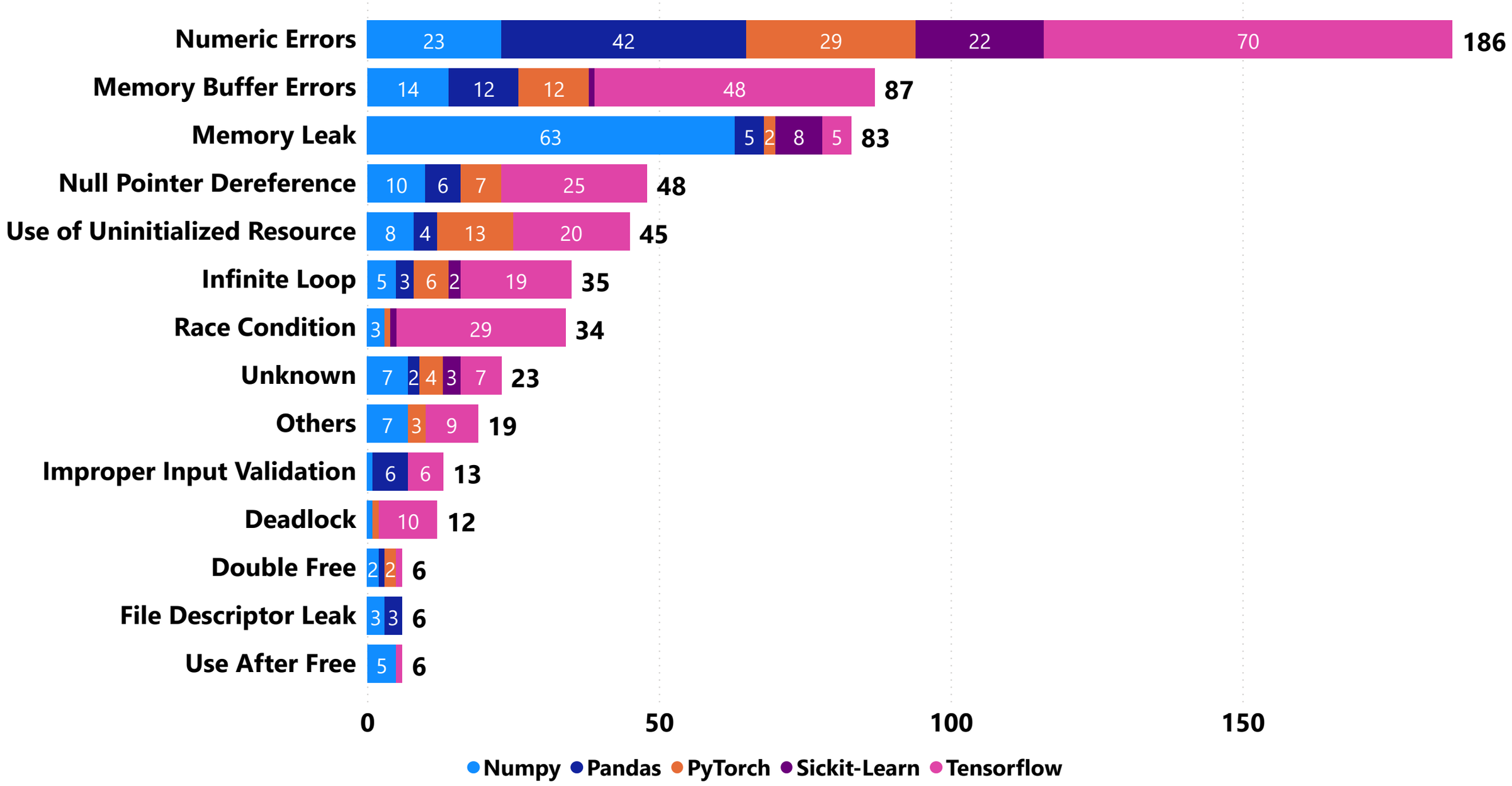
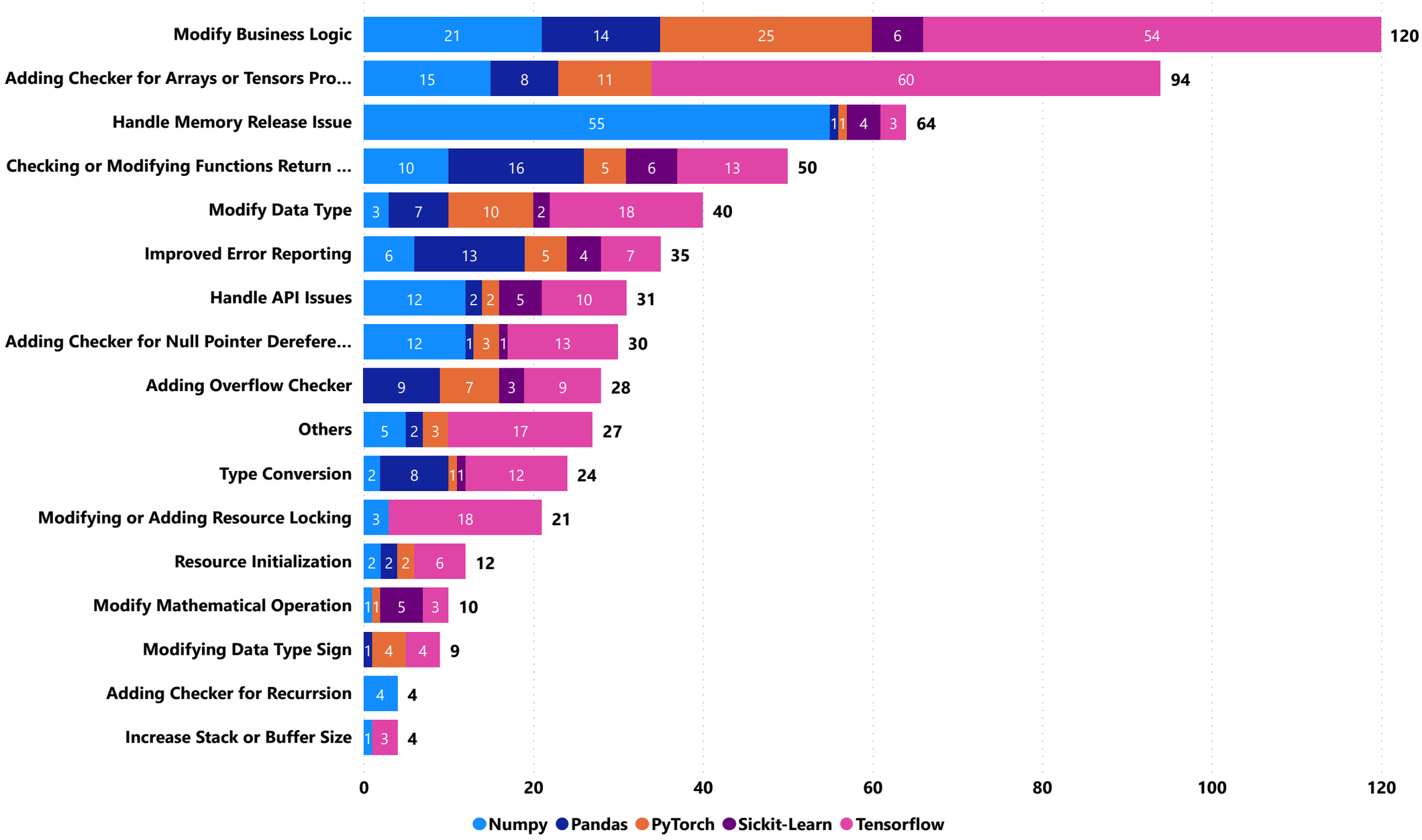
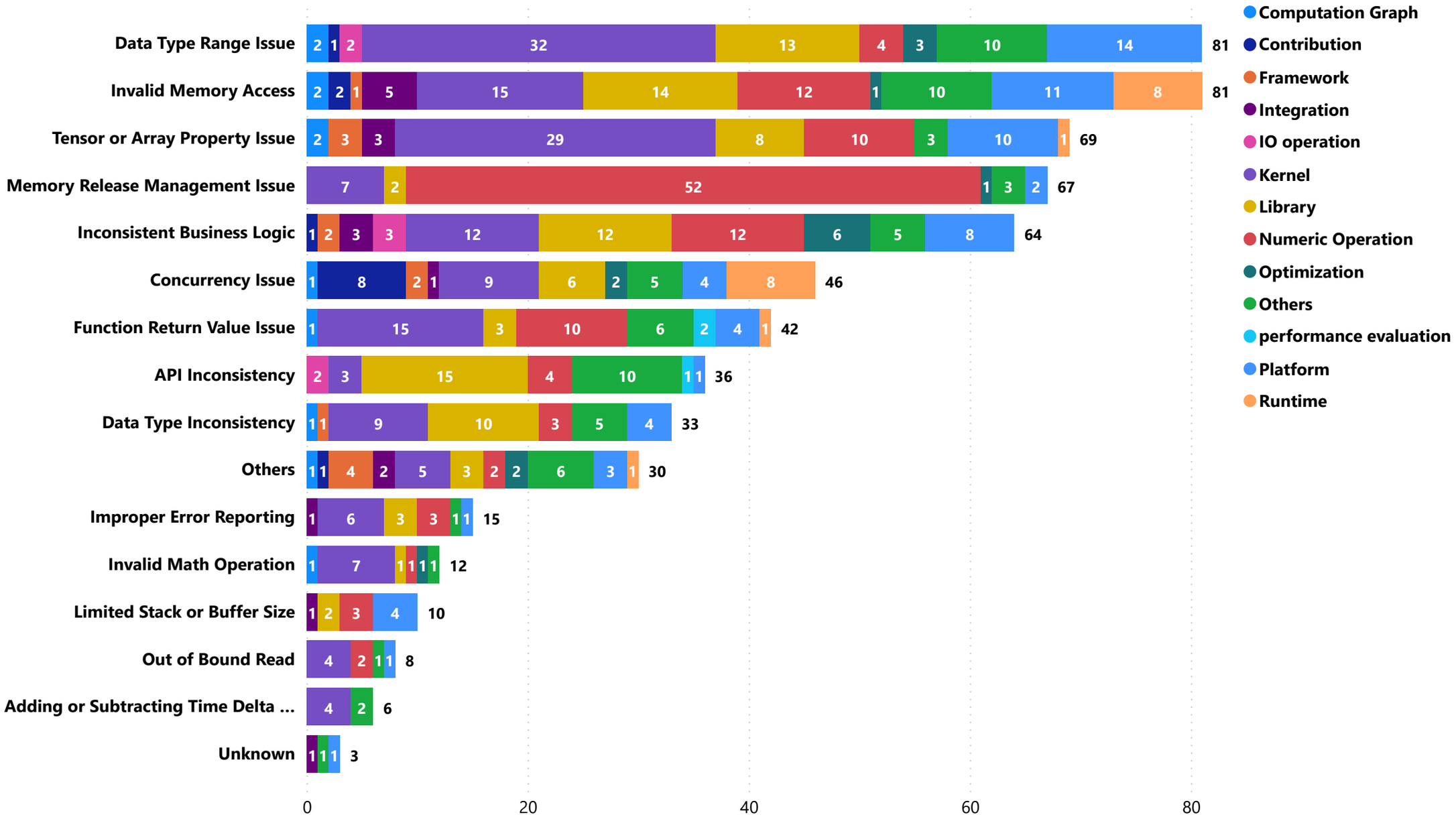

Numeric Errors
23
42
29
22
70
186
Memory Buffer Errors
14
12
12
48
87
Memory Leak
63
5
2
8
5
83
Null Pointer Dereference
10
6
7
25
48
Use of Uninitialized Resource
8
4
13
20
45
Infinite Loop
5
3
6
2
19
35
Race Condition
3
29
34
Unknown
7
2
4
3
7
23
Others
7
3
9
19
Improper Input Validation
6
6
13
Deadlock
10
12
Double Free
2
2
6
File Descriptor Leak
3
3
6
Use After Free
5
6
0
50
100
150
Numpy
Pandas
PyTorch
Sickit-Learn
Tensorflow


Modify Business Logic
21
14
25
6
54
120
Adding Checker for Arrays or Tensors Pro...
15
