

# NLP-based Test Selection

Sensible way to better Manual Testing?

# The Problem

A lot of manual tests like this

Home / P1.Extensions - File Manager Tests / Delete a file ▾

## Delete a file

Last modified by Gabriela Anghitoaei on 2022/05/03 09:29

Home File Manager Tests Home Run Test

### Steps to reproduce

1. Click on File Manager from Applications Panel
2. Click on All Files
3. Select a file
4. Click on Delete
5. Click on OK

### Expected results

The file is deleted.

### Results

Results 1 - 15 out of 17 per page of 15 ▾

Page 1 2

Product	App	Browsers	Databases	Servlet Containers	Tested By	Tested On	Result	Jira Issue
XWiki 6.4	Mozilla Firefox 35	HyperSQL 2.3.2		Ramona Conoro	12-02-2015 03:22	Passed		
XWiki 6.4	Internet Explorer 10	HyperSQL 2.3.2		Ramona Conoro	12-02-2015 02:57	Failed	<a href="http://jira.xwiki.org/browse/FILEMAN-98">http://jira.xwiki.org/browse/FILEMAN-98</a>	
XWiki 6.4.1	Google Chrome 40	HyperSQL 2.3.2		Ramona Conoro	20-02-2015 08:12	Passed		

# The Problem

A lot of manual tests like this

The screenshot shows a web browser window with the URL [/P1.Extensions - File Manager Tests / Delete a file](#). The page title is "Delete a file". It was last modified by Gabriela Architao on 2022/05/03 09:29. Below the title, there are three buttons: "Home", "File Manager Tests Home", and "Run Test". A red box highlights the "File Manager Tests Home" button. To its right, another red box highlights the "Steps to reproduce" section. This section contains the following steps:

1. Click on File Manager from Applications Panel
2. Click on All Files
3. Select a file
4. Click on Delete
5. Click on OK

Below this, another red box highlights the "Expected results" section, which contains the text: "The file is deleted." At the bottom left, the text "Expected results" is followed by "The file is deleted."

## Steps to reproduce

1. Click on File Manager from Applications Panel
2. Click on All Files
3. Select a file
4. Click on Delete
5. Click on OK

## Expected results

The file is deleted.

## Results

Results 1 - 15 out of 17 per page of 15

Page 1 2

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XWiki 6.4.1	Google Chrome 40	HyperSQL 2.3.2			Ramona Conoro	20-02-2015 08:12	Passed	

[Colibri] Fill Primary Action Button Background Color	Color Themes Tests	value1	XWiki 7.1.4			0
[Deprecated] See List Of Joined Wikis	Main		No test executions found			0
[Deprecated] Do Not Display Left Panel Column	Main		No test executions found			0
[Deprecated] Install And Uninstall Application From Wiki	Main		No test executions found			0
[Colibri] Fill Title Color	Color Themes Tests	value1	XWiki 6.4.3			0
[Colibri] Fill Informative Text Color	Color Themes Tests	value1	XWiki 6.4.3			0
Space Macro Create Space From Wiki Homepage	Enterprise Tests	value2	XWiki 7.1.4			0
[Colibri] Fill Page Header Background Color	Color Themes Tests	value1	XWiki 6.4.3			0
[Deprecated] Delete annotated text	Annotations Tests	value2	XWiki 8.1			0
[Deprecated] Create Wiki From Template	Main		No test executions found			0
[Colibri] Fill Border Color	Color Themes Tests	value1	XWiki 7.1.4			0
[Deprecated] Create a page in subwiki	Main		No test executions found			0
[Colibri] Fill Add Menu Entry Link Color	Color Themes Tests	value1	XWiki 6.4.3			0
[Deprecated] See Activity Stream Of A Wiki created with a normal user	Main		No test executions found			0
[Deprecated] Groups Access Rights Deny Delete Rights	Main		No test executions found			0
[Colibri] Fill Primary Action Button Text Color	Color Themes Tests	value1	XWiki 6.4.3			0
[Deprecated] Set And Unset Wiki As Template From Inline Mode	Main		No test executions found			0
[Deprecated] Rename a document	Main	value1	No test executions found			0
[Deprecated] Add an annotation in subwiki	Main		No test executions found			0
[Colibri] Fill Panel Header Background Color	Color Themes Tests	value1	XWiki 6.4.3			0
[Colibri] Fill Secondary Action Button Background	Color Themes Tests	value1	XWiki 6.4.3			0

# Cut and Paste a folder

Last modified by Gabriela Anechitoaei on 2022/05/03 09:27

Home

File Manager Tests Home

Run Test

## Steps to reproduce

1. Go to File Manager region
2. Right click on a folder
3. Select Cut
4. Go to another folder
5. Right click on the new folder
6. Select Paste Into Folder

## Expected results

The new file was moved to the new location.

Product	Result	Jira Issue
	All	
XWiki 6.4	✗ Failed	<a href="http://jira.xwiki.org/browse/FILEMAN-98">http://jira.xwiki.org/browse/FILEMAN-98</a>
XWiki 6.4	✓ Passed	
XWiki 6.4.1	✓ Passed	
XWiki 6.4.1	✓ Passed	
XWiki 6.4.2	✓ Passed	
XWiki 7.1.2	✓ Passed	
XWiki 7.1.4	✓ Passed	
XWiki 7.2M2	✓ Passed	
XWiki 7.4.1	✓ Passed	

# Cut and Paste a folder

Last modified by Gabriela Anechitoaei on 2022/05/03 09:27

Home

File Manager Tests Home

Run Test

## Steps to reproduce

1. Go to File Manager region
2. Right click on a folder
3. Select Cut
4. Go to another folder
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## Expected results

The new file was moved to the new location.

Product	Result	Jira Issue
	All	
XWiki 6.4	✗ Failed	<a href="http://jira.xwiki.org/browse/FILEMAN-98">http://jira.xwiki.org/browse/FILEMAN-98</a>
XWiki 6.4	✓ Passed	
XWiki 6.4.1	✓ Passed	
XWiki 6.4.1	✓ Passed	
XWiki 6.4.2	✓ Passed	
XWiki 7.1.2	✓ Passed	
XWiki 7.1.4	✓ Passed	
XWiki 7.2M2	✓ Passed	
XWiki 7.4.1	✓ Passed	

# Cut and Paste a folder

Last modified by Gabriela Anechitoaei on 2022/05/03 09:27

Home

File Manager Tests Home

Run Test

## Steps to reproduce

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The new file was moved to the new location.

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XWiki 6.4	✓ Passed	
XWiki 6.4.1	✓ Passed	
XWiki 6.4.1	✓ Passed	
XWiki 6.4.2	✓ Passed	
XWiki 7.1.2	✓ Passed	
XWiki 7.1.4	✓ Passed	
XWiki 7.2M2	✓ Passed	
XWiki 7.4.1	✓ Passed	

# Cut and Paste a folder

Last modified by Gabriela Anechitoaei on 2022/05/03 09:27

Home

File Manager Tests Home

Run Test

## Steps to reproduce

1. Go to File Manager region
2. Right click on a folder
3. Select Cut
4. Go to another folder
5. Right click on the new folder
6. Select Paste Into Folder

## Expected results

The new file was moved to the new location.

Product	Result	Jira Issue
All		
XWiki 6.4	✗ Failed	<a href="http://jira.xwiki.org/browse/FILEMAN-98">http://jira.xwiki.org/browse/FILEMAN-98</a>
XWiki 6.4	✓ Passed	
XWiki 6.4.1	✓ Passed	
XWiki 6.4.1	✓ Passed	
XWiki 6.4.2	✓ Passed	
XWiki 7.1.2	✓ Passed	
XWiki 7.1.4	✓ Passed	
XWiki 7.2M2	✓ Passed	
XWiki 7.4.1	✓ Passed	

# Cut and Paste a folder

Last modified by Gabriela Anechitoaei on 2022/05/03 09:27

Home

File Manager Tests Home

Run Test

## Steps to reproduce

1. Go to File Manager region
2. Right click on a folder
3. Select Cut
4. Go to another folder
5. Right click on the new folder
6. Select Paste Into Folder

## Expected results

The new file was moved to the new location.

Product	Result	Jira Issue
	All	
XWiki 6.4	✖ Failed	<a href="http://jira.xwiki.org/browse(FILEMAN-98">http://jira.xwiki.org/browse(FILEMAN-98</a>
XWiki 6.4	✔ Passed	
XWiki 6.4.1	✔ Passed	
XWiki 6.4.1	✔ Passed	
XWiki 6.4.2	✔ Passed	
XWiki 7.1.2	✔ Passed	
XWiki 7.1.4	✔ Passed	
XWiki 7.2M2	✔ Passed	
XWiki 7.4.1	✔ Passed	

# Cut and Paste a file

Last modified by Gabriela Anechitoaei on 2022/05/03 09:28

[Home](#) [File Manager Tests Home](#) [Run Test](#)

## Steps to reproduce

1. Click on File Manager from Applications Panel
2. Right click on File Manager and add 2 folders
3. Add to one folder one file
4. Select the file added
5. Click on Cut button
6. Go to the 2<sup>nd</sup> folder
7. Paste the file in that folder

## Expected results

The file was moved to the second folder.

Product	Result	Jira Issue
	All	
XWiki 10.1	Passed	
XWiki 6.4	Passed	
XWiki 6.4	Failed	<a href="http://jira.xwiki.org/browse(FILEMAN-98">http://jira.xwiki.org/browse(FILEMAN-98</a>
XWiki 6.4	Failed	<a href="http://jira.xwiki.org/browse(FILEMAN-98">http://jira.xwiki.org/browse(FILEMAN-98</a>
XWiki 6.4.1	Passed	
XWiki 6.4.1	Passed	
XWiki 6.4.1	Passed	
XWiki 6.4.2	Passed	
XWiki 7.1.2	Passed	

# Copy and Paste a folder

Last modified by Gabriela Anechitoaei on 2022/05/03 09:29

Home

File Manager Tests Home

Run Test

## Steps to reproduce

1. Go to File Manager region
2. Right click on a folder
3. Select Copy
4. Go to another folder
5. Right click on the new folder
6. Select Paste Into Folder

## Expected results

The folder was copied to the new location.

