Kitami Institute of Technology

IJCAI-17

LaCATODA

LEARNING DEEP ON CYBERBULLYING IS ALWAYS BETTER THAN BRUTE FORCE

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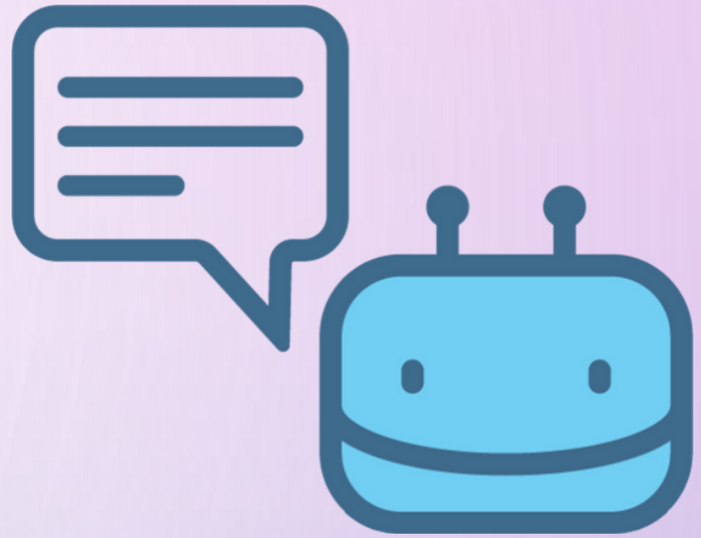
1. KITAMI INSTITUTE OF TECHNOLOGY
2. TAMPERE UNIVERSITY OF TECHNOLOGY

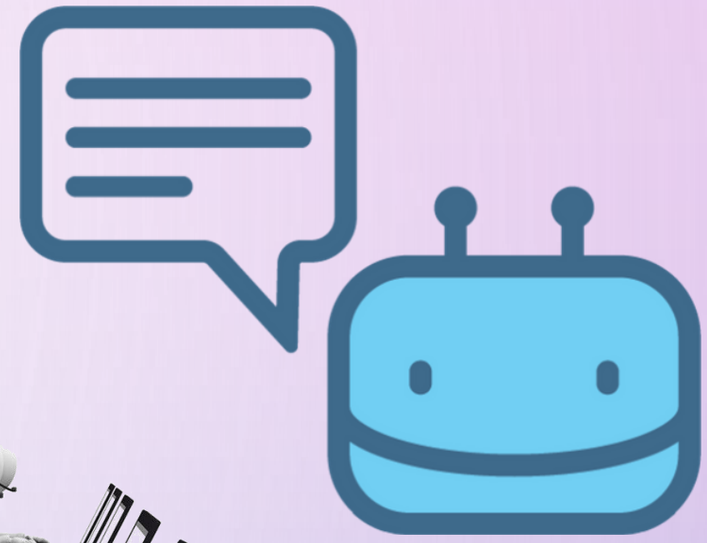
BACKGROUND



- DIALOG AGENTS APPLICATIONS

Q

BACKGROUND



- DIALOG AGENTS APPLICATIONS
  - CALL CENTERS
  - CUSTOMER SUPPORT
  - CASUAL CONVERSATIONS
  - LANGAUGE EDUCATION
  - ADVERTISEMENT / PROPAGANDA
  - PR / ANTI-PR
  - **FORUM MODERATION**

BACKGROUND

- FORUM MODERATION
  - ONE OF THE PROBLEMS ON FORA:

CYBERBULLYING

BACKGROUND

- CYBERBULLYING

" USING **TECHNOLOGY** TO RIDICULE OR **HUMILIATE** OTHERS "

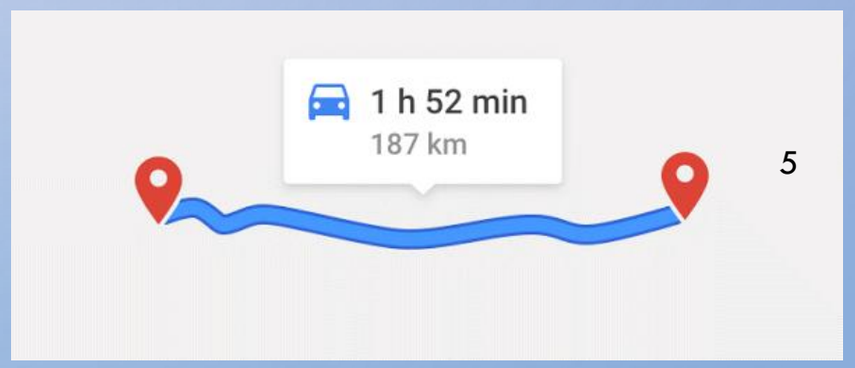
REPETITIVE

IMBALANCE OF POWER

(ONE VS MANY / WEAKER VS STRONGER)

EASY TO DO ON INETERNET

(LONGER PSYCHOLOGICAL DISTANCE)



BACKGROUND

- CYBERBULLYING

  CAUSES :

  AGGRESSION

  ALIENATION

  DEPRESSION

  SELF-MUTILATION

  SUICIDE

BACKGROUND

- CYBERBULLYING

CAUSES :

