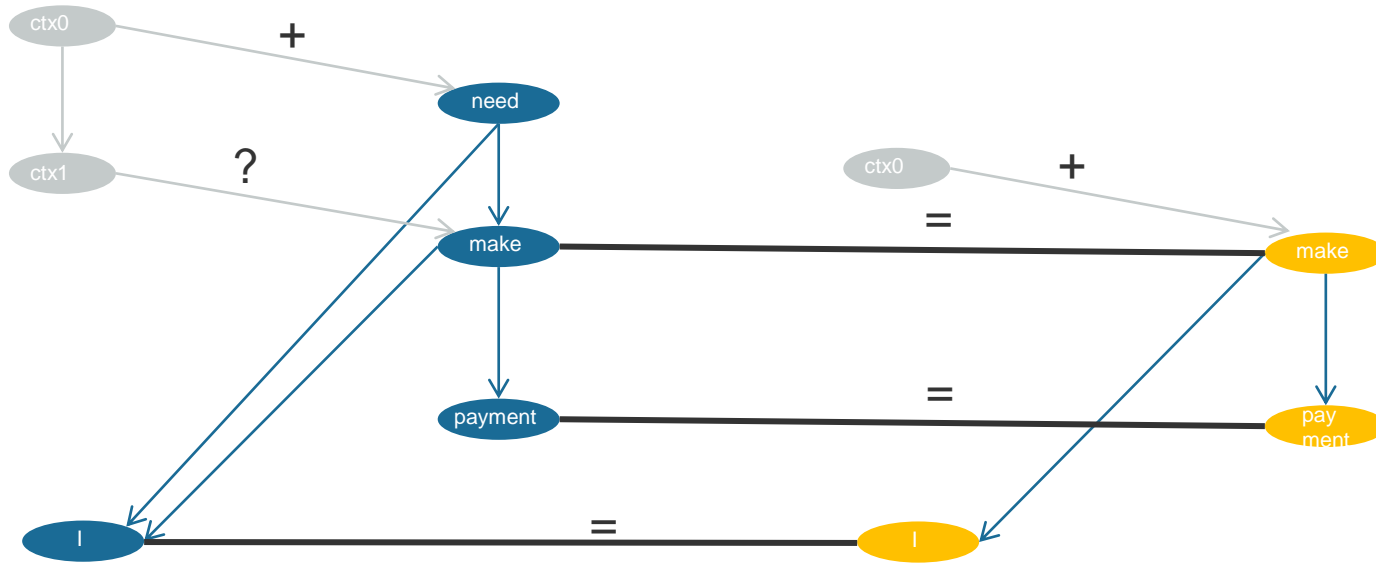
Tom Cruise is a pilot

Did Tom Cruise fly a plane?



