Fast, Cheap and Under Control:

Evaluating Revision Data Reliably

Abram Hindle, Michael W. Godfrey, Richard C. Holt

Software Architecture Group
David R. Cheriton School of Computer Science
University of Waterloo
Canada
http://swag.uwaterloo.ca/
{ahindle,migod,holt}@cs.uwaterloo.ca

Introduction

- Our focus
  - Arguing for Cheap and Fast techniques
    - that can be verified (Under control)
  - Demonstrate 2 of projects
    - Release Mining
    - Indentation Metrics
- Conclusions

Fast, Cheap and Under Control

- Fast - speed, execution time
- Cheap - how much effort to run, to implement
- Under Control - it has been verified or demonstrated that it works.
  - Someone else went through the leg work to provide evidence that it works.
  - Show that it reliably works for many cases

Fast and Cheap methods we have used

- Looked at change history as events and not as diffs
  - Characterize behaviour around events.
- Measured diffs via their indentation to infer complexity
  - If you rank changes by variance or sum of indentation, you're effectively ranking by complexity!

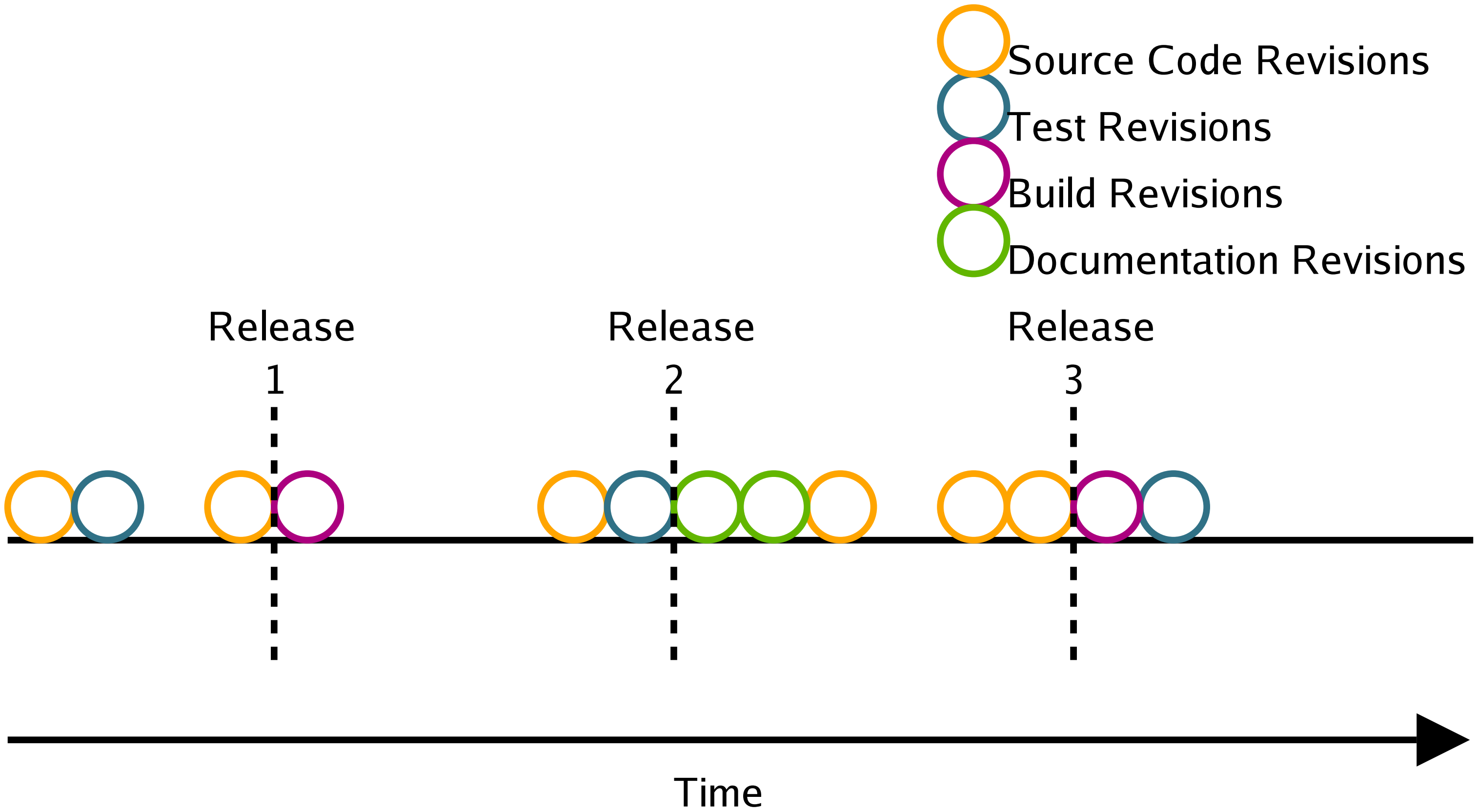

Figure 1: Partitioned revisions and releases over time in order to focus on behaviour around release time

Get the Diff

```
> void square( int * arr, int n ) {
> □□□□int i = 0;
> □□□□for ( i = 0 ; i < n ; i++ ) {
> □□□□□□□□arr[ i ] *= arr[ i ];
> □□□□}
> }
```

Measure the Indentation

Raw Indentation	0	4	4	8	4	0
Logical Indentation	0	1	1	2	1	0

Produce Summary Statistics

Metric	Raw	Logical
LOC	6.000	6.000
AVG	3.330	0.833
MED	4.000	1.000
STD	2.750	0.687
VAR	9.070	0.567
SUM	20.000	5.000
MCC	2.000	2.000
HVOL	152.000	152.000
HDIFF	15.000	15.000
HEFFORT	2127.000	2127.000

Challenges

- Scalability
  - Software ranges in size
- Tool Support
  - How many of you can parse PHP or Perl right now?
- Flexibility
  - How much do you have to know or do before hand?
- Software is complicated and unique
  - Some analyses will not work

Cheap

- Cost
- Implementation time
- How much prep work do we need to do
- How much data do we need to provide
  - For instance, do we even need the diff or the source code?
  - Do we need language specific tools?

Cheap and Adoptable!

- Even the developers of a project can apply it
- Doesn't take a lot of work to integrate a technique
- Low cost of adoption and adaption.
- Cheap yet verified!
- End-user doesn't need to prove the technique works
  - We do

Fast

- Often easy and cheap is fast
- By ignoring certain kinds of information (diffs) we can get results quickly
  - Or at least provide results at an acceptable granularity
- Efficiency: Good run-times over large data sets

Under Control

- The fast part is for the end user
  - We can do the slow parts
    - Verification, corpus, examples

Under Control

- Can we show it works?
- Can we provide a reasonable argument and actual evidence to show our fast, cheap technique works?
  - Sometimes control is slow, but once done we don’t need to do it again
- How flexible is it?
- Can we do more?

Is it Reliable?

- Just because something is easy and fast doesn't mean it right or doesn't mean it is accurate
- We have to validate if something is correct and works for many cases
  - With large samples of software we can test reliability, we can have reasonable statistical significance.
  - Test our techniques with large systems or large number of systems

Cheap and Fast Research?

- Cheap and Fast doesn’t necessarily make for fast research
  - You have to verify it works
  - Since we deal with software you should try it on real software or good representatives
  - If we can show it works, we stay in control

Cheap Example: Release Patterns

- Characterize a project's behaviour around release time before and after release
- Break a stream of revisions down by file type around release time and analyze that stream
- Cheap: Only needs file names and revision times
- Verification: Some by hand investigation
  - Ask the developers if this sounds right

Verification Example

- Indentation study
  - Is indentation regular?
    - Parse through 300 popular projects on source forge and find out!
  - For revisions, is indentation correlated with complexity?
    - Run complexity metrics on all source code revisions of 300 projects

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Verification Example

- Large Data-sets push statistical packages to their limits.
  - Don’t ask R to give you a correlation coefficient of 1 million or more elements.
- To verify, we spent 8 CPU years.
  - Ran thousands of jobs of on the Ontario Sharcnet cluster (Whale has 3000 CPUs)
  - Luckily correlation is associative (parallelizable)

Conclusions

- Fast and Cheap is easier for everyone (except us)
- We stand a better chance to see Fast and Cheap techniques adopted
  - SourceForge now has CVS/SVN viewers which graph repository activity
- Verification of claims can be done on large data-sets
  - Parallelizable tests allow years of CPU time to be folded into days.

Final

- Any Questions?

This work was partially funded by an NSERC PGS-D scholarship.

We thank Ontario Sharcnet for the computer equipment provided.

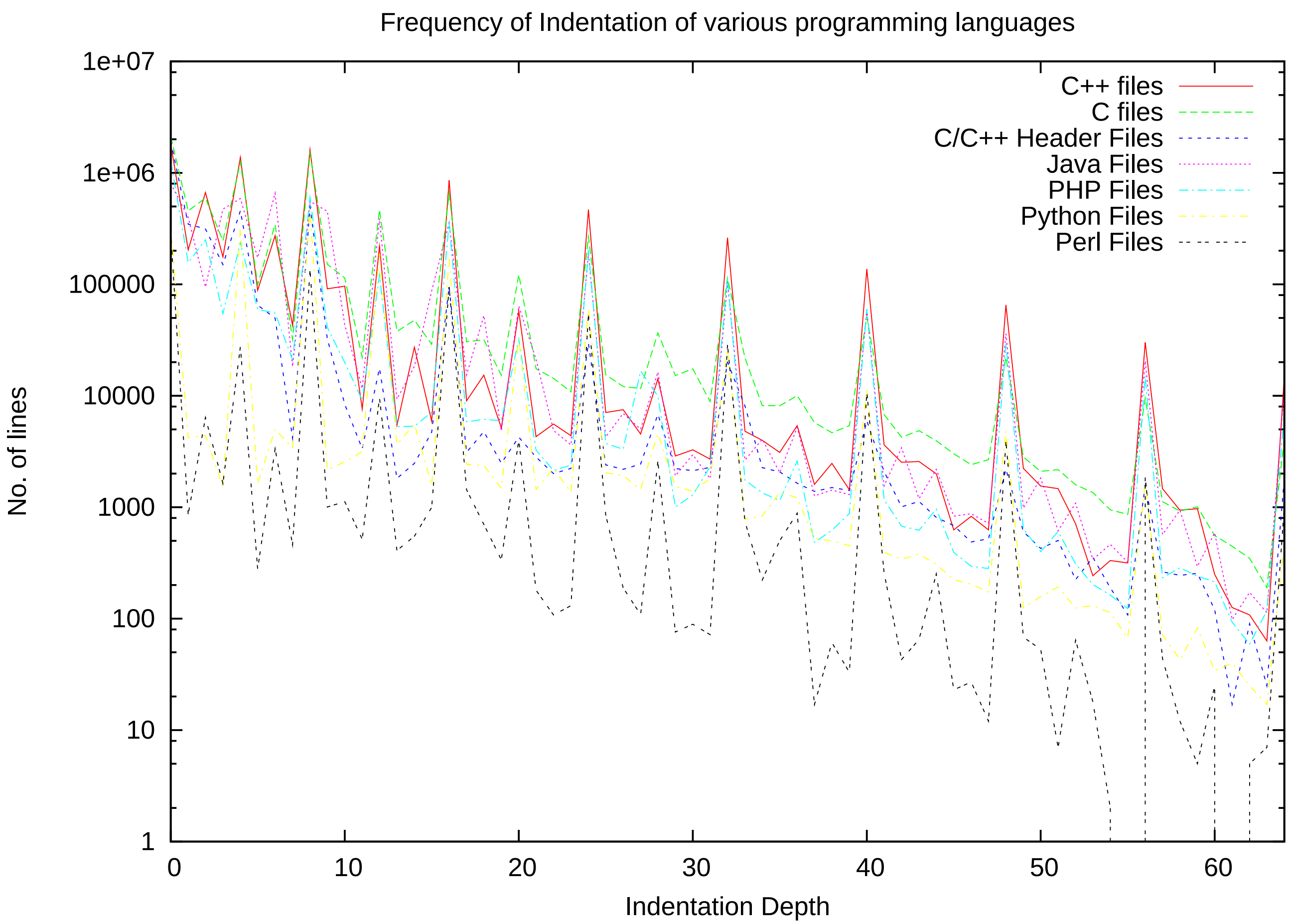


Figure 2: Frequency of Physical Indentation of various languages (Log Scale)