AGGRESSION

ALIENATION

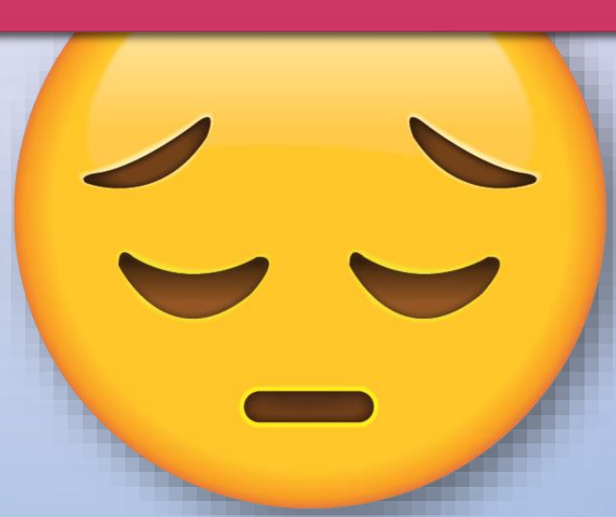
DEPRESSION

SELF-MUTILATION

SUICIDE

REAL WORLD PROBLEM

MORE LIFE ON INTERNET =
= MORE CYBERBULLYING



8% TO EVEN 20% OF USERS (OFTEN KIDS)

Q

BACKGROUND

- MANY INTERNET FORA (OVER 1 MIL.[1])

  IMPOSSIBLE TO MODERATE EVERYTHING MANUALLY

- ONLINE PATROL (TEACHERS, PARENTS VOLUNTEERS)
  - READ EVERYTHING TO FIND CYBERBULLYING
  - NOT ENOUGH TIME
  - PSYCHOLOGICAL BURDEN

NEED TECHNOLOGY SUPPORT

1) https://www.quora.com/How-many-online-forums-are-in-existence

PREVIOUS RESEARCH

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SO-PMI-IR / phrases

Language Combinatorics / Preprocessing

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Language Combinatorics = Brute Force Search

SVM / optimization

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PREVIOUS RESEARCH

Feature sophistication

simple→ **→sophisticated**

bag-of-words

words

phrases

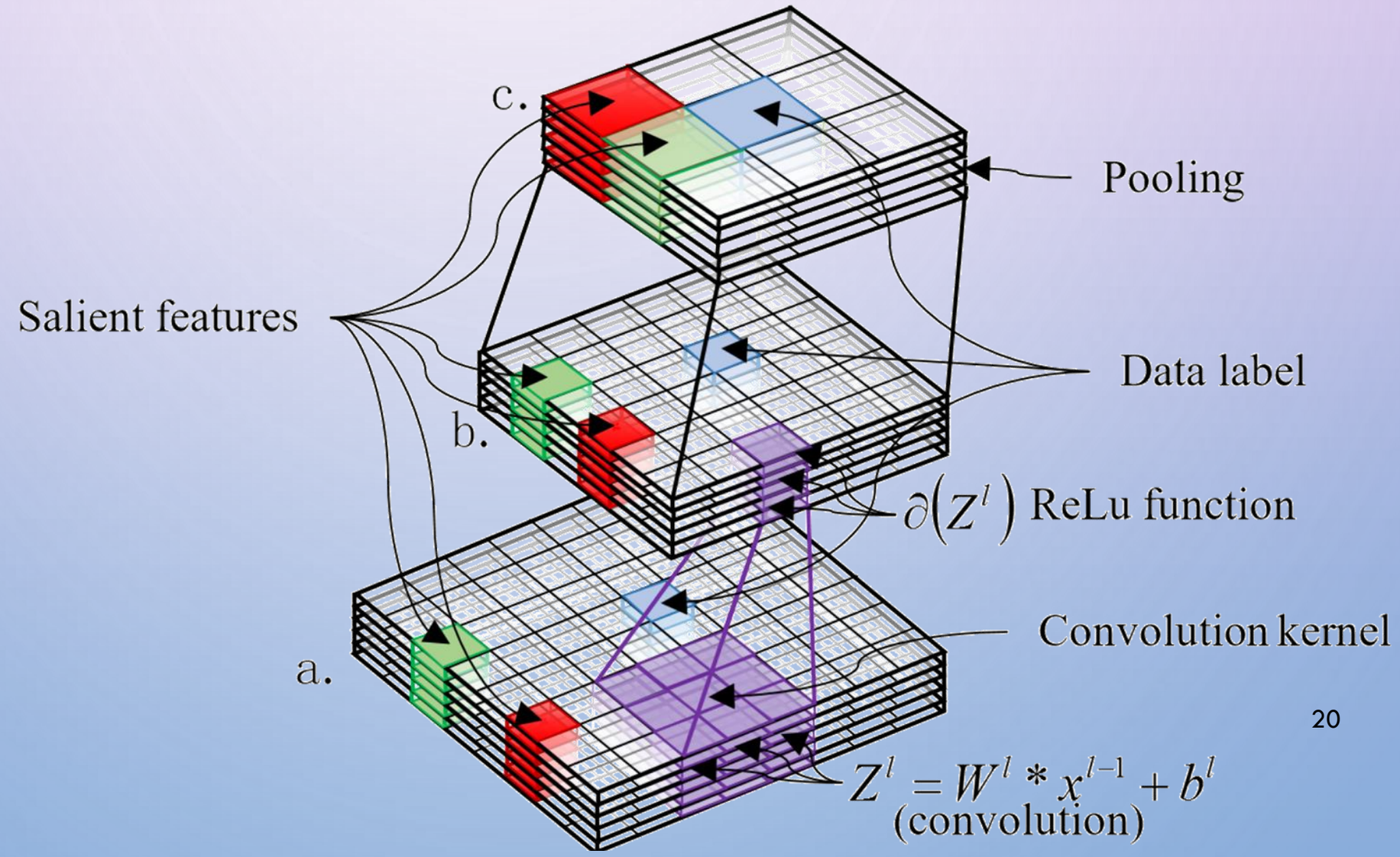
word patterns

syntactic pat.

