Adaptive Distributional Word Models for Robust Semantic Information Systems

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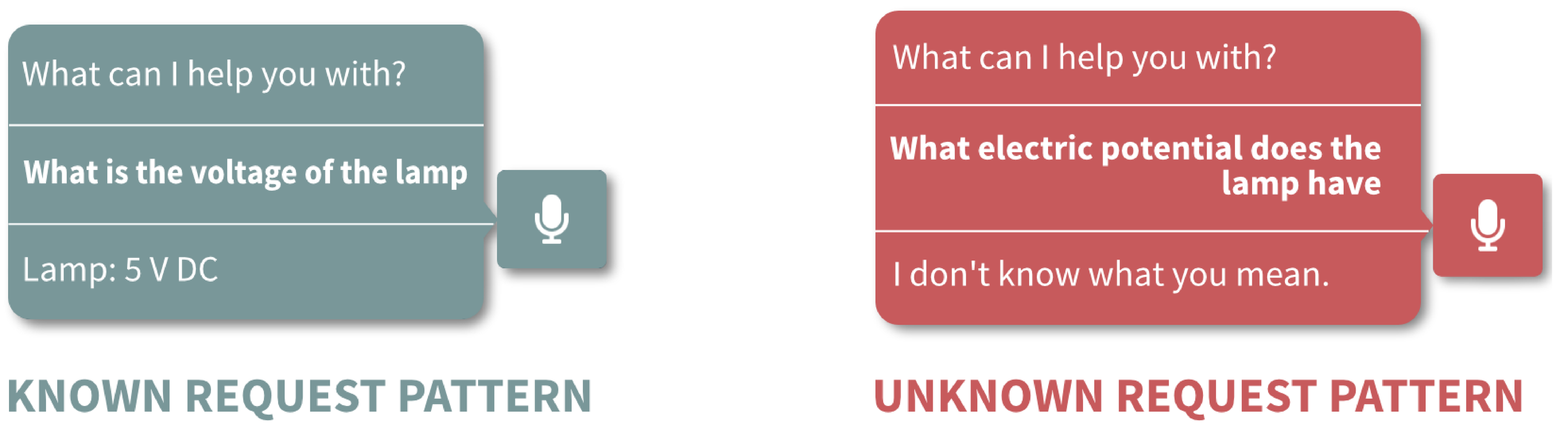
Introduction

Setting: Repair and Maintenance of Complex Machinery

- Predominantly manual tasks demanding two-handed interaction
- **Problem**: Looking up information in technical documentation interrupts task
- **Solution**: Hands-free interaction with voice assistant

But: Problems with Current Voice Assistants

- Require rigid input phrase structures
- User has to learn how to paraphrase requests
- **Result**: Non-natural interaction, suboptimal usability



Objectives

1. **Enhance robustness** of voice assistants in the domain of Technical Service with respect to **varying phrasing**
2. **Integrate** findings into an **existing information system**
3. Develop mechanism to **adapt to user feedback**

Language Representation Models

Idea: Utilize state-of-the-art language representation models

- Map words/sentences onto multi-dimensional vectors
- Vectors encode syntactic and semantic relations

Word Vector Models

Generate vectors for each individual word

- Word2Vec [1]
- GloVe [2]
- FastText [3]