Product	Result	Jira Issue
	All	
XWiki 6.4	Passed	
XWiki 6.4	Failed	<a href="http://jira.xwiki.org/browse/FILEMAN-98">http://jira.xwiki.org/browse/FILEMAN-98</a>
XWiki 6.4.1	Passed	
XWiki 6.4.1	Passed	
XWiki 6.4.2	Passed	
XWiki 7.1.2	Passed	
XWiki 7.1.4	Passed	
XWiki 7.2M2	Passed	
XWiki 7.4.2	Passed	

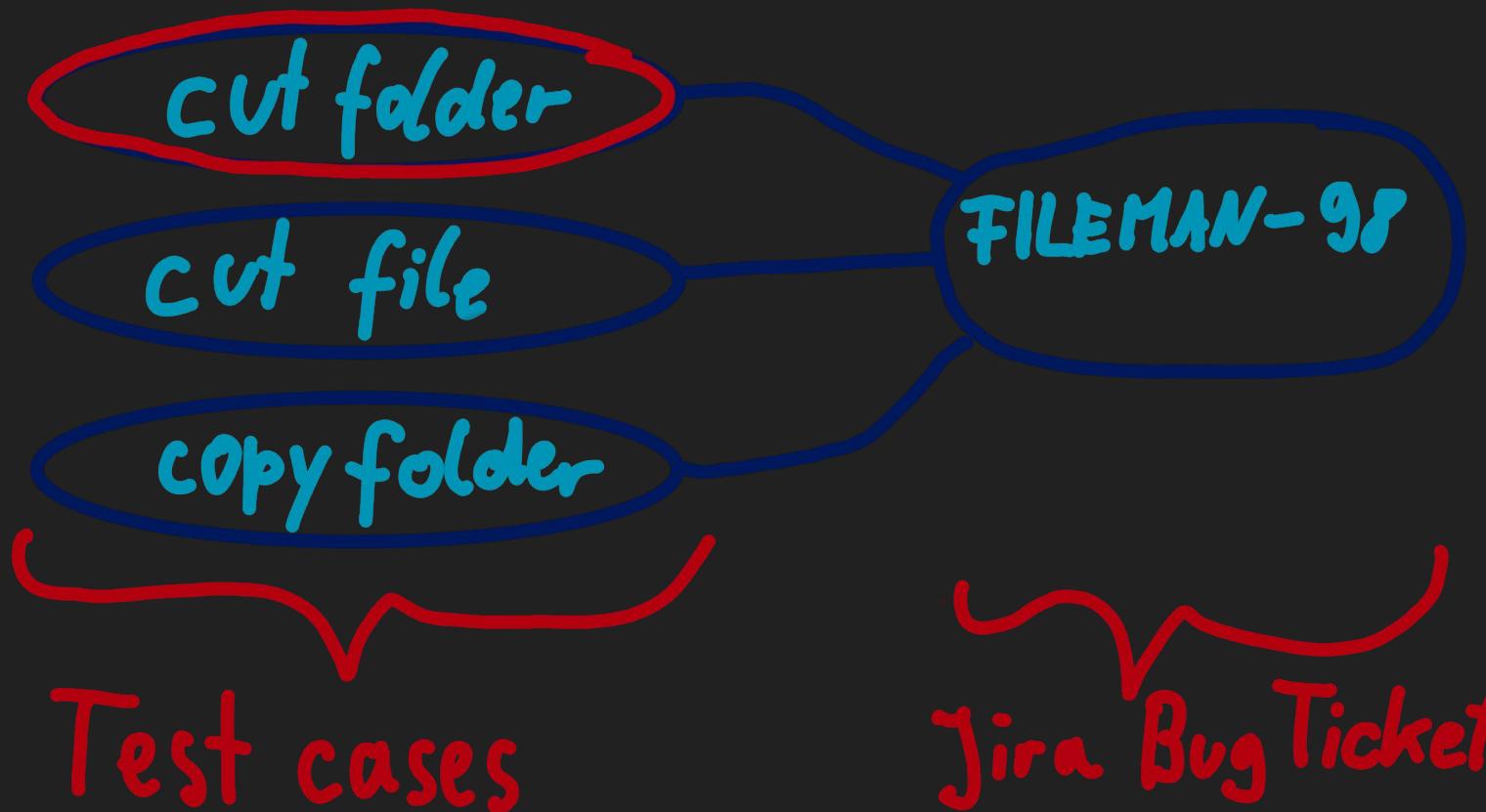
The solution - Similar Tests may belong to similar bug tickets:



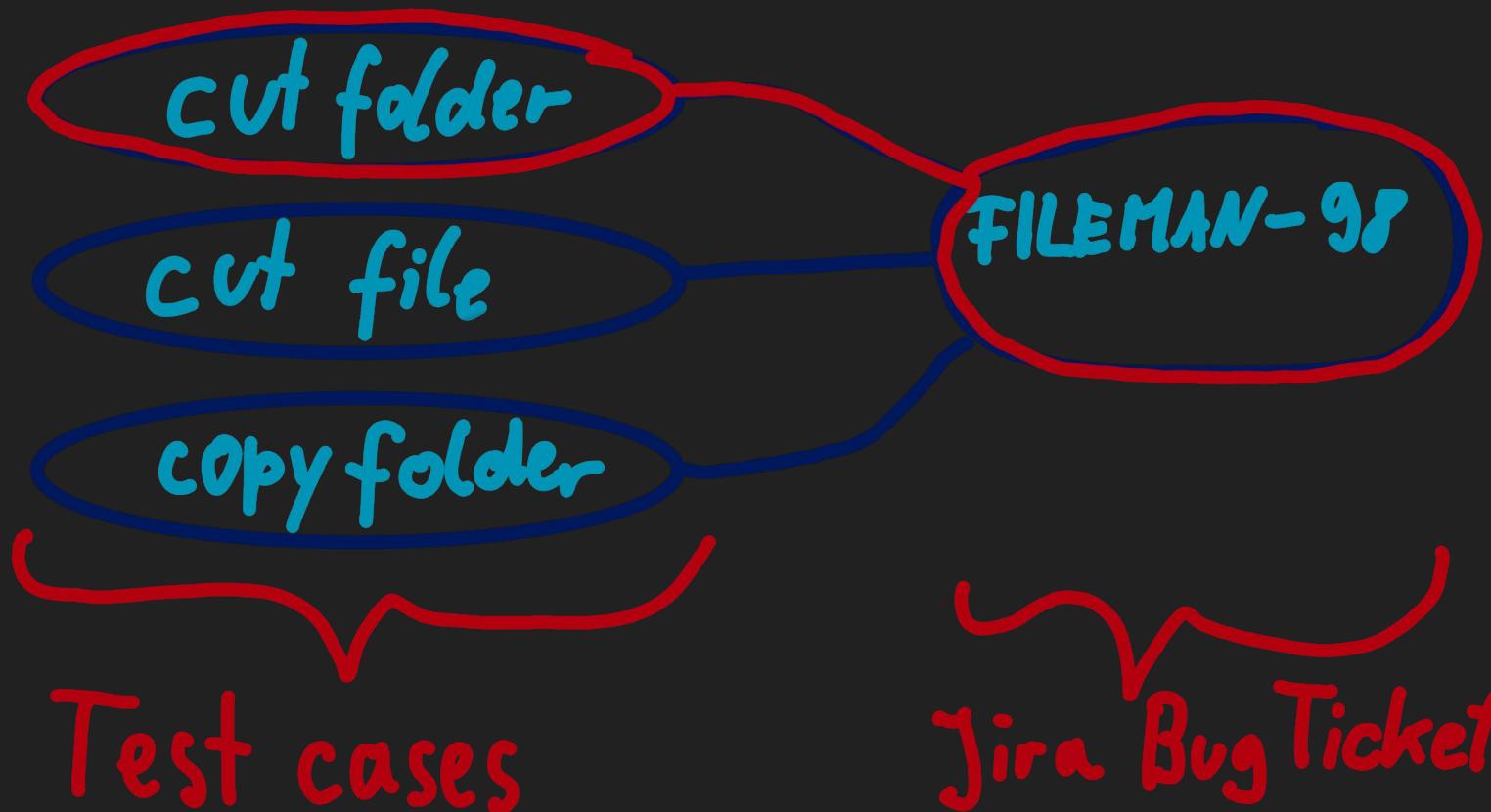
Test cases

Jira Bug Ticket

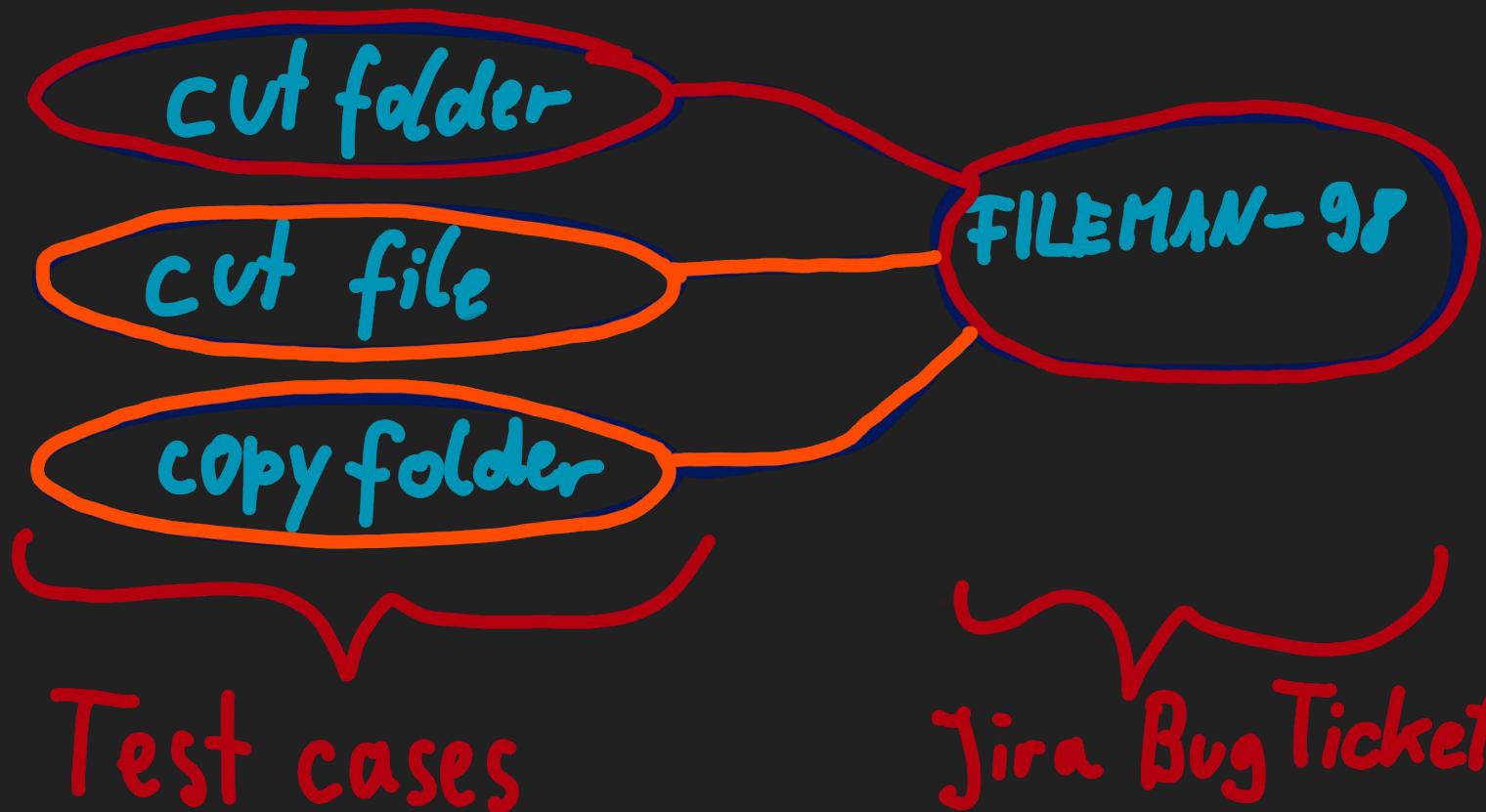
The solution - Similar Tests may belong to similar bug tickets:



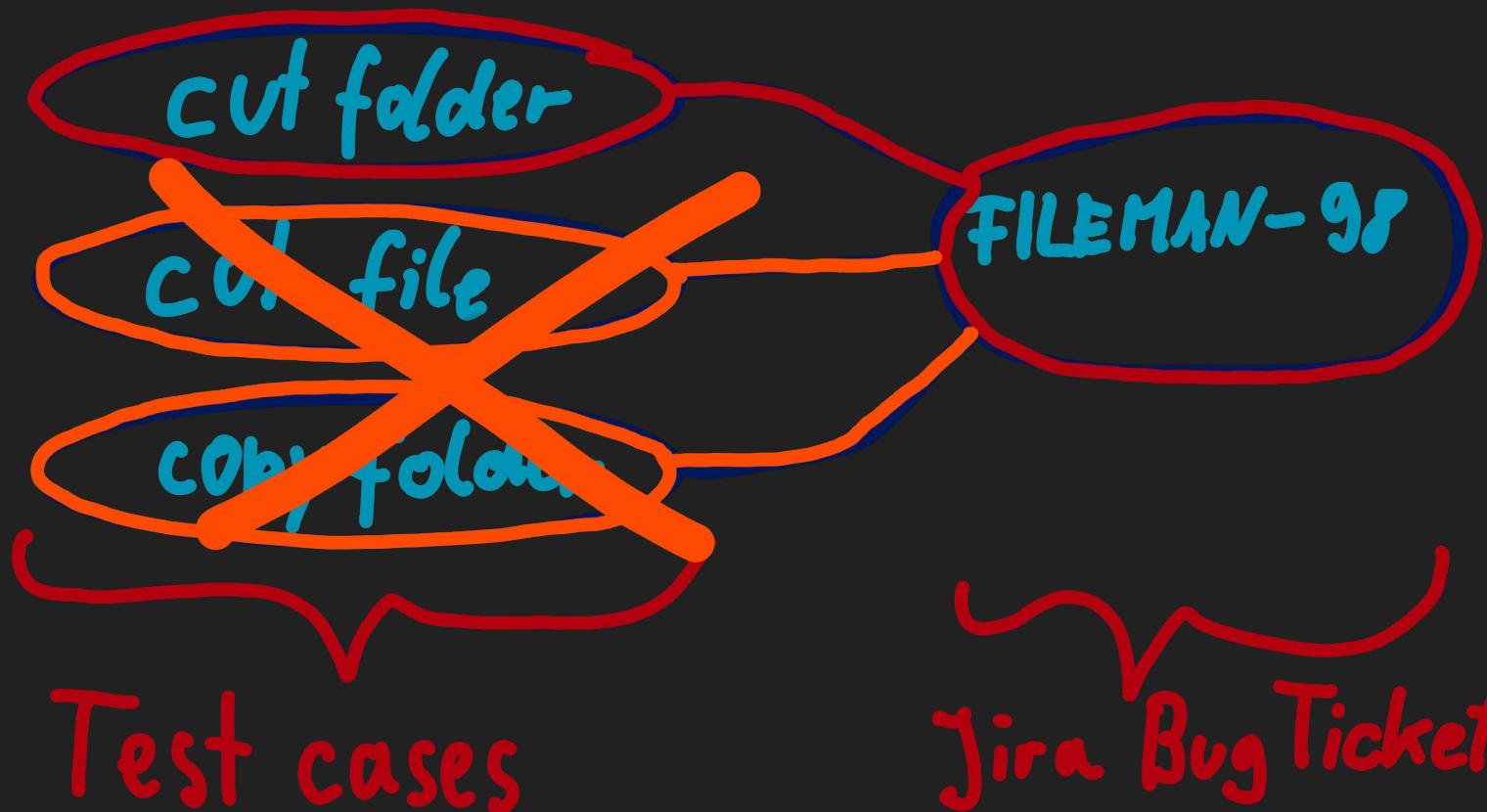
The solution - Similar Tests may belong to similar bug tickets:



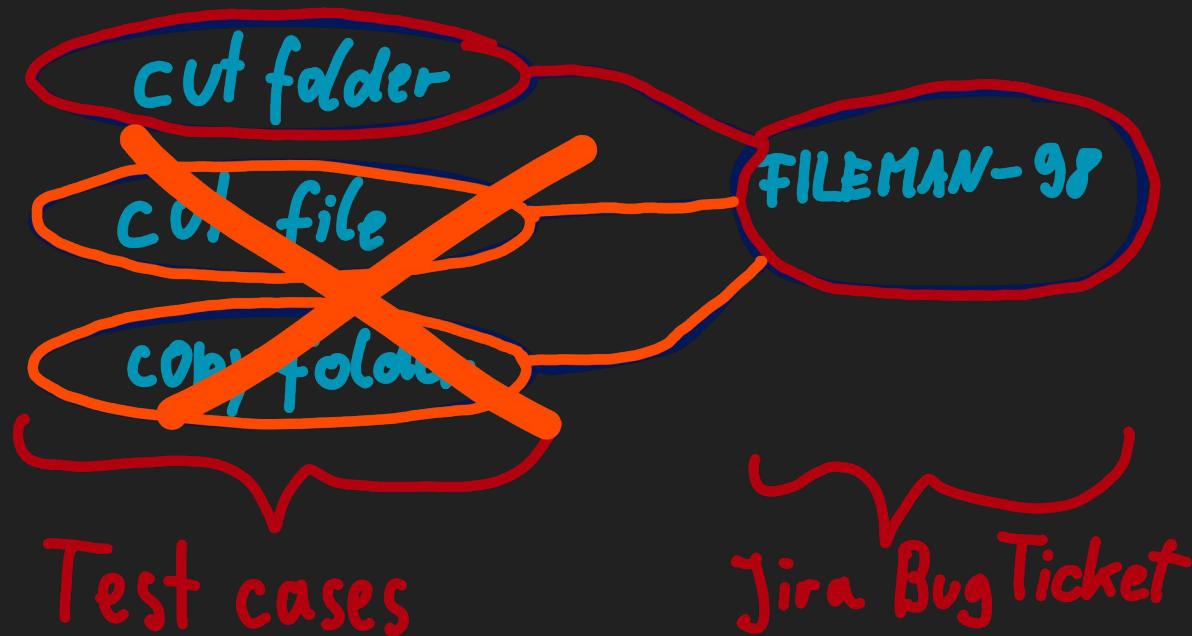
The solution - Similar Tests may belong to similar bug tickets:



The solution - Similar Tests may belong to similar bug tickets:



The solution - Similar Tests may belong to similar bug tickets:



-> Our Goal: Remove similar Test Cases from Selection

# Cut and Paste a folder

Last modified by Gabriela Anechitoaei on 2022/05/03 09:27

Home

File Manager Tests Home

Run Test

## Steps to reproduce

1. Go to File Manager region
2. Right click on a folder
3. Select Cut
4. Go to another folder
5. Right click on the new folder
6. Select Paste Into Folder

## Expected results

The new file was moved to the new location.

Product	Result	Jira Issue
	All	
XWiki 6.4	✗ Failed	<a href="http://jira.xwiki.org/browse/FILEMAN-98">http://jira.xwiki.org/browse/FILEMAN-98</a>
XWiki 6.4	✓ Passed	
XWiki 6.4.1	✓ Passed	
XWiki 6.4.1	✓ Passed	
XWiki 6.4.2	✓ Passed	
XWiki 7.1.2	✓ Passed	
XWiki 7.1.4	✓ Passed	
XWiki 7.2M2	✓ Passed	
XWiki 7.4.1	✓ Passed	

# Cut and Paste a folder

Last modified by Gabriela Anechitoaei on 2022/05/03 09:27

Home

File Manager Tests Home

Run Test

## Steps to reproduce

1. Go to File Manager region
2. Right click on a folder
3. Select Cut
4. Go to another folder
5. Right click on the new folder
6. Select Paste Into Folder

## Expected results

The new file was moved to the new location.

Product	Result	Jira Issue
	All	
XWiki 6.4	✗ Failed	<a href="http://jira.xwiki.org/browse/FILEMAN-98">http://jira.xwiki.org/browse/FILEMAN-98</a>
XWiki 6.4	✓ Passed	
XWiki 6.4.1	✓ Passed	
XWiki 6.4.1	✓ Passed	
XWiki 6.4.2	✓ Passed	
XWiki 7.1.2	✓ Passed	
XWiki 7.1.4	✓ Passed	
XWiki 7.2M2	✓ Passed	
XWiki 7.4.1	✓ Passed	

# The solution - based on Approach by Viggiano et al. (2023)

Steps to reproduce:

- "Go to File Manager region"
- "Right click on a folder"
- "Select Cut"
- "Go to another folder"
- "Right click on the new folder"
- "Select Paste Into Folder"

# The solution - Word Stemming

Steps to reproduce:

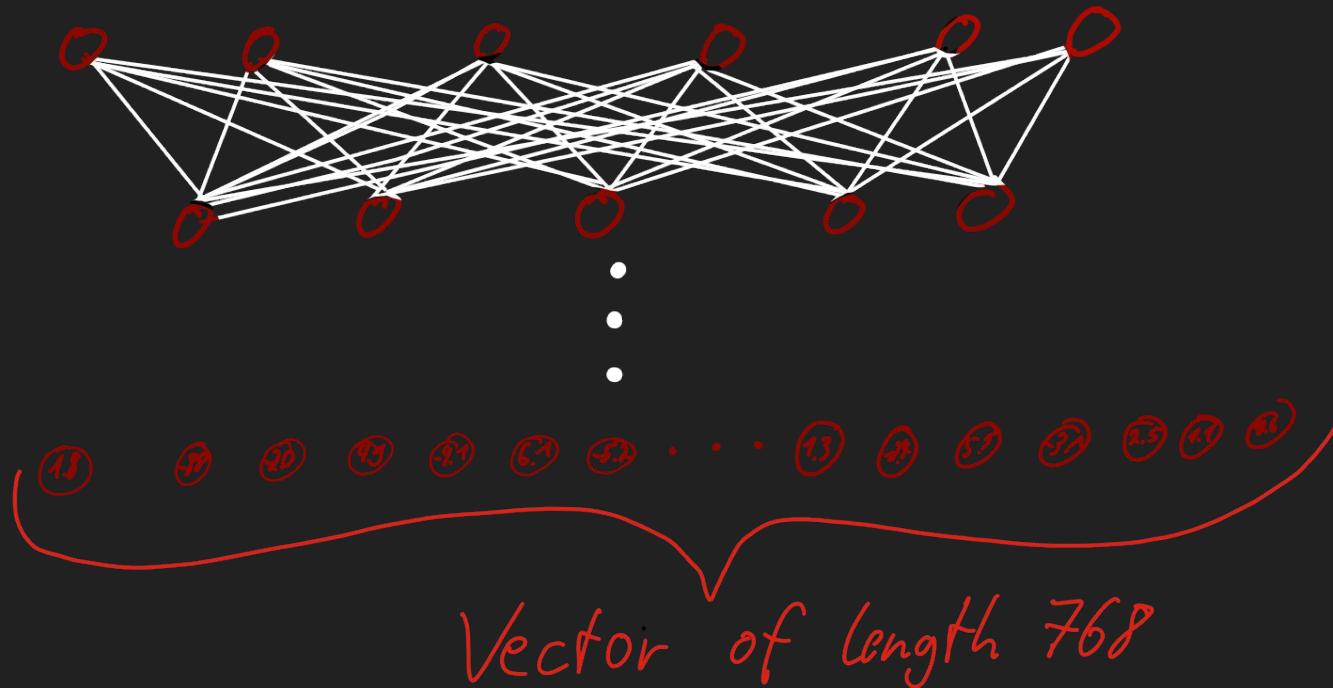
- "go file manag region"
- "right click folder"
- "select cut"
- "go anoth folder"
- "right click new folder"
- "select past folder"

# Sentence Embeddings with BERT



cut the folder and paste it.