DEEP LEARNING

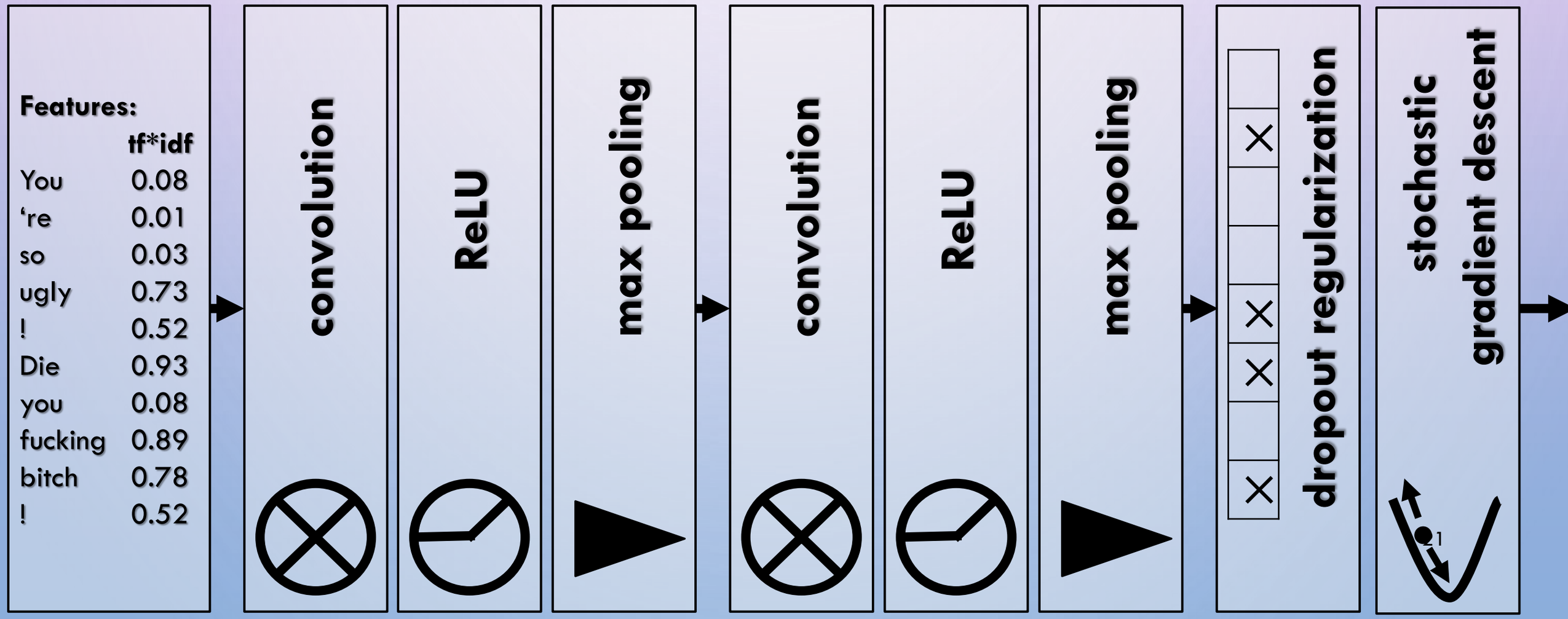
PROPOSED METHOD

- DEEP CONVOLUTIONAL NEURAL NETWORK



PROPOSED METHOD

- DEEP CONVOLUTIONAL NEURAL NETWORK



*) dummy weights only for explanation.

PROPOSED METHOD

- **CONVOLUTION**

Features:	**tf*idf**
You	0.08
‘re	0.01
so	0.03
ugly	0.73
!	0.52
Die	0.93
you	0.08
fucking	0.89
bitch	0.78
!	0.52