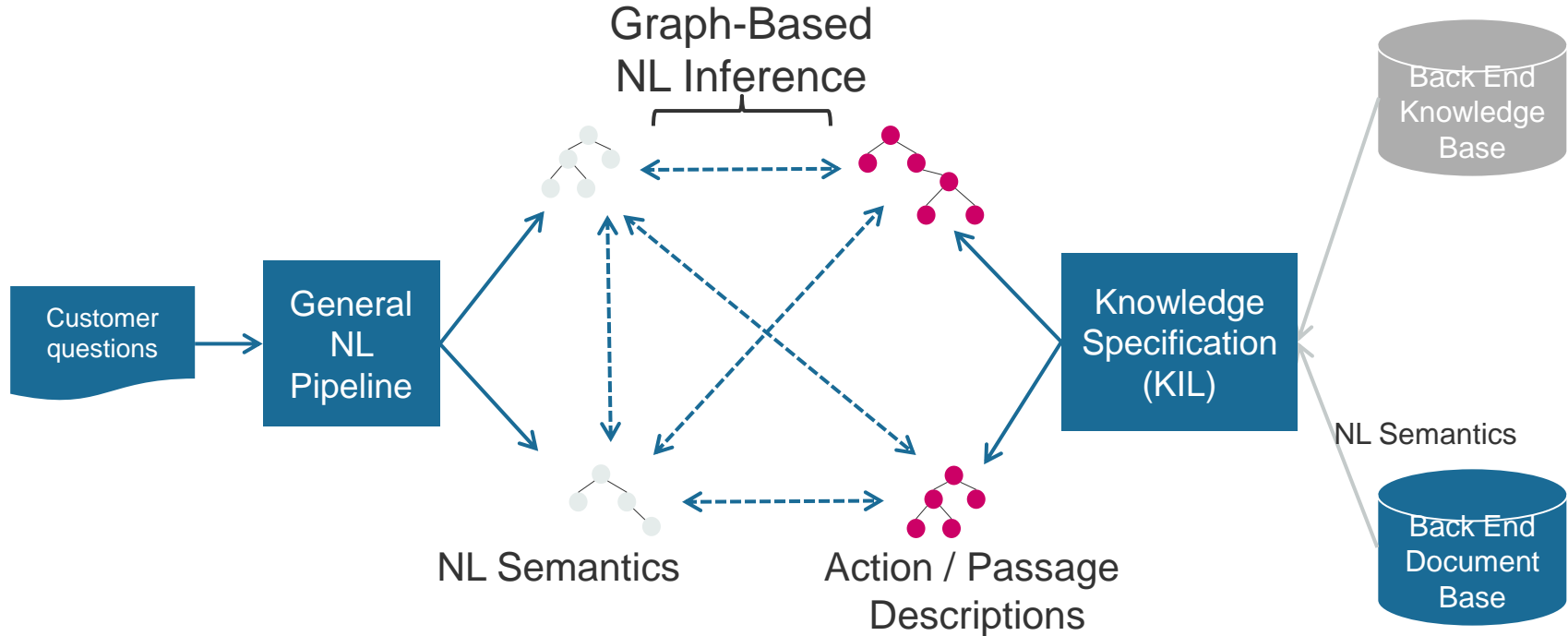
Expand text with additional knowledge

# Contexts, Polarity, Instantiability





# NL & KB Inference



# Mixing Canonical and Non-Canonical Data

Is anywhere showing that movie where Tom Cruise flies a plane?



Which Movie?

TV / Movie Listings?

Bigger Knowledge

Information may not yet or ever be in a formal knowledge base

The image shows two overlapping web pages. The top page is from Rotten Tomatoes, displaying the 'MOVIE INFO' for 'Top Gun'. The text reads: 'Devil-may-care navy pilot Pete Mitchell (Tom Cruise) is sent to Miramar Naval Air Station for advanced training. Here he vies with Tom Kasansky (Val Kilmer) for the coveted "Top Gun"'. Below this is a small movie poster. The bottom page is from IMDb, showing the 'Top Gun Plot' section. It begins with 'Maverick is a hot pilot. When he encounters a pair of MiGs over the Persian Gulf, his wingman is clearly outflown and freaks. On almost no fuel, Maverick is able to talk him

Big Knowledge

Scrape structured data, or ingest from content aggregator

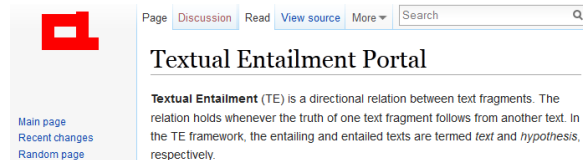
The image shows a screenshot of the Amazon TV Guide page for the movie 'Top Gun'. The page header includes 'TV GUIDE', a search bar, and navigation links for 'SIGN IN / UP' and 'WHAT'S ON'. The main content area features the movie title 'Top Gun' with the year '1986' and the genre 'MOVIE'. Below the title is a small movie poster and a 'Watchlist' button. To the right of the poster, there is a 'Cast & Crew | Review' link and a paragraph of text: 'This poem to hotshot Navy fighter pilots and high technology extracurricular activities... despite its familiar plot and characters so vivid they vanish from memory as soon as the house lights come up. Brash young pilot Lt. Pete Mitchell (Tom Cruise), nickname... maverick'. Below this text are the release date 'Released: 1986', the rating 'Rating: PG', and user ratings: 'User Rating: ★★★★★ (33 ratings)' and 'Your Rating: ☆☆☆☆☆'. At the bottom of the page, it says 'There are no airings in the next 14 days.'



