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Sibylvariant Transformations for Robust Text Classification

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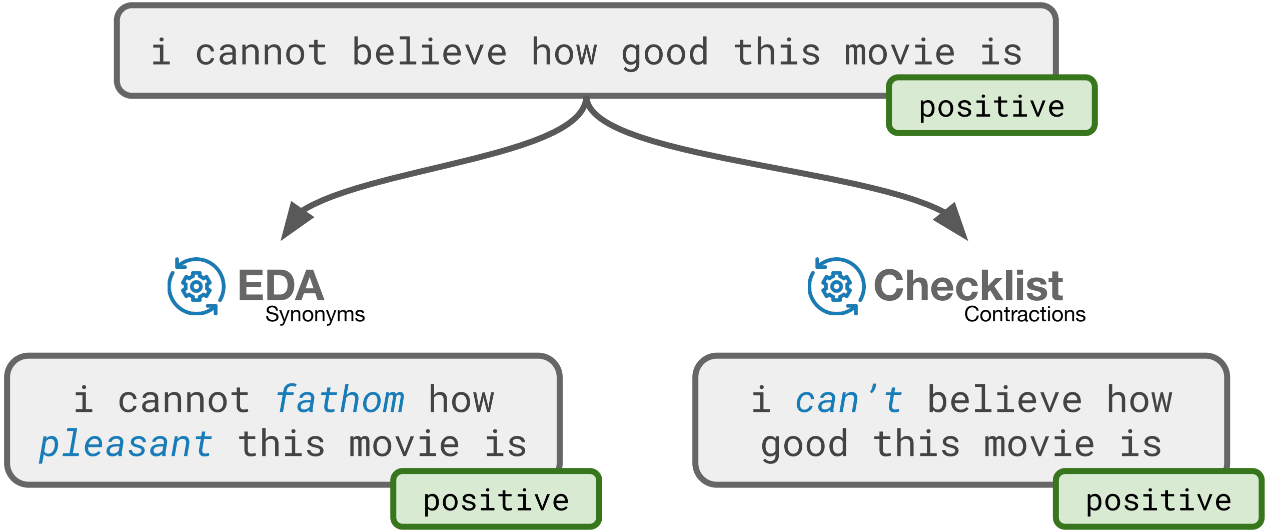
https://github.com/UCLA-SEAL/Sibyl

