

Paper	Tensorflow	pytorch	keras	Caffe	mxnet	theano	onnx	Scikit-learn	Chainer	CNTK	pandas	numpy	scipy	deeplearning4j	Total number	Year	Purpose
An empirical study on real bugs for machine learning programs The Open-Closed Principle of Modern Machine Learning Frameworks				✓	✓	✓		✓	✓	✓					3	2017	
Various Frameworks and Libraries of Machine Learning and Deep Learning: A Survey	✓	✓	✓	✓	✓	✓			✓	✓				✓		2018	
A comprehensive study on deep learning bug characteristics	✓		✓	✓	✓	✓									5	2019	
An Empirical Study of Common Challenges in Developing Deep Learning Applications	✓	✓												✓	3	2019	Study posts on SO about these libraries
The Scent of Deep Learning Code: An Empirical Study	✓		✓	✓	✓	✓									59	2020	Collect the projects that imports these libraries as ML projects
Taxonomy of Real Faults in Deep Learning Systems	✓	✓													3	2020	Study three DL frameworks and the posts on SO about these frameworks
An Empirical Study of the Dependency Networks of Deep Learning Libraries	✓	✓				✓									3	2020	Study the dependency networks of deep learning libraries (deep learning projects that depend on these 3 libraries)
What do programmers discuss about deep learning frameworks	✓	✓				✓									3	2020	
Repairing deep neural networks: Fix patterns and challenges	✓		✓	✓		✓									5	2020	
Automatic Unit Test Generation for Machine Learning Libraries: How Far Are We?															5	2021	
On Reporting Performance and Accuracy Bugs for Deep Learning Frameworks: An Exploratory Study from GitHub	✓	✓	✓	✓	✓				✓	✓					10	2021	
Understanding Software-2.0: A Study of Machine Learning Library Usage and Evolution	✓	✓	✓	✓		✓		✓		✓					15	2021	
Machine Learning Frameworks in Open-Source Software: An Exploratory Study on Code and Project Smells	✓	✓	✓					✓								2022	
Flet-Edge: A Full Life-cycle Evaluation Tool for deep learning framework on the Edge	✓	✓			✓										5	2022	Evaluate model on these frameworks
Code Smells in Machine Learning Systems	✓		✓	✓	✓	✓									59	2022	
An exploratory study of deep learning supply chain	✓	✓													2	2022	Study the supply chain of these two projects
An Empirical Study of Library Usage and Dependency inDeep Learning Frameworks	✓	✓	✓	✓		✓		✓							6	2022	Study DL projects that depend on these libraries/frameworks
Characterizing and Understanding Software Security Vulnerabilities in Machine Learning Libraries	✓	✓						✓			✓	✓	✓		7	2023	
A Generic Performance Model for Deep Learning in a Distributed Environment	✓	✓			✓											2023	Evaluate model on these frameworks
Automatic Static Bug Detection for Machine Learning Libraries: Are We There Yet?	✓	✓			✓										4	2023	
Exploring the Impact of Code Clones on Deep Learning Software			✓						✓		✓				45	2023	
What Kinds of Contracts Do ML APIs Need?	✓	✓	✓					✓			✓				4	2023	Study the posts on SO about these libraries to under users' ML API specifications
The Good, the Bad, and the Missing: Neural Code Generation for Machine Learning Tasks	✓	✓	✓					✓							4	2023	Study the ML APIs in these libraries
Automatic Unit Test Generation for Deep Learning Frameworks based on API Knowledge	✓	✓						✓		✓					4	2023	Study the ML APIs in these libraries
Studying Logging Practice in Machine Learning-based Applications	✓	✓	✓	✓	✓	✓		✓							7	2023	Collect the projects that imports these libraries as ML projects
Fault Localization for Buggy Deep Learning Framework Conversions in Image Recognition	✓	✓	✓												4	2023	Study framework conversion
What Causes Exceptions in Machine Learning Applications? Mining Machine Learning-Related Stack Traces on Stack Overflow	✓	✓	✓					✓							7	2023	Study the posts on SO about these libraries
Knowledge-Based Version Incompatibility Detection for Deep Learning	✓	✓										✓			4	2023	
Exploring the Characteristics of Popular Deep Learning GitHub Repositories	✓	✓	✓	✓			✓		✓	✓				✓	19	2023	
Why Do Deep Learning Projects Differ in Compatible Framework Versions? An Exploratory Study	✓	✓													2	2023	Compatible Framework Versions, study the dl projects use these two frameworks
On the sustainability of deep learning projects: Maintainers'perspective	✓	✓	✓	✓		✓									19	2023	
Compatibility Issues in Deep Learning Systems: Problems and Opportunities	✓	✓	✓	✓		✓									5	2023	Five most discussed DL libraries on SO
Bug Characterization in Machine Learning-based Systems	✓	✓	✓	✓	✓					✓					8	2024	
Balancing Effectiveness and Flakiness of Non-Deterministic Machine Learning Tests															22	2024	Evaluate tests in these ML libraries
Understanding Newcomers' Onboarding Process in Deep Learning Projects	✓	✓	✓	✓		✓									20	2024	
Good Tools are Half the Work:Tool Usage in Deep Learning Projects	✓	✓	✓	✓	✓	✓			✓	✓				✓	31	2024	Conventional and