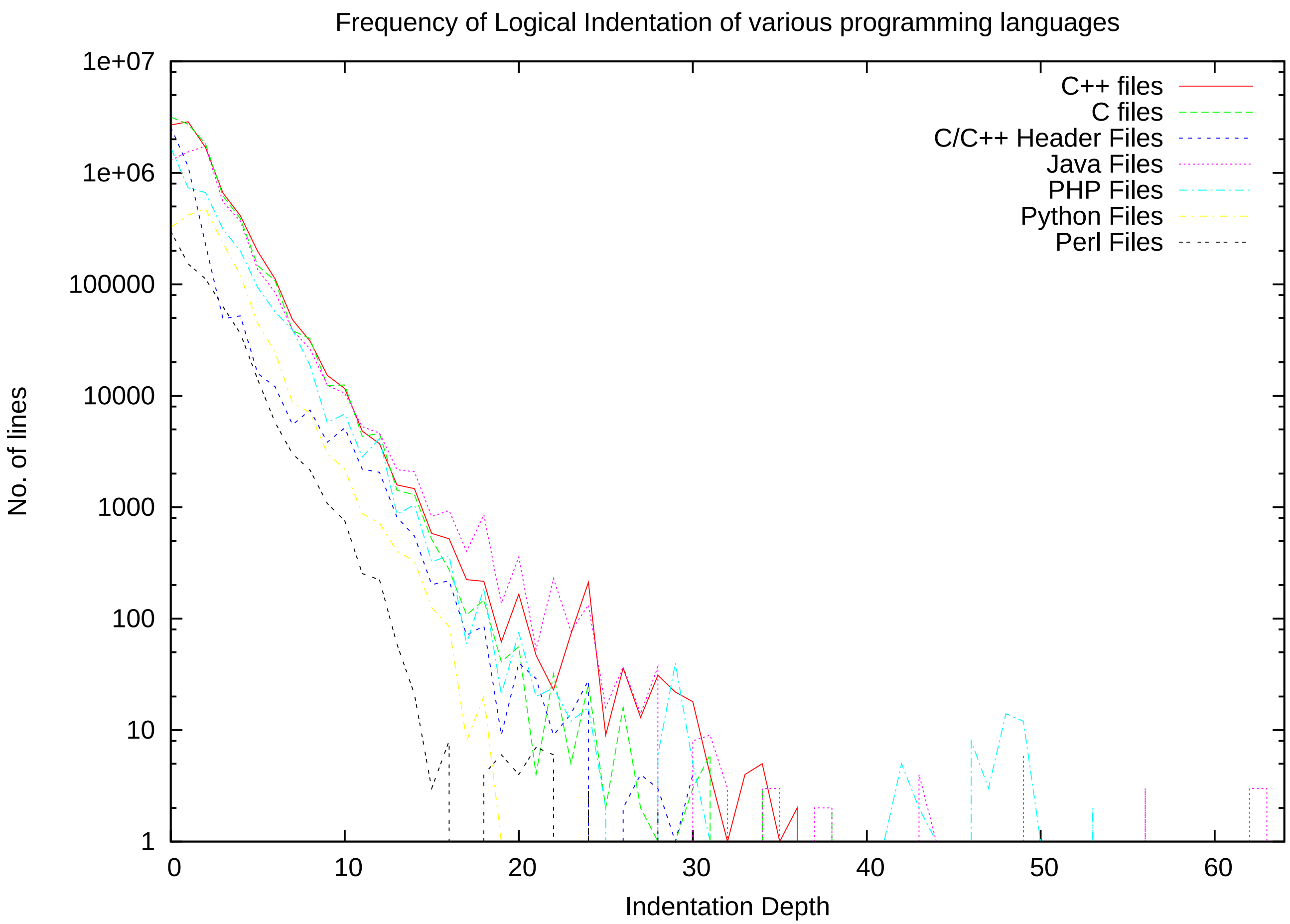


Figure 3: Frequency of Physical Logical Indentation of various languages (Log Scale)

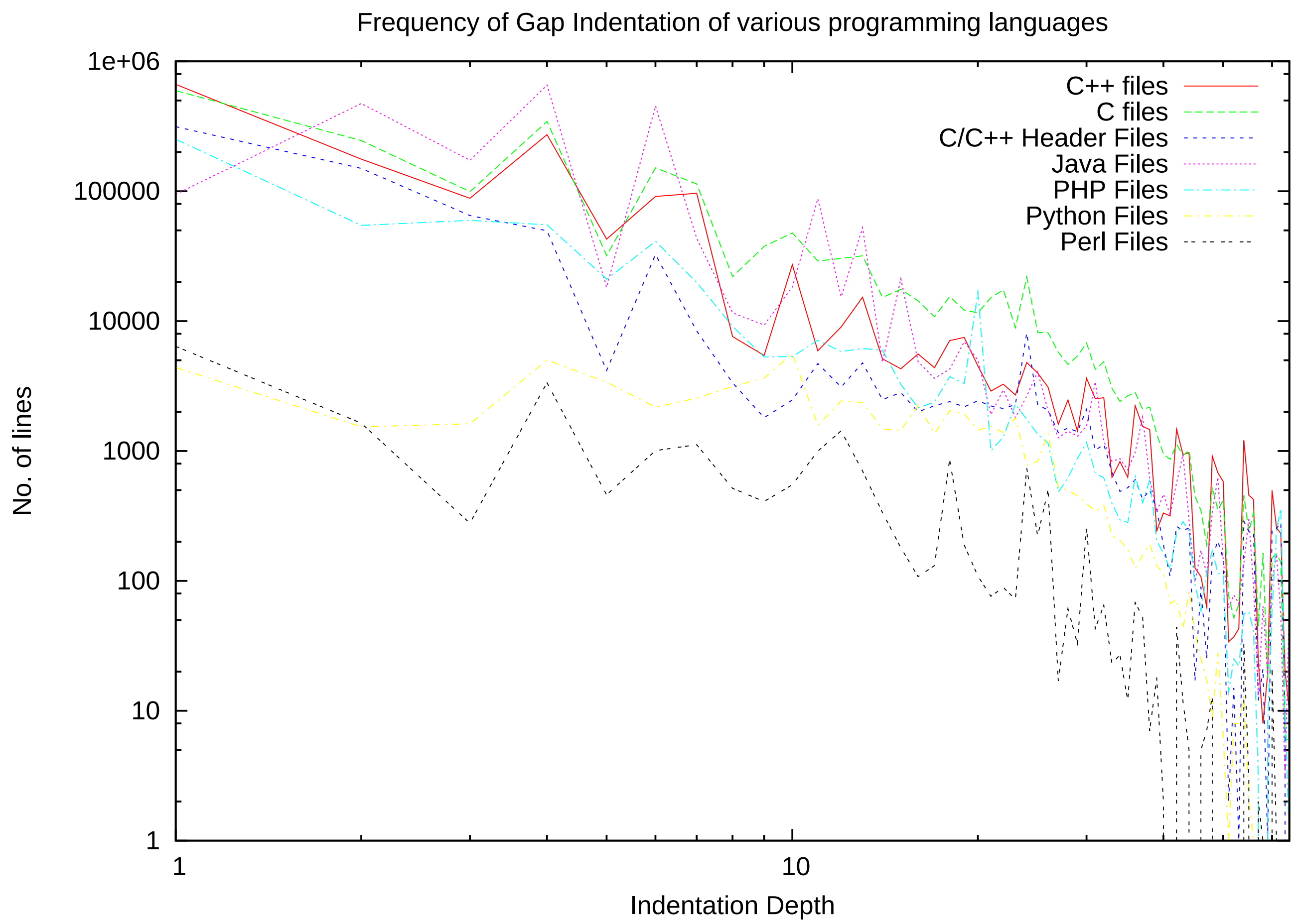


Figure 4: Frequency of Gap Indentation (non-logical units of indentation) of various languages (Log Scale)

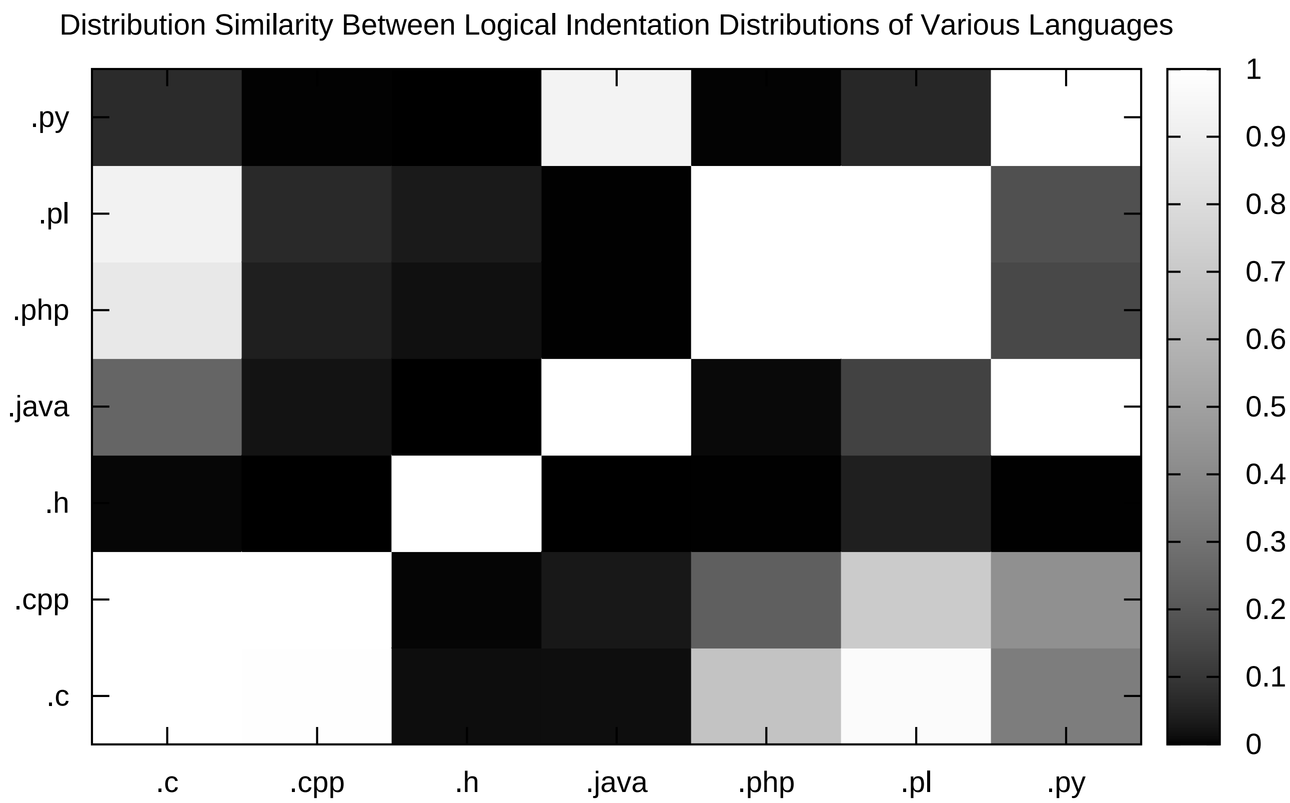
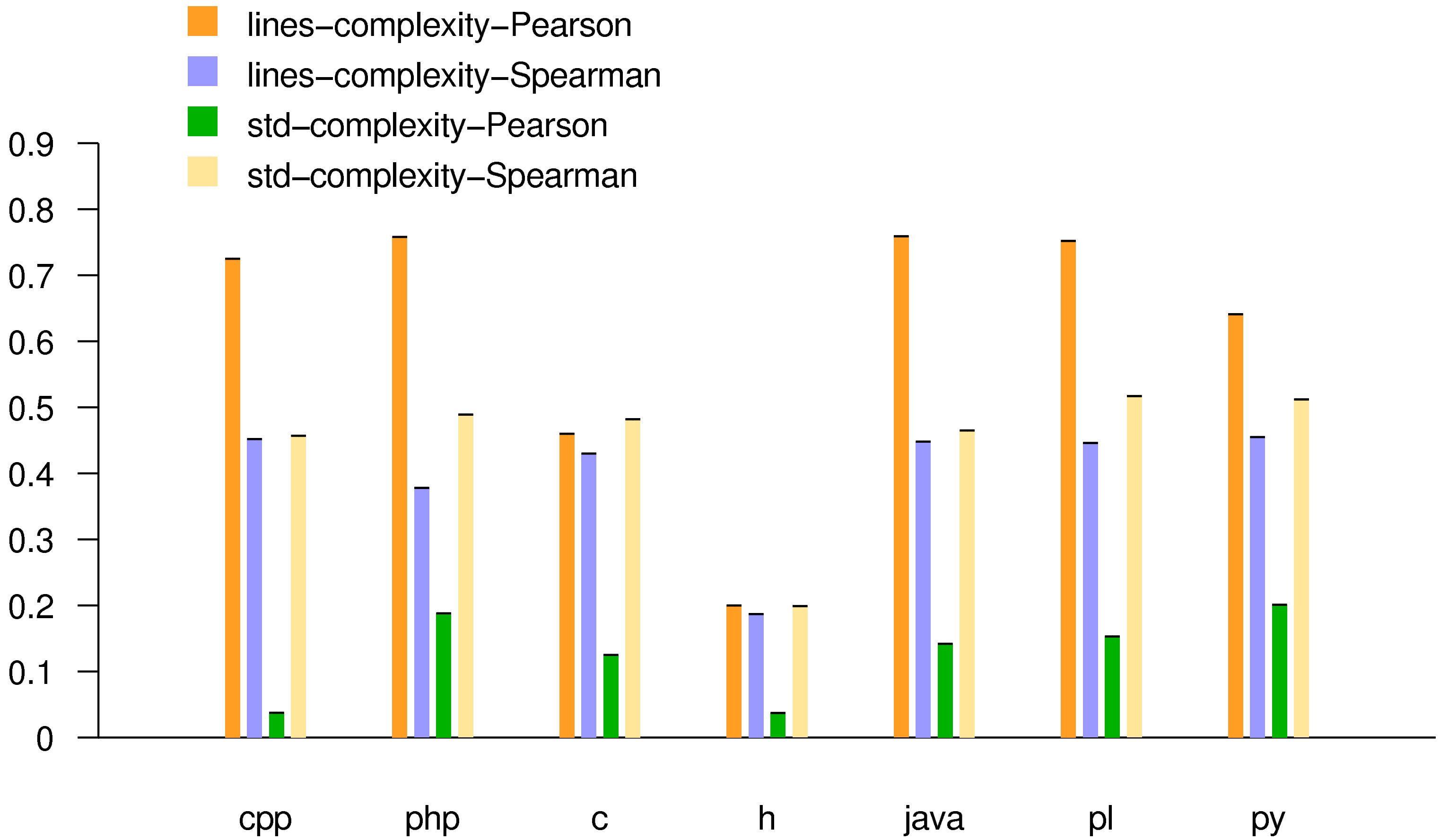


Figure 5: Similarity of Indentation between Languages


lines−complexity−Pearson
lines−complexity−Spearman
std−complexity−Pearson
std−complexity−Spearman
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
cpp
php
c
h
java
pl
py