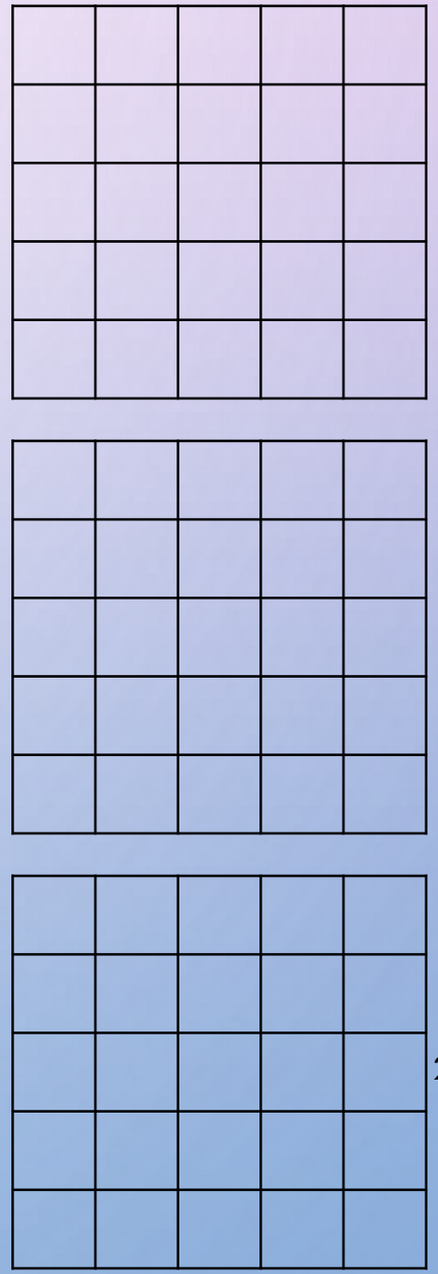
Batch = 5x5

You	‘re	so	ugly	!
Die	you	f*ng	b*ch	!
…				

Slide batch window

.08	.01	.03	.73	.52
.93	.08	.89	.78	.52
…				

Average of weights in batch for each feature



PROPOSED METHOD

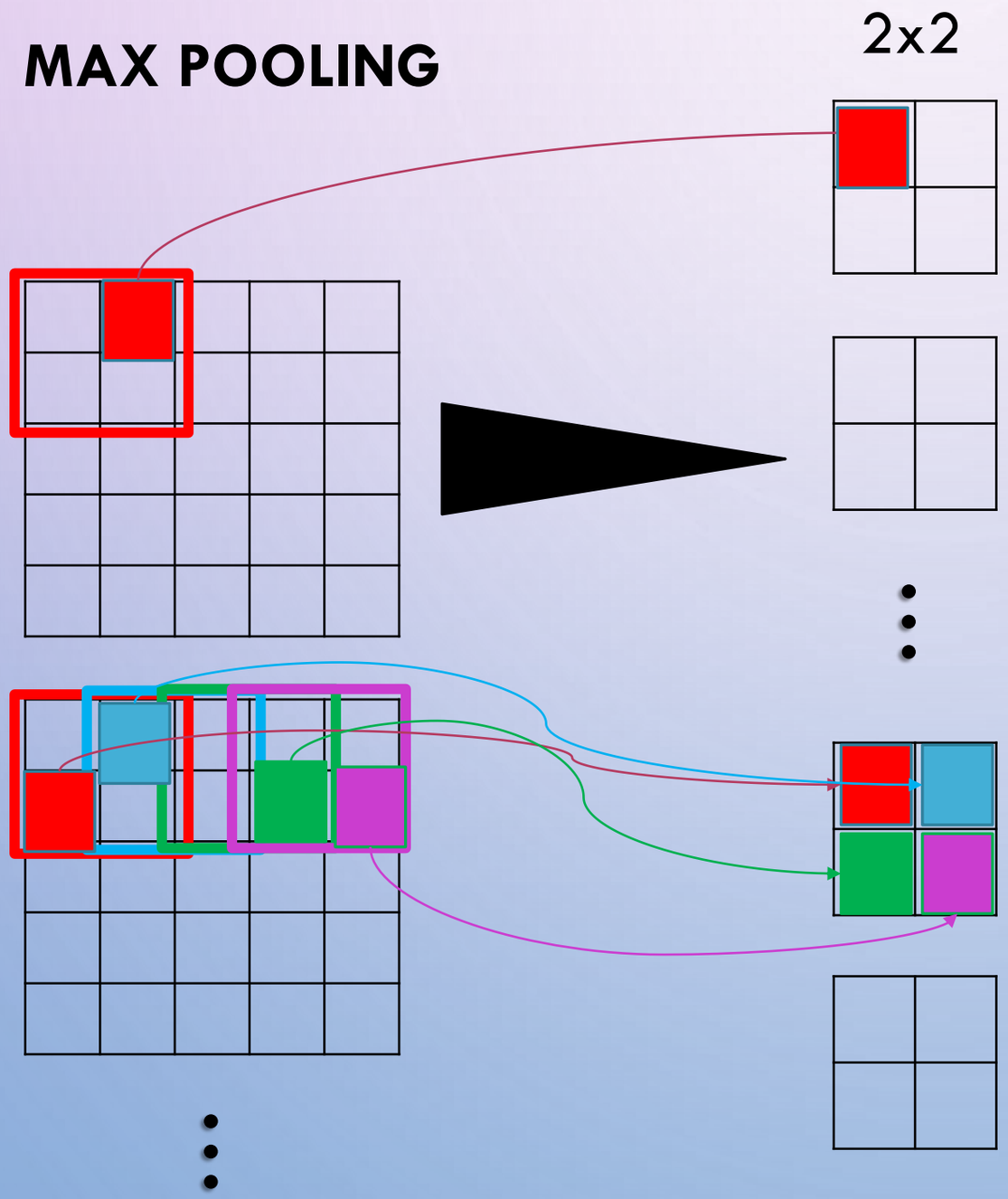