Contextualized Vector Models

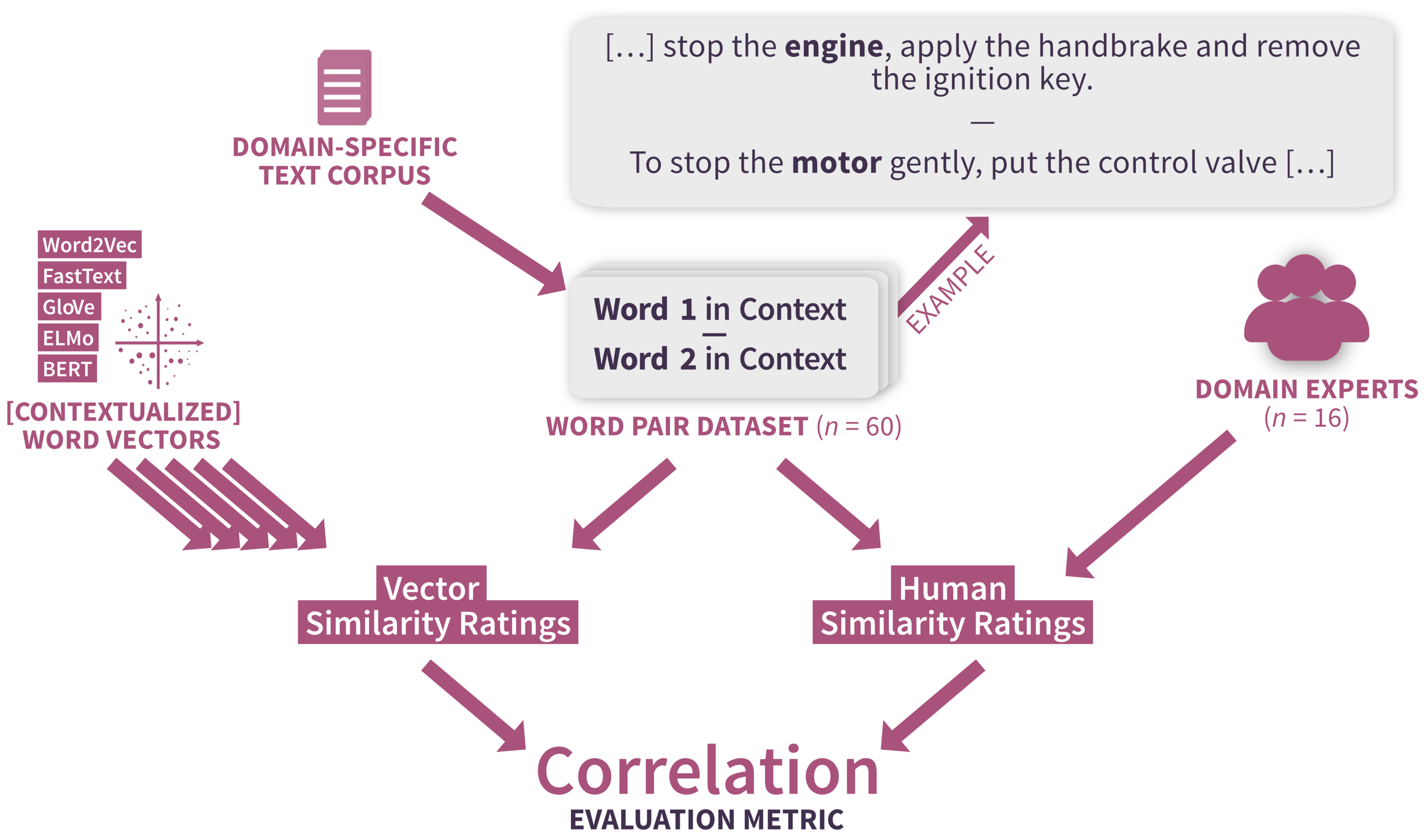
Take word context into consideration

- ELMo [4]
- BERT [5]

Approach: Evaluate pre-trained, self-trained and transfer-learned model instances

Methods: Intrinsic Evaluation

Question: How well do vectors capture semantic similarity?



Methods: Extrinsic Evaluation

Question: How well do vectors perform in a downstream task?

Task 1 – Multiclass Classification

Classify a natural language request to one out of four categories.

Task 2 – Binary Classification

Classify, if two natural language requests are semantically equal.

