

# Learning a Codebase

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# 1 Repository

## 1.1 Glossary - Summary

- The founder developer starts in the first six months of a project.
- The late joiner developers start after six months.
- Sustained developers make 50 or more commits and commit for 250 days or more.
- Transient developers have fewer commits or commit for a shorter period.

## 1.2 Repository Summary Table

Table 1: Summary of fifteen open-source repositories identified from GitHub that have at least 1000 pull requests and at least three sustained late joiner developers. Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more. Developers with fewer than three commits are excluded. Please note that five developers each worked on two repositories.

ID	Repo Name	Founder	Founder	Joiner	Joiner	Commit	Start	End
		Transient Contributor	Sustained Contributor	Transient Contributor	Sustained Contributor			
3	activiti	11	6	70	5	2329	2010-Jun-18	On going
5	airbyte-platform	8	1	93	6	1712	2020-Aug-04	2023-Sep-27
7	ambari	4	0	76	15	4125	2011-Sep-22	2023-Nov-18
10	automq	2	0	65	3	616	2011-Sep-07	2017-Apr-21
14	buck	13	6	204	21	6316	2013-Mar-21	2021-May-17
15	camel	5	1	328	13	5441	2007-Mar-19	On going
18	checkstyle	1	1	112	9	2803	2001-Jun-22	On going
20	cxf	12	3	44	3	1687	2008-Apr-29	On going
21	intellij-community	3	7	215	84	28741	2004-Nov-11	2018-Apr-18
26	guava	1	0	60	3	955	2009-Sep-15	2024-Jan-23
28	jenkins	2	1	201	4	3594	2006-Nov-05	On going
33	openmrs-core	1	0	162	3	1466	2006-May-03	On going
36	presto	1	3	244	18	4867	2012-Aug-09	On going
37	quarkus	4	5	167	8	2682	2018-Jun-22	On going
39	selenium	6	0	79	8	1718	2004-Nov-03	On going
Total		74	34	2120	203	69052		

## 2 Sample scatter touched against commit -

A scatter plot of touched components by number of commits. Developers with fewer than three commits are excluded. The sample size was capped at 203 developers (The total number of sustained later joiner, as this is the most important category).

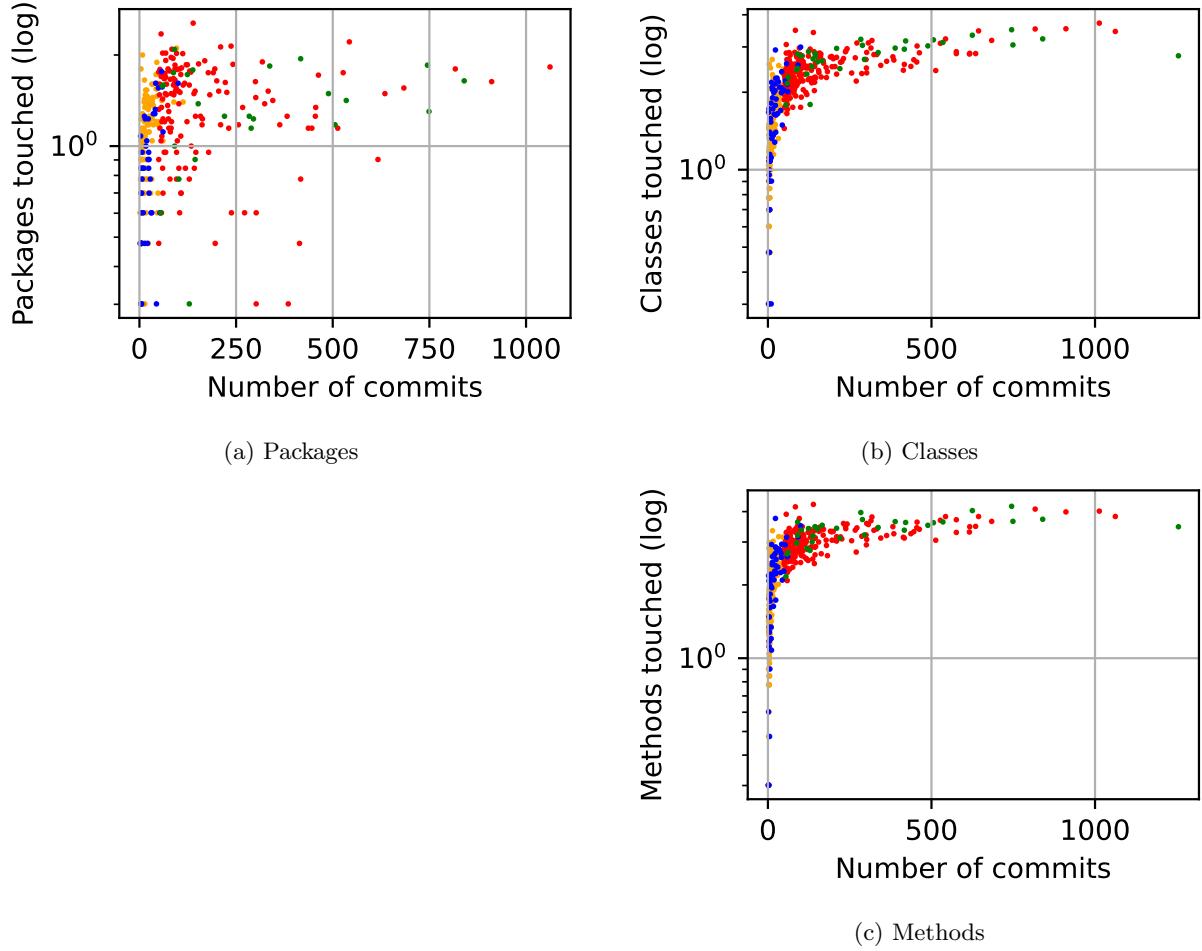


Figure 1: Scatter plots above illustrate the number of developer commits (x-axis) against the total number of components touched (y-axis converted to log). The sample size was capped at 203 developers (The total number of sustained later joiner, as this is the most important category). Key for the four categories of developer:

- Blue: Transient Founder - Sample size 68 developers.
- Green: Sustained Founder - Sample size 34 developers.
- Orange: Transient Later Joiner - Sample size 203 developers.
- Red: Sustained Later Joiner - Sample size 203 developers.