↓      ↓      ↓      ↓      ↓      ↓  
3017    2000    19626    2002    19355    2013



# The solution - Word Stemming

Steps to reproduce:

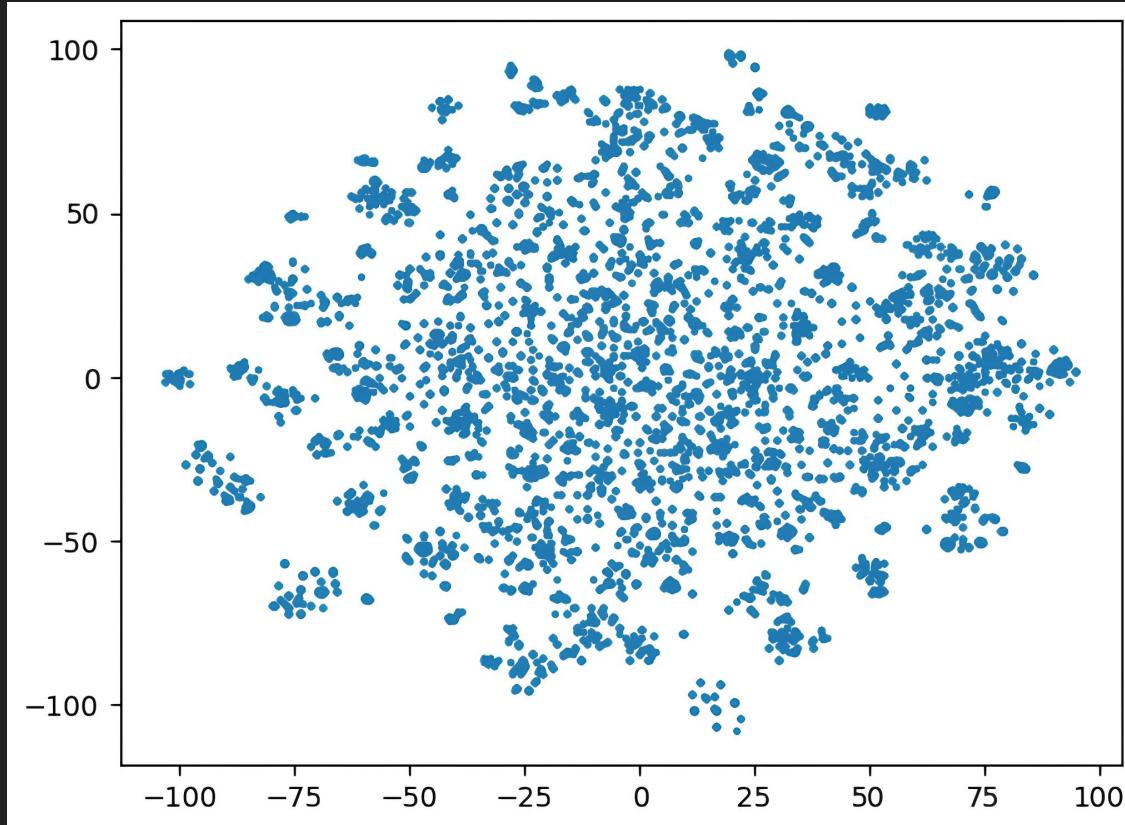
- "go file manag region"
- "right click folder"
- "select cut"
- "go anoth folder"
- "right click new folder"
- "select past folder"

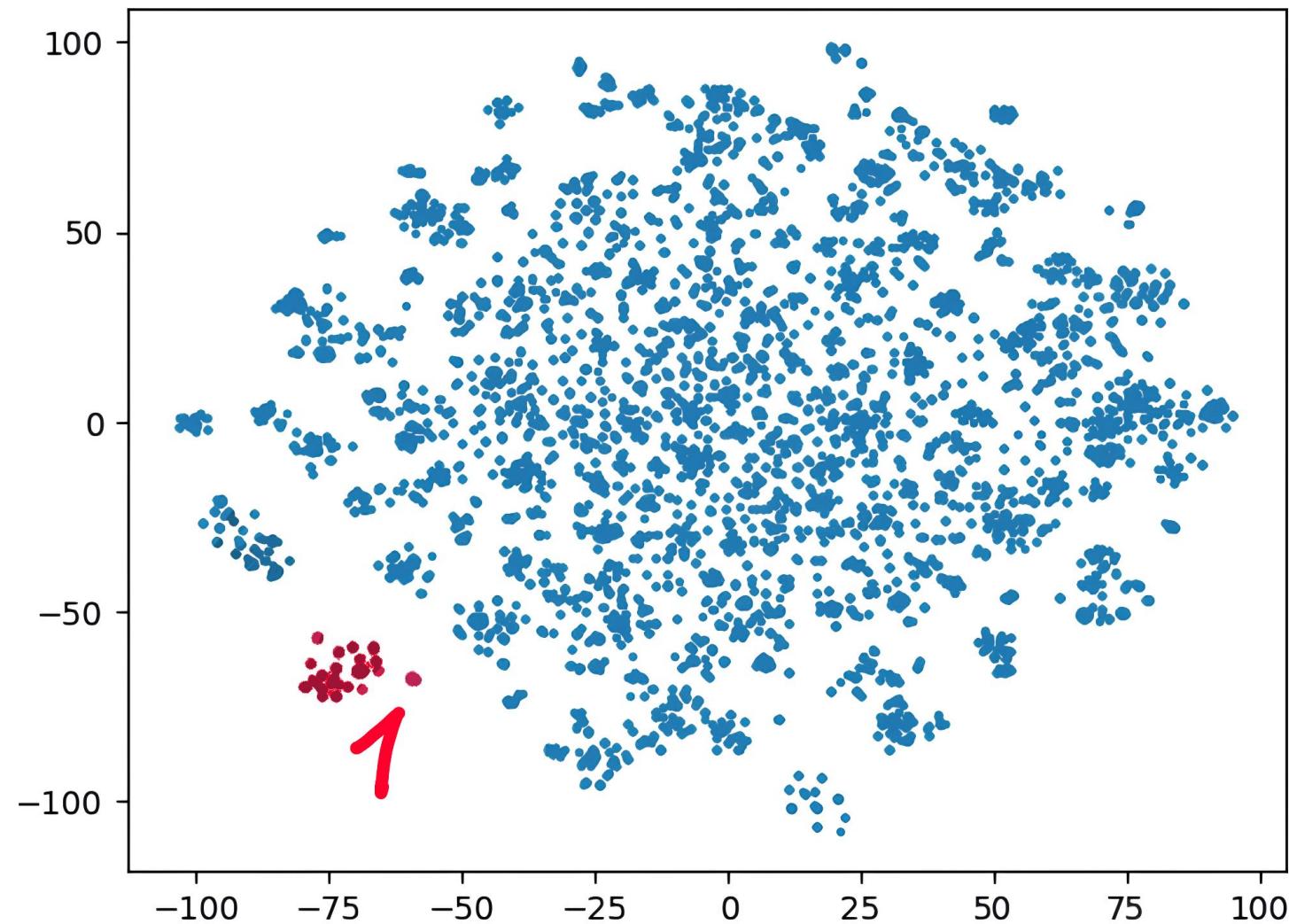
# The solution - Embeddings

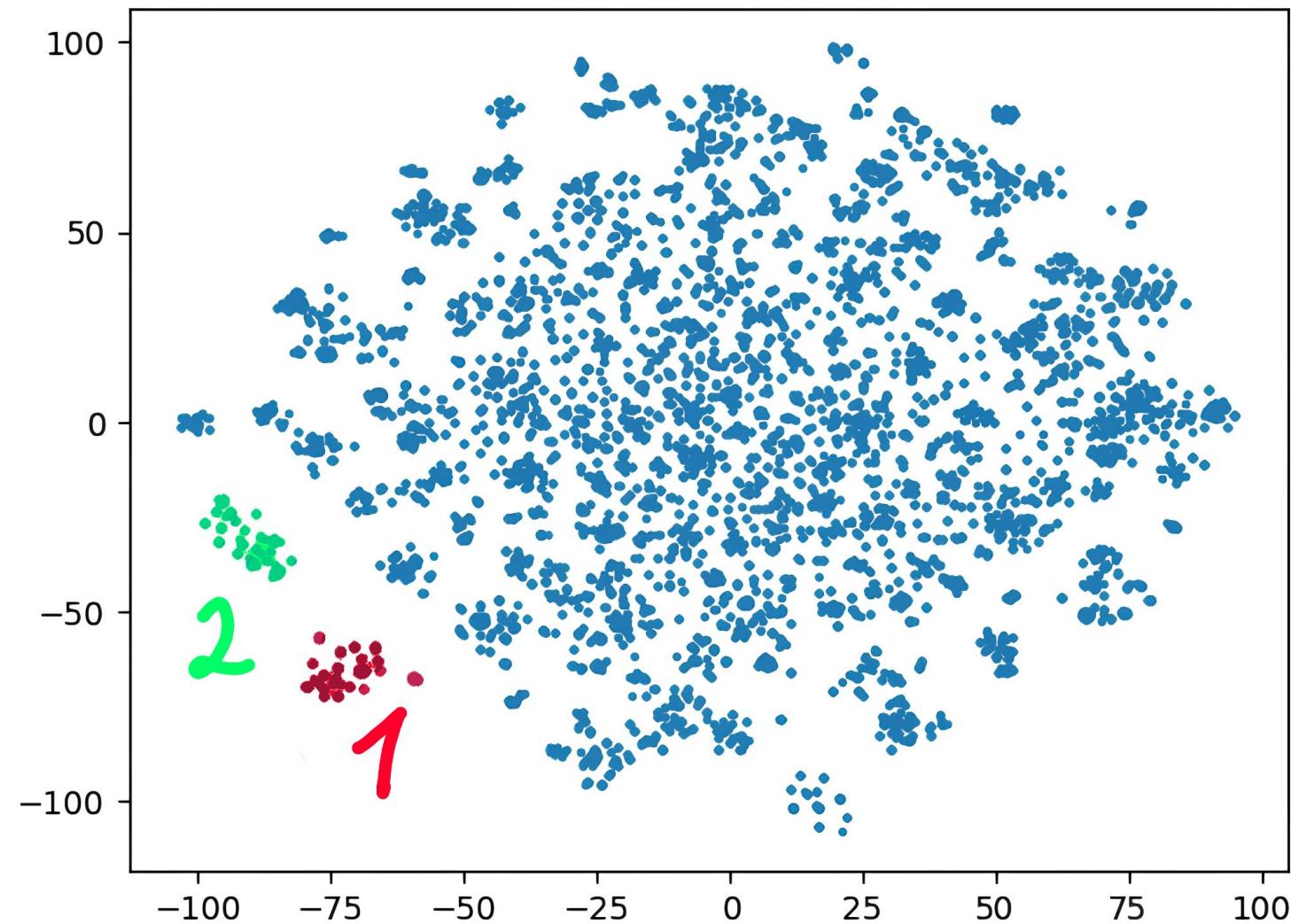
Steps to reproduce:

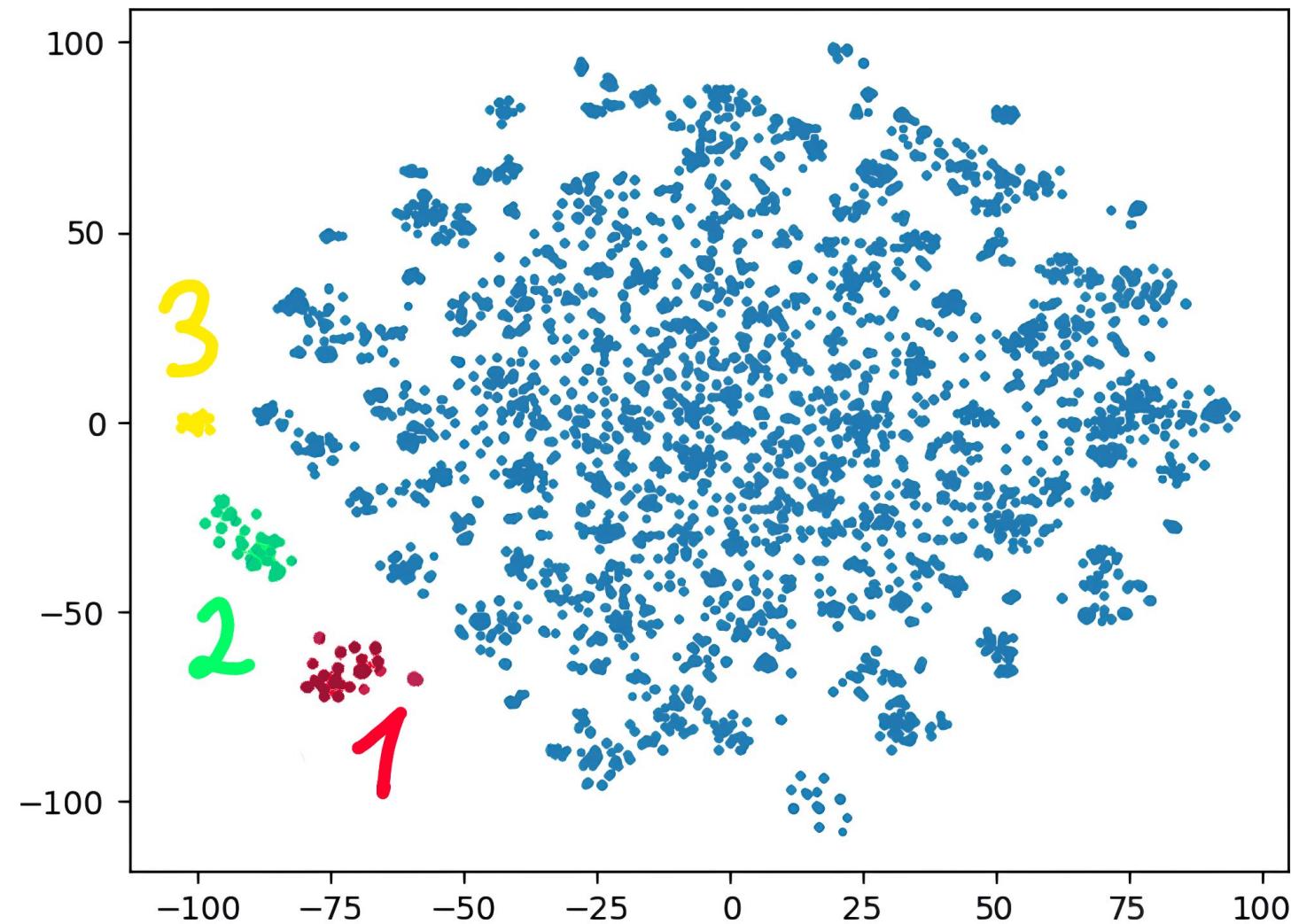
- [-0.023 -0.01 -0.005 0.022 ... -0.011 -0.033 -0.002 -0.029]
- [ 0.011 -0.003 -0.008 0.03 ... -0.024 0.001 0.078 0.005]
- [ 0.017 -0.033 -0.027 0.01 ... -0.033 -0.018 0. - -0.034]
- [ 0.007 0.038 -0.004 0.047 ... 0. 0.015 0.025 -0.003]
- [-0.036 -0.016 0.021 -0.01 ... -0.012 -0.001 0.097 0.047]
- [-0.015 0.059 -0.002 0.004 ... -0.018 -0.025 0.054 -0.02 ]

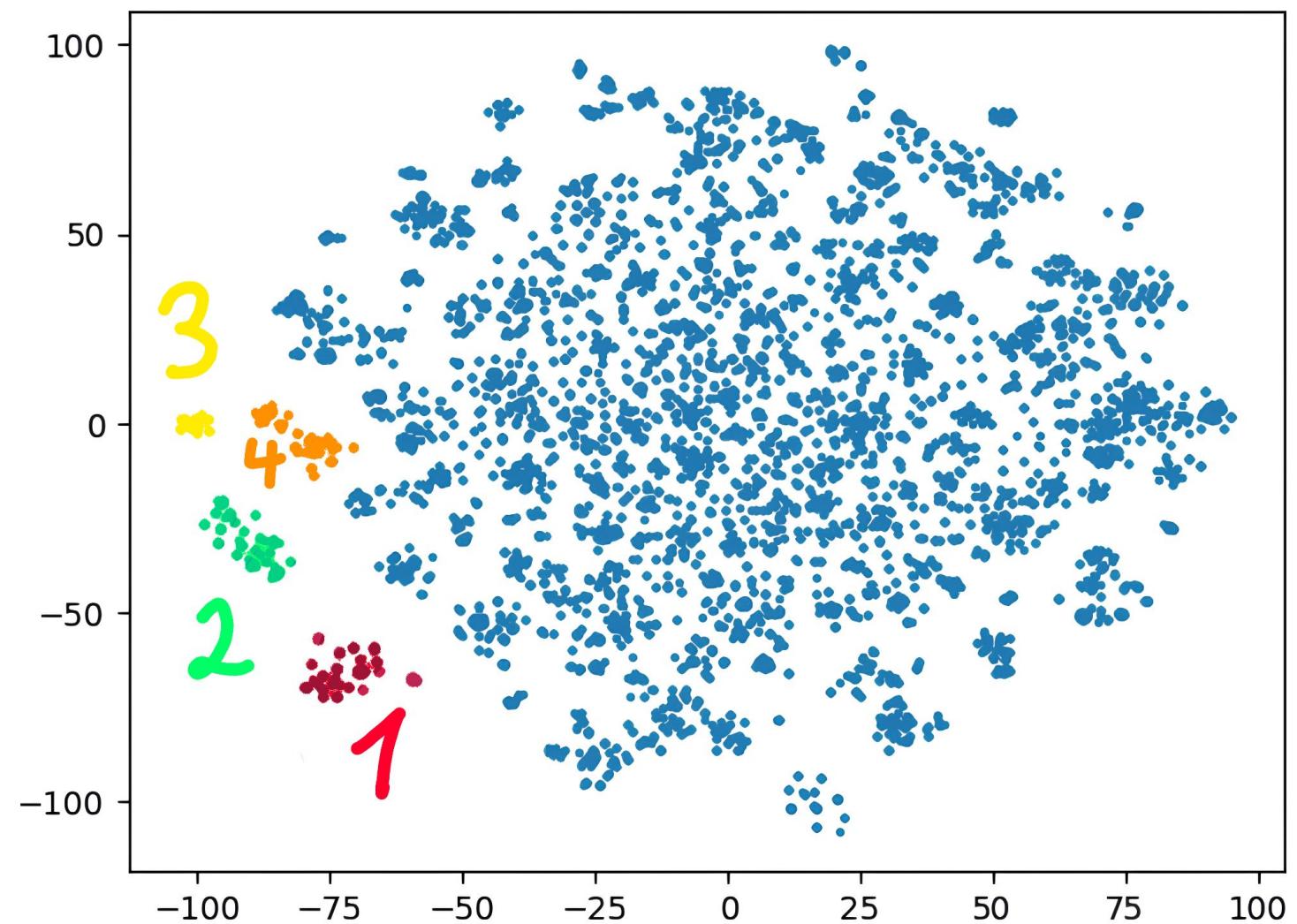
# Visualization of 9000 test step embeddings