Example

Request	**Category** (Task 1)	**Equal** (Task 2)
What is the resistance of x?	Electric Resistance	Yes
What is the ohmage value of x?	Electric Resistance	
What is the pressure at x?	Pressure	No
Which voltage should I measure at x?	Electric Potential	

Results

Intrinsic Evaluation

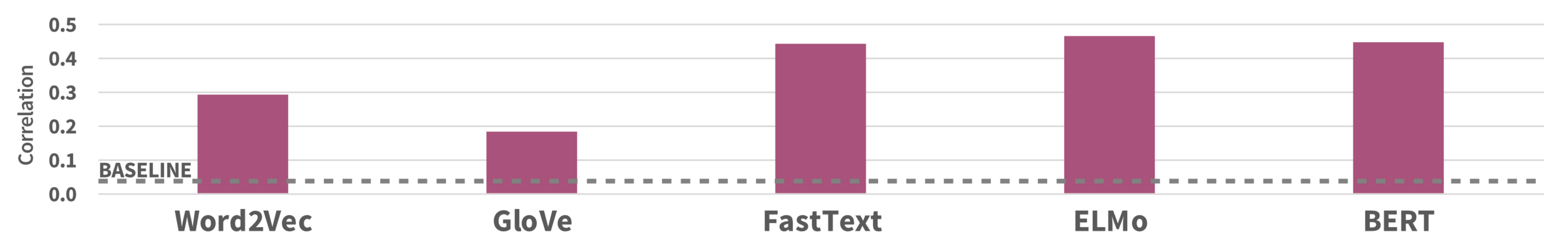


Figure 1: Spearman correlations between expert annotated ratings and the best performing instance of each model.

Extrinsic Evaluation

	Baseline	Word2Vec	GloVe	FastText	ELMo	BERT
Task 1	0.8001	0.8878	0.8624	**0.9465**	0.9058	0.4907
Task 2	0.7936	0.9737	0.9886	0.9898	**0.9909**	0.8033

Table 1: F1 scores of best performing instance of each model.

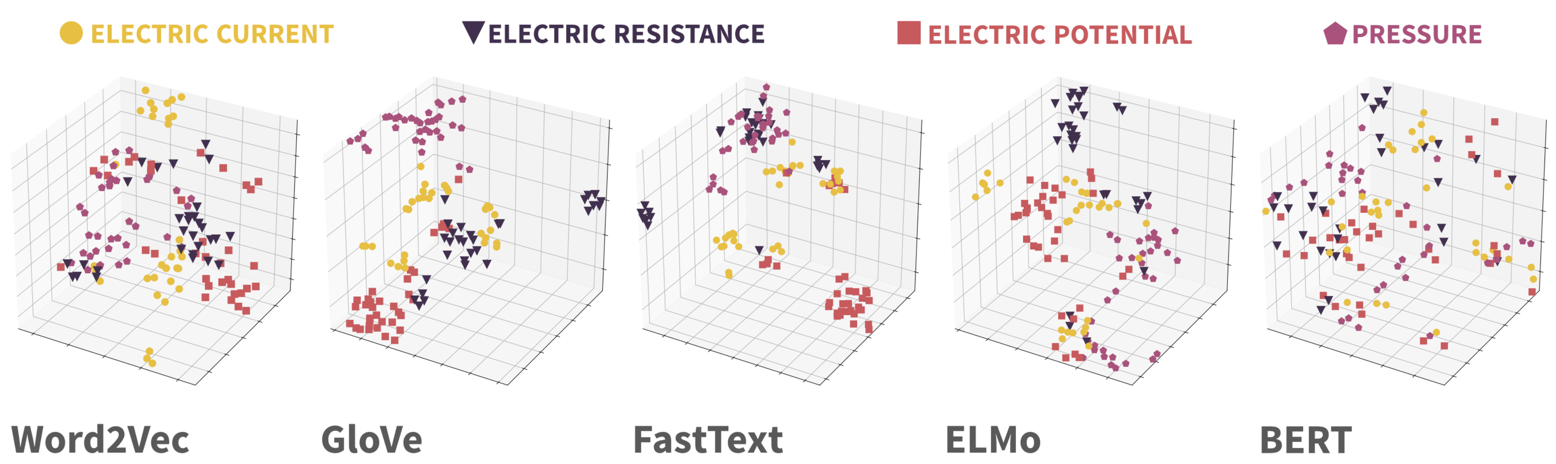


Figure 2: 3D t-SNE projections of natural language request vectors.

Implementation

- Prototypically integrated well-performing models into information system *Service Mate*
- Asking user if a given answer was adequate enables system to learn and adapt dynamically

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