### 3 Repository average touched - By commit and by day

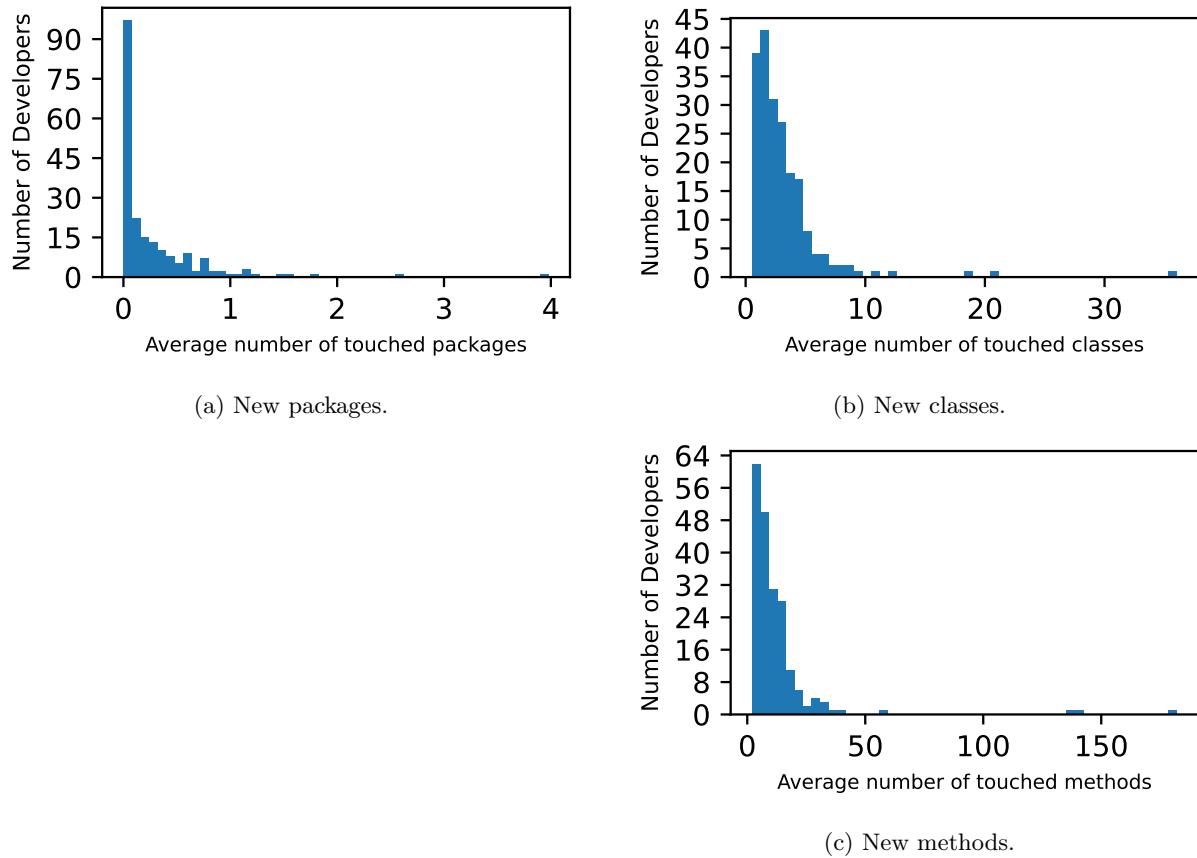
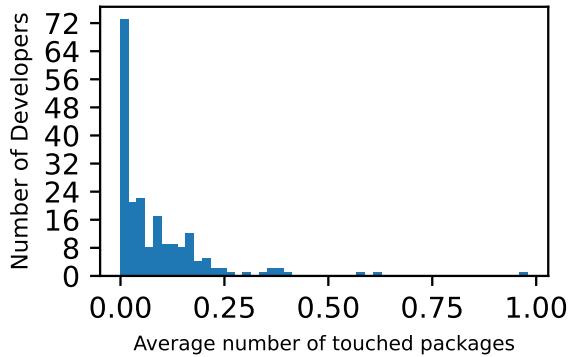
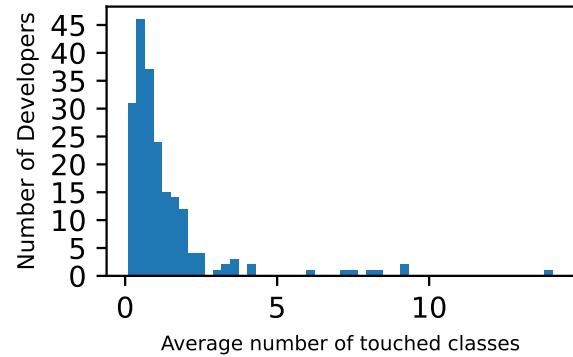


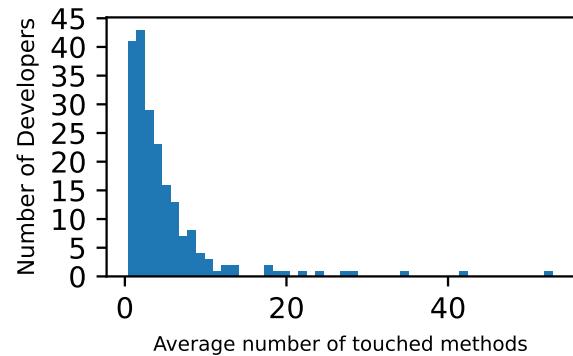
Figure 2: Average number of new components touched per commit (x-axis) for 203 against the number of sustained later joiner developers (y-axis) from fifteen projects sampled from GitHub.



(a) New packages.



(b) New classes.

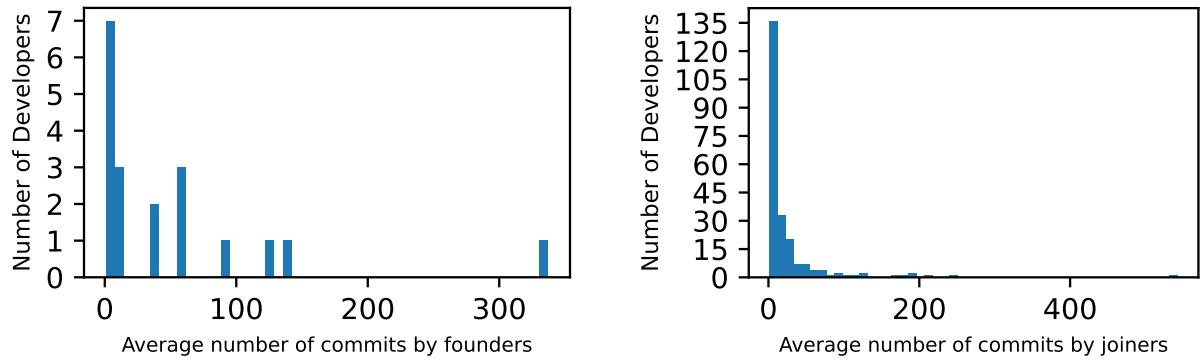


(c) New methods.

Figure 3: Average number of new components touched per day (x-axis) for 203 against the number of sustained later joiner developers (y-axis) from fifteen projects sampled from GitHub.