Invariant (INV) Transformations

Nearly all transformations are constrained to **preserve** the source label



i cannot believe how good this movie is

positive

EDA
Synonyms

i cannot *fathom* how *pleasant* this movie is

positive

Checklist
Contractions

i *can't* believe how good this movie is

positive

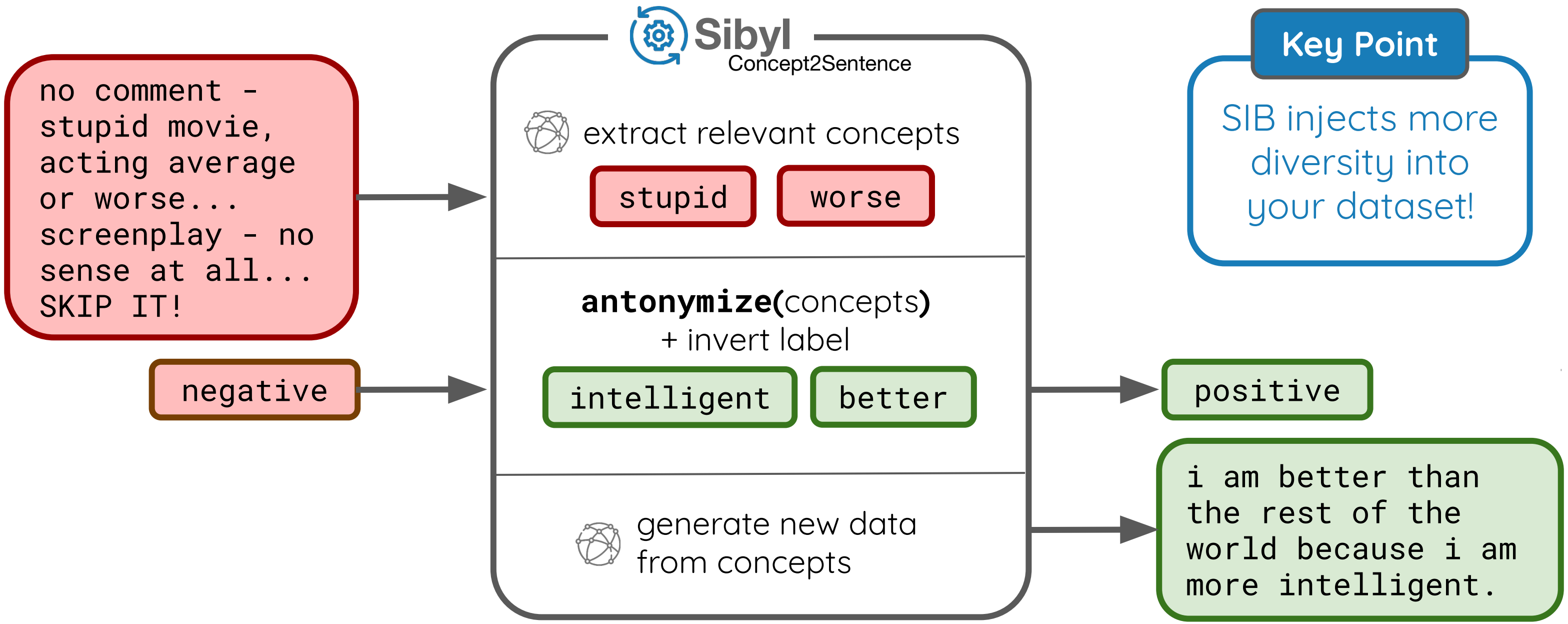
Key Point

Limits the amount of change you can inject, reducing input space coverage + diversity

What if we could knowably change the label and inject more diversity?

Sibylvariant (SIB) Transformations

Jointly transform the input and label



no comment - stupid movie, acting average or worse... screenplay - no sense at all... SKIP IT!

