

Duplicate bug report detection through machine learning techniques

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Introduction

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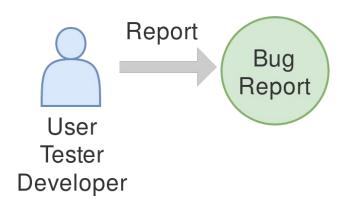
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LPC54608J512_Project	 — — —	ox12_Project_Demo.axf				GPIOA [MK64FN1M0xx	12] Register	Address	Value	^	D Z ADCO	0x4003b000	Analog-to-Digi	
AK64FN1M0xxx12_Project		536881672 (Shell [P: 1]				GPIOD [MK64FN1M0xx		0x4006600		100	ADC1	0x400bb000	Analog-to-Digi	
Includes	✓ m Thread #4	536887400 (IDLE : Runn	ning [P: 0]) (Susper	nded : Signal : SIGTRAP:T	race/breakpoint trap)	I2C0 [MK64FN1M0xx1]	00	0x4006600			AIPSO	0x40000000	AIPS-Lite Bridge	
3 CMSIS	E FRTOS1	_vApplicationIdleHool	k() at Events.c:120	0x10fa			2 8101 241				AIPS1	0x40080000	AIPS-Lite Bridge	
drivers	= prvidle	Task() at tasks.c:3'327 (0x18284				> 1000 F > 1000 C1	0x4006600 0x4006600			AXBS	0x40004000	Crossbar switch	
3 frdmk64f	🔲 0x0										CANO	0x40024000	Flex Controller	
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MK64FN1M0xxx12_Project.c	VTaskD	elay() at tasks.c:1'374 0	0x179f0				✓ ### C2	0x4006600			CMP1	0x40073008	High-Speed Co	
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startup_mk64f12.c	= 0x0						RMEN	[3:3]	Value_0		CMT	0x40062000	Carrier Modula	
utilities	> 🔊 Thread #6	536877560 (TzCtrl [P: 1]) (Suspended : Co	ontainer)			SBRC	[4:4]	Value_0			0x40032000	Cyclic Redunda	
fsl_debug_console.c	✓ n [®] Thread #7	536889112 (Tmr Svc [P	: 2]) (Suspended :	Container)			es HDRS	[5:5]	Value_0		DAC0	0x400cc000	12-Bit Digital-t	
h fsl_debug_console.h	VPortYi	ieldFromISR() at port.c	:947 0x16660				ADEXT	[6:6]	Value_0		DACI	0x400cd000	12-Bit Digital-t	
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doc		erTask() at timers.c:56					> ### FLT	0x4006600					DMA channel	
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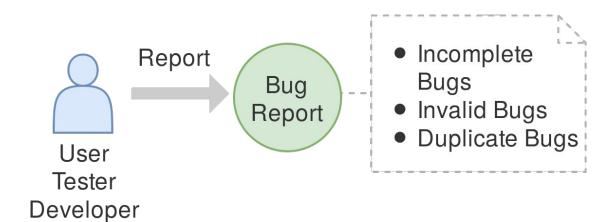
Introduction

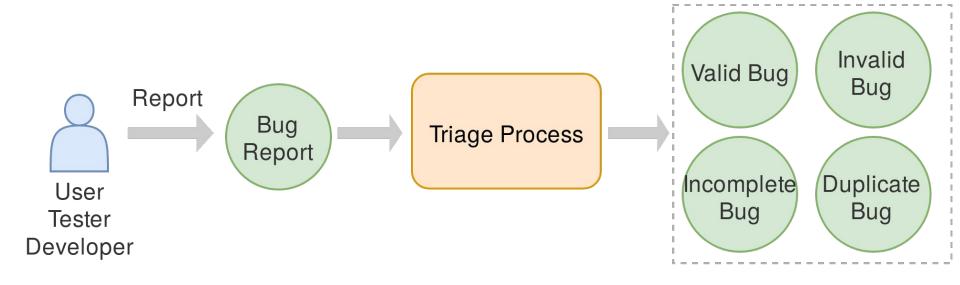
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eclipse				DOWNLOAD	GETTING STARTED	MEMBERS	PROJECTS	MORE -
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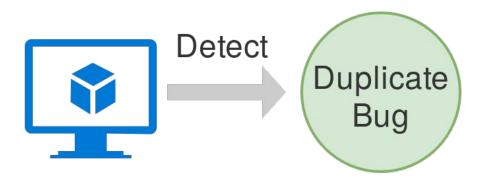