## 4 Repository: 14

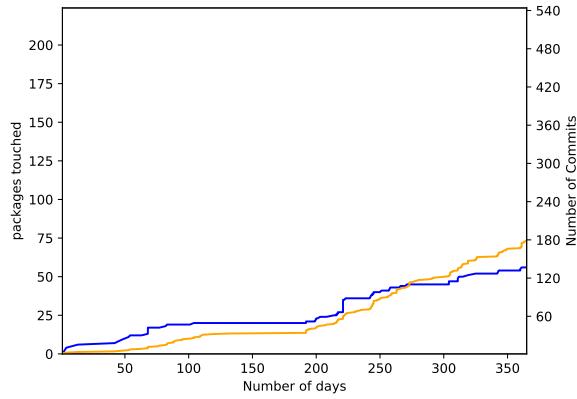
### 4.1 Developer commit - Repository 14 Developer Commits



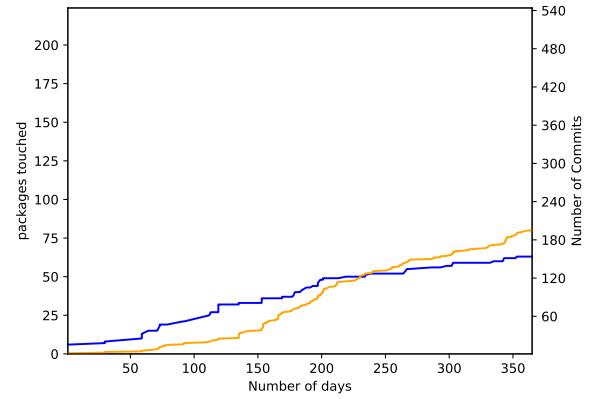
(a) Average number of new commits by 19 (x-axis) against the number of founder developers (y-axis) (b) Average number of new commits by 225 (x-axis) against the number of joiner developers (y-axis)

Figure 4: The average number of commits made against the number of founder and joiner developers.

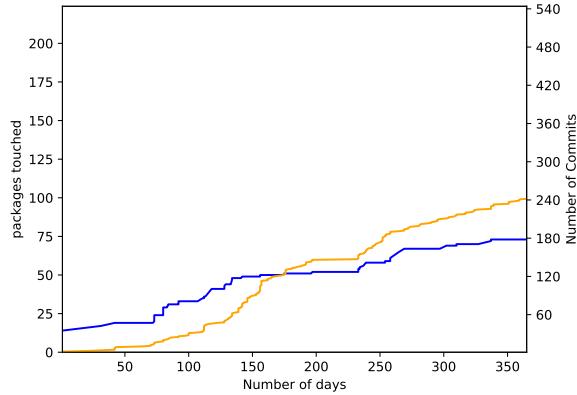
## **4.2 Developer touched - Repository 14: Developer packages knowledge**



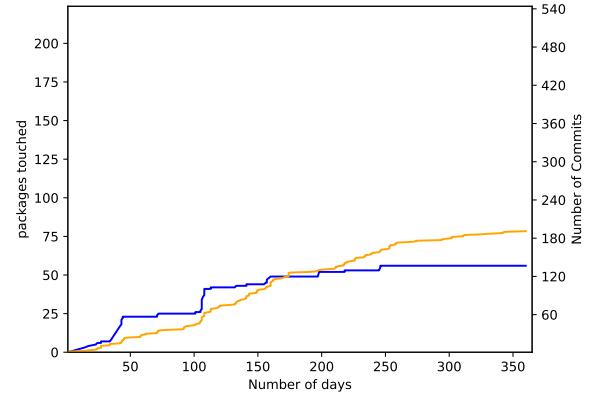
(a) Repository: 14 Developer 1774: Developer touched 56 packages after 178 commits.



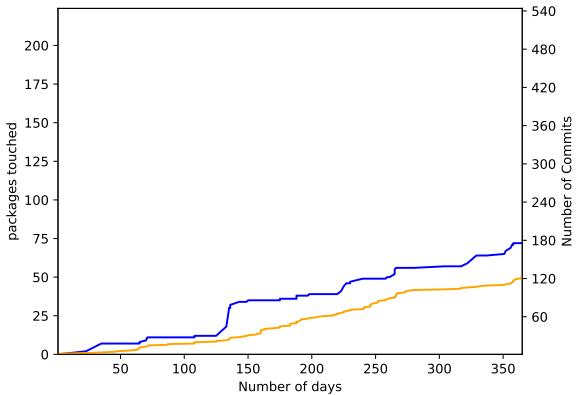
(b) Repository: 14 Developer 2986: Developer touched 63 packages after 195 commits.



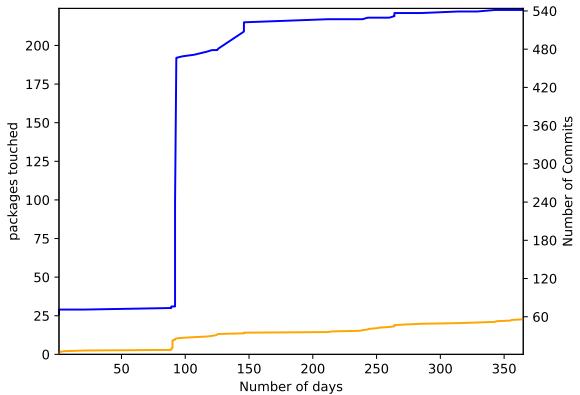
(c) Repository: 14 Developer 3000: Developer touched 73 packages after 242 commits.



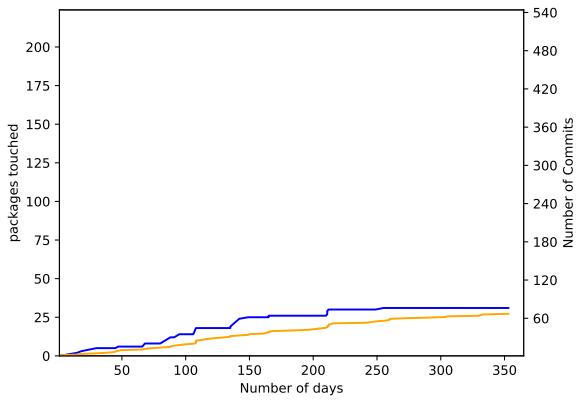
(d) Repository: 14 Developer 3020: Developer touched 56 packages after 191 commits.



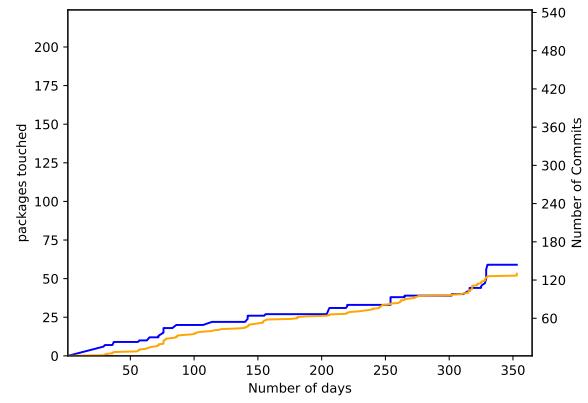
(e) Repository: 14 Developer 3037: Developer touched 72 packages after 124 commits.