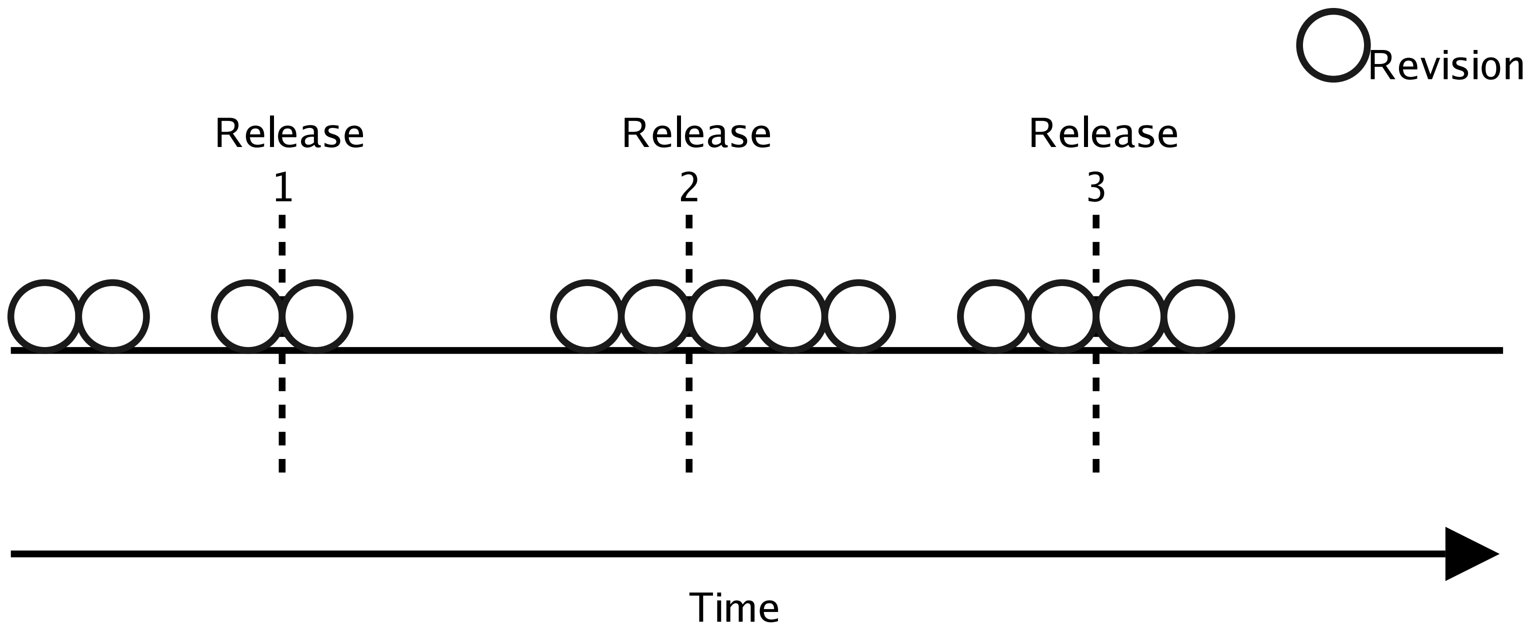


Figure 6: Revisions and releases over time. Extract the revisions

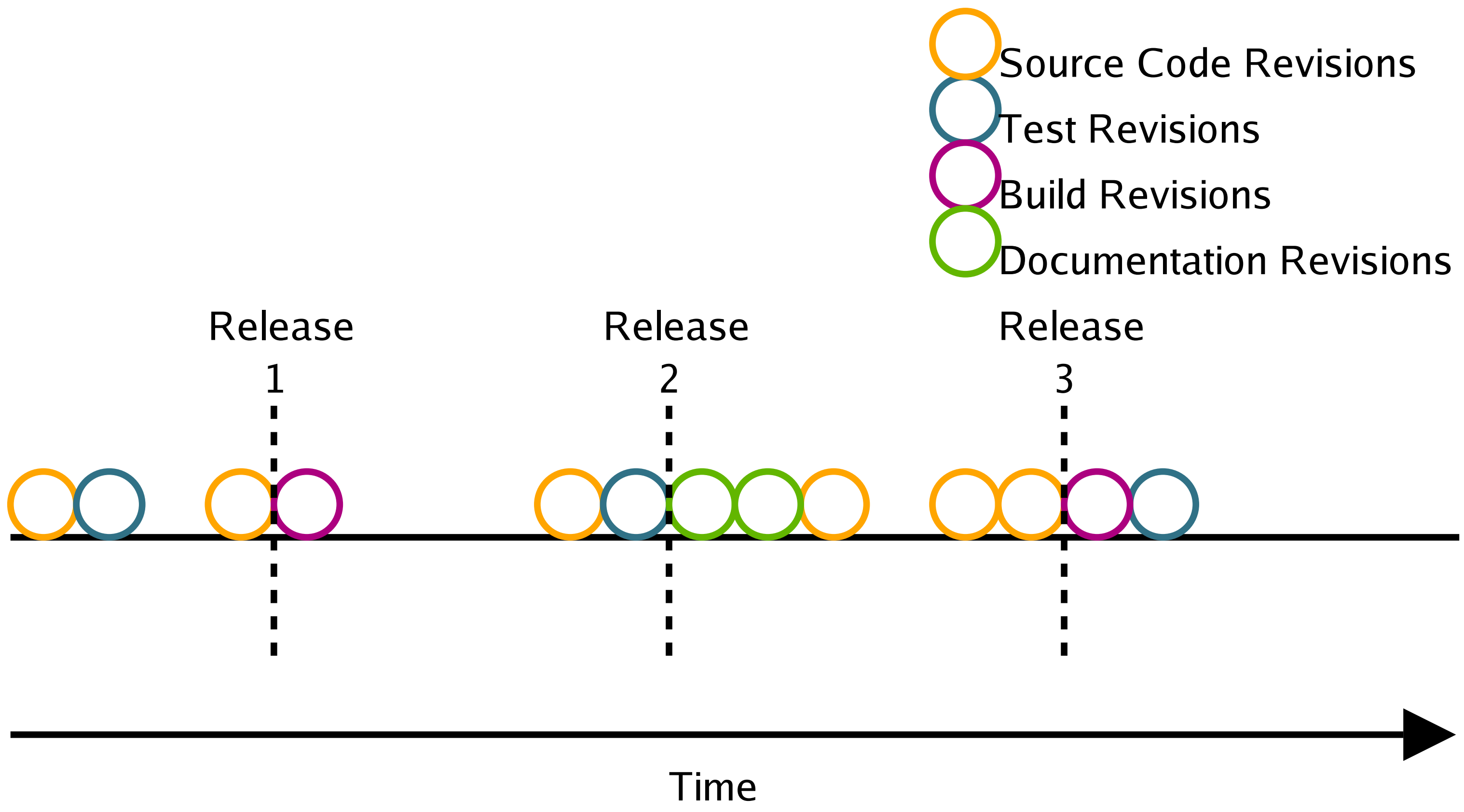


Figure 7: Partitioned revisions and releases over time

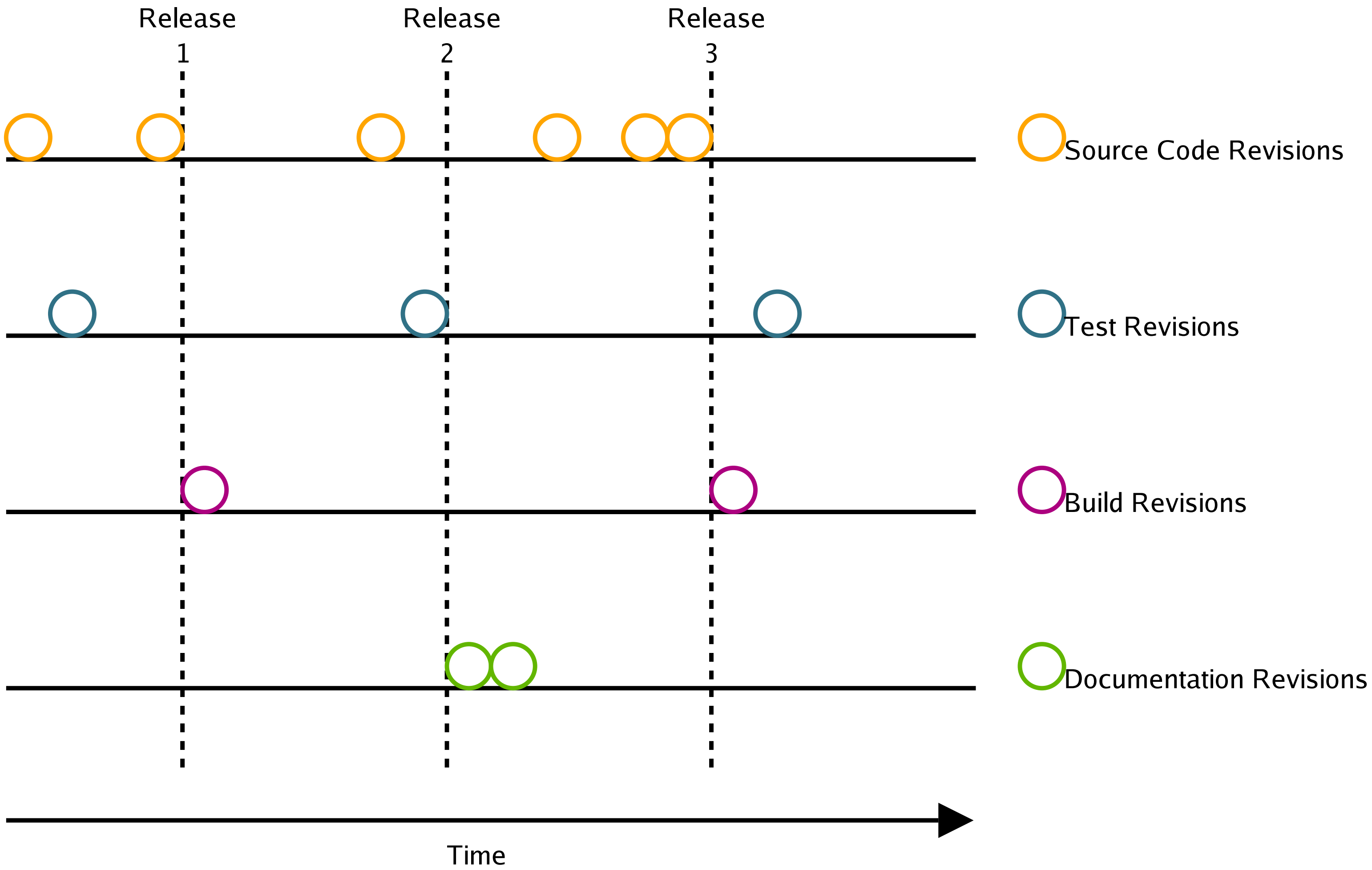


Figure 8: Partitioned revisions and releases over time, separated