- **RECTIFIED LINEAR UNITS (RELU)**

.83	-.2	.04	.02	.1
.12	.76	-.32	.21	-.12
…				

.83	**0**	.04	.02	.1
.12	.76	**0**	.21	**0**
…				

PROPOSED METHOD

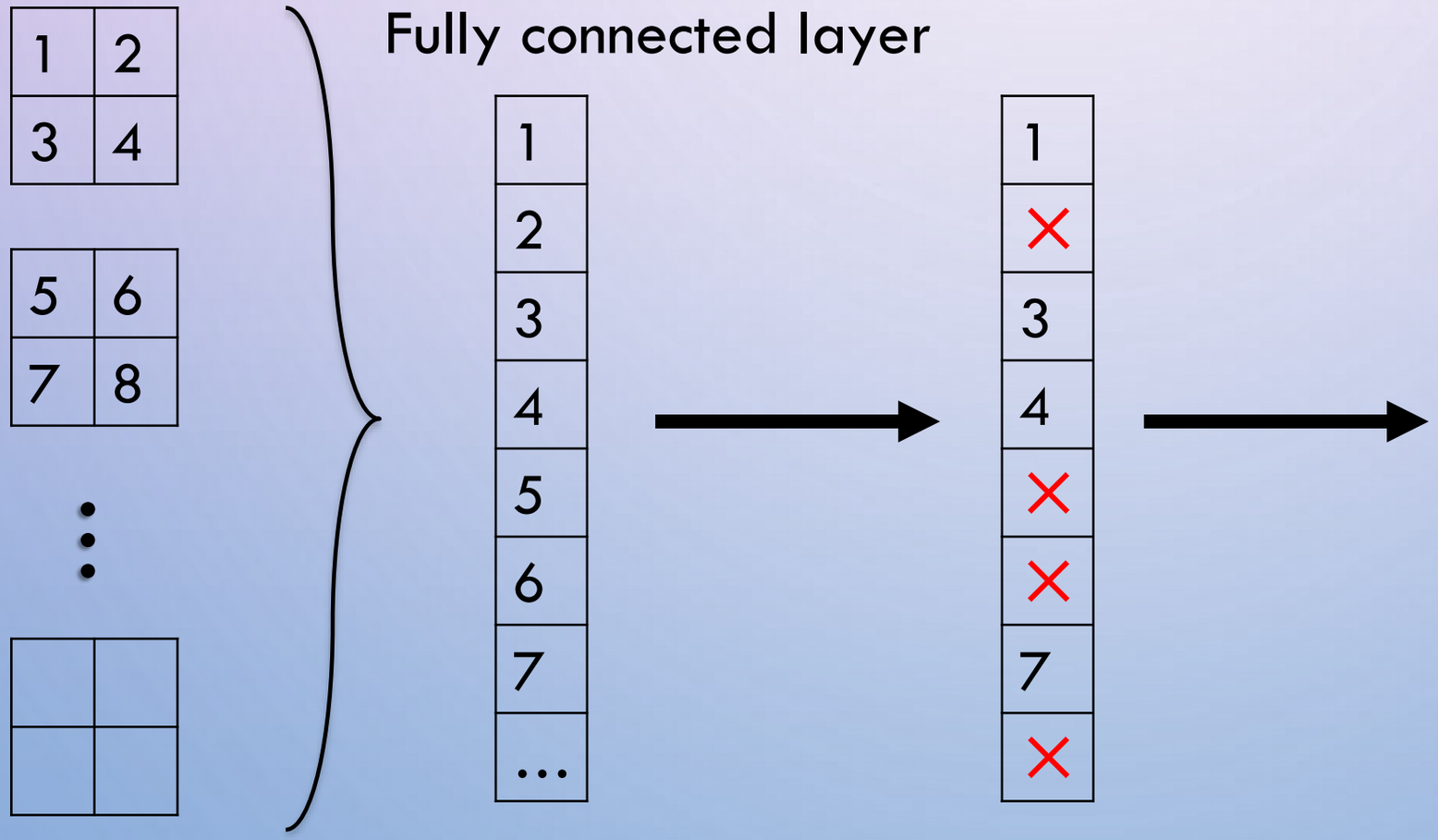
- **MAX POOLING**