Triage Process

- Manual checking
- Time and money consuming
- Large user base project: Firefox ~300 new reports per day

Objective



- Increase software quality and save resource
 - Decrease triage team overload
 - Avoid two or more developers fixing the same bug
 - Avoid to fix a bug already solved

Duplicate bug report detection

- Detect whether a bug is duplicate or not
- Master set
 - Master report
 - Duplicate reports
 - Every report is in a master set
- Three approaches
 - Decision-making approach
 - Binary classification approach
 - Ranking approach

Decision-making approach

- Pairs of bug reports (Training and Evaluation)
- Drawbacks
 - Too Easy
 - High probability to create easy non-duplicate pairs
 - Far from the real scenario
 - Compare new bug with a set of bugs in the dataset

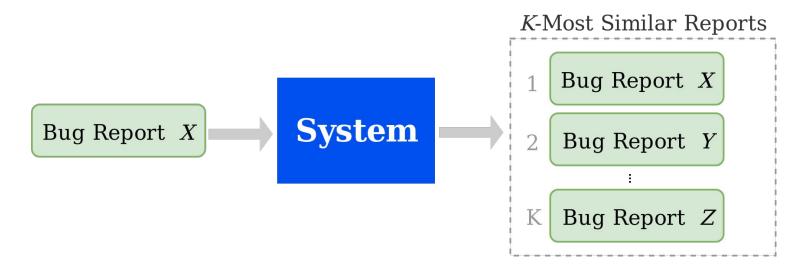


Binary classification approach

- Automatic prediction of the report as duplicate or not
 - General information extracted from the database and the new bug reports
- False negative can have a great impact
- Really difficult task

Ranking approach

- Recommend a similarity list
- A person check the list and label the report as duplicate or not
 - Decrease the decision time
- The most used approach in the literature
- Metric: Recall Rate
 - Rate of reports whose the lists have at least one bug report from the same master set

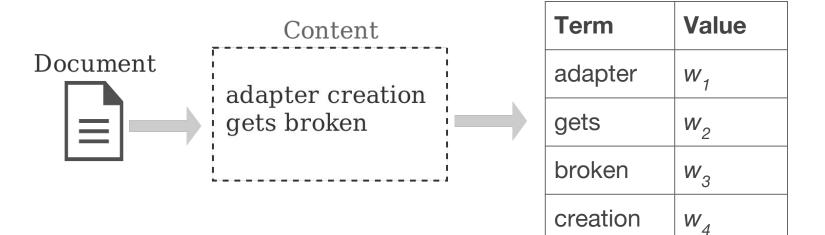


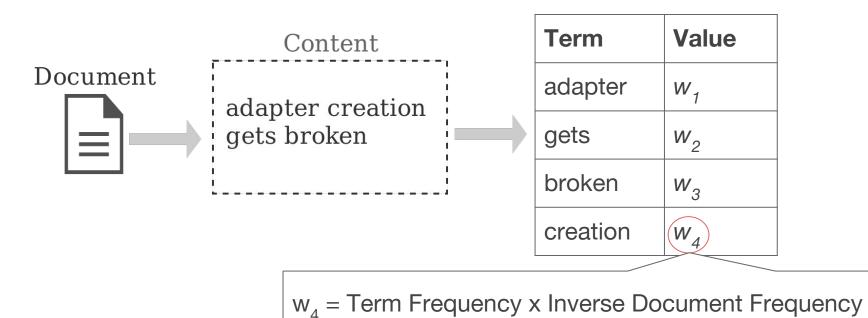
Ranking approach

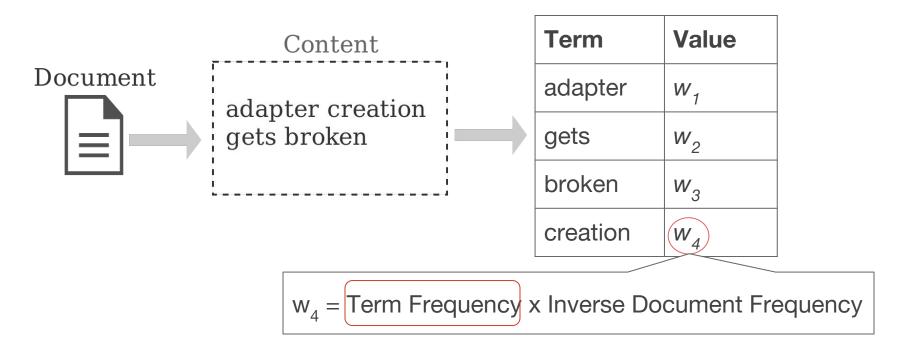
- Two methodologies: Deshmukh et al. 2017 and Sun et al. 2011
- Deshmukh et al. 2017
 - Training, validation and test datasets are randomly generated
 - Evaluation: similarity list are created using bug from the test dataset
 - Unrealistic scenario
 - It makes the problem easier
 - Decrease number of comparisons
 - Concept Drift mitigation
- Sun et al. 2011
 - Reports are sorted by creation date
 - Training, validation and test are generate by period of time
 - New bug report is compared with all previous bug reports
 - More realistic scenario