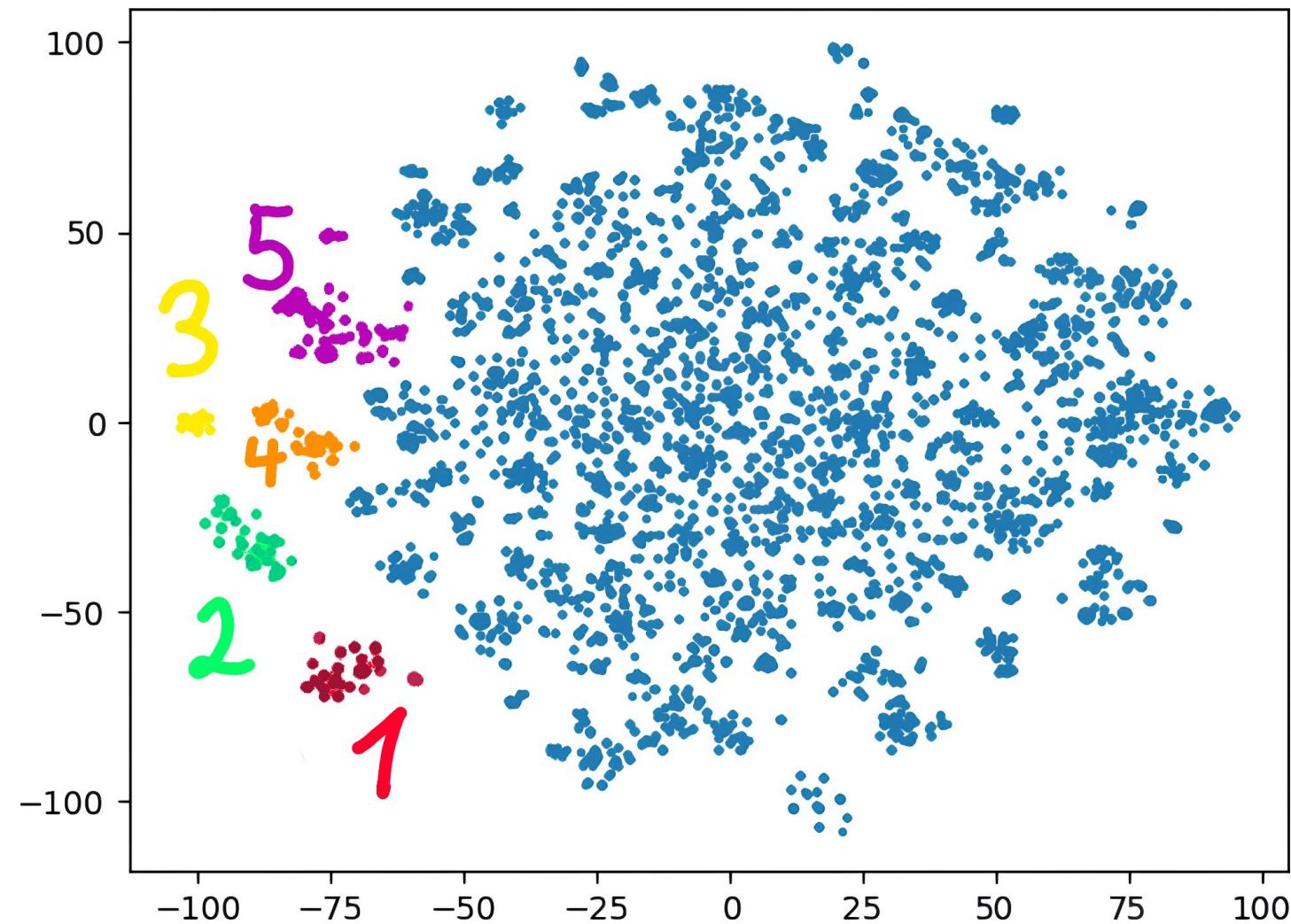


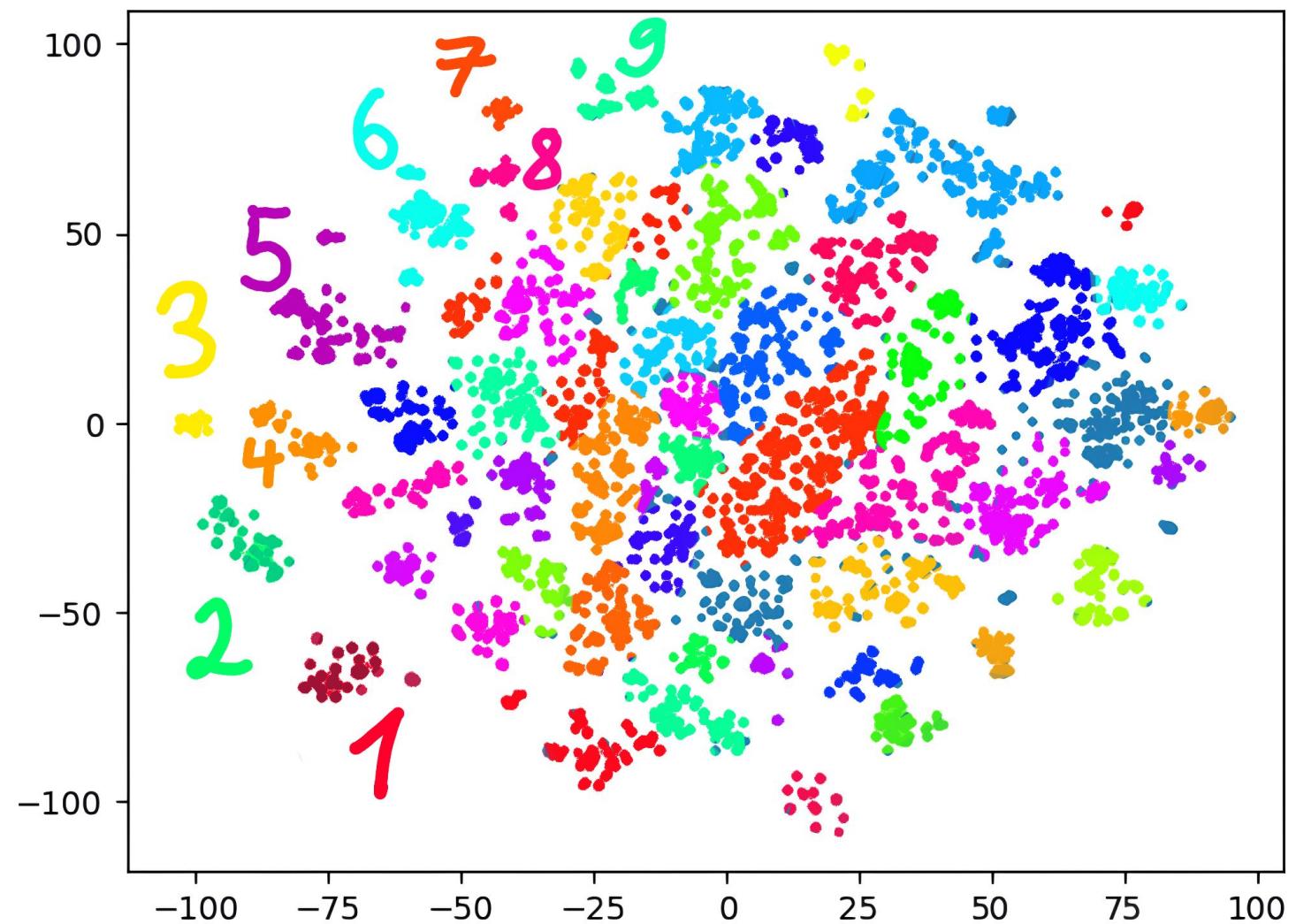












# The solution - Clustering

Steps to reproduce:

- 3 "Go to File Manager region"
- 2 "Right click on a folder"
- 4 "Select Cut"
- 3 "Go to another folder"
- 2 "Right click on the new folder"
- 3 "Select Paste Into Folder"

(KMeans Clustering with 5 Clusters with steps of 2 tests)

# The solution - Clustering

Steps to reproduce:

- 3 "Go to File Manager region"
- 2 "Right click on a folder"
- 4 "Select Cut"
- 3 "Go to another folder"
- 2 "Right click on the new folder"
- 3 "Select Paste Into Folder"

[3, 2, 4, 3, 2, 3]



[0, 0, 2, 3, 1]

-> [0, 0, 2, 3, 1] is a representation of this test

# The solution - Clustering

Steps to reproduce:

- 1 "Click on File Manager from Applications Panel"
- 0 "Right click on File Manager and add 2 folders"
- 0 "Add to one folder one file"
- 1 "Select the file added"
- 4 "Click on Cut button"
- 3 "Go to the 2nd folder"
- 3 "Paste the file in that folder"

[1, 0, 0, 1, 4, 3, 3]



[2, 2, 0, 2, 1]

-> [2, 2, 0, 2, 1] is a representation of this test

Test 1 -> [2, 2, 0, 2, 1]

Test 2 -> [0, 0, 2, 3, 1]

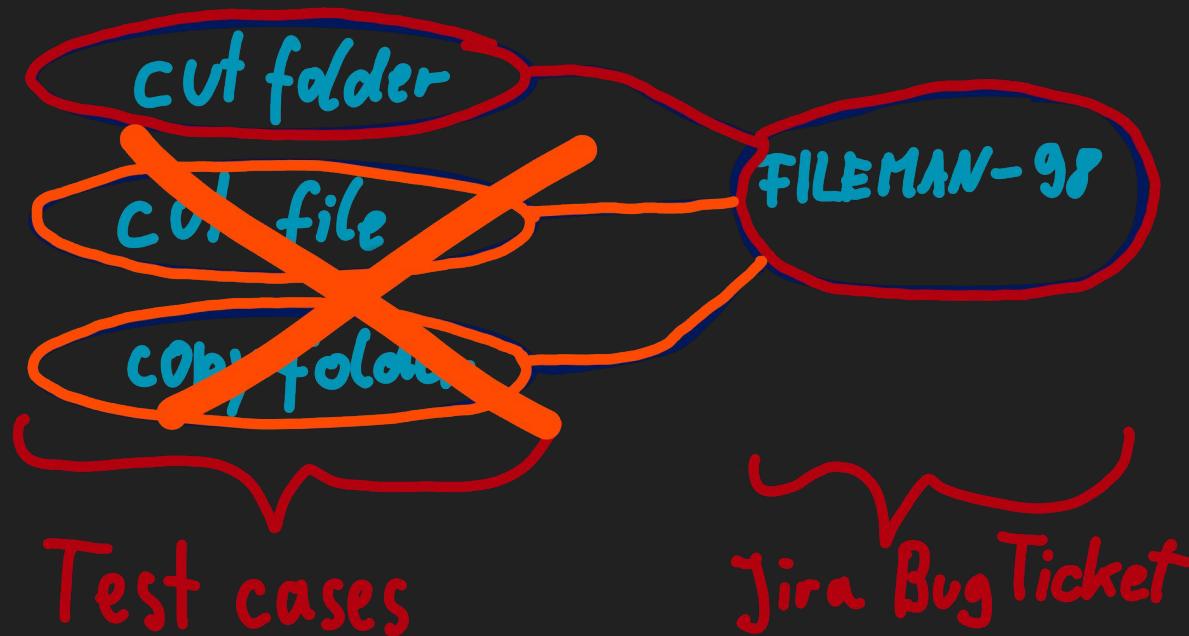
Test 3 -> [4, 3, 1, 1, 1]

Test 4 -> [4, 0, 2, 0, 0]

Test 5 -> [1, 1, 0, 2, 3]

Test 6 -> [3, 0, 3, 1, 2]

The solution - Similar Tests may belong to similar bug tickets:



-> Our Goal: Remove similar Test Cases

**Test 1 -> Cluster 2**

**Test 2 -> Cluster 2**

**Test 3 -> Cluster 3**

**Test 4 -> Cluster 1**

**Test 5 -> Cluster 4**

**Test 6 -> Cluster 2**

Test 1 -> Cluster 2

~~Test 2 -> Cluster 2~~

Test 3 -> Cluster 3

Test 4 -> Cluster 1

Test 5 -> Cluster 4

~~Test 6 -> Cluster 2~~

Does this work?