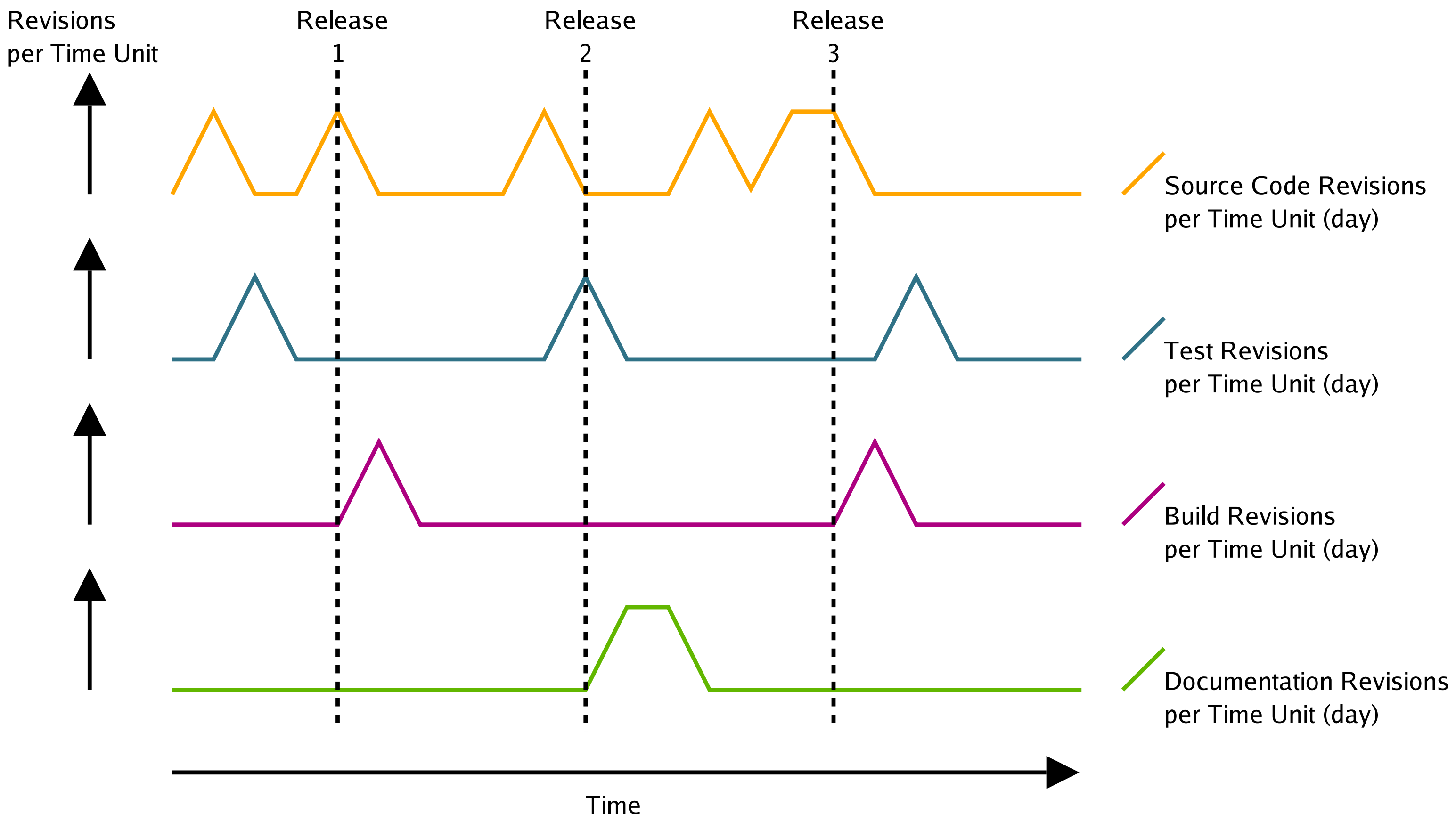


Figure 9: Partitioned revisions aggregated per day

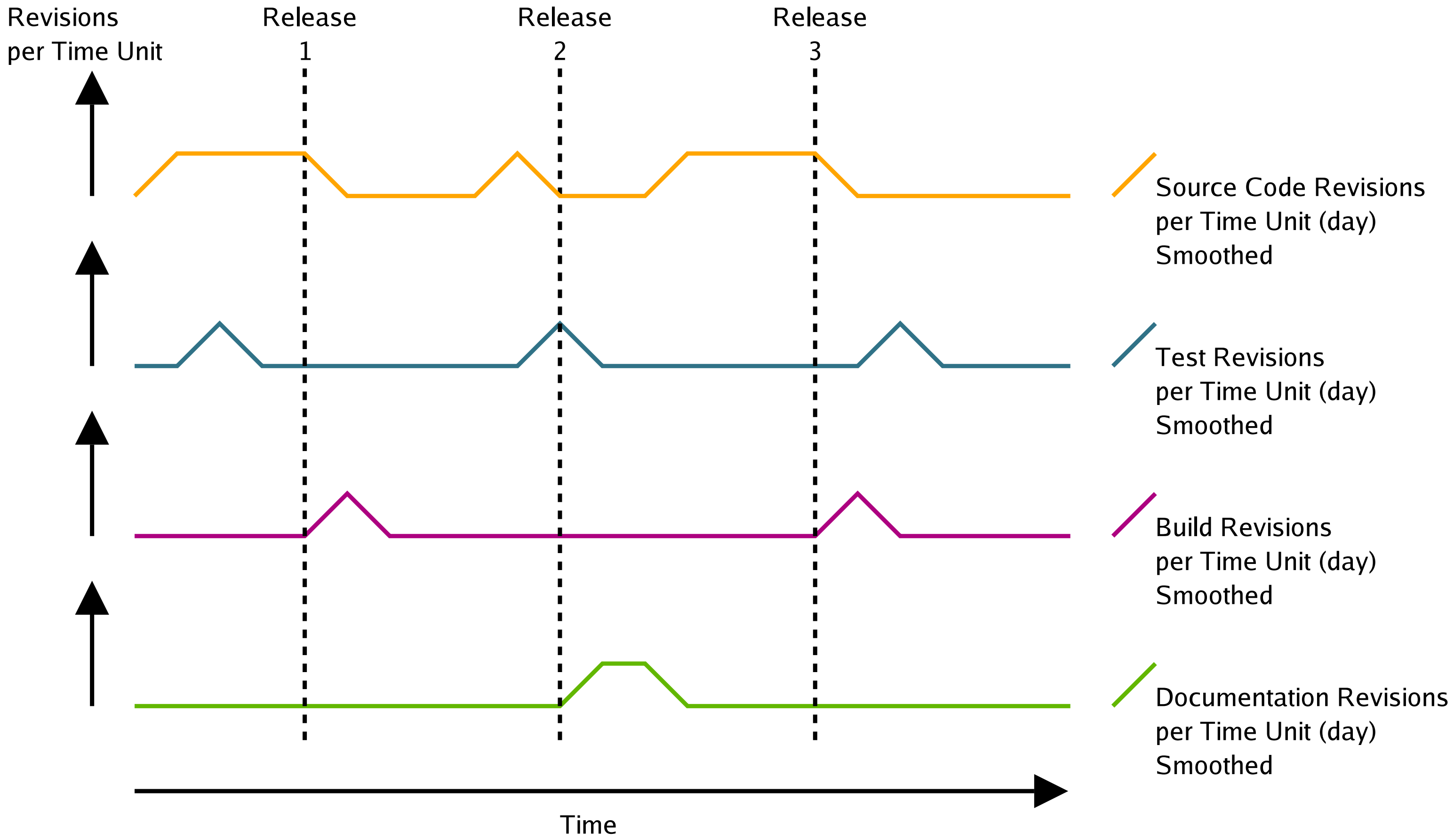


Figure 10: Partitioned revisions aggregated per day and smoothed

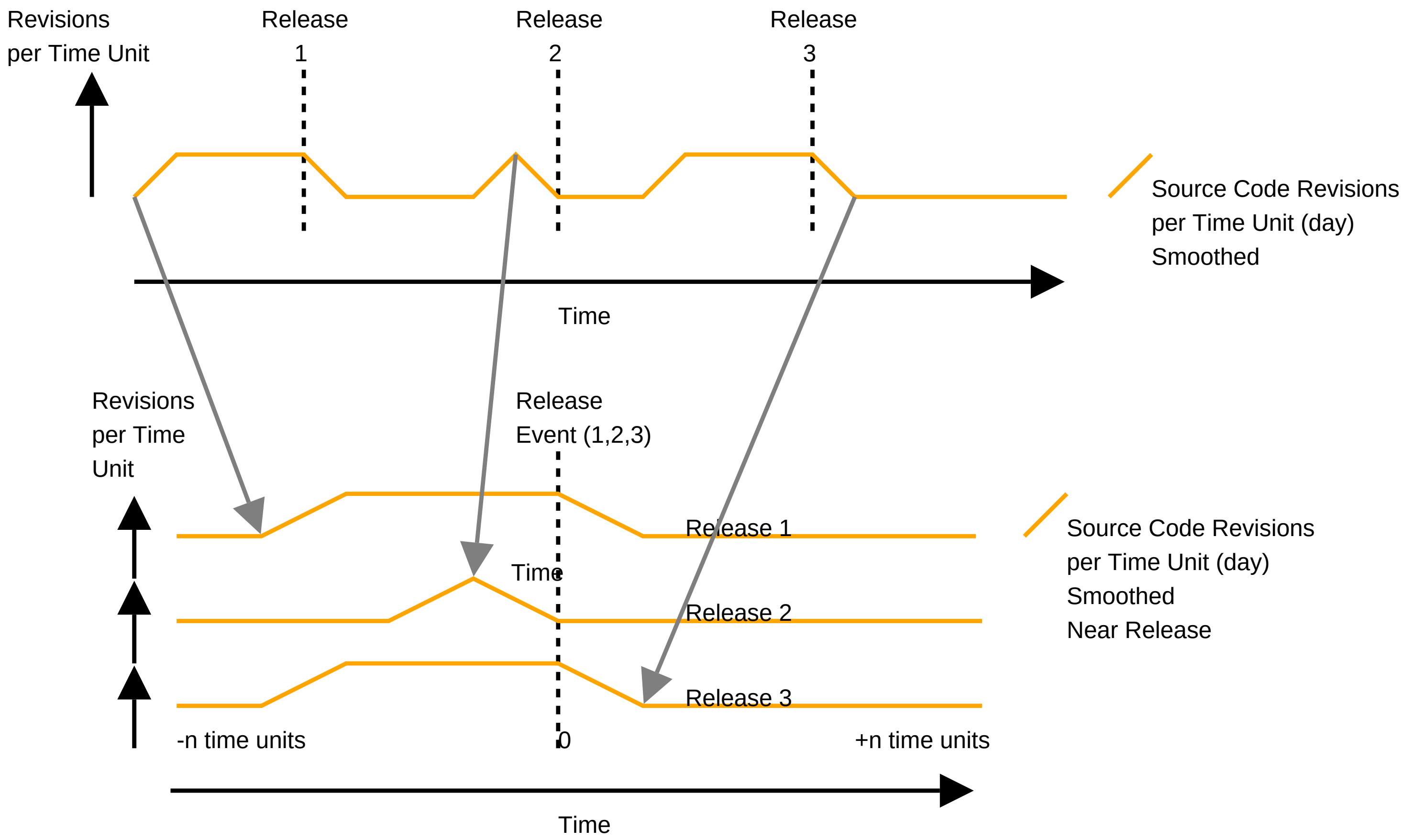


Figure 11: Select the revisions around release times

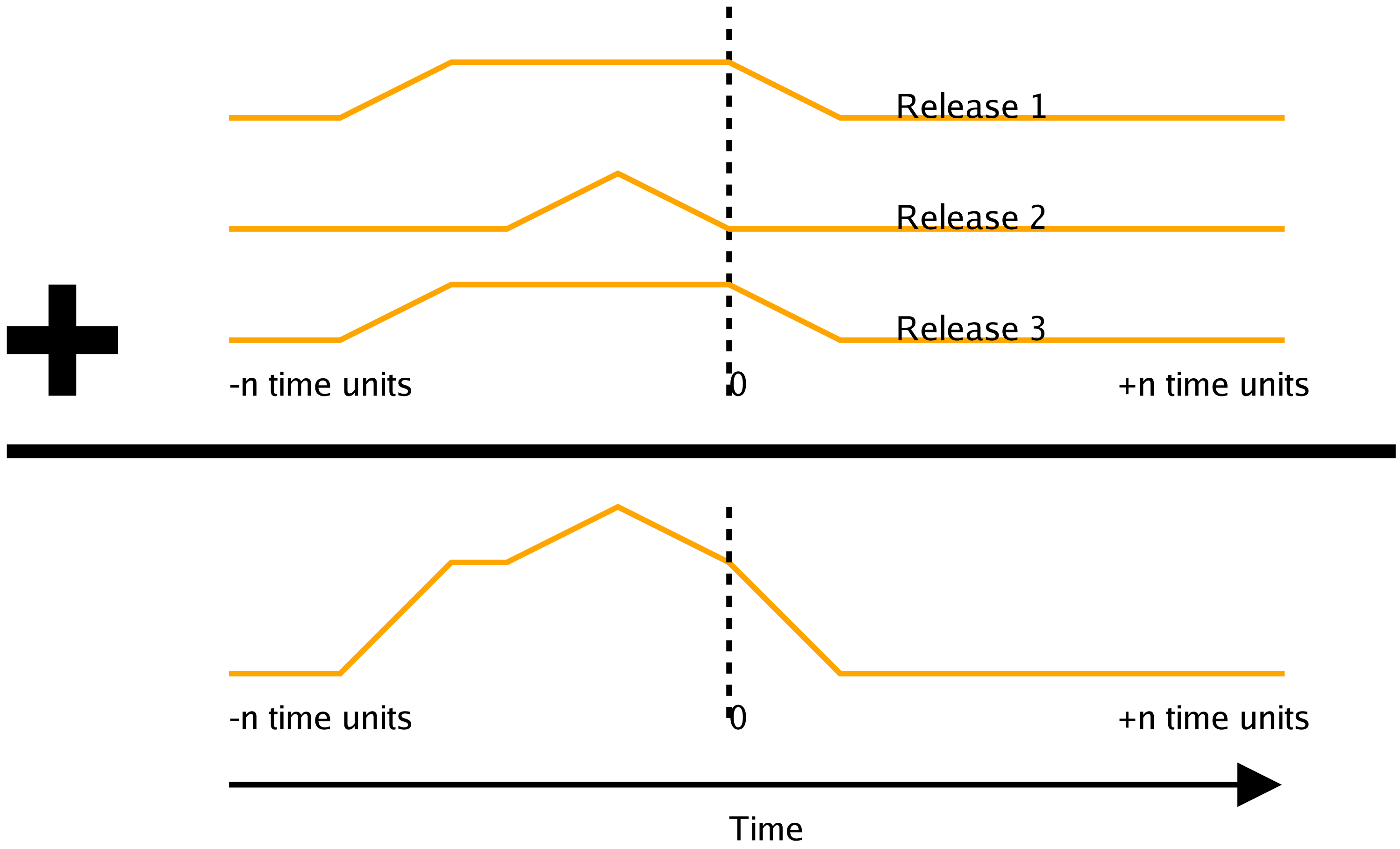