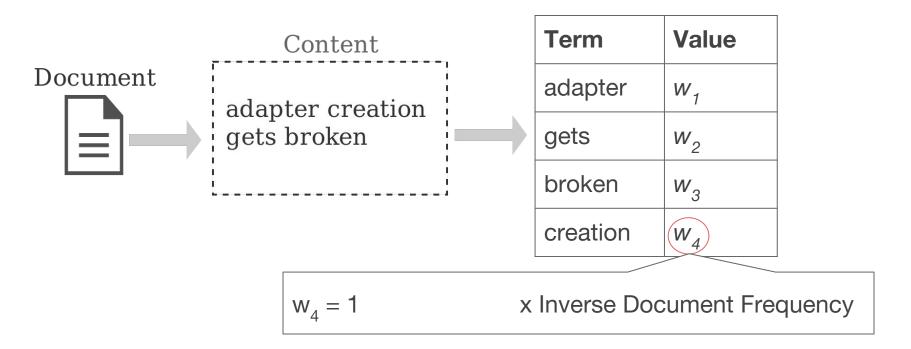
Our Solution

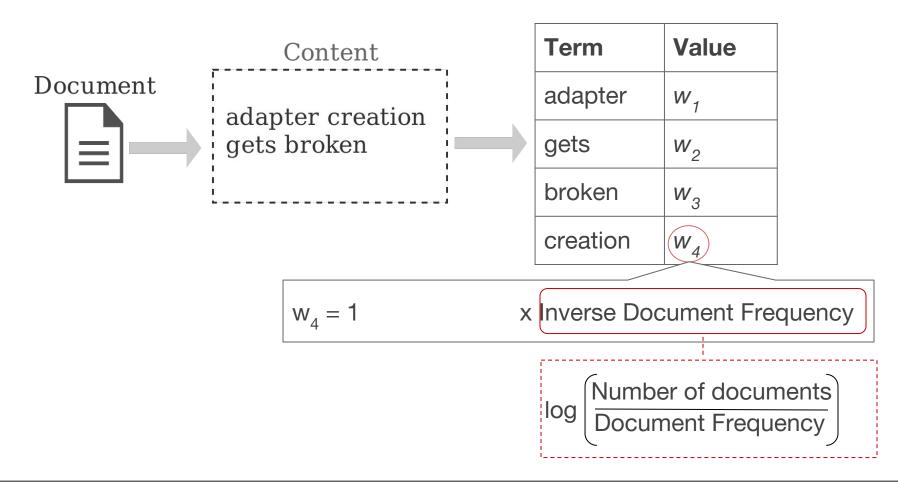
- Ranking approach + Sun's Methodology
- Only textual data
 - Summary and description
- Baseline: TF-IDF
- Model: Word Embeddings + Convolution Neural Network