# Latest RTE Bake-Off: SemEval 2014

## Recognizing Textual Entailment

Topic of active academic research & bake-offs since 2004



Team	Accuracy
1. Illinois	84.5
2= Nuance NLIE	82.6*
6. Meaning Factory	81.6
....	
9. Nuance ECD	78.9*
...	
14. Stanford NLP	74.5
...	

First attempt

Achieved without  
acquisition of  
paraphrase relations  
or extensive  
world knowledge

*\*Nuance did not participate*

# Big Knowledge Inference

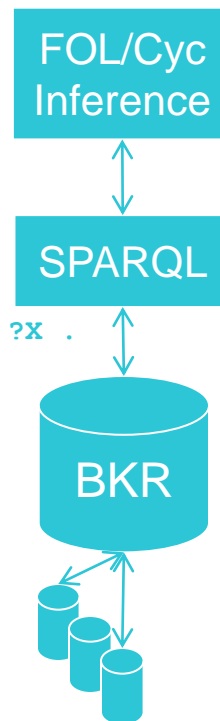
## Finding answers in the Big Knowledge Repository

- Question is mapped into a SPARQL query
  - SPARQL: “SQL for triple stores”
  - First-order inference useful for mapping to SPARQL
- Triples retrieved from BKR
  - BKR accesses back-end databases, determined by semantic routing
- Term bindings returned to FOL inference

```
?X = bkr:F14
```

```
SELECT ?X
WHERE {
  bkr:TomCruise bkr:fly ?X .
  ?X isa bkr:Aircraft .
}
```

```
<bkr:TomCruise
  bkr:fly
  bkr:F14>
```



Back-end provider data

# Problem

Getting NL and big knowledge to talk to each other

- Inference and processing mechanisms can be very different
- Must share output representations
  - Use shared representations to interleave NL and BK inference
- Can structured output from NL inference be shared with BK?
  - Difficult if NLI output is a weighted classification of sentence pairs.

# Solution: Term Bindings

- Although NLI and BKR inference is different, results are represented uniformly as **term bindings**
  
- SPARQL queries to knowledge repository return **term bindings**
  - `?X = bkr:TomCruise`
  
- Term matches between premise and conclusion in NLI are **term bindings**
  - `Whoc = TomCruisep`

# Discovering and refining intents

## Discovery

- Start with automatic acquisition of intents from logs
  - Likely to be of lower quality than hand constructed intents

## Refinement

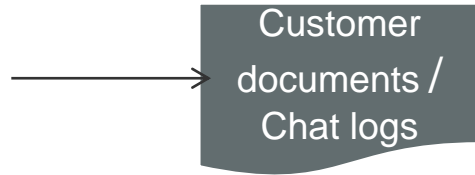
- Use HAVA to refine initial intent definitions
  - Allows quick deployment with incomplete / poor intents
  - Combination of human assisted learning and manual review increases scope of VA over time
  - Possibility of using HAVA behind completely empty VAs

1. Evaluate against existing domain.
2. Move to new domains.



# Intent classification

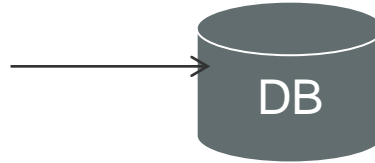
“Can I get a car insurance quote?”



“You can start the auto insurance quote process [here](#).”

General/Class-based

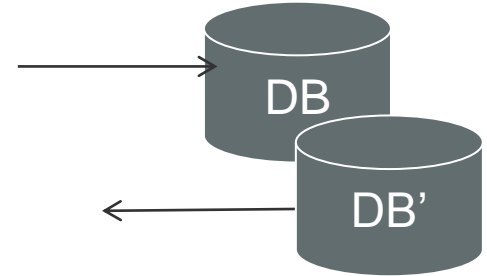
“How much is my next car insurance payment?”



“\$736.00 is due on March 31, 2016.”