Figure 12: Aligned revisions aggregated

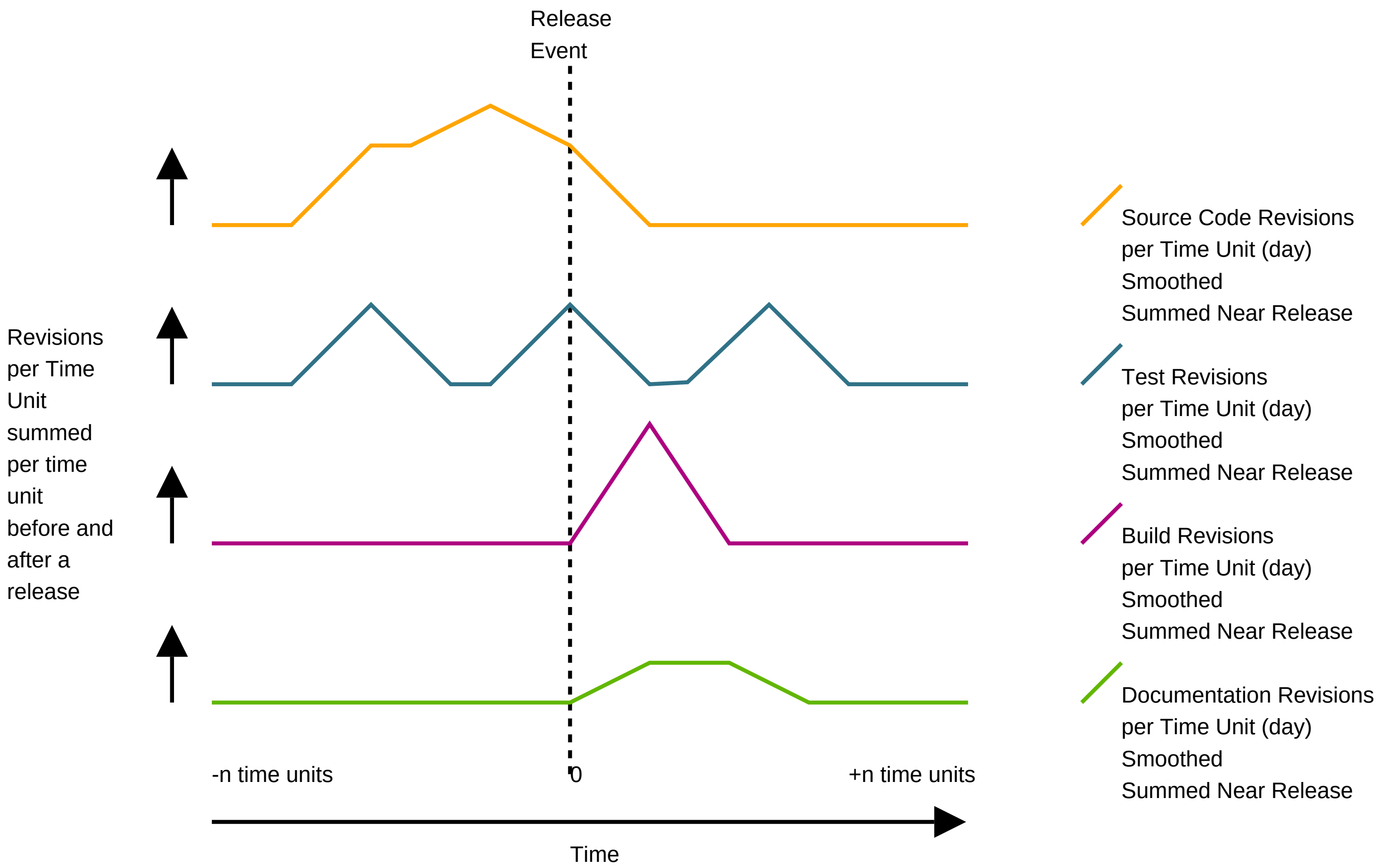


Figure 13: Align and aggregate revisions of each class

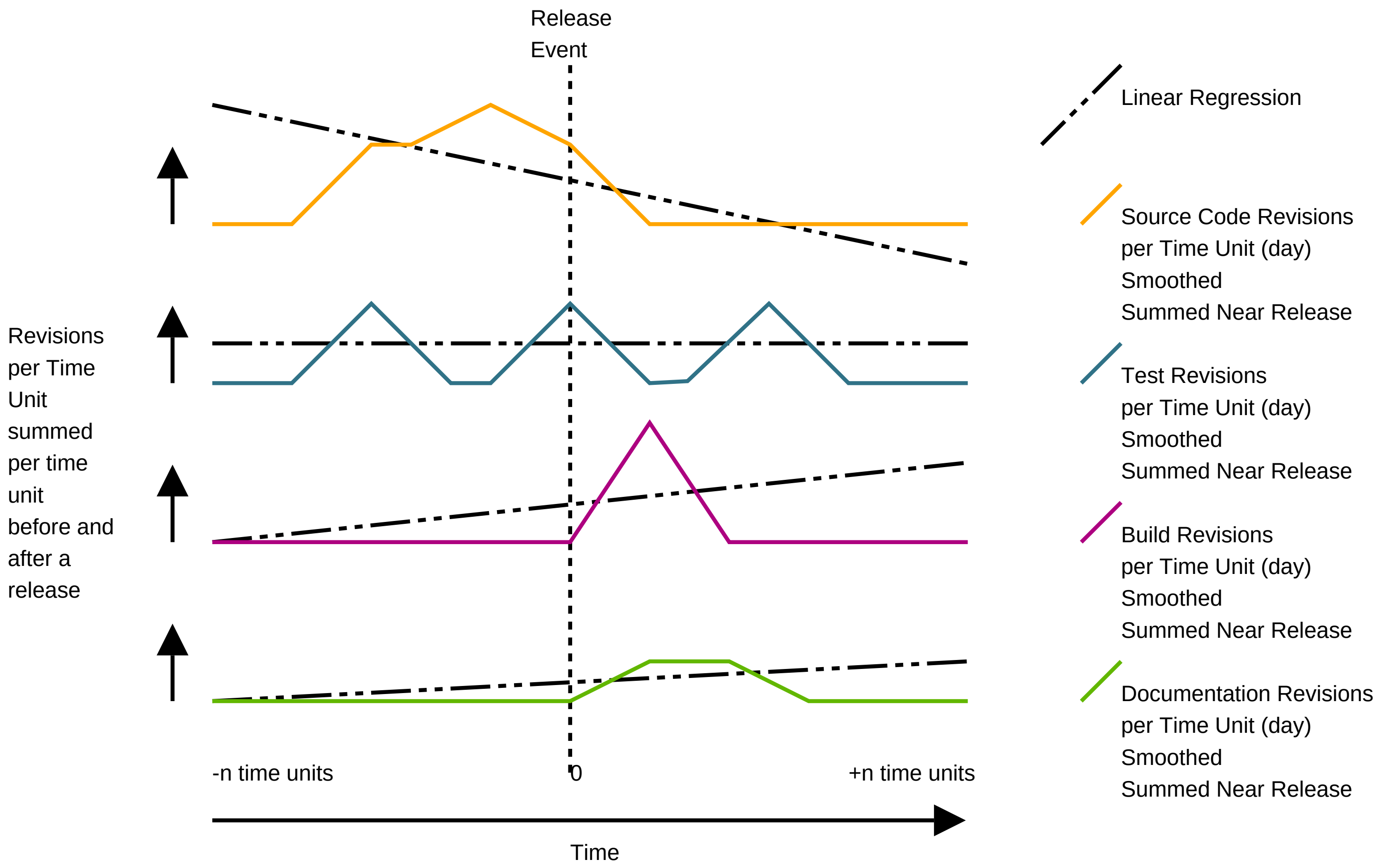
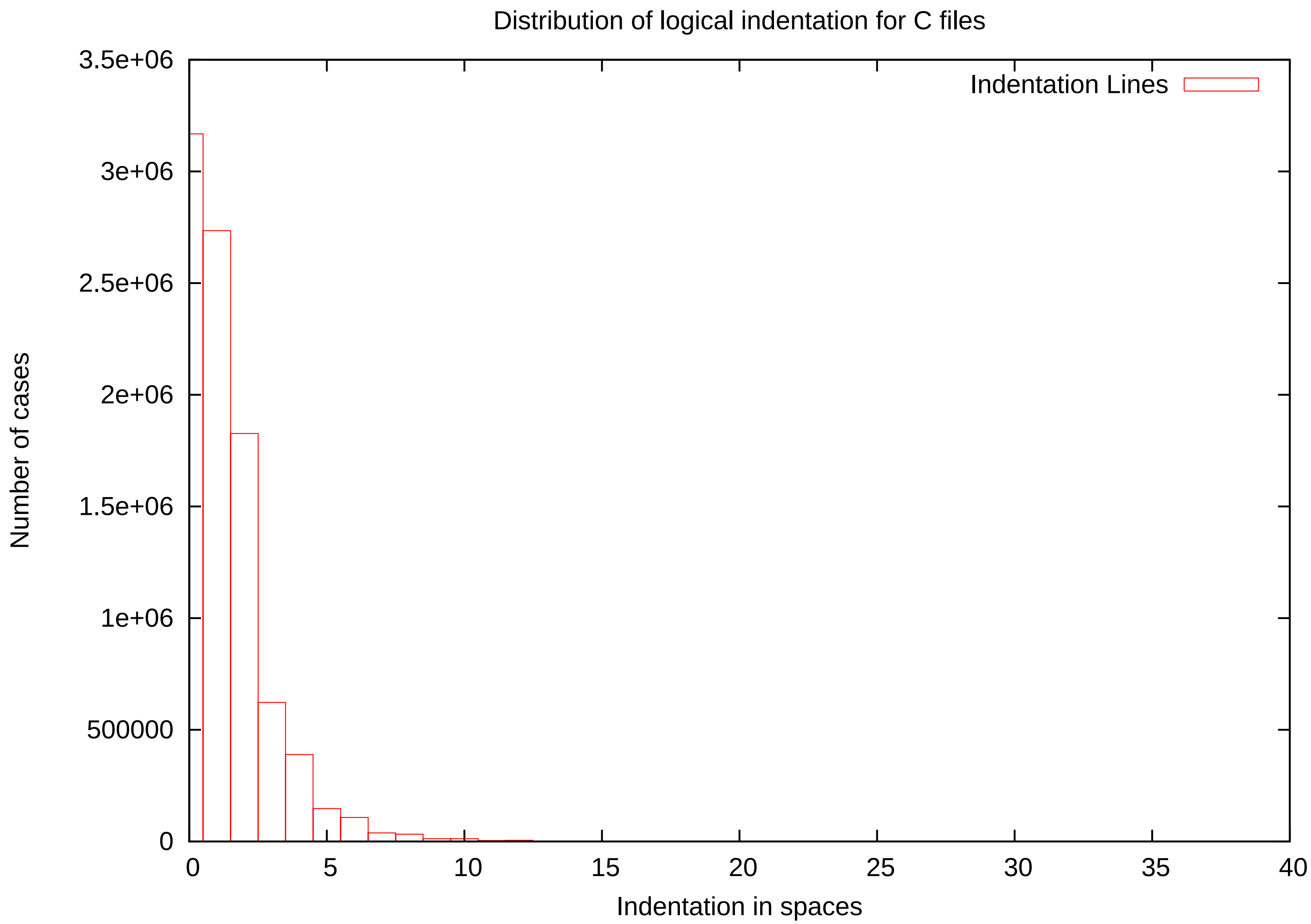
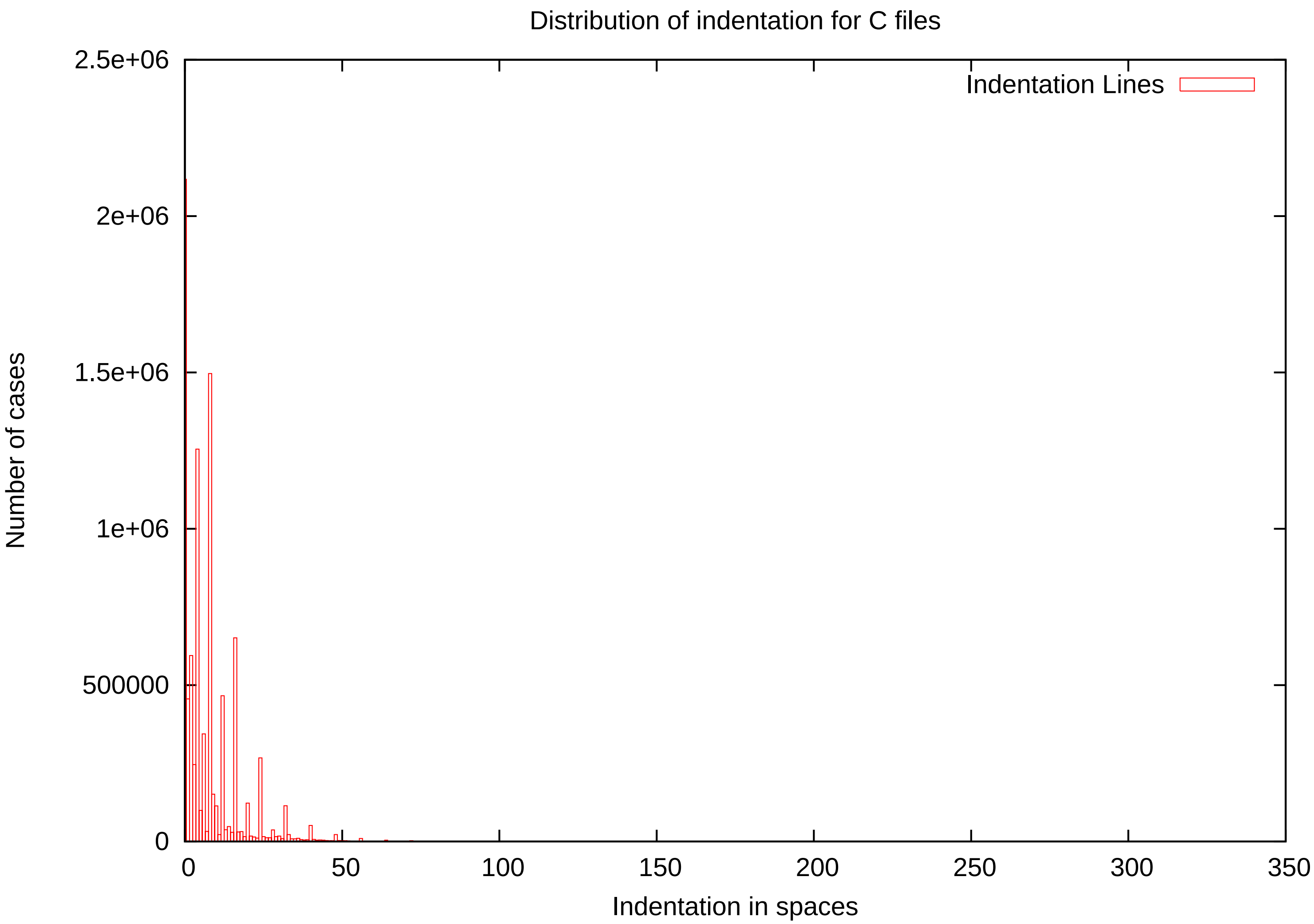
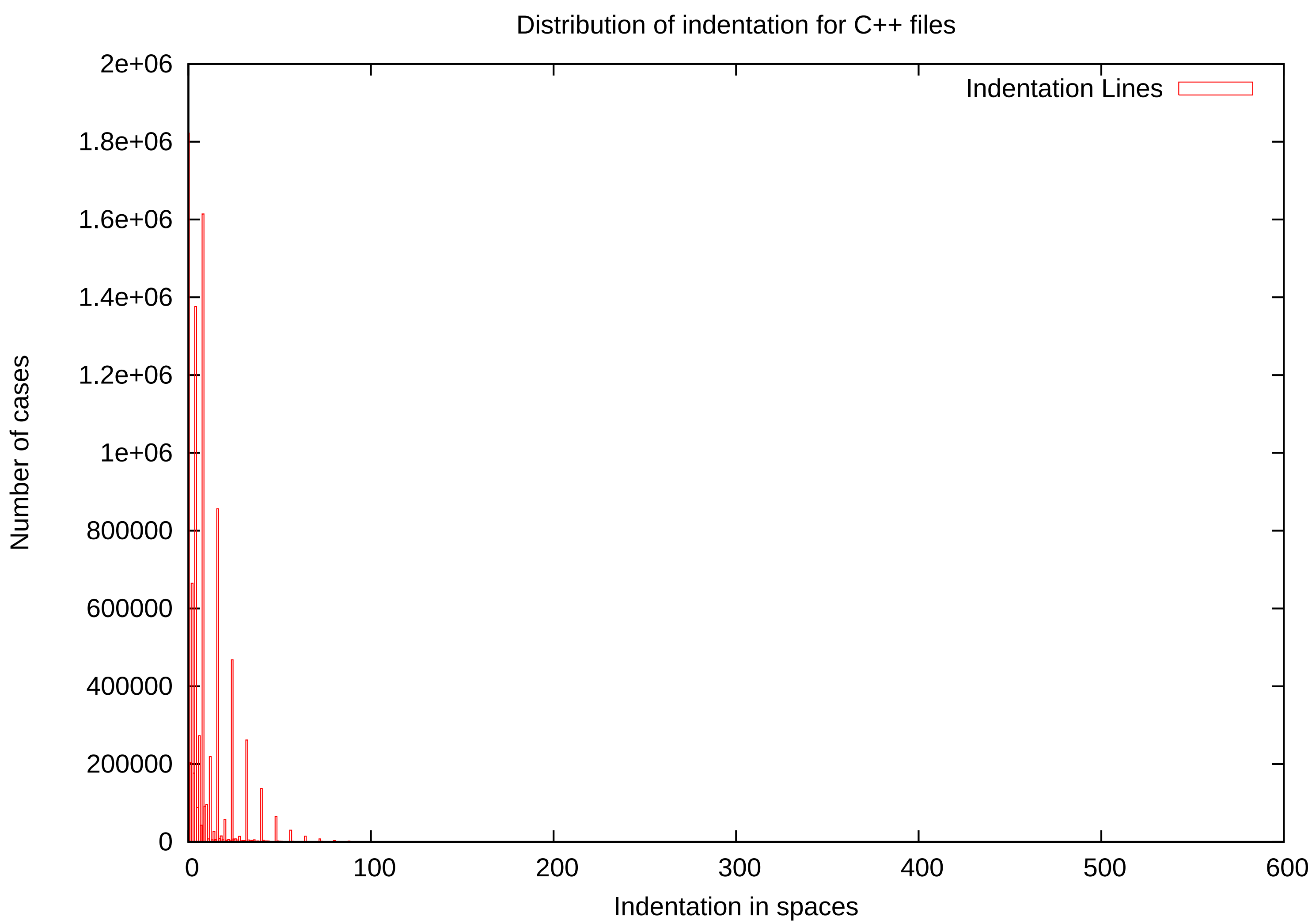
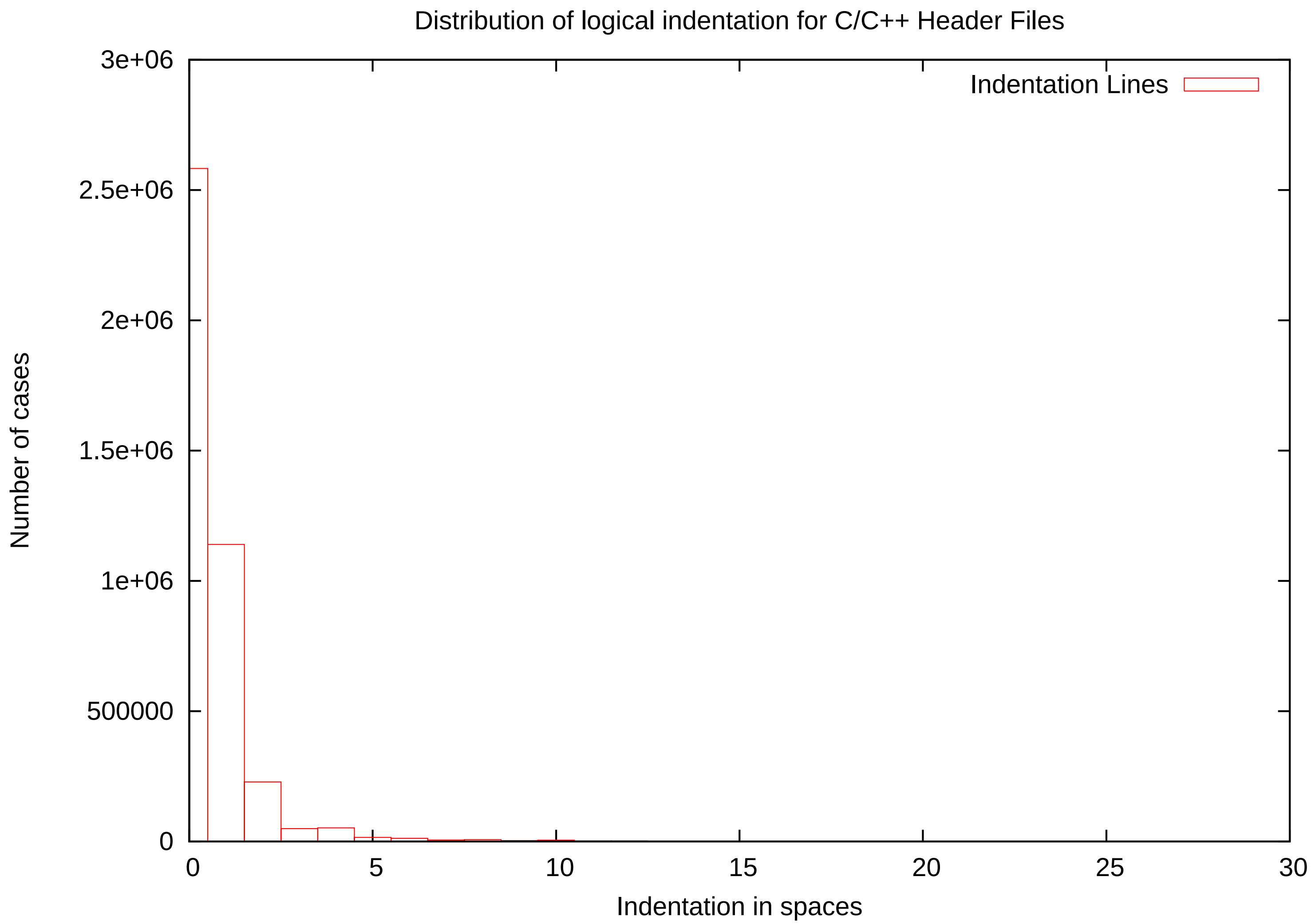