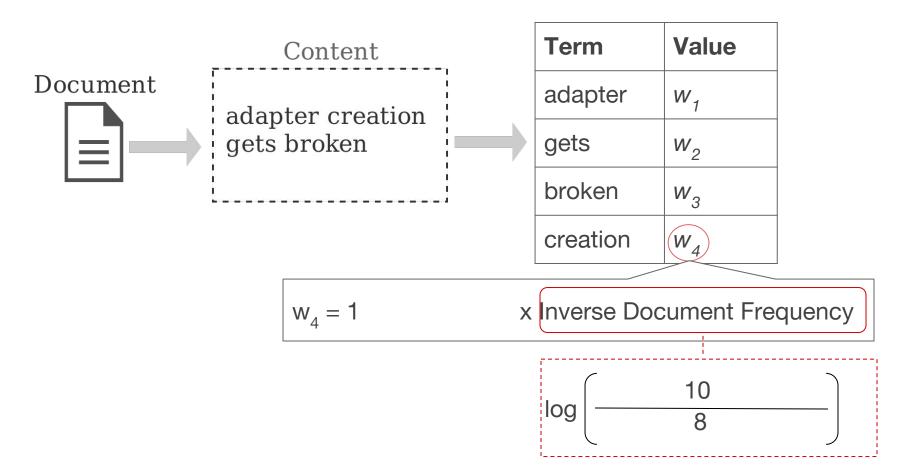




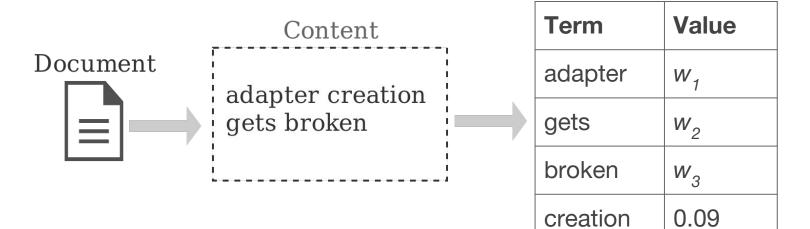








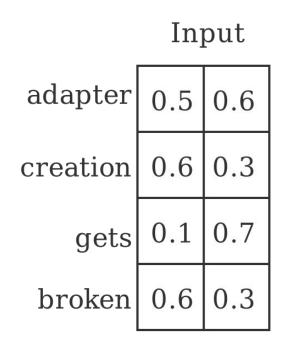
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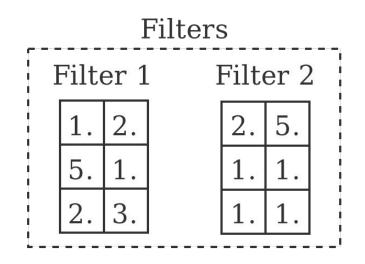


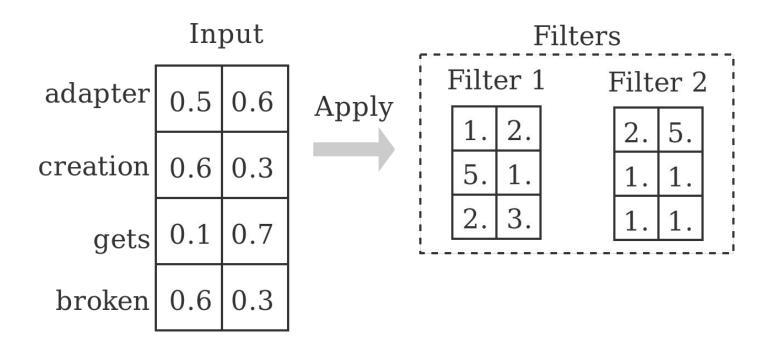
Represent word as vector

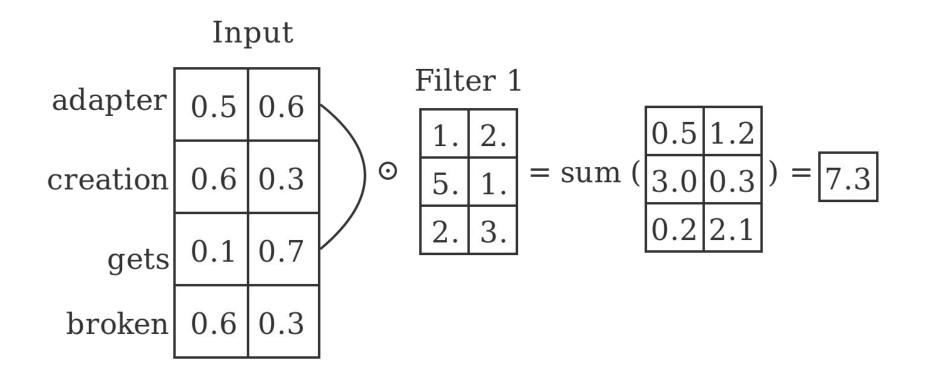
- Word Embedding
 - Dense vectors with real numbers
 - More compact representation
 - Semantic and syntactic information