8
11
60
94
Handle Memory Release Issue
55
1
1
4
3
64
Checking or Modifying Functions Return ...
10
16
5
6
13
50
Modify Data Type
3
7
10
2
18
40
Improved Error Reporting
6
13
5
4
7
35
Handle API Issues
12
2
2
5
10
31
Adding Checker for Null Pointer Derefere...
12
1
3
1
13
30
Adding Overflow Checker
9
7
3
9
28
Others
5
2
3
17
27
Type Conversion
2
8
1
1
12
24
Modifying or Adding Resource Locking
3
18
21
Resource Initialization
2
2
2
6
12
Modify Mathematical Operation
1
1
5
3
10
Modifying Data Type Sign
1
4
4
9
Adding Checker for Recurrsion
4
4
Increase Stack or Buffer Size
1
3
4
0
20
40
60
80
100
120
Numpy
Pandas
PyTorch
Sickit-Learn
Tensorflow


Data Type Range Issue
2 1 2 32 13 4 3 10 14 81
Invalid Memory Access
2 2 1 5 15 14 12 1 10 11 8 81
Tensor or Array Property Issue
2 3 3 29 8 10 3 10 1 69
Memory Release Management Issue
7 2 52 1 3 2 67
Inconsistent Business Logic
1 2 3 3 12 12 12 6 5 8 64
Concurrency Issue
1 8 2 1 9 6 2 5 4 8 46
Function Return Value Issue
1 15 3 10 6 2 4 1 42
API Inconsistency
2 3 15 4 10 1 1 36
Data Type Inconsistency
1 1 9 10 3 5 4 33
Others
1 1 4 2 5 3 2 2 6 3 1 30
Improper Error Reporting
1 6 3 3 1 1 15
Invalid Math Operation
1 7 1 1 1 1 12
Limited Stack or Buffer Size
1 2 3 4 10
Out of Bound Read
4 2 1 1 8
Adding or Subtracting Time Delta ...