* Reduce dimensionality and correct over-fitting

PROPOSED METHOD

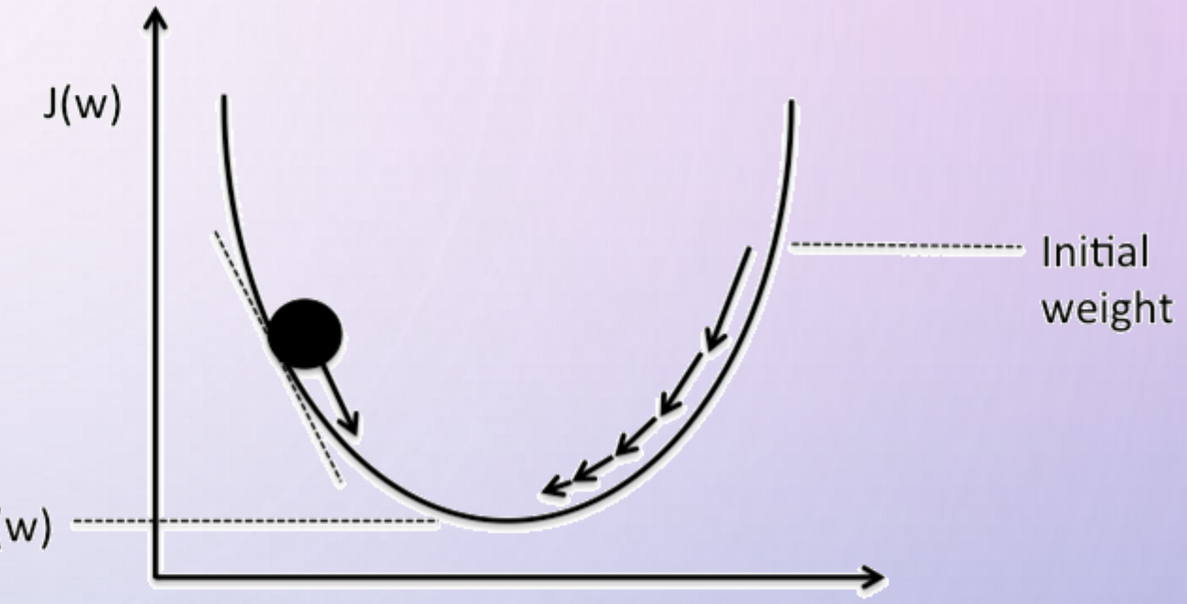
- **DROPOUT REGULARIZATION**



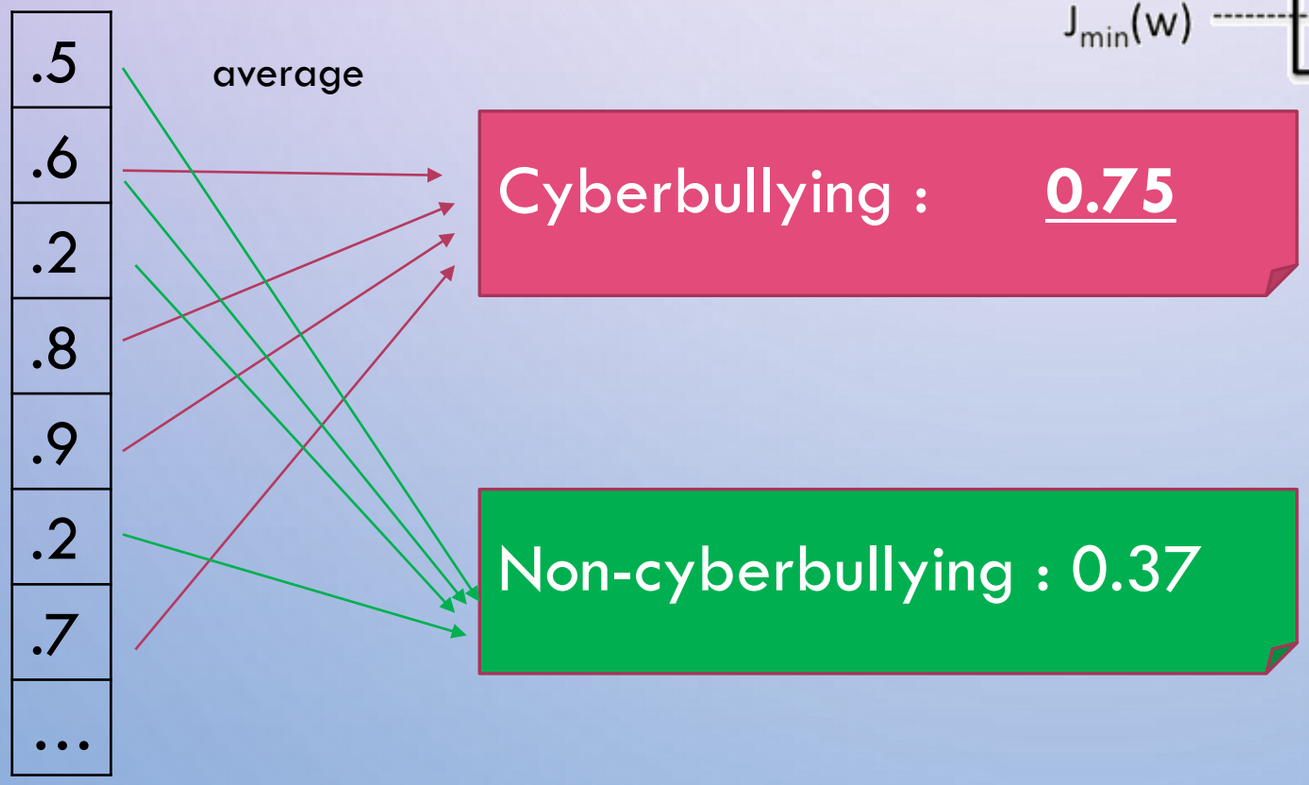
* Randomly delete some units during training to prevent co-adaptation of hidden units