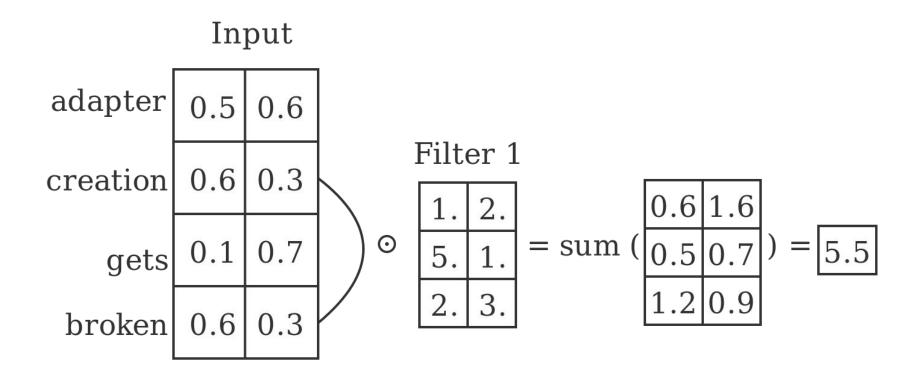
Word	Representation
adapter	[0.5, 0.6]
broken	[0.3, 0.2]
gets	[0.1, 0.7]
creation	[0.6, 0.3]