negative

Sibyl

Concept2Sentence

extract relevant concepts

stupid

worse

antonymize(concepts**)**
+ invert label

intelligent

better

generate new data from concepts

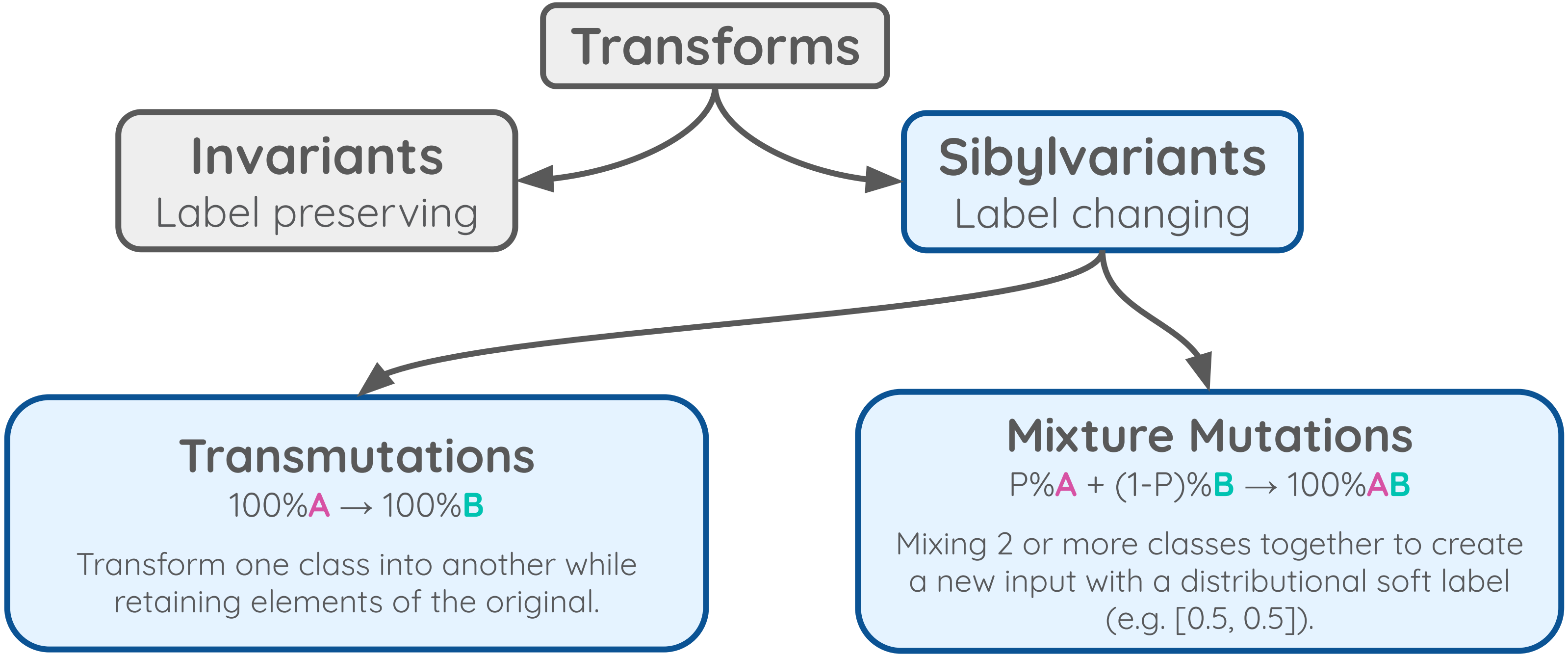
positive

i am better than the rest of the world because i am more intelligent.

Key Point

SIB injects more diversity into your dataset!

Unified Framework for Data Transforms



Transforms

Invariants
Label preserving

Sibylvariants
Label changing

Transmutations

100%A → 100%B

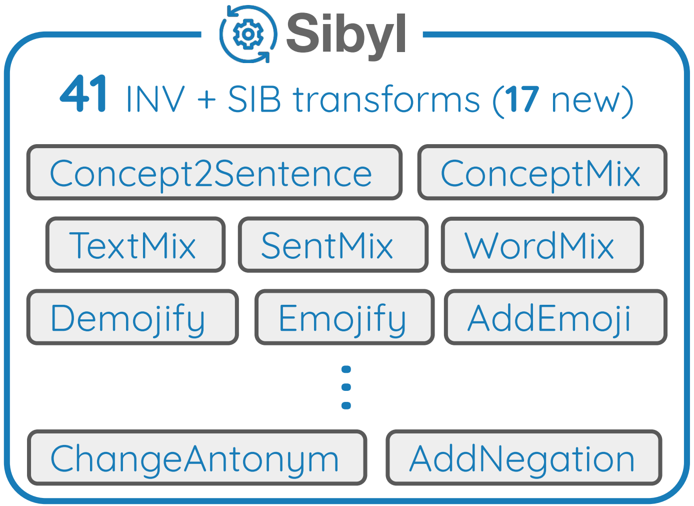
Transform one class into another while retaining elements of the original.

Mixture Mutations

P%A + (1-P)%B → 100%AB

Mixing 2 or more classes together to create a new input with a distributional soft label (e.g. [0.5, 0.5]).

Sibyl Tool



Sibyl

41 INV + SIB transforms (**17** new)

Concept2Sentence ConceptMix

TextMix SentMix WordMix

Demojify Emojify AddEmoji

⋮

ChangeAntonym AddNegation

Task determines type!