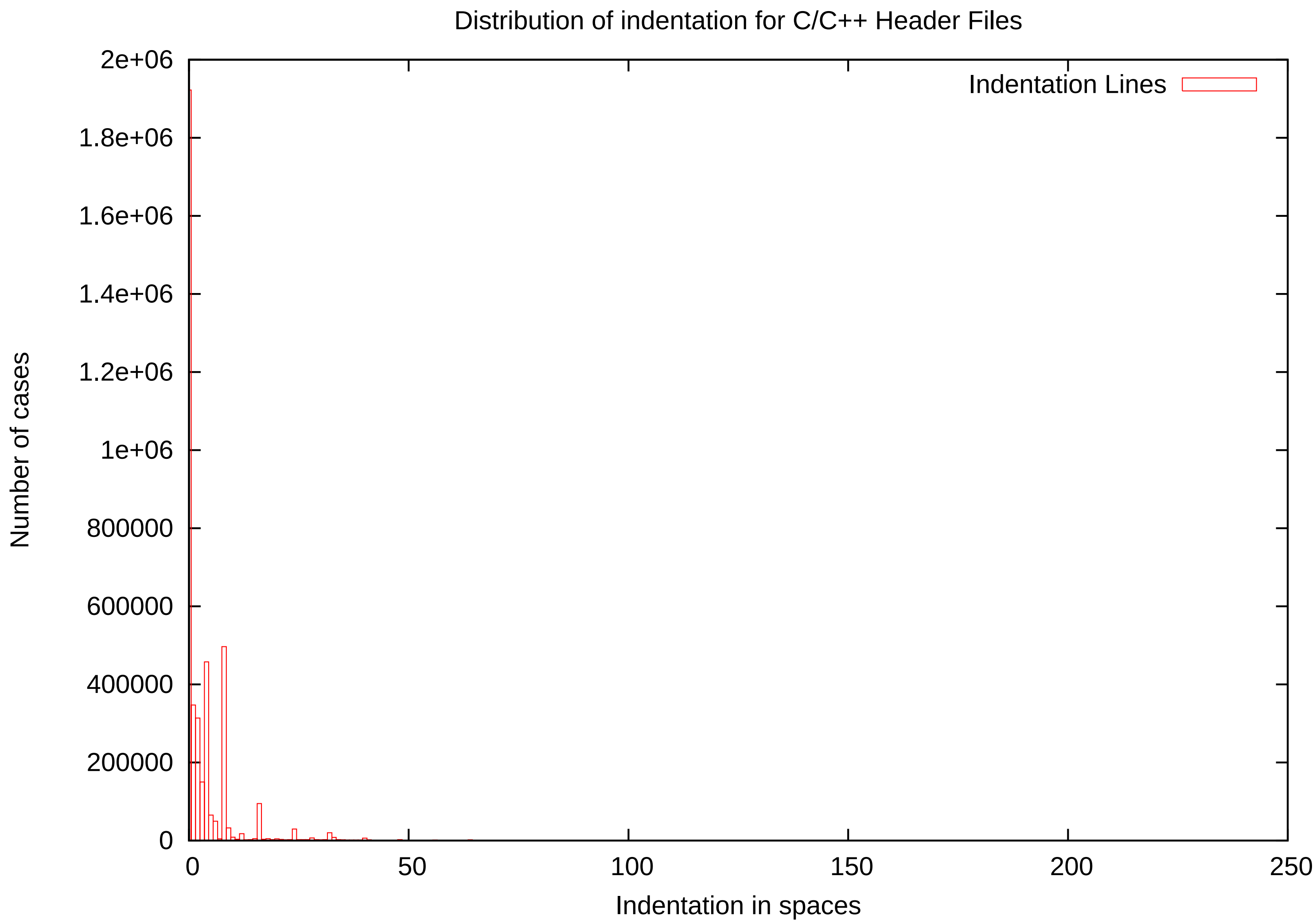
Figure 14: Analysis: averages and linear regressions

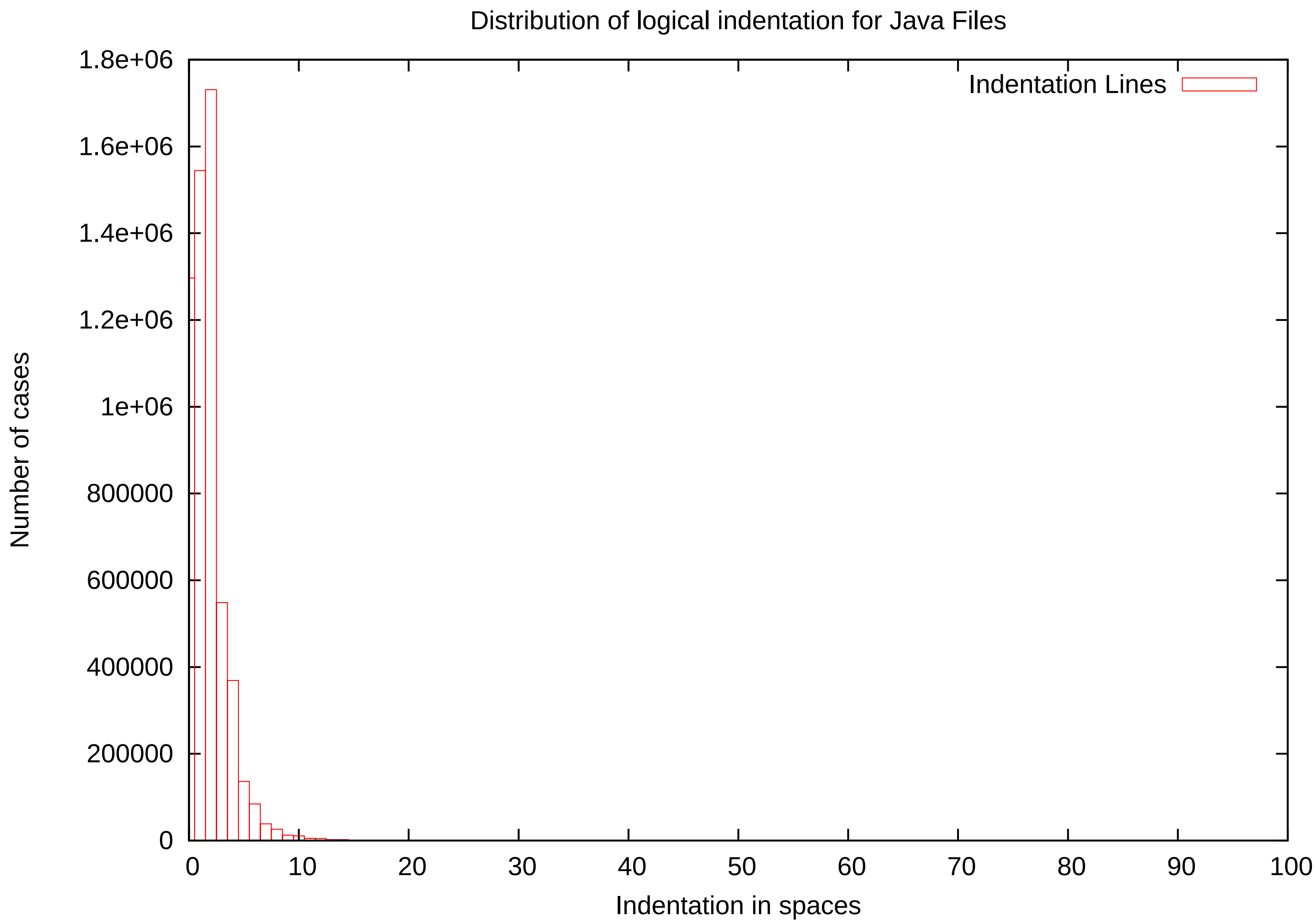

Distribution of logical indentation for C files
Indentation Lines
3.5e+06
3e+06
2.5e+06
2e+06
1.5e+06
1e+06
500000
0
0
5
10
15
20
25
30
35
40
Number of cases
Indentation in spaces