[Colibri] Fill Primary Action Button Background Color	Color Themes Tests	value1	XWiki 7.1.4			0
[Deprecated] See List Of Joined Wikis	Main		No test executions found			0
[Deprecated] Do Not Display Left Panel Column	Main		No test executions found			0
[Deprecated] Install And Uninstall Application From Wiki	Main		No test executions found			0
[Colibri] Fill Title Color	Color Themes Tests	value1	XWiki 6.4.3			0
[Colibri] Fill Informative Text Color	Color Themes Tests	value1	XWiki 6.4.3			0
Space Macro Create Space From Wiki Homepage	Enterprise Tests	value2	XWiki 7.1.4			0
[Colibri] Fill Page Header Background Color	Color Themes Tests	value1	XWiki 6.4.3			0
[Deprecated] Delete annotated text	Annotations Tests	value2	XWiki 8.1			0
[Deprecated] Create Wiki From Template	Main		No test executions found			0
[Colibri] Fill Border Color	Color Themes Tests	value1	XWiki 7.1.4			0
[Deprecated] Create a page in subwiki	Main		No test executions found			0
[Colibri] Fill Add Menu Entry Link Color	Color Themes Tests	value1	XWiki 6.4.3			0
[Deprecated] Set Activity Stream Of A Wiki Created with a normal user	Main		No test executions found			0
[Deprecated] Groups Access Rights Deny Delete Rights	Main		No test executions found			0
[Colibri] Fill Primary Action Button Text Color	Color Themes Tests	value1	XWiki 6.4.3			0
[Deprecated] Set And Unset Wiki As Template From Inline Mode	Main		No test executions found			0
[Deprecated] Rename a document	Main	value1	No test executions found			0
[Deprecated] Add an annotation in subwiki	Main		No test executions found			0
[Colibri] Fill Panel Header Background Color	Color Themes Tests	value1	XWiki 6.4.3			0
[Colibri] Fill Secondary Action Button Background	Color Themes Tests	value1	XWiki 6.4.3			0

“Completely Random”

# Cut and Paste a folder

Last modified by Gabriela Anechitoaei on 2022/05/03 09:27

[Home](#)

[File Manager Tests Home](#)

[Run Test](#)

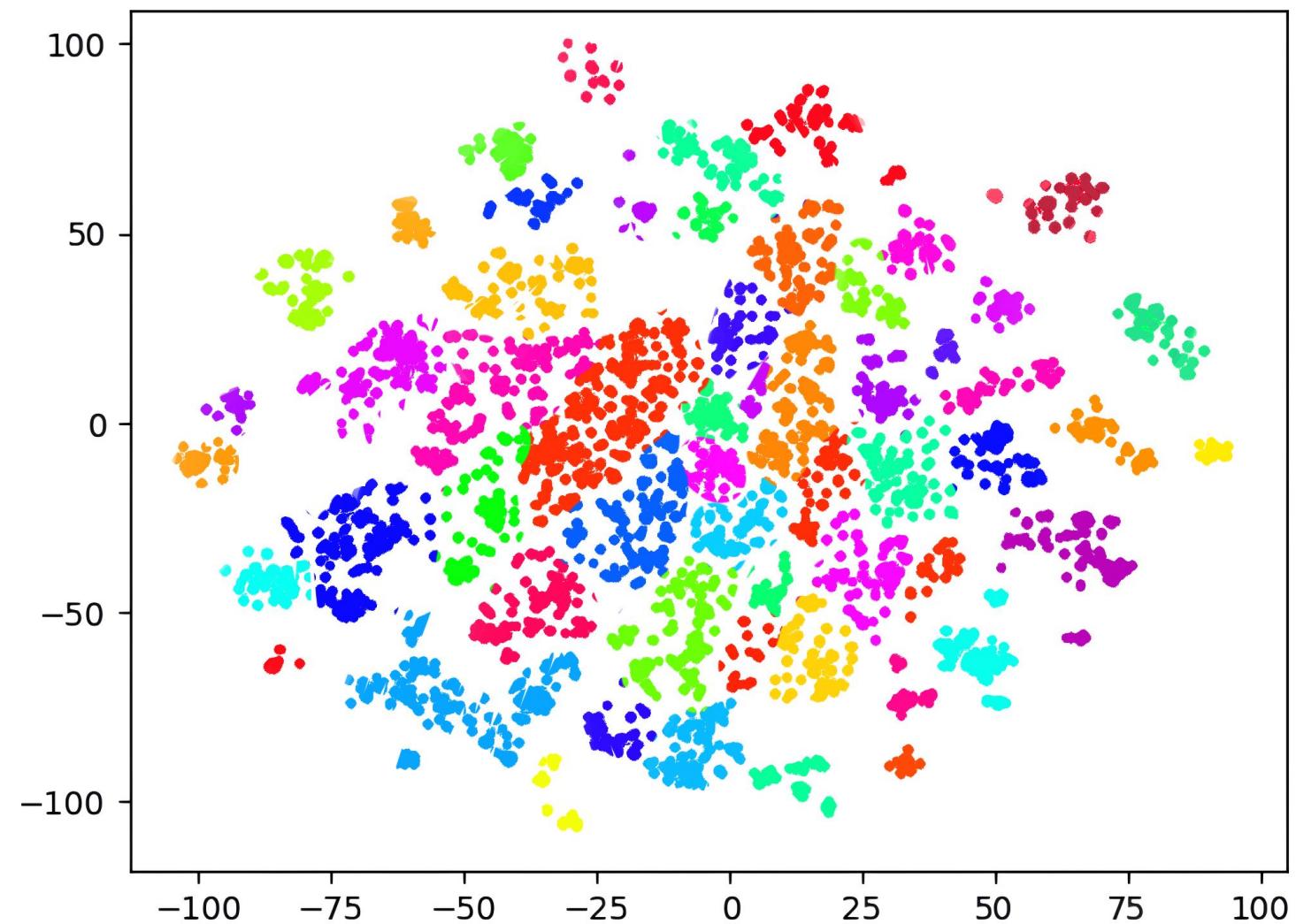
## Steps to reproduce

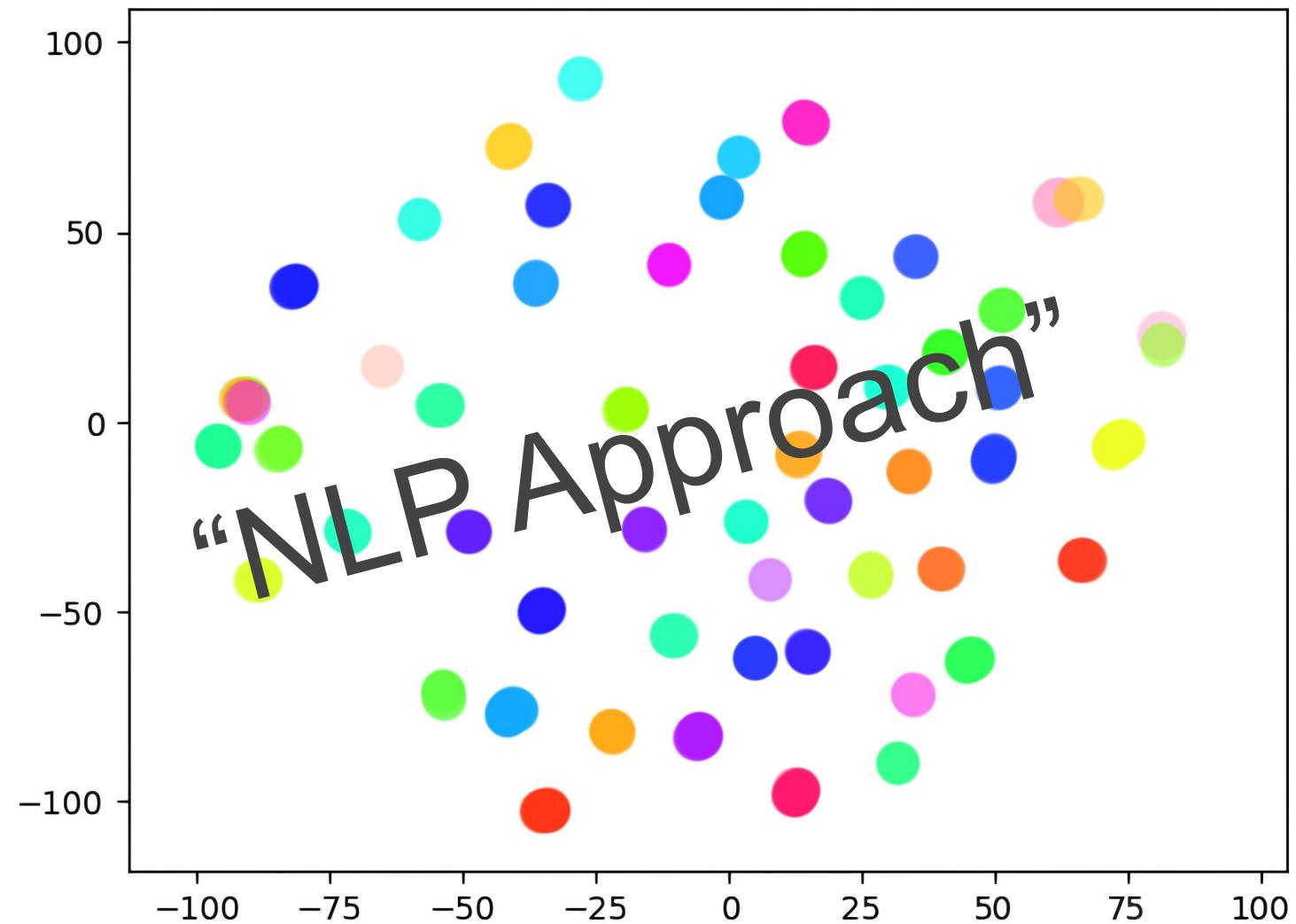
1. Go to File Manager region
2. Right click on a folder
3. Select Cut
4. Go to another folder
5. Right click on the new folder
6. Select Paste Into Folder

## Expected results

The new file was moved to the new location.