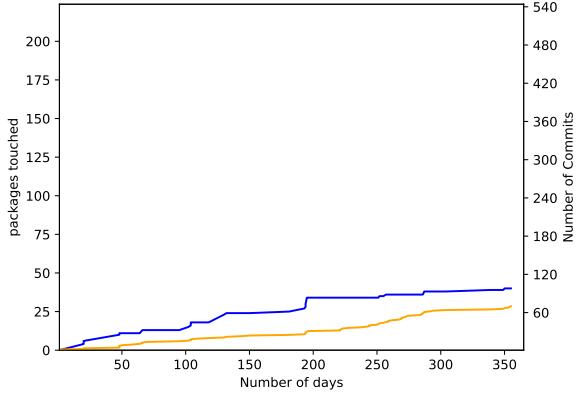
(f) Repository: 14 Developer 3050: Developer touched 223 packages after 56 commits.



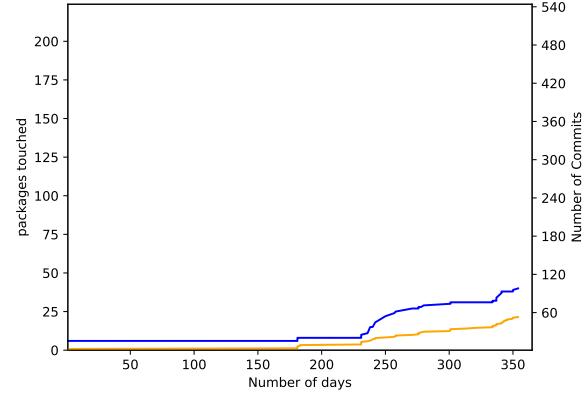
(a) Repository: 14 Developer 3071: Developer touched 31 packages after 67 commits.



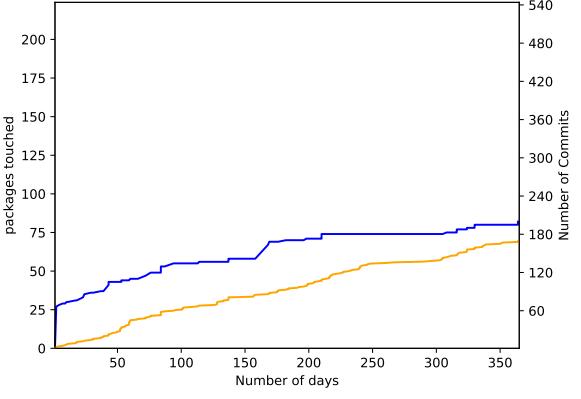
(b) Repository: 14 Developer 3072: Developer touched 59 packages after 130 commits.



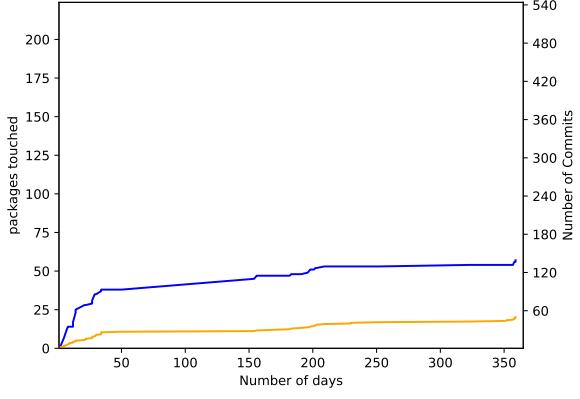
(c) Repository: 14 Developer 3141: Developer touched 40 packages after 70 commits.



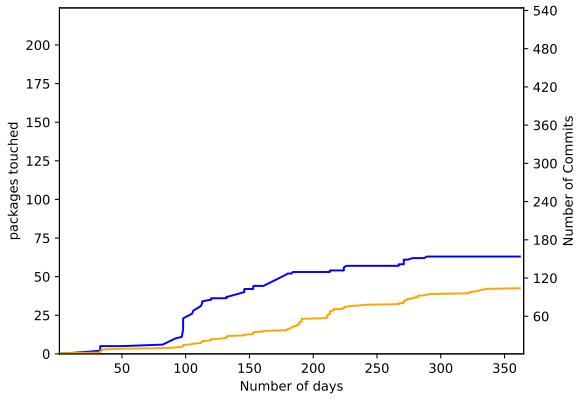
(d) Repository: 14 Developer 3143: Developer touched 40 packages after 53 commits.



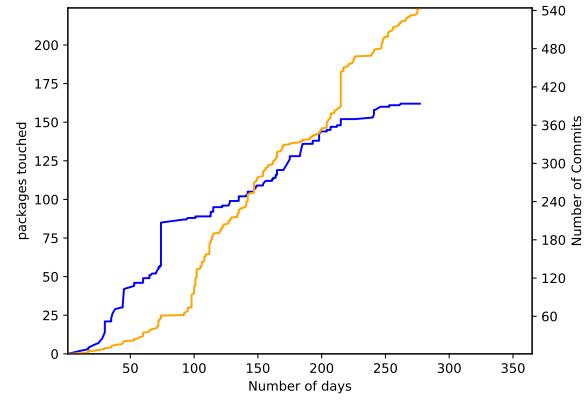
(e) Repository: 14 Developer 3163: Developer touched 82 packages after 169 commits.



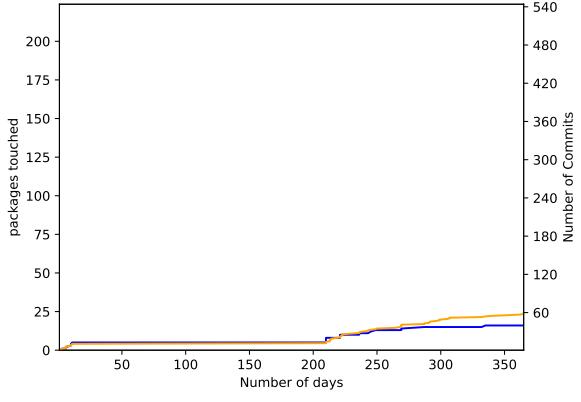
(f) Repository: 14 Developer 3172: Developer touched 57 packages after 50 commits.