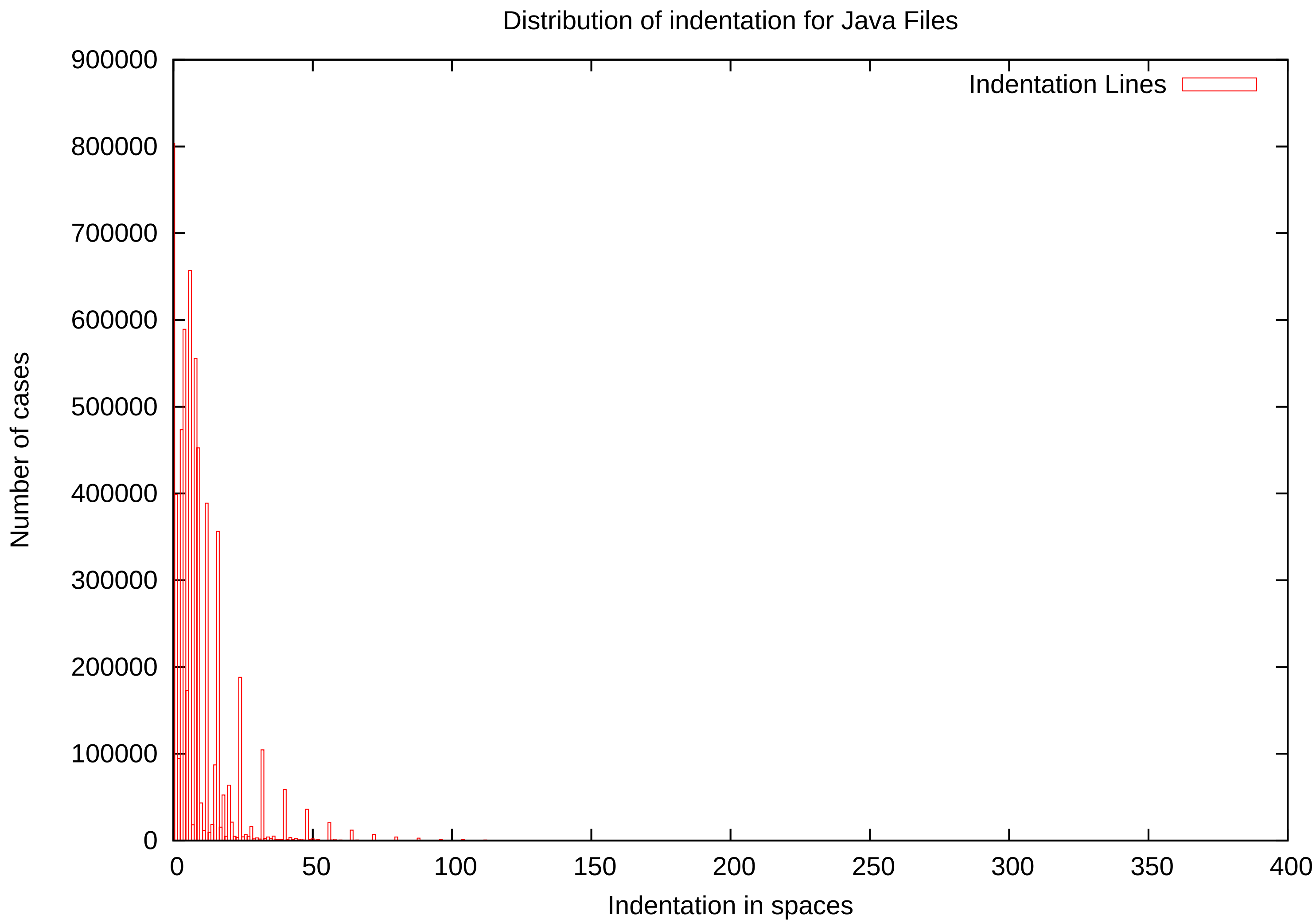

Distribution of indentation for C files
Indentation Lines
Number of cases
Indentation in spaces
2.5e+06
2e+06
1.5e+06
1e+06
500000
0
0
50
100
150
200
250
300
350

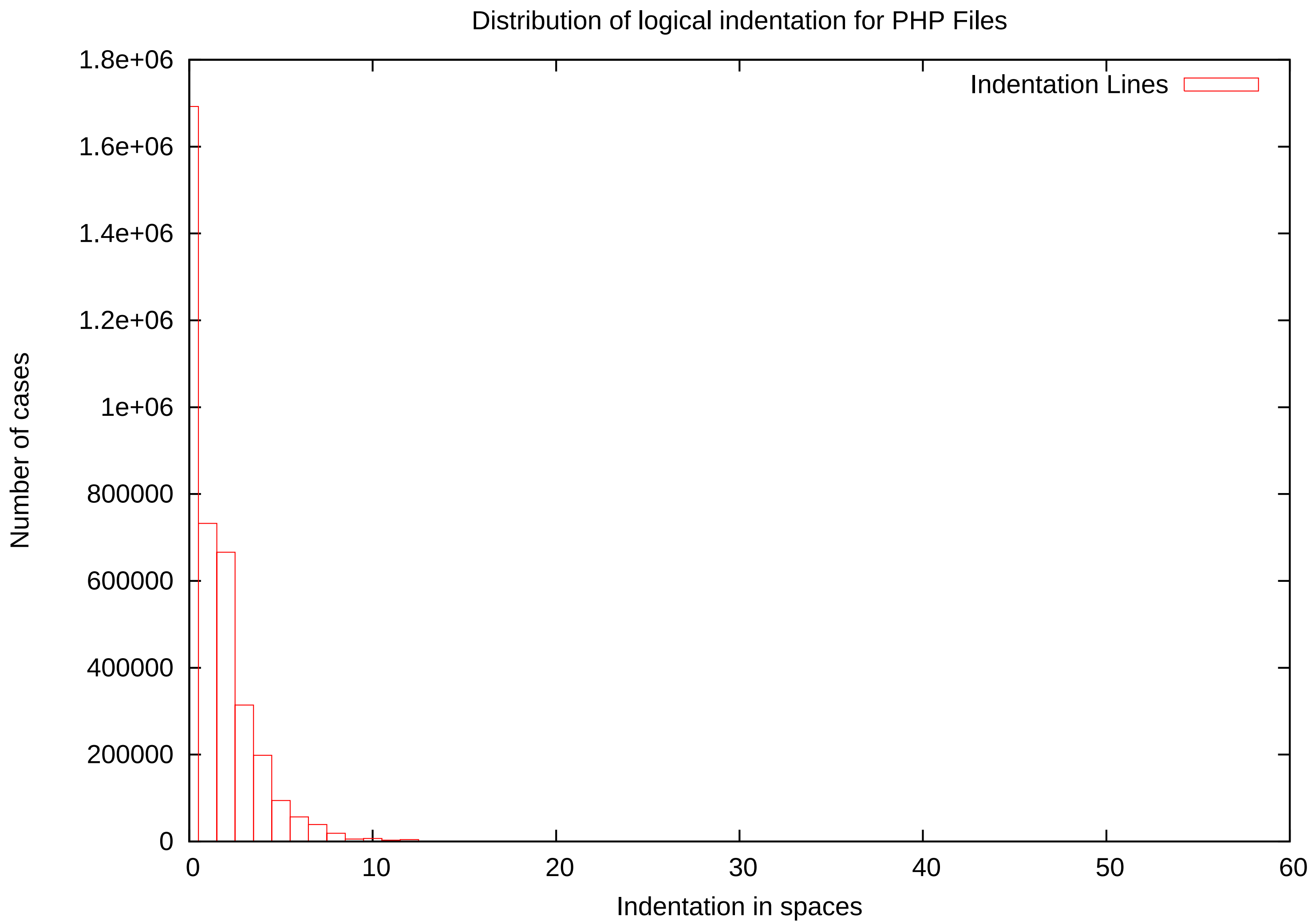

Distribution of indentation for C++ files
Indentation Lines
Number of cases
2e+06
1.8e+06
1.6e+06
1.4e+06
1.2e+06
1e+06
800000
600000
400000
200000
0
0
100
200
300
400
500
600
Indentation in spaces

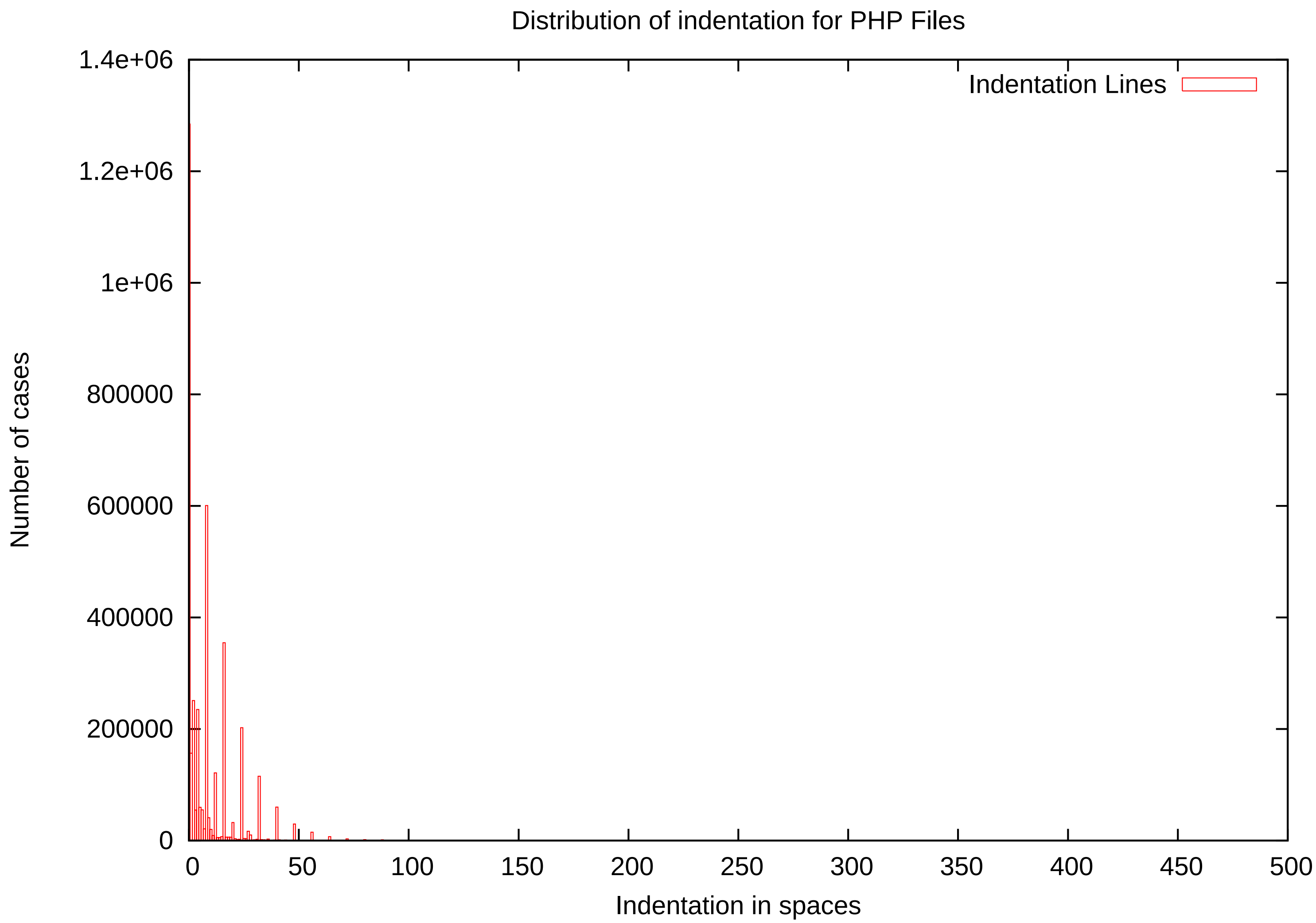

Distribution of logical indentation for C/C++ Header Files
Indentation Lines
Number of cases
Indentation in spaces
3e+06
2.5e+06
2e+06
1.5e+06
1e+06
500000
0
0
5
10
15
20
25
30

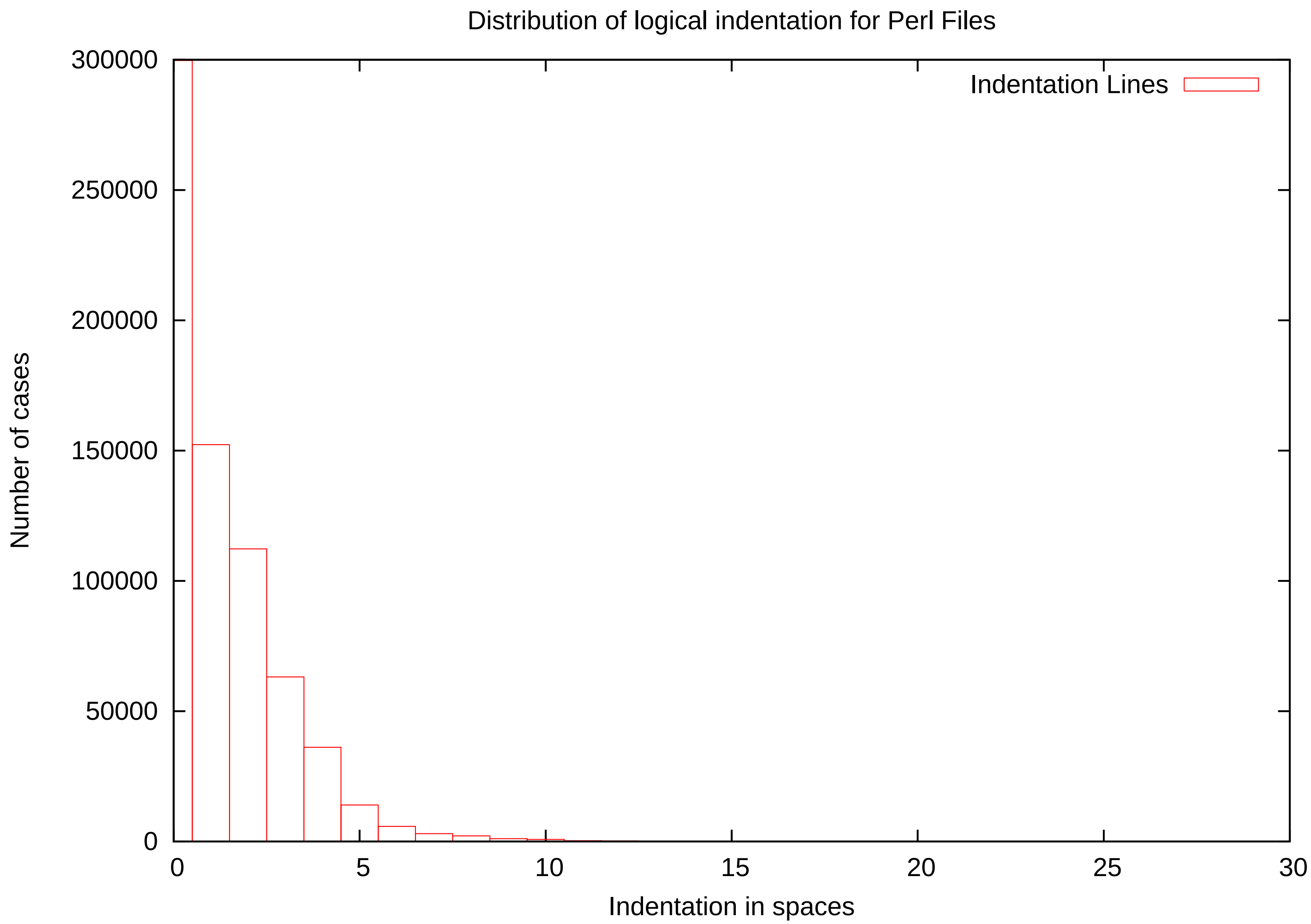

Distribution of indentation for C/C++ Header Files
Indentation Lines
Number of cases
Indentation in spaces
2e+06
1.8e+06
1.6e+06
1.4e+06
1.2e+06
1e+06
800000
600000
400000
200000
0
0
50
100
150
200
250