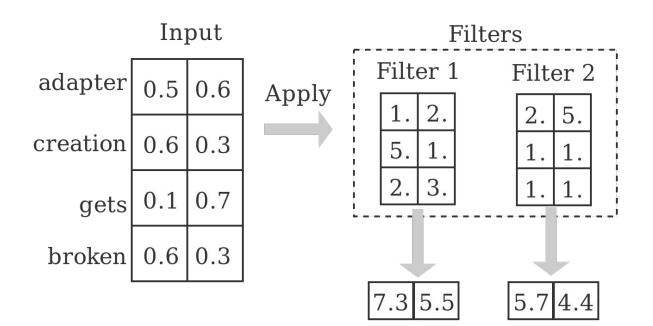


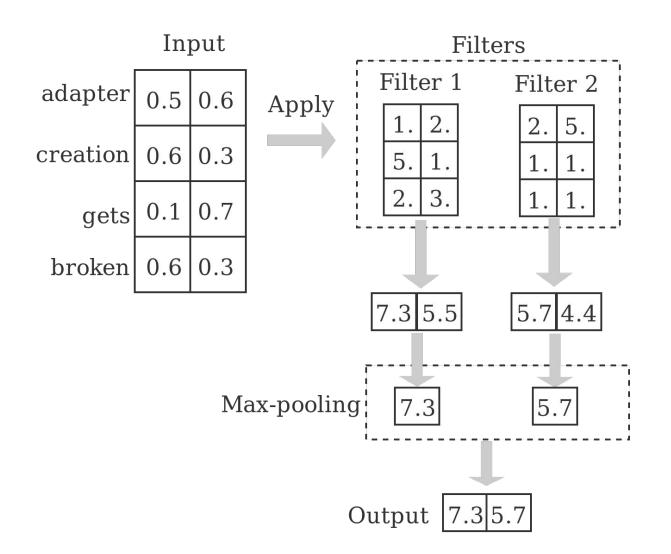




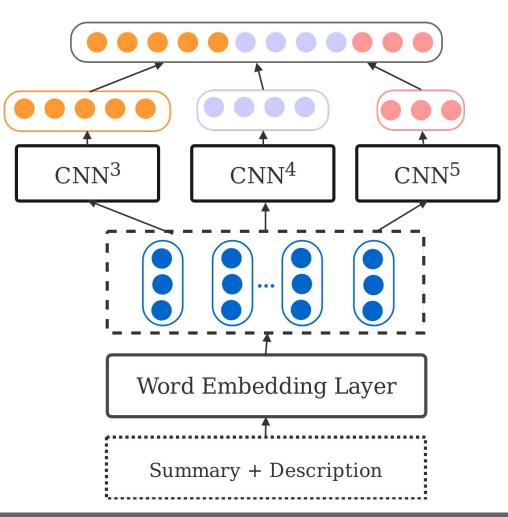


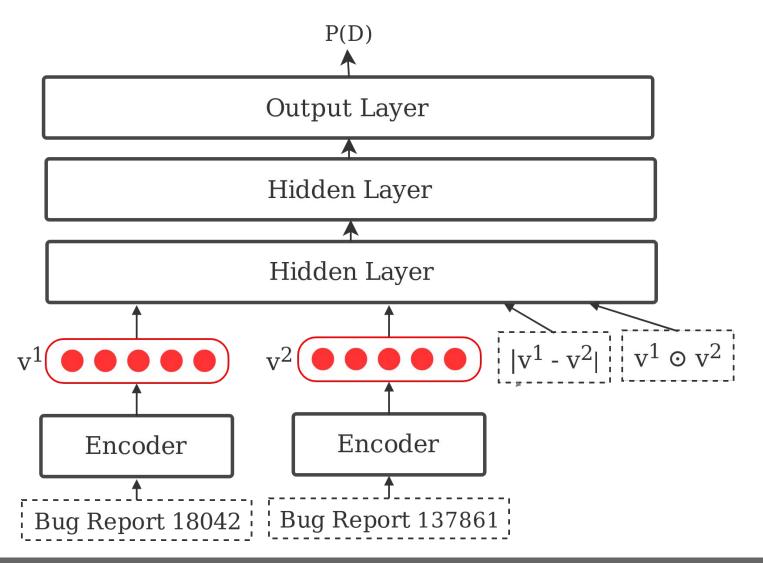




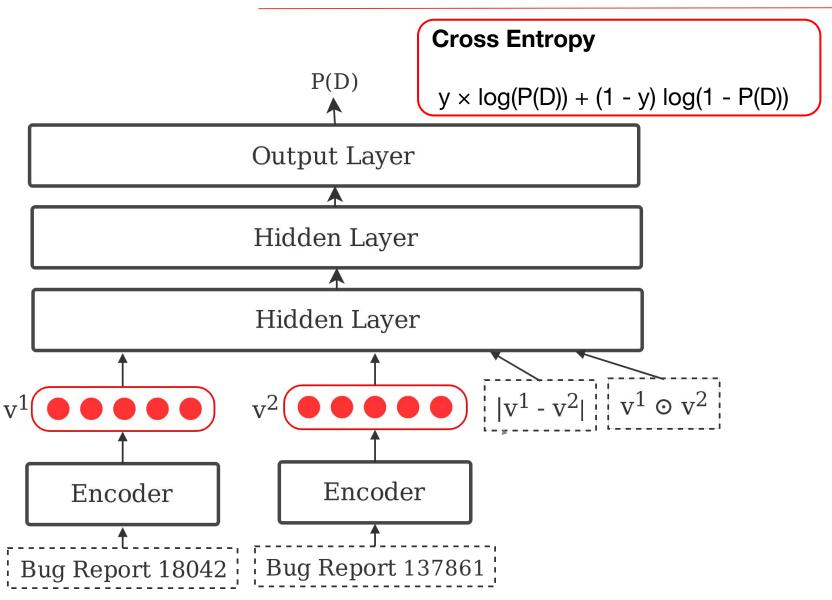


- Encoder
 - Represent the report as vector





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Preliminar Results

Model	Тор-5	Тор-10	Top-15	Тор-20
TF-IDF	44.80%	51.27%	54.97%	57.88%
DL Model	37.11%	43.95%	48.61%	52.03%

- Challenge:
 - Generate relevant non-duplicate pairs (negative) can be difficult
 - Most non-duplicate pairs are easy
 - \circ ~ n² different combinations
 - o n = 174,002 ⇔ n² ≅ 30 x 10⁹
- Solution: Random subsample negative examples each epoch
 - Constraint: loss has to be greater than 0
 - Keep rate between positive and negative examples

Preliminar Results

Model	Тор-5	Top-10	Top-15	Тор-20
TF-IDF	44.80%	51.27%	54.97%	57.88%
DL Model	37.11%	43.95%	48.61%	52.03%
DL Model - subsampling by epoch	44.02%	51.03%	55.49%	58.43%

Preliminar Results

Model	Тор-5	Top-10	Top-15	Тор-20	
TF-IDF	44.80%	51.27%	54.97%	57.88%	
DL Model				52.03% -	
DL Model - subsampling by epoch	44.02%	51.03%	55.49%	58.43% -	0.40%

Future Work

- Bottleneck: select negative pairs
 - Try different approaches
- Encoder receives information from the first bug
 - Attention
- Combine different information sources
 - Categorical information, stack trace, tracing
- Use our solution to help our partners
 - Partner data

Thank you for your attention! Questions?

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Represent word as vector

- One hot encoding
 - Binary Vectors
 - Vector Size = Vocabulary Size
 - Curse of Dimensionality

Word	Representation
adapter	[1,0,0,0]
broken	[0,1,0,0]
gets	[0,0,1,0]
creation	[0,0,0,1]