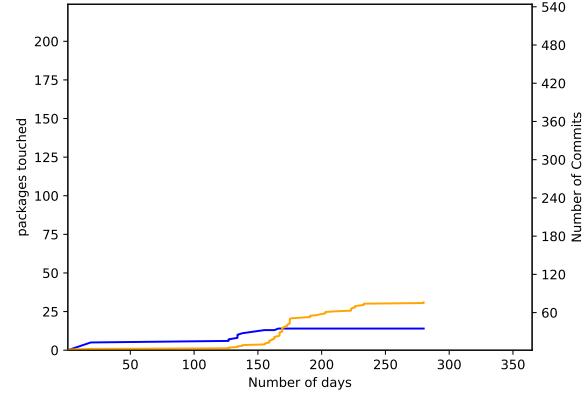
(a) Repository: 14 Developer 3178: Developer touched 63 packages after 104 commits.



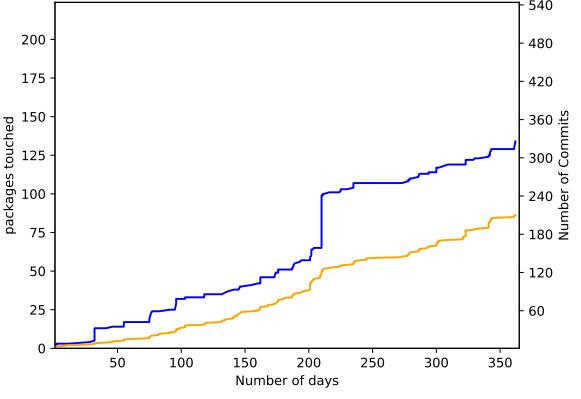
(b) Repository: 14 Developer 3216: Developer touched 162 packages after 543 commits.



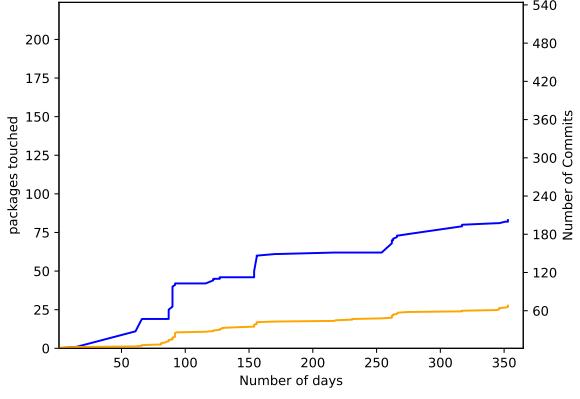
(c) Repository: 14 Developer 3217: Developer touched 16 packages after 58 commits.



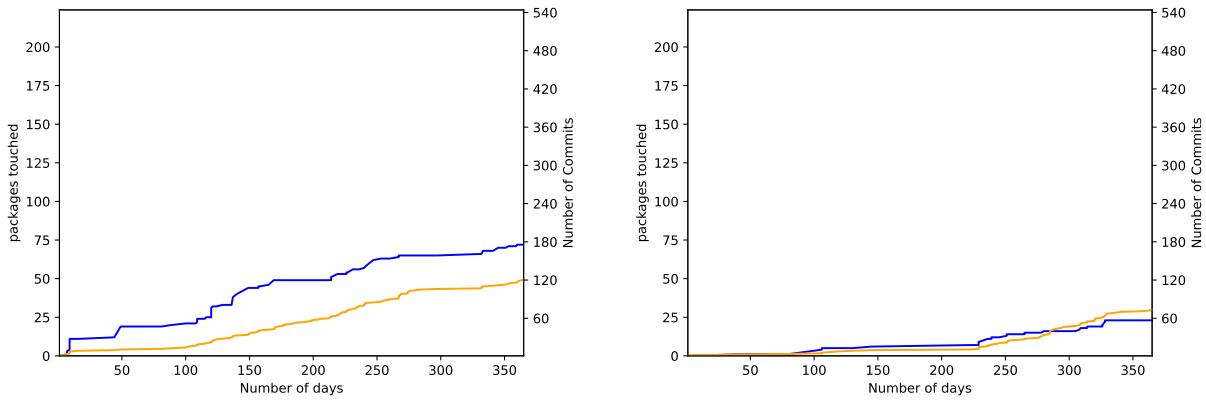
(d) Repository: 14 Developer 3272: Developer touched 14 packages after 76 commits.



(e) Repository: 14 Developer 3339: Developer touched 134 packages after 210 commits.

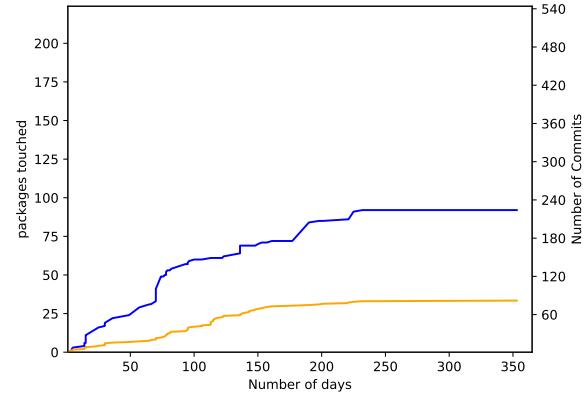


(f) Repository: 14 Developer 3354: Developer touched 83 packages after 68 commits.



(a) Repository: 14 Developer 3456: Developer touched 72 packages after 121 commits.

(b) Repository: 14 Developer 3473: Developer touched 23 packages after 73 commits.



(c) Repository: 14 Developer 3485: Developer touched 92 packages after 82 commits.

Figure 8: Number of days in the developers first year (x-axis) against packages touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

### 4.3 Repository histogram commit - 14 For packages with total

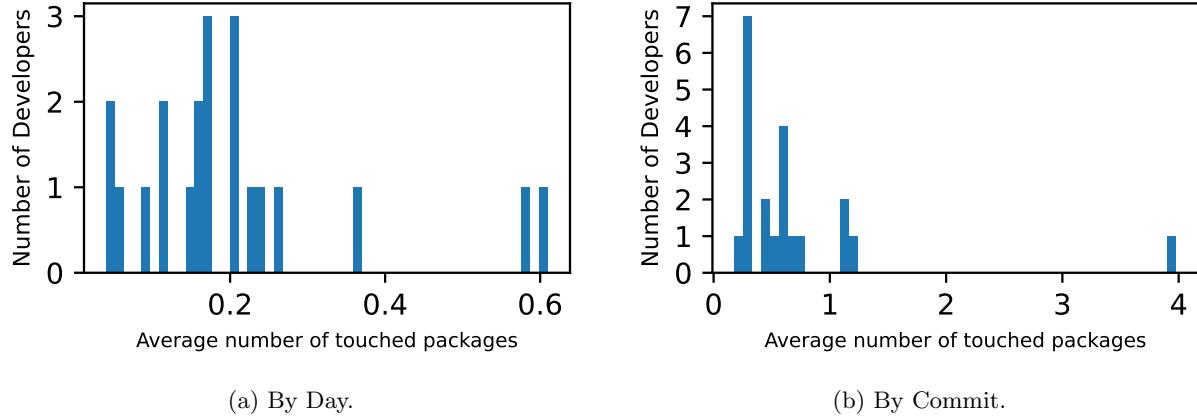
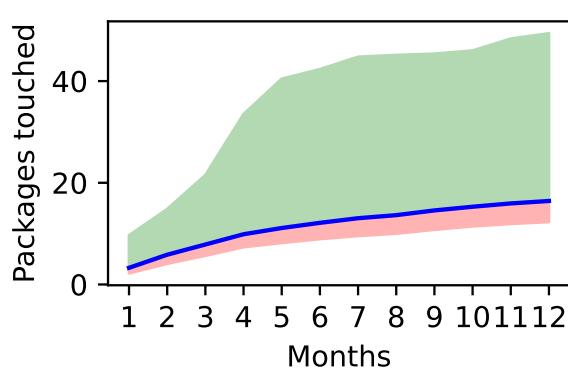