Complex/Personalized

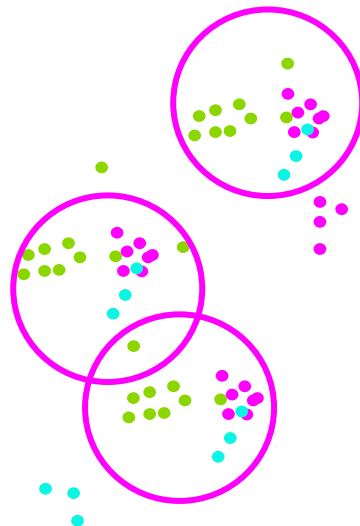
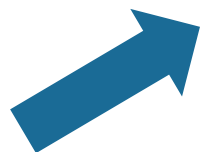
“Can I change to every 6 months?”



“Your payment has been changed to quarterly with monthly reminders.”

Transactional

# NiK Clustering: General & Class-based



NiK/NLI:  
Joint clustering of questions,  
answers, passages

## Standard NES string similarity

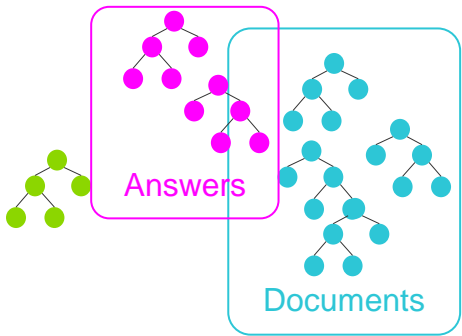
Search relevance / similarity  
Natural language inference  
Graph similarity  
DNN/Seq2Seq

Clustering  
approaches

Currently, the only automation in Nina intent definition is clustering of trigger questions from chat logs in Nuance Experience Studio.

# Nina Knowledge clustering

“Can I get a car insurance quote?”

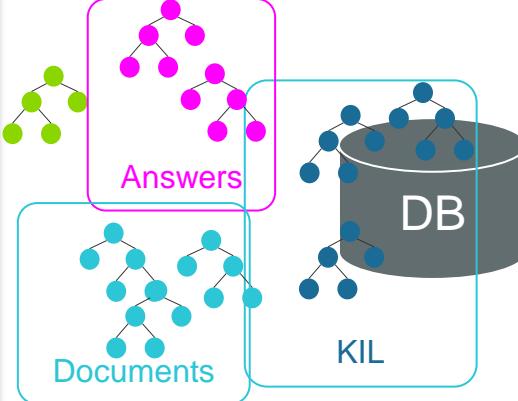


The diagram shows a tree structure with nodes. A pink box labeled 'Answers' contains a cluster of pink nodes. A cyan box labeled 'Documents' contains a cluster of cyan nodes. A small green tree structure is also visible on the left.

“You can start the auto insurance quote process [here](#).”

General

“How much is my next car insurance payment?”

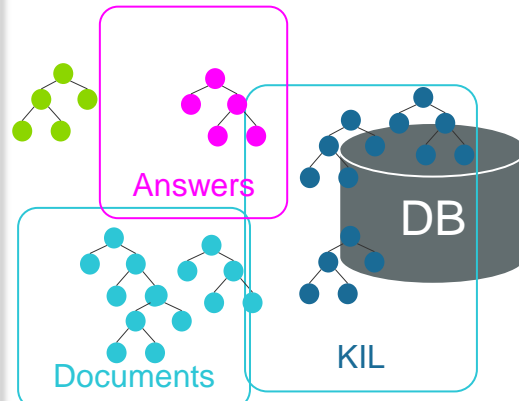


The diagram shows a tree structure with nodes. A pink box labeled 'Answers' contains a cluster of pink nodes. A cyan box labeled 'Documents' contains a cluster of cyan nodes. A grey cylinder labeled 'DB' is connected to a cyan box labeled 'KIL' which contains a cluster of cyan nodes. A small green tree structure is also visible on the left.

“\$736.00 is due on March 31, 2016.”

Personalized

“Can I change to every 6 months?”



The diagram shows a tree structure with nodes. A pink box labeled 'Answers' contains a cluster of pink nodes. A cyan box labeled 'Documents' contains a cluster of cyan nodes. A grey cylinder labeled 'DB' is connected to a cyan box labeled 'KIL' which contains a cluster of cyan nodes. A small green tree structure is also visible on the left.

“Your payment has been changed to quarterly with monthly reminders.”

Transactional