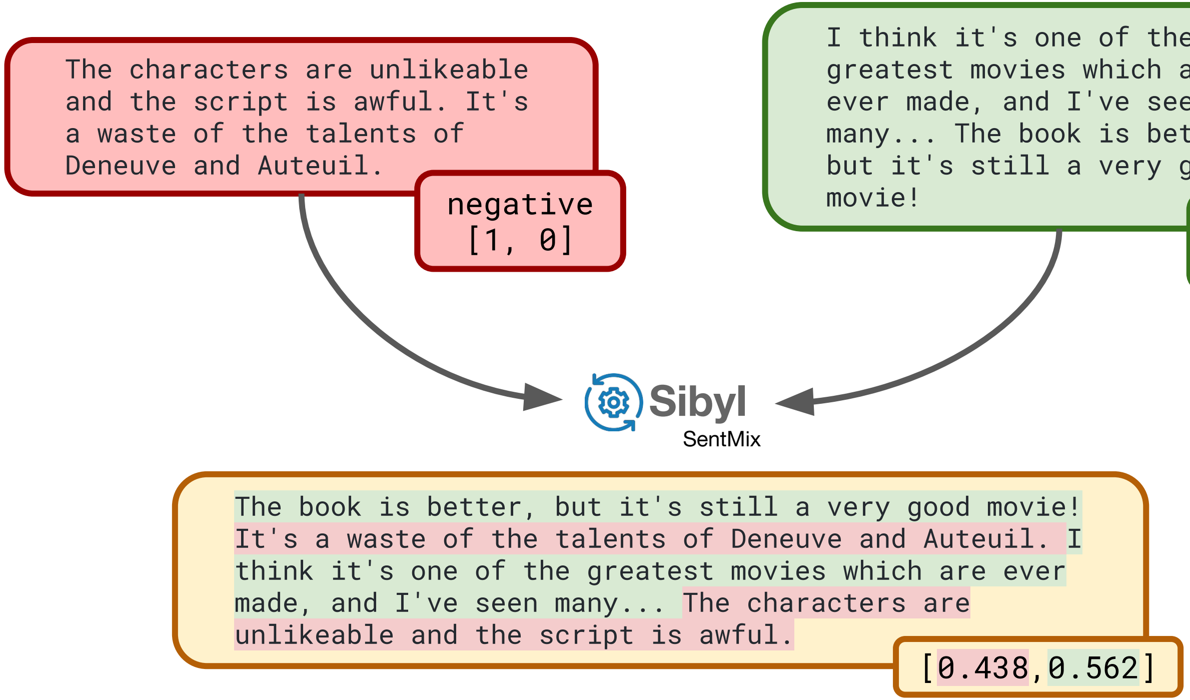
ex. ChangeAntonym

“I love pizza” → “I *hate* pizza”

SIB for **sentiment analysis**
INV for **grammaticality**

Sibyl transforms are configured as either INV or SIB for 5 different tasks: sentiment analysis, topic classification, grammaticality, similarity, entailment

Examples | SentMix (Mixture Mutation)



The characters are unlikeable and the script is awful. It's a waste of the talents of Deneuve and Auteuil.

negative
[1, 0]

I think it's one of the greatest movies which are ever made, and I've seen many... The book is better, but it's still a very good movie!

positive
[0, 1]

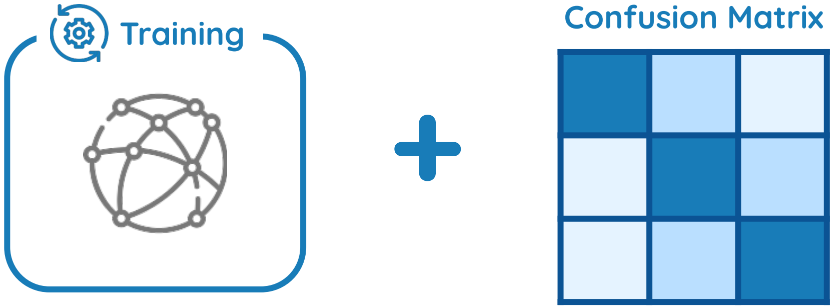
The book is better, but it's still a very good movie! It's a waste of the talents of Deneuve and Auteuil. I think it's one of the greatest movies which are ever made, and I've seen many... The characters are unlikeable and the script is awful.

[0.438,0.562]

Key Point

Creating mixtures helps the model differentiate with greater nuance

Adaptive SIB Training



Key Point

SIB enables a new kind of training that leads to improved performance

- Periodically assess model performance by class
- Generate more examples by targeting commonly confused classes
  - ex. mix “sports” topics with “politics” more often

Evaluating Effectiveness of SIB vs. INV

Generalization

Does training on SIB-augmented data improve model accuracy?

Defect Detection

How effective are SIB-transformed tests at inducing misclassifications?

Robustness

Does training on SIB data make models more robust to attack?