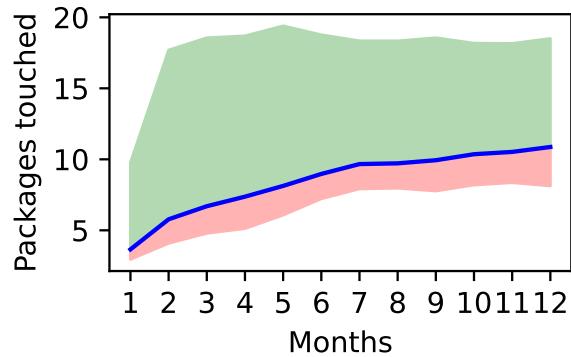
Figure 9: Histogram of new packages touched (x-axis) against number of developers (y-axis). Graphs for 21 sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

#### 4.4 Time series developer - 14 For packages touched for each period

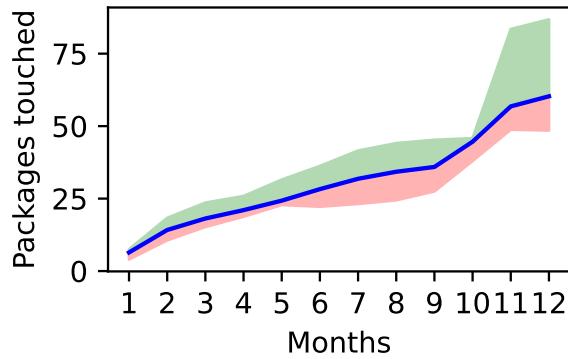
A time series of packages touched on average each month.



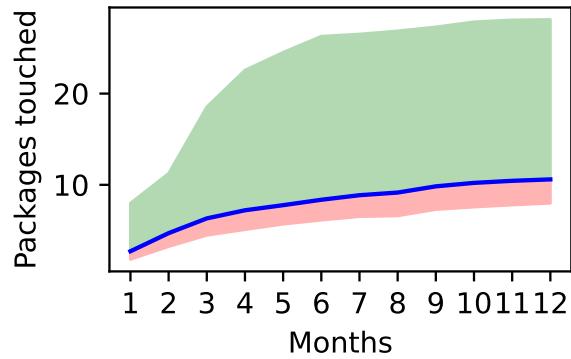
(a) All developers (244) showing packages touched



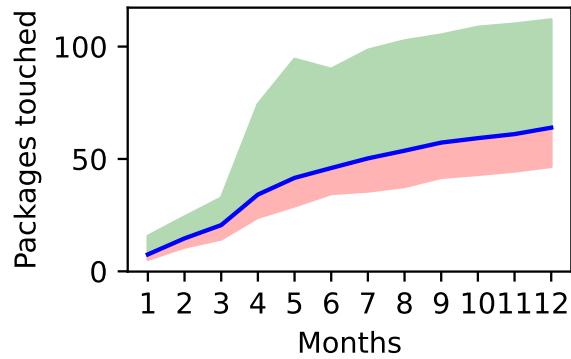
(b) Transient founder developers (13) showing packages touched



(c) Sustained founder developers (6) showing packages touched

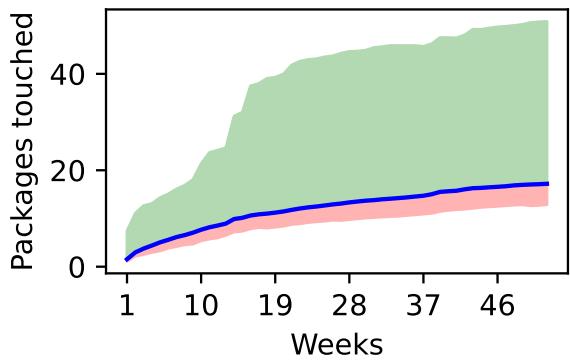


(d) Transient later joiner developers (204) showing packages touched

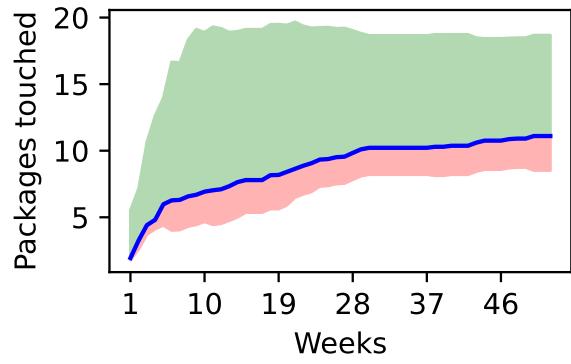


(e) Sustained later joiner developers (21) showing packages touched

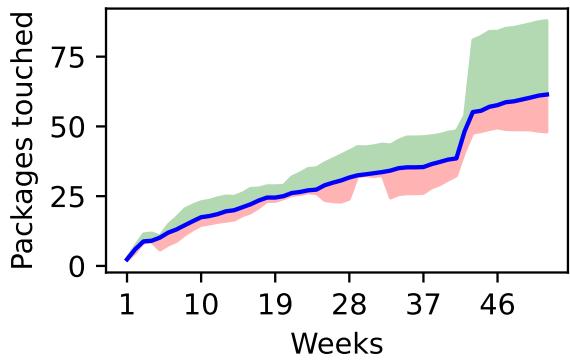
Figure 10: A time series of the number of month (x-axis) against the average (mean) total packages touched (y-axis), with positive (orange) and negative (red) filled standard deviation.