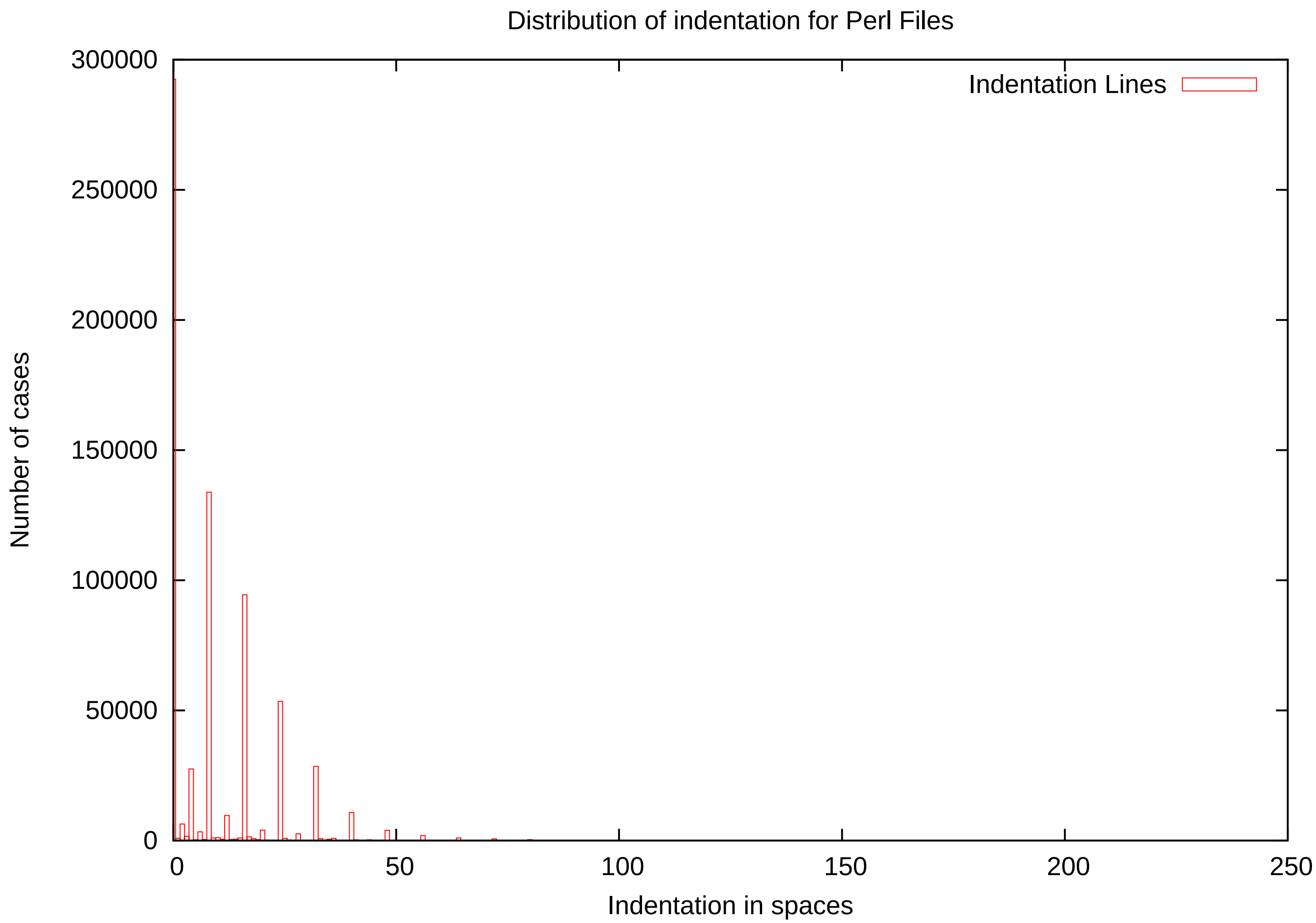

Distribution of logical indentation for Java Files
Indentation Lines
Number of cases
1.8e+06
1.6e+06
1.4e+06
1.2e+06
1e+06
800000
600000
400000
200000
0
0
10
20
30
40
50
60
70
80
90
100
Indentation in spaces

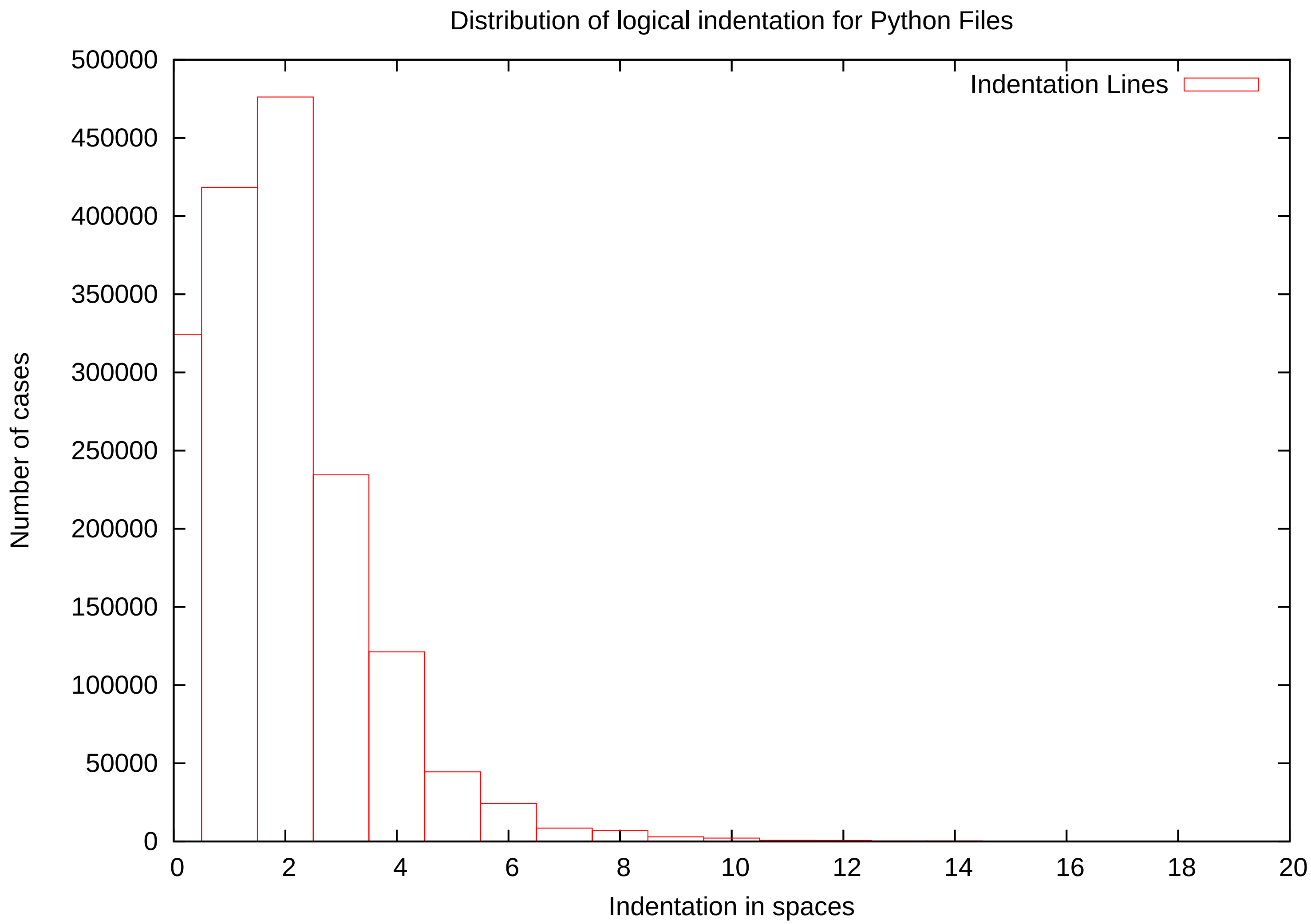

Distribution of indentation for Java Files
Indentation Lines
Number of cases
Indentation in spaces
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
0
50
100
150
200
250
300
350
400

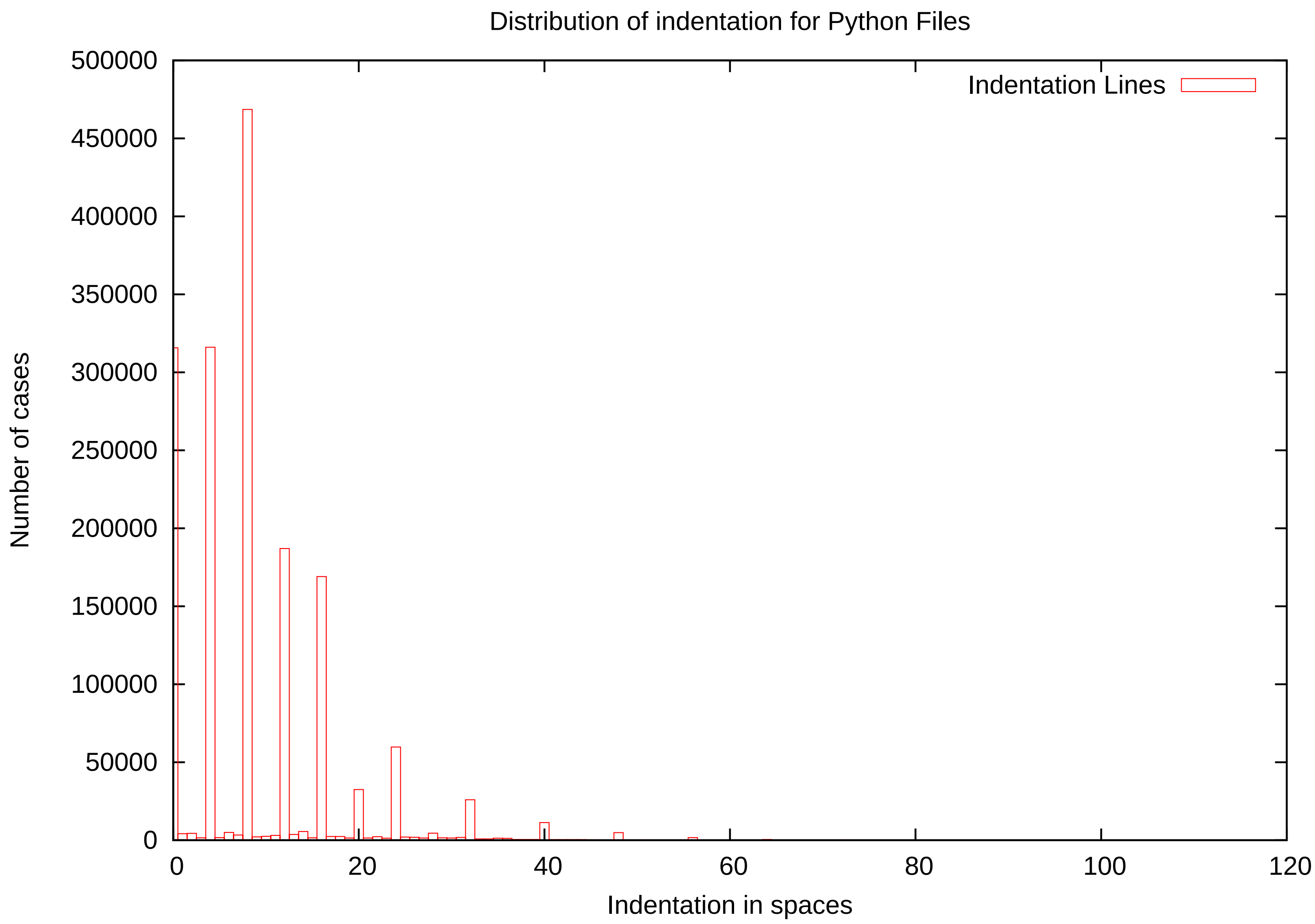

Distribution of logical indentation for PHP Files
Indentation Lines
Number of cases
Indentation in spaces
1.8e+06
1.6e+06
1.4e+06
1.2e+06
1e+06
800000
600000
400000
200000
0
0
10
20
30
40
50
60


Distribution of indentation for PHP Files
Indentation Lines
Number of cases
1.4e+06
1.2e+06
1e+06
800000
600000
400000
200000
0
0
50
100
150
200
250
300
350
400
450
500
Indentation in spaces


Distribution of logical indentation for Perl Files
Indentation Lines
Number of cases
300000
250000
200000
150000
100000
50000
0
0
5
10
15
20
25
30
Indentation in spaces


Distribution of indentation for Perl Files
Indentation Lines
Number of cases
300000
250000
200000
150000
100000
50000
0
0
50
100
150
200
250
Indentation in spaces


Distribution of logical indentation for Python Files
Indentation Lines
Number of cases
Indentation in spaces
500000
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
2
4
6
8
10
12
14
16
18
20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500000
450000
400000
350000
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250000
200000
150000
100000
50000
0
0
20
40
60
80
100
120
Indentation in spaces