PROPOSED METHOD

- **STOCHASTIC GRADIENT DESCENT**



Fully connected layer

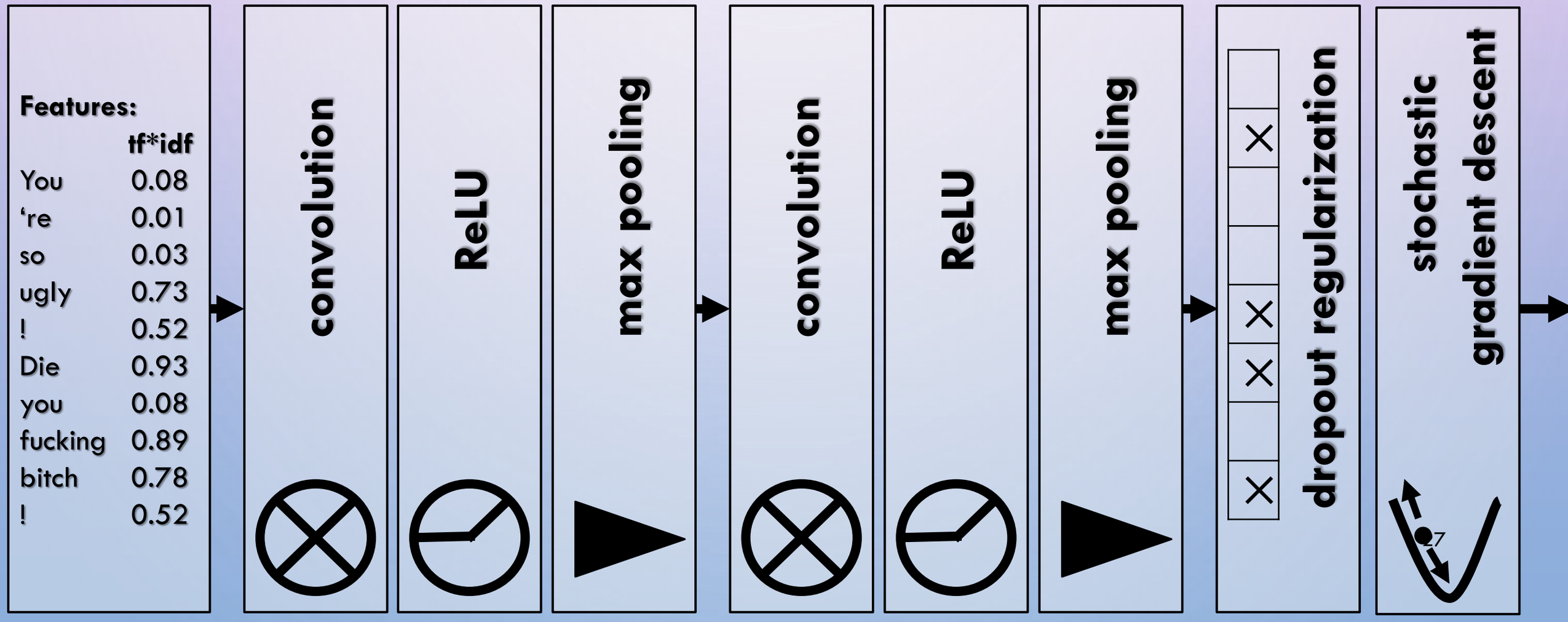


	correct	answer	Error
CB	1	.75	.25
N-CB	0	.37	.63
	Total error=		**0.88**

* Slide weight a little back and forth to minimize error

PROPOSED METHOD

- DEEP CONVOLUTIONAL NEURAL NETWORK



PROPOSED METHOD

- LANGAUGE COMBINATORICS
- DEEP CONVOLUTIONAL NEURAL NETWORK
- SHALLOW CNN
- SVM
  - LINEAR
  - POLYNOMIAL
  - RADIAL BASED FUNCTION
  - SIGMOID
- DECISION TREES (J48)
- RANDOM FORESTS
- KNN
- NAÏVE BAYES
- JRIP

[Ptaszynski et al., 2010]
[Sood et al., 2012]
[Dinakar et al., 2012]
[Sarna and Bhatia, 2015]
[Ptaszynski et al., 2015a,b]
…AND A FEW OTHERS

PROPOSED METHOD

- LANGAUGE COMBINATORICS → BRUTE FORCE
- DEEP CONVOLUTIONAL NEURAL NETWORK
- SHALLOW CNN → Neural Nets
- SVM
  - LINEAR
  - POLYNOMIAL
  - RADIAL BASED FUNCTION
  - SIGMOID

→ SVM

- DECISION TREES (J48)
- RANDOM FORESTS

→ trees

- KNN
- NAÏVE BAYES
- JRIP

→ lazy / rules

10-fold
X-validation

DATASET

- ACTUAL DATA COLLECTED BY INTERNET PATROL (ANNOTATED BY EXPERTS)
- FROM UNOFFICIAL SCHOOL FORUMS (BBS)
- PROVIDED BY HUMAN RIGHT CENTER IN JAPAN (MIE PREFECTURE)
- ACCORDING TO THE DEFINITION BY JAPANESE MINISTRY OF EDUCATION (MEXT)
- 1,490 HARMFUL AND 1,508 NON-HARMFUL ENTRIES

FEATURE SELECTION

<u>Example</u>: John McDonnald killed Mary Poppins!

- **TOKENIZATION:** JOHN MCDONNALD KILLED MARY POPPINS !
- **LEMMATIZATION:** JOHN MCDONNALD KILL MARY POPPINS !
- **PARTS OF SPEECH:** NOUN NOUN VERB NOUN NOUN EXCL.
- **TOKENS WITH POS:** JOHN_NOUN MCDONNALD_NOUN KILLED_VERB MARY_NOUN POPPINS_NOUN !_EXCL.
- **LEMMAS WITH POS:** JOHN_NOUN MCDONNALD_NOUN KILL_VERB MARY_NOUN POPPINS_NOUN !_EXCL.
- **TOKENS WITH NAMED ENTITY RECOGNITION:** JOHN [COMPANY] KILLED MARY POPPINS !
- **LEMMAS WITH NER:** JOHN [COMPANY] KILL MARY POPPINS !
- **CHUNKING:** JOHN_MCDONNALD_KILLED MARY_POPPINS_!
- **DEPENDENCY STRUCTURE:** 1-JOHN 1-MCDONNALD 2-KILLED 3-MARY 3-POPPINS 3-!
- **CHUNKING WITH NER:** JOHN_[COMPANY]_KILLED MARY_POPPINS_!
- **DEPENDENCY STRUCTURE WITH NAMED ENTITIES:** 1-JOHN 1-[COMPANY] 2-KILLED 3-MARY 3-POPPINS 3-!