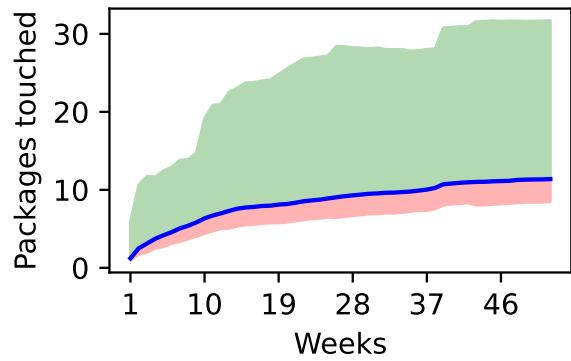
(a) All developers (244) showing packages touched



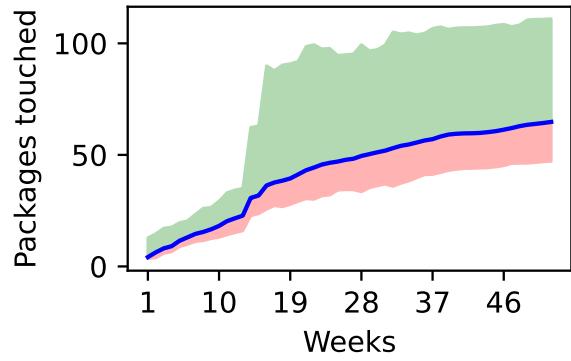
(b) Transient founder developers (13) showing packages touched



(c) Sustained founder developers (6) showing packages touched

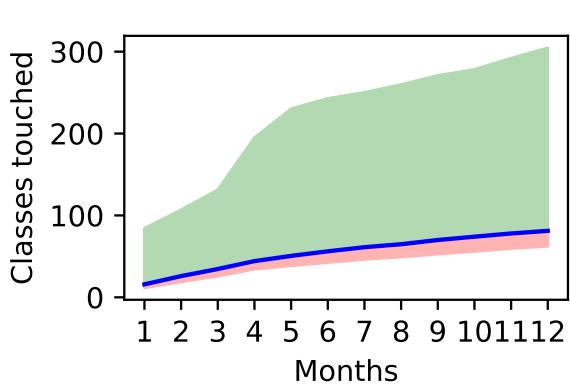


(d) Transient later joiner developers (204) showing packages touched

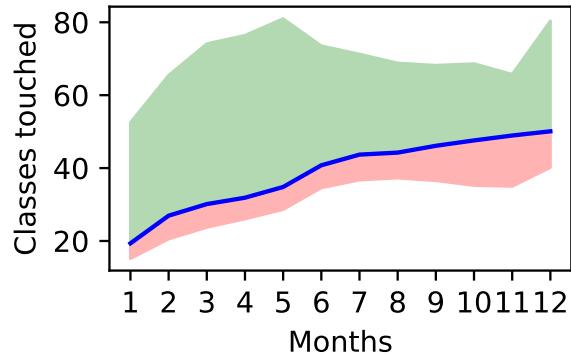


(e) Sustained later joiner developers (21) showing packages touched

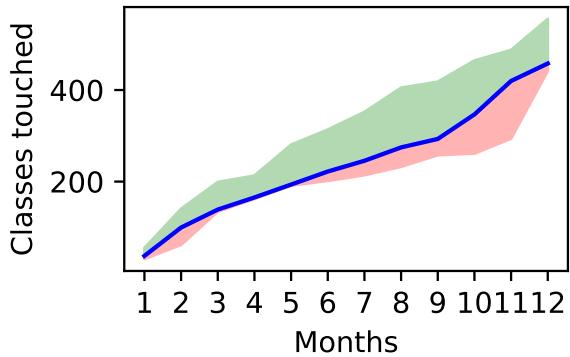
Figure 11: A time series of the number of week (x-axis) against the average (mean) total packages touched (y-axis), with positive (orange) and negative (red) filled standard deviation.



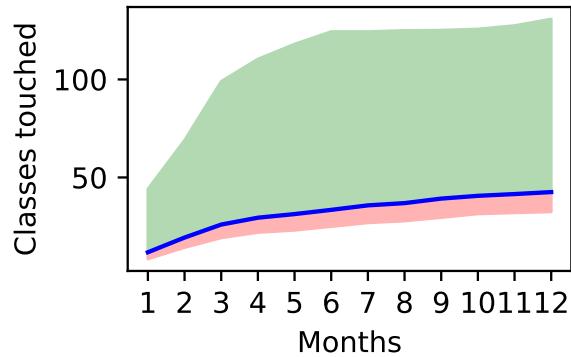
(a) All developers (244) showing classes touched



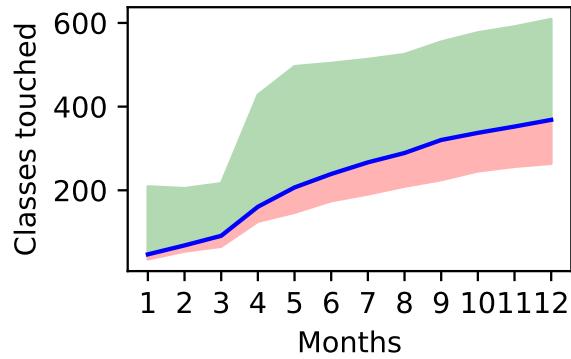
(b) Transient founder developers (13) showing classes touched



(c) Sustained founder developers (6) showing classes touched

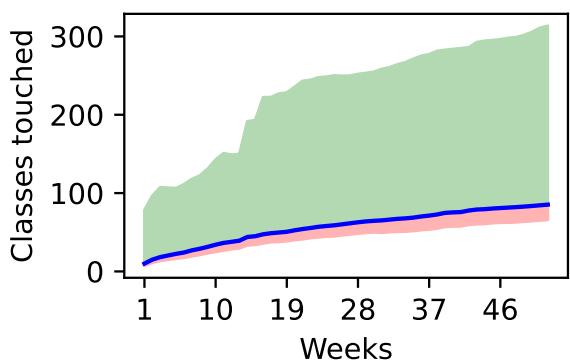


(d) Transient later joiner developers (204) showing classes touched

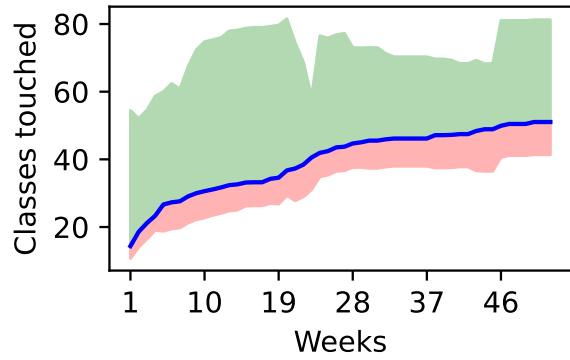


(e) Sustained later joiner developers (21) showing classes touched

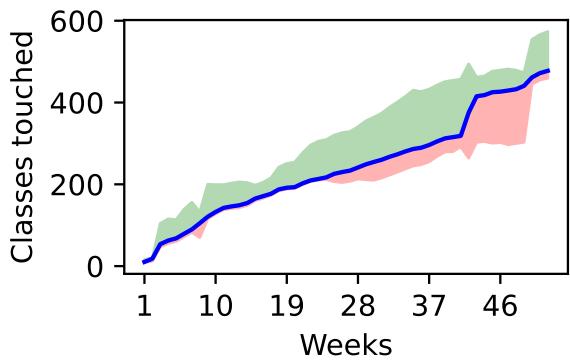
Figure 12: A time series of the number of month (x-axis) against the average (mean) total classes touched (y-axis), with positive (orange) and negative (red) filled standard deviation.



