# DeepType: Multilingual Entity Linking by Neural Type System Evolution

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# Introduction

- Background
  - Integration of structured and unstructured modalities is a **difficult process**, involving many decisions concerning how best to represent the information so that it will be captured or useful, and hand-labeling large amounts of data.
- DeepType：
  - integrating symbolic information into the reasoning processof a neural network with a type system
  - reformulating the design problem into a mixed integer problem: create a type system and subsequently train a neural network with it

# Approach

- Create
  - Create a type system by selecting roots and edges from an ontology
- Train the type system:
  - Discrete variables
    - utilize the parent-children relations
    - heuristic search or stochastic optimization over the discrete variable assignments controlling type system design
  - Continuous variables
    - utilize a classifier to fit the type system
    - gradient descent to fit classifier parameters

# Approach

- rely on heuristic search or stochastic optimization to find suitable assignments
- Oracle and Learnability heuristic can quality the disambiguation power and Ability to learn type axis —measuring disambiguation accuracy $S_{oracle}$
  - Oracle: disambiguation power
  - Learnability heuristic: average performance of classifier accuracy of a entity prediction model
- Linkcount — $S_{greedy}$
- Add a per type axis penalty — $\lambda$

# Approach

- Type classifier
  - Classifier: BiLSTM
  - Classifier belief: for each mention, obtain the type conditional probability for all type axes
  - Prediction model: $LinkCount(m, e)$

# Experiments

- Difference of three search methodologies for Type system discovery
  - Beam search and Greedy Method
  - Cross-Entropy Method
  - Genetic Algorithm
- Type system baseline
  - Human-designed type system
- Cross-lingual entity linking task
- NER task
- Resolution complexity: reduced from $O(N^2)$ to $O(N)$