Product	Result	Jira Issue
	All	
XWiki 6.4	✗ Failed	<a href="http://jira.xwiki.org/browse(FILEMAN-98">http://jira.xwiki.org/browse(FILEMAN-98</a>
XWiki 6.4	✓ Passed	
XWiki 6.4.1	✓ Passed	
XWiki 6.4.1	✓ Passed	
XWiki 6.4.2	✓ Passed	
XWiki 7.1.2	✓ Passed	
XWiki 7.1.4	✓ Passed	
XWiki 7.2M2	✓ Passed	
XWiki 7.4.1	✓ Passed	

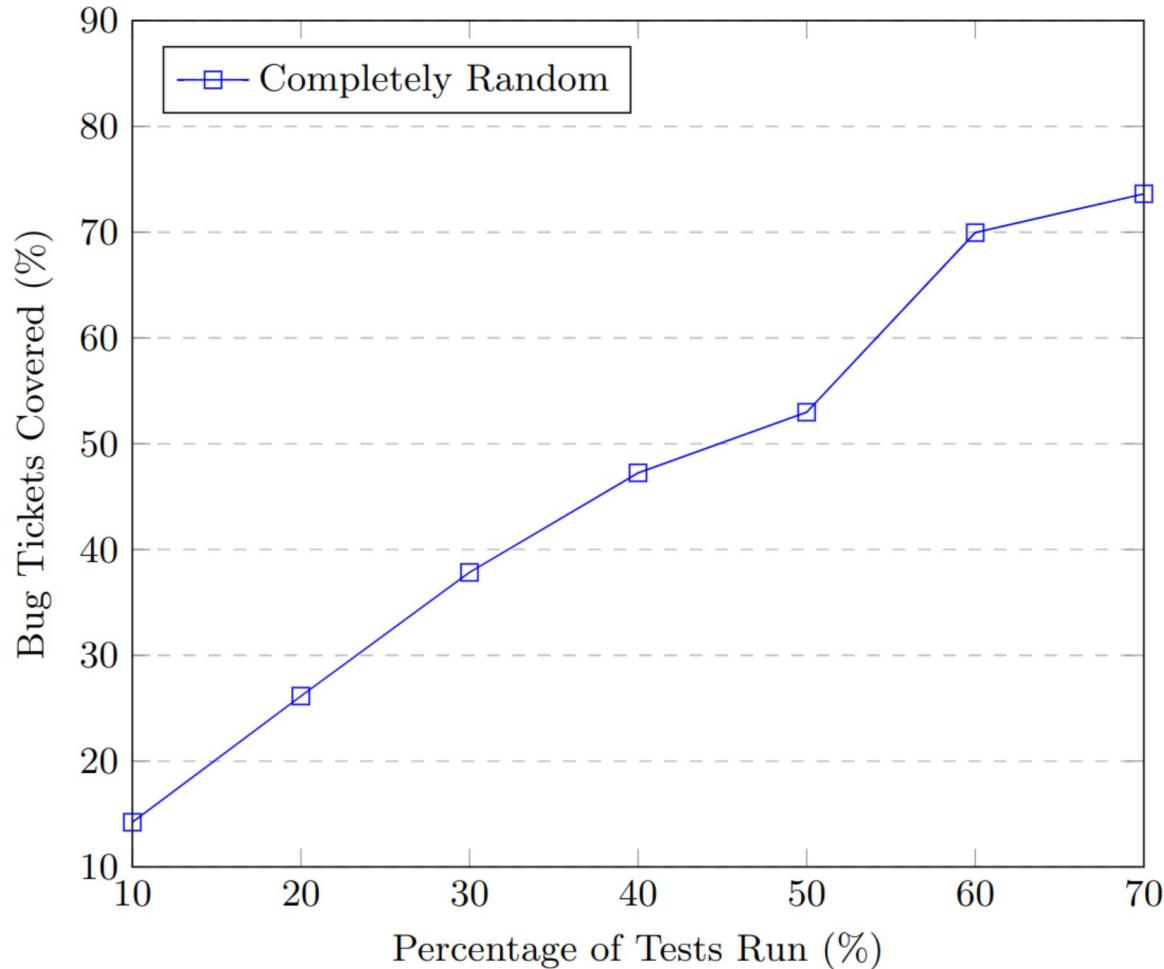




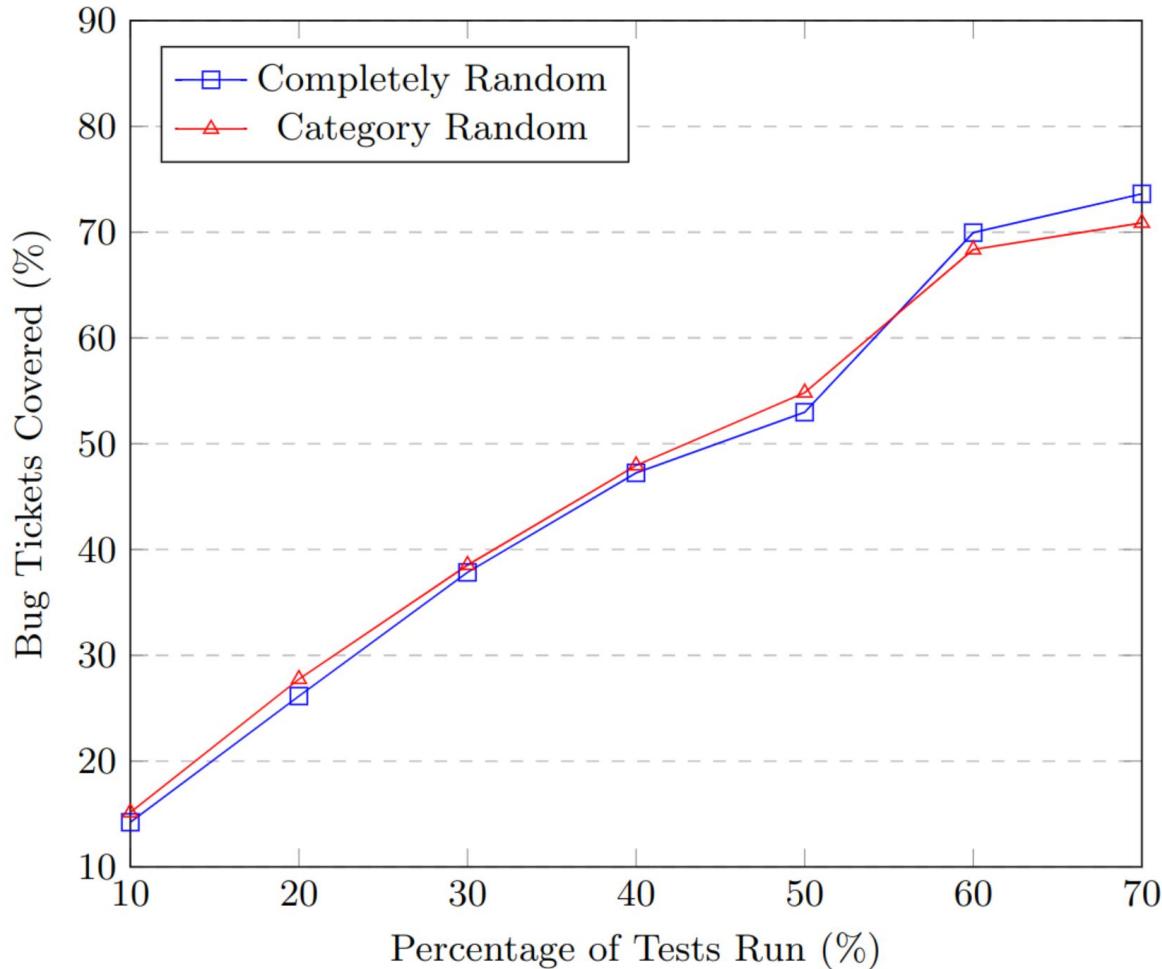
# Results

1. Completely Random
2. Category Random
3. NLP Approach

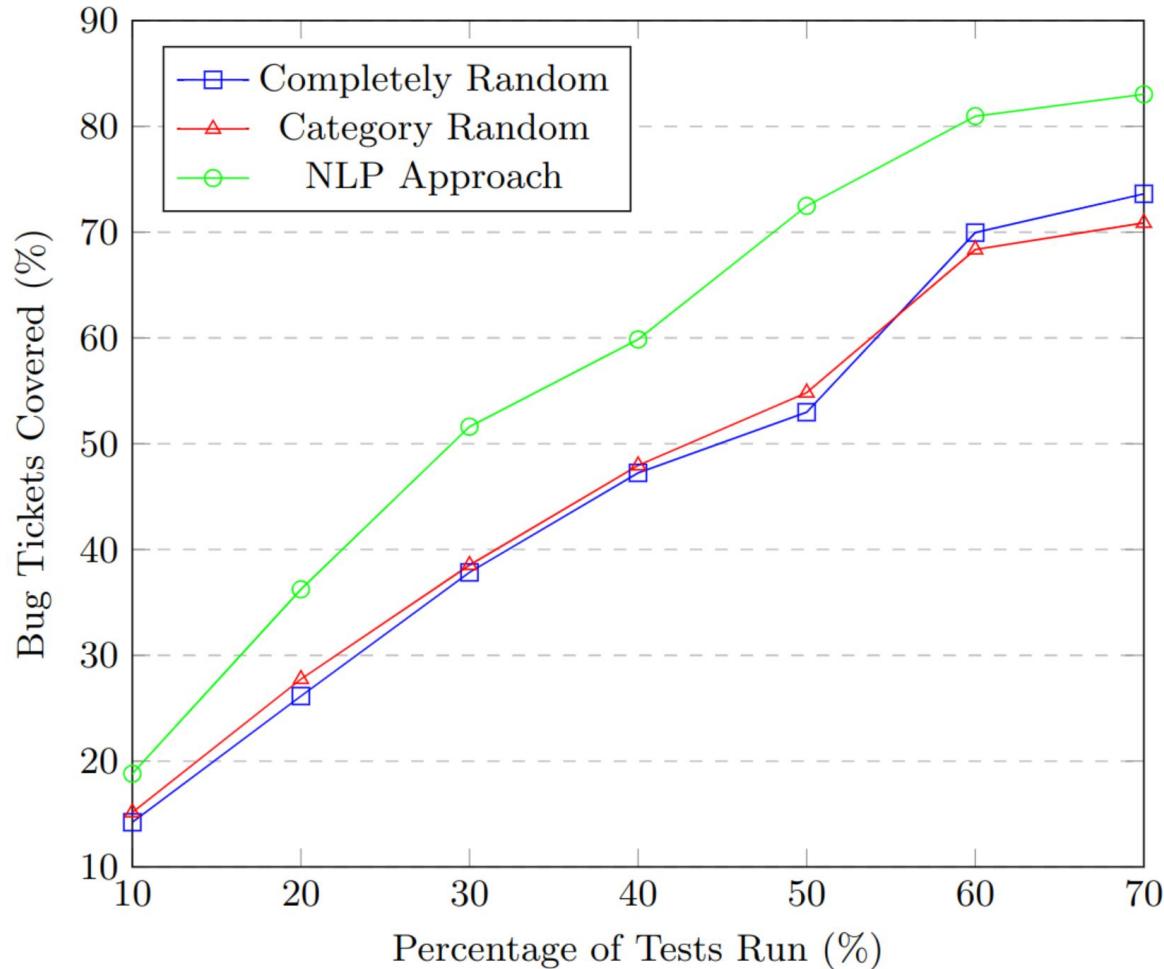
## Bug Ticket Coverage Comparison



## Bug Ticket Coverage Comparison



## Bug Ticket Coverage Comparison





1.600 Tests  
60.000 Test Executions

# Discussion

Tradeoff between **executions** vs. **resources**:

- improves upon baseline
- comparatively easy to implement
- saves time

**But:**

- we miss significant amount of bugs

# Threats to Validity

- Medium-sized Dataset
- not detailed enough test descriptions
- only used part of information
- Ignores importance of tests
  - -> Better with manual selection?

# Contributions + Findings

- Validated textual similarity as an indicator of test case similarity (-> Viggiano)
- Clustering based on similarities improves bug detection
- Can save time if resources are constrained (big projects)

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=> YES!