4 2 6
Unknown
1 1 1 3
0
20
40
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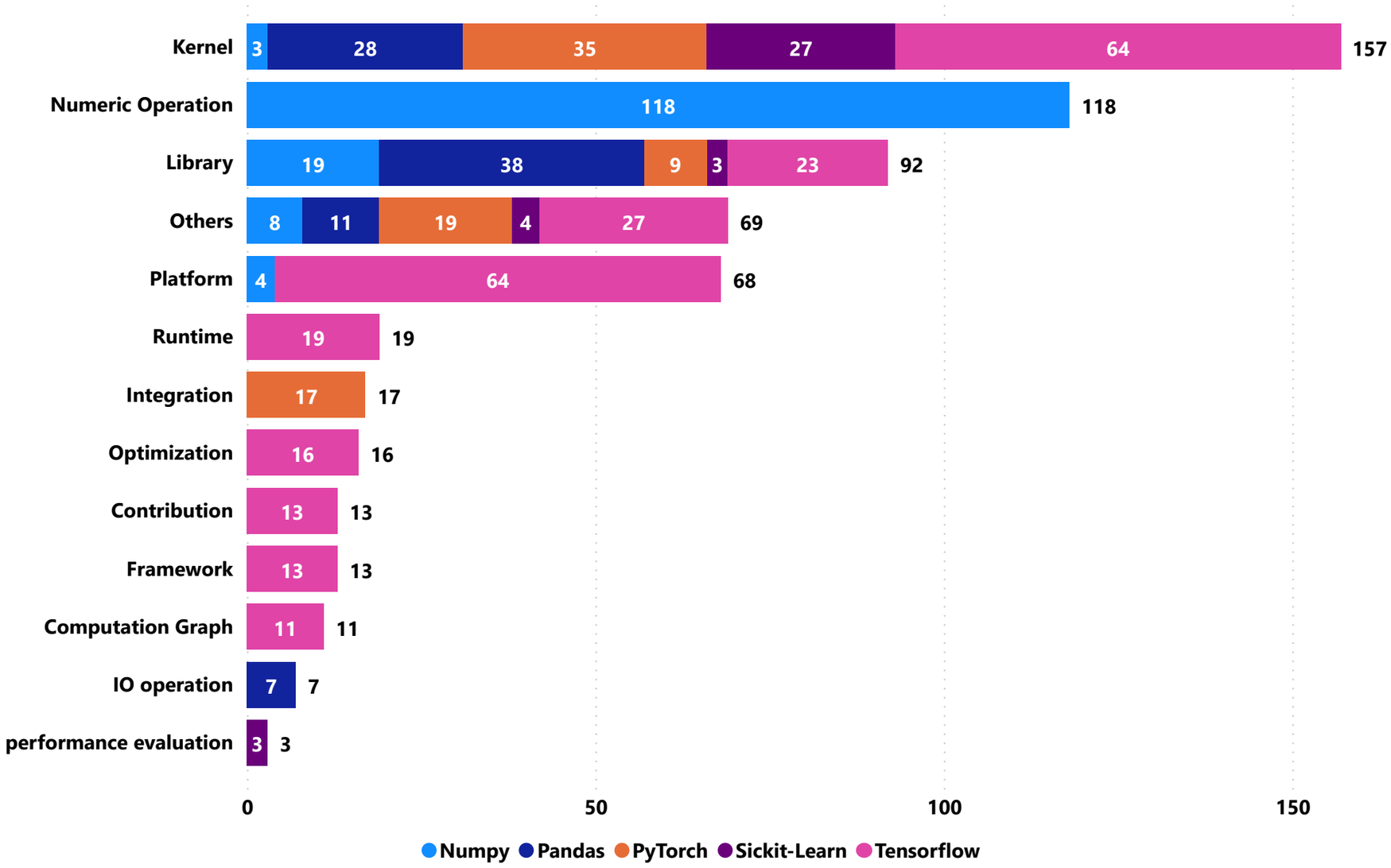
80
Computation Graph
Contribution
Framework
Integration
IO operation
Kernel
Library
Numeric Operation
Optimization
Others
performance evaluation
Platform
Runtime


Kernel
3
28
35
27
64
157
Numeric Operation
118
118
Library
19
38
9
3
23
92
Others
8
11
19
4
27
69
Platform
4
64
68
Runtime
19
19
Integration
17
17
Optimization
16
16
Contribution
13
13
Framework
13
13
Computation Graph
11
11
IO operation
7