Systematic Evaluation

6 datasets (3 sentiment, 3 topic)

11 transformation pipelines
(2 randomly sampled INV / SIB transforms)

3 levels of resource availability (10,200,2500)

216 models

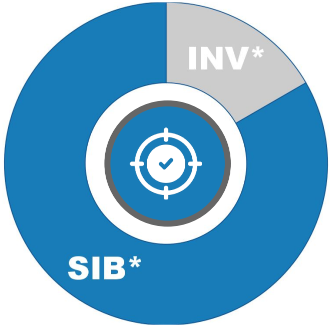
30m training inputs

480k tests

3.3k adversaries

Results: SIB vs. INV

Generalization

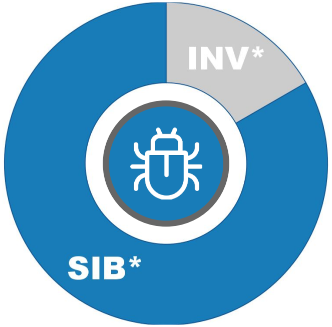


89% of the time

Model Accuracy

SIB > INV

Defect Detection

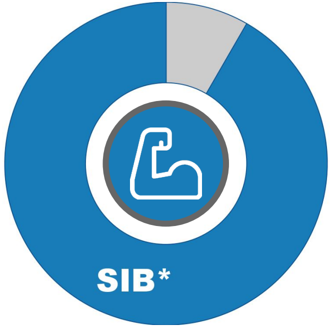


83% of the time

# of Misclassifications

SIB > INV

Robustness

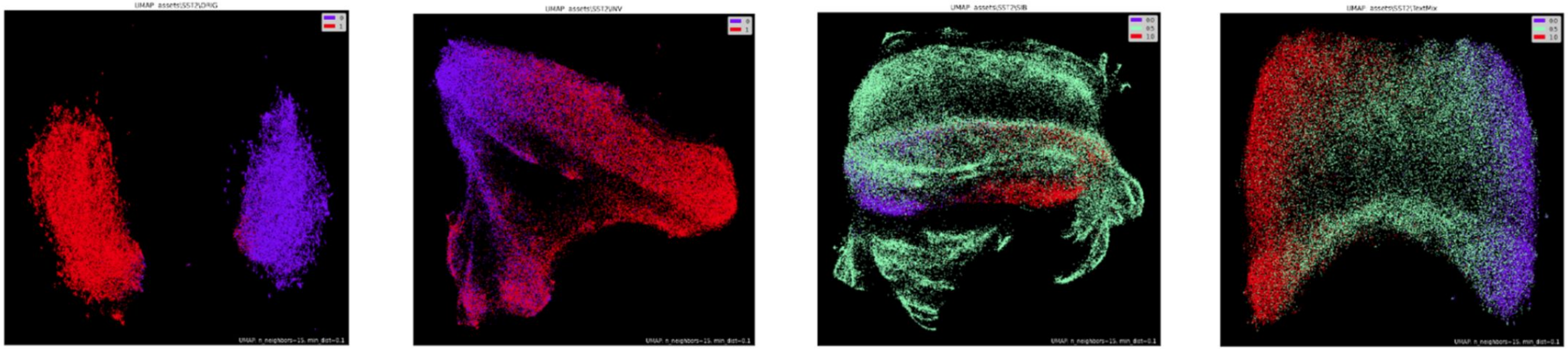


11x more often

Robustness

SIB > INV

How does SIB help?



(a) T_{ORIG} (b) T_{INV} (c) T_{SIB} (d) T_{TextMix}

UMAP embeddings of inputs by class

- SIB diversifies datasets more than INV to improve input space coverage
- SIB data may support margin maximizing decision surfaces

Conclusion: SIB complements INV

Framework

Transmutations
Mixture Mutations
Adaptive SIB Training

Sibyl Tool

Taxonomized **41** transforms (**17** new) + packaged in tool

Evaluation

SIB transforms outperform INV ones
89% more accuracy
83% more defects
11x more robust

```
> pip install sibyl-tool
```

https://github.com/UCLA-SEAL/Sibyl