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

- LAZY CLASSIFIERS :
  - GENERALLY POOR PERFORMANCE (F1 ~ 50% - 60%)
  - BETTER WITH NER (F1 ~ 70%)

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  - RANDOM FORREST – PRETTY GOOD (F1 ~ 80%), BUT TIME INEFFICIENT

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  - J48 – LOW
  - RANDOM FORREST – PRETTY GOOD (F1 ~ 80%), BUT TIME INEFFICIENT
- SVM
  - LINEAR – NICE (UP TO F1=82.5%)
  - OTHER – POOR
  - SUPER FAST TO TRAIN (BEST TIME TO PERFORMANCE RATIO)

RESULTS AND DISCUSSION

- BEST FEATURE SETS:
  - TOKENS + NER
  - LEMMAS + NER

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- BEST FEATURE SETS:
  - TOKENS + NER
  - LEMMAS + NER

** CYBERBULLYING IS OFTEN ABOUT REVEALING PRIVATE INFORMATION, NOT ONLY ABOUT SLANDERING **

- 2ND BEST METHOD (EXCEPT PROPOSED)
  - BRUTE FORCE (F1=80.3%)
  - EXCEPT ONE SVM CASE
    - LINEAR SVM ON LEMMAS (F1 = 82.5%)

RESULTS AND DISCUSSION

- BEST METHOD
  - CNN WITH 2HIDDEN LAYERS (PROPOSED)
  - F1=93.5%
  - NER ALWAYS HELPED

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…WHY?

RESULTS AND DISCUSSION

- GREATEST PROBLEM WITH NEURAL NETS
  (AND ALSO MANY OTHER MACHINE LEARNING METHODS)

Q

RESULTS AND DISCUSSION

- GREATEST PROBLEM WITH NEURAL NETS
  (AND ALSO MANY OTHER MACHINE LEARNING METHODS)

- INTERPRETABILITY
  - WHY RESULTS WERE AS GOOD?
  - WHAT EXACTLY WAS SO GOOD ABOUT IT?
  - WHAT INFLUENCED THE RESULTS?

RESULTS AND DISCUSSION

- GREATEST PROBLEM WITH NEURAL NETS
  (AND ALSO MANY OTHER MACHINE LEARNING METHODS)

- INTERPRETABILITY
  - WHY RESULTS WERE AS GOOD?
  - WHAT EXACTLY WAS SO GOOD ABOUT IT?
  - WHAT INFLUENCED THE RESULTS?

IF YOU DON'T KNOW THE CAUSE YOU CAN ALWAYS LOOK FOR CORRELATION

RESULTS AND DISCUSSION

1. NAMED ENTITY RECOGNITION USUALLY HELPED ESPECIALLY WITH CNN
2. …?

→GENERAL LOOK AT THE DATA

→WHAT IS DIFFERENT ABOUT THE DATA?

RESULTS AND DISCUSSION

- LEXICAL DENSITY [URE, 1971]

ALL UNIQUE WORDS IN CORPUS / ALL WORDS IN CORPUS

[Ure, 1971] J. Ure. Lexical density and register differentiation. Applications of Linguistics, pages 443–452, 1971.

RESULTS AND DISCUSSION

- LEXICAL DENSITY [URE, 1971]

ALL UNIQUE WORDS IN CORPUS / ALL WORDS IN CORPUS

NOT JUST WORDS:

TOKENS, LEMMAS, POS, TOKEN-POS, TOKEN-NER, LEMMA-POS, LEMMA-NER, CHUNKS, CHUNKS-NER, DEPENDENCY, DEP-NER,

[Ure, 1971] J. Ure. Lexical density and register differentiation. Applications of Linguistics, pages 443–452, 1971.

RESULTS AND DISCUSSION

- ~~LEXICAL DENSITY [URE, 1971]~~ → **FEATURE DENSITY**

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FEATURE DENSITY

- CALCULATE FD FOR ALL DATASETS
- CHECK CORRELATION BETWEEN FD AND CLASSIFIER RESULTS

FEATURE DENSITY

Classifier	ρ value	2-sided p-value
CNN-2L	0.638	*p=0.035
SVM-pol	-0.431	p=0.185
SVM-sig	-0.534	p=0.091
SPEC(BEP)	-0.550	p=0.133
RF	-0.560	p=0.073
SVM-lin	-0.564	p=0.076
SPEC(F1)	-0.636	p=0.066
SVM-rad	-0.639	*p=0.034
CNN-1L	-0.709	*p=0.019
JRip	-0.729	*p=0.011
NB	-0.736	*p=0.013
J48	-0.791	**p=0.006
kNN	-0.809	**p=0.004

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DENSIER DATA KILLS CLASSIFIER

POORLY PERFORMING CLASSIFIERS: NEGATIVE STRONG CORELATION WITH FD

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PROBABLY* **DENSIER DATA HARMS CLASSIFIER**

(*low significance)

MODERATELY PERFORMING CLASSIFIERS:
NEGATIVE MEDIUM CORELATION FITH FD

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CNN-2L	0.638	*p=0.035
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SVM-sig	-0.534	p=0.091
SPEC(BEP)	-0.550	p=0.133
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→ CNN – BEST PERFORMANCE
STRONG POSITIVE
CORRELATION WITH FD

DENSIER DATA = BETTER RESULTS

FEATURE DENSITY

Classifier	ρ value	2-sided p-value
CNN-2L	0.638	*p=0.035
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→ CNN – BEST PERFORMANCE
STRONG POSITIVE
CORRELATION WITH FD

FUTURE:
LET'S CHECK
EVEN
DENSIER DATA

CONCLUSIONS

- PROBLEM: CYBERBULLYING DETECTION
- MANY FEATURE SETS
- MANY CLASSIFIERS
- PROPOSED DEEP CNN SOLUTION
- NAMED ENTITY ANNOTATION USUALLY HELPED DETECT CYBERBULLYING
- FEATURE DENSITY POSITIVELY CORELATED WITH CNN RESULTS
  - WILL CHECK EVEN DENSIER FEATURE SETS
  - WILL CHECK FOR OTHER TASKS : SENTIMENT, DECEPTION, SARCASM, ETC.

THANK YOU FOR YOUR KIND ATTENTION!

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