7
performance evaluation
3
3
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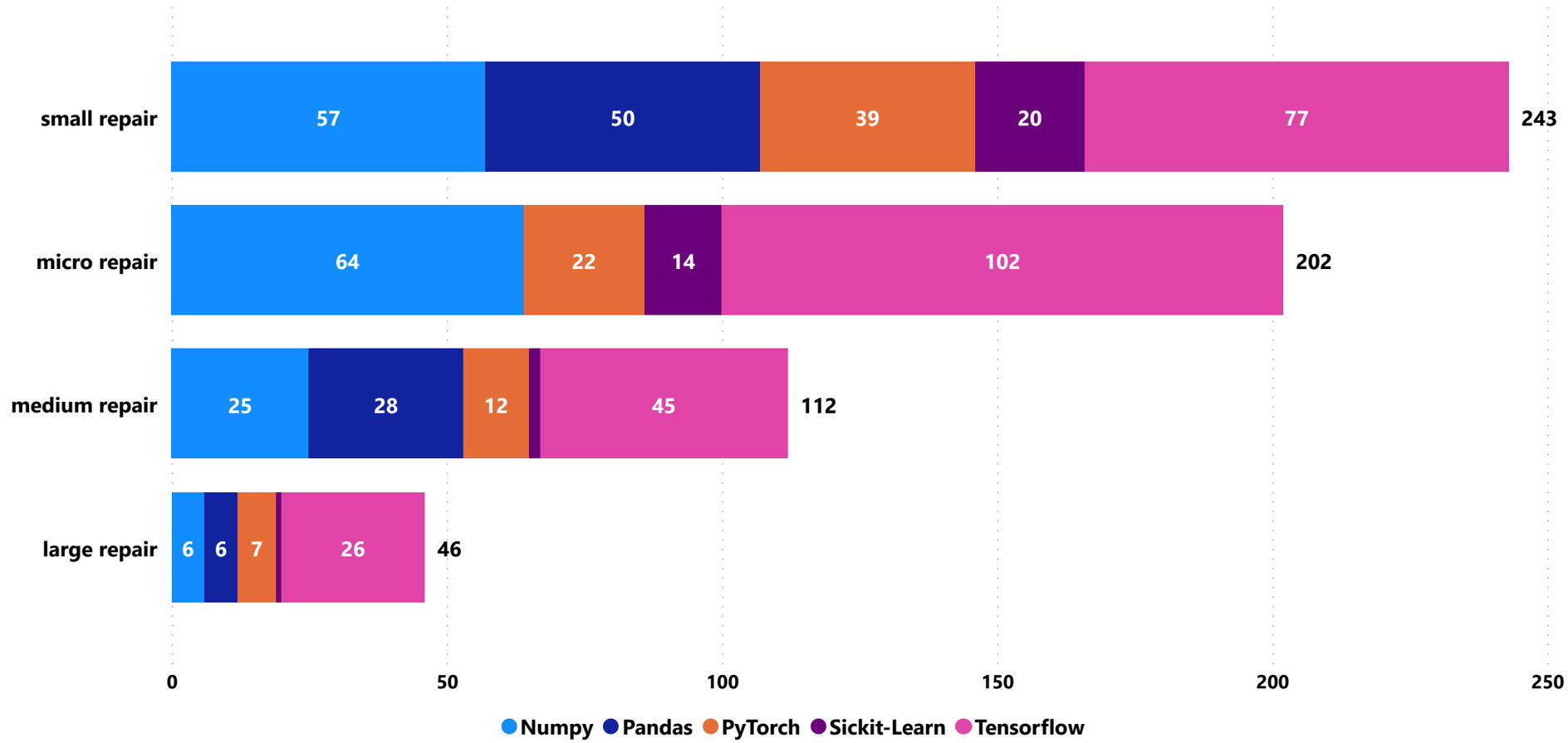
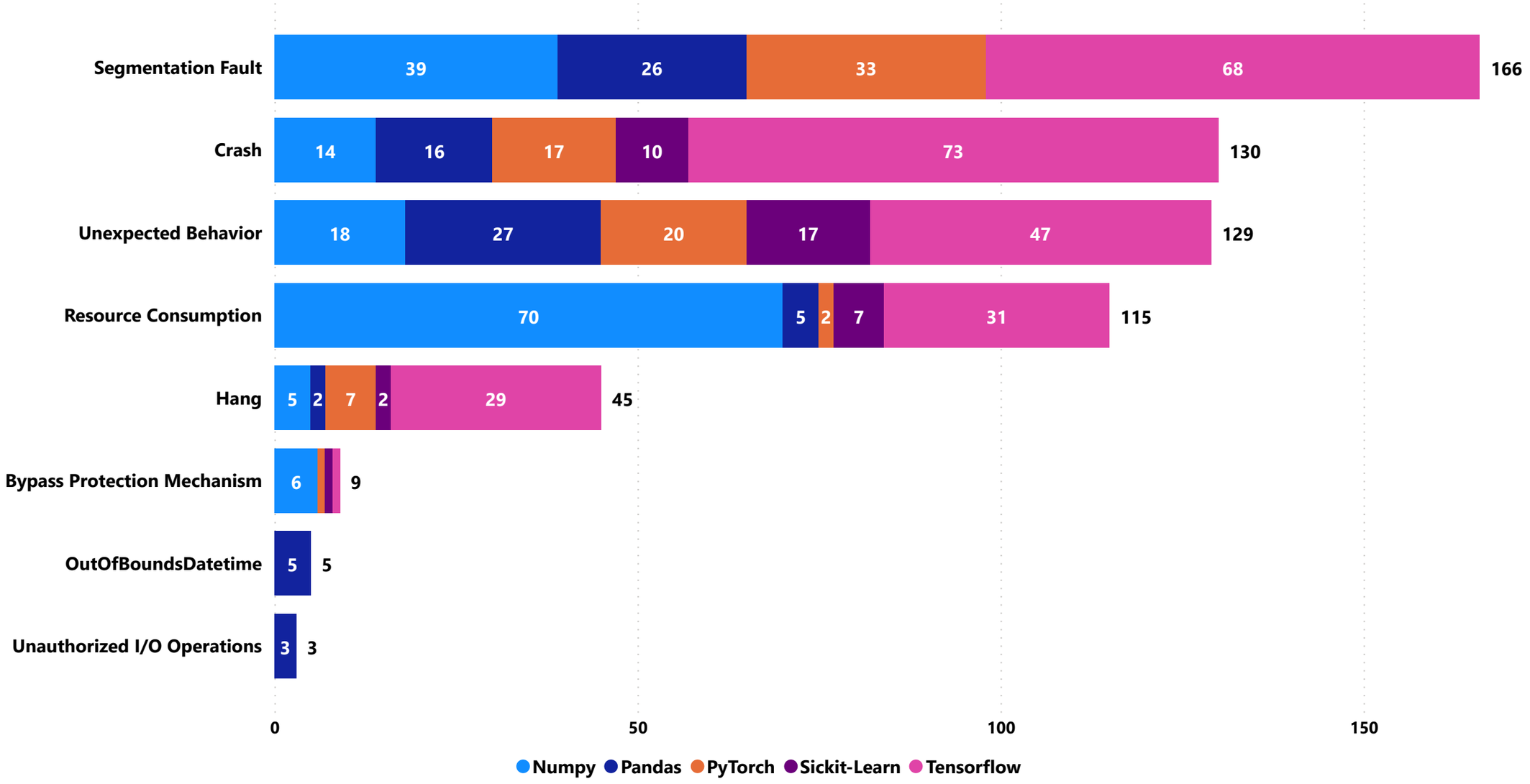
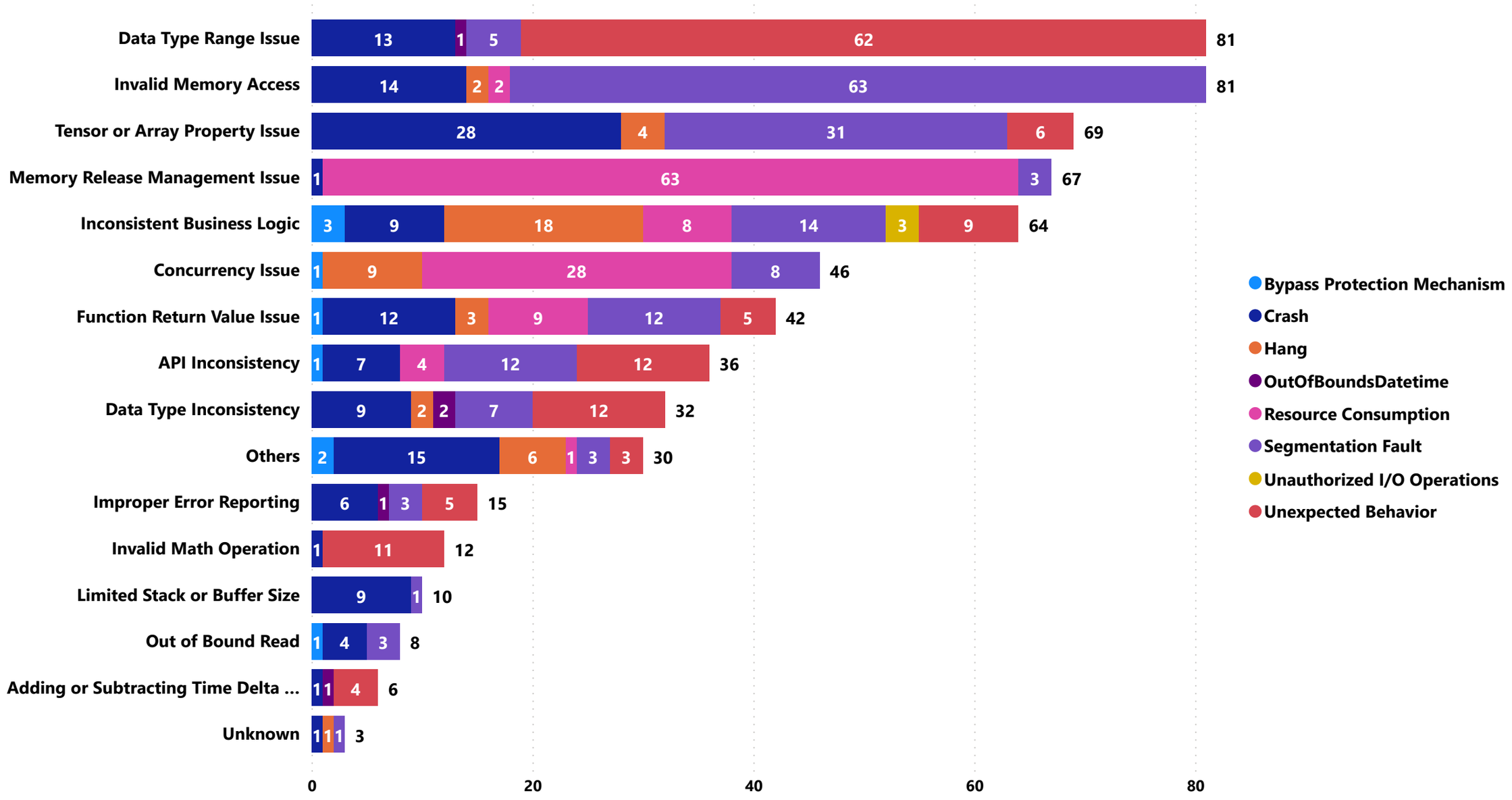
100
150
Numpy
Pandas
PyTorch
Sickit-Learn
Tensorflow


small repair
57
50
39
20
77
243
micro repair
64
22
14
102
202
medium repair
25
28
12
45
112
large repair
6
6
7
26
46
0
50
100
150
200
250
Numpy
Pandas
PyTorch
Sickit-Learn
Tensorflow


Segmentation Fault
39
26
33
68
166
Crash
14
16
17
10
73
130
Unexpected Behavior
18
27
20
17
47
129
Resource Consumption
70
5
2
7
31
115
Hang
5
2
7
2
29
45
Bypass Protection Mechanism
6
9
OutOfBoundsDatetime
5
5
Unauthorized I/O Operations
3
3
0
50
100
150
Numpy
Pandas
PyTorch
Sickit-Learn
Tensorflow


Data Type Range Issue
13
1
5
62
81
Invalid Memory Access
14
2
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63
81
Tensor or Array Property Issue
28
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31
6
69
Memory Release Management Issue
1
63
3
67
Inconsistent Business Logic
3
9
18
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14
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64
Concurrency Issue
1
9
28
8
46
Function Return Value Issue
1
12
3
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12
5
42
API Inconsistency
1
7
4
12
12
36
Data Type Inconsistency
9
2
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Others
2
15
6
1
3
3
30
Improper Error Reporting
6
1
3
5
15
Invalid Math Operation
1
11
12
Limited Stack or Buffer Size
9
1
10
Out of Bound Read
1
4
3
8
Adding or Subtracting Time Delta ...
1
1
4
6
Unknown
1
1
1
3
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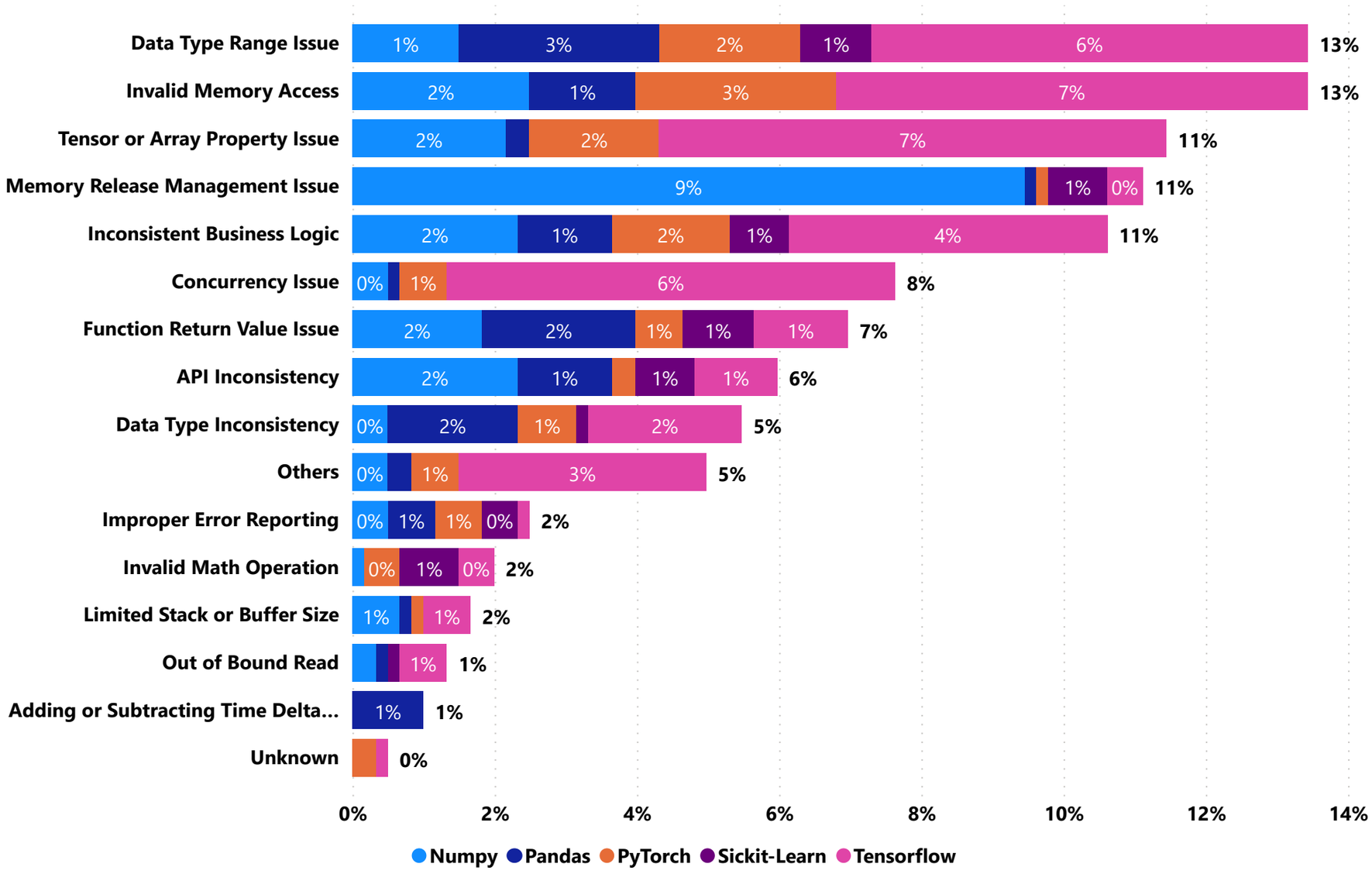
20
40
60
80
Bypass Protection Mechanism
Crash
Hang
OutOfBoundsDatetime
Resource Consumption
Segmentation Fault
Unauthorized I/O Operations
Unexpected Behavior


Data Type Range Issue
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Invalid Memory Access
2%
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Tensor or Array Property Issue
2%
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Memory Release Management Issue
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Inconsistent Business Logic
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Concurrency Issue
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Function Return Value Issue
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API Inconsistency
2%
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Data Type Inconsistency
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Improper Error Reporting
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Invalid Math Operation
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Numpy
Pandas
PyTorch
Sickit-Learn
Tensorflow