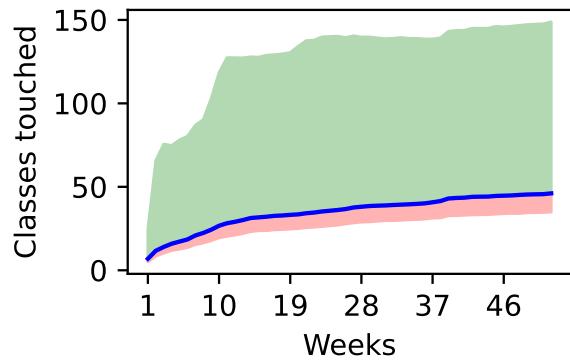
(a) All developers (244) showing classes touched



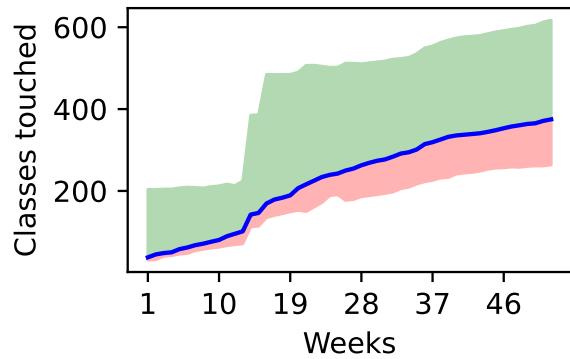
(b) Transient founder developers (13) showing classes touched



(c) Sustained founder developers (6) showing classes touched

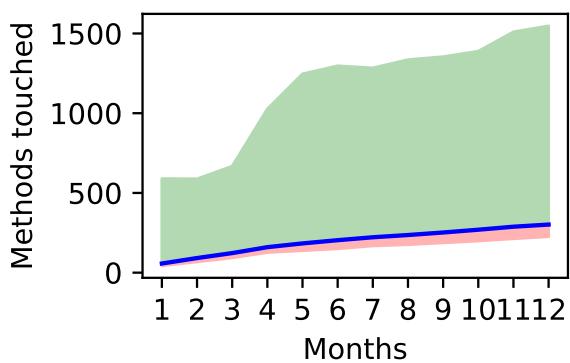


(d) Transient later joiner developers (204) showing classes touched

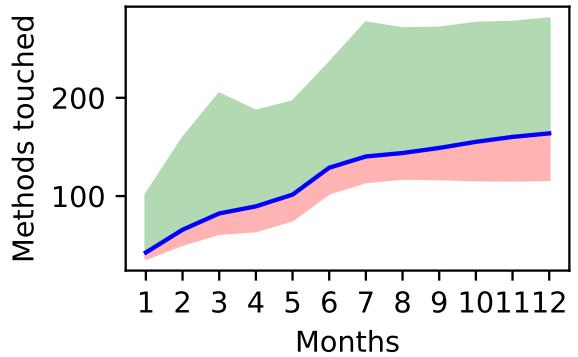


(e) Sustained later joiner developers (21) showing classes touched

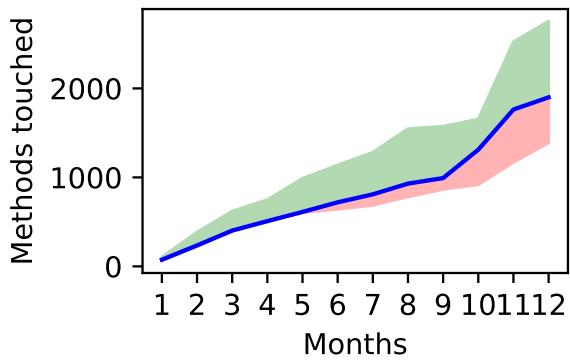
Figure 13: A time series of the number of week (x-axis) against the average (mean) total classes touched (y-axis), with positive (orange) and negative (red) filled standard deviation.



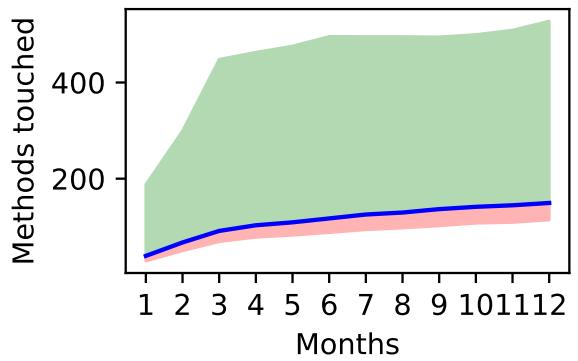
(a) All developers (244) showing methods touched



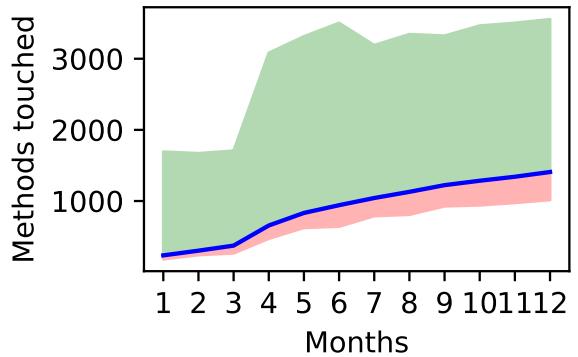
(b) Transient founder developers (13) showing methods touched



(c) Sustained founder developers (6) showing methods touched

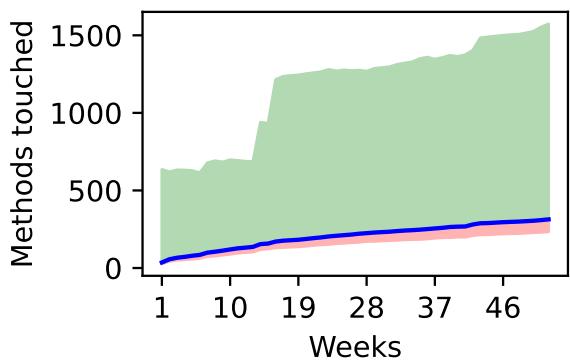


(d) Transient later joiner developers (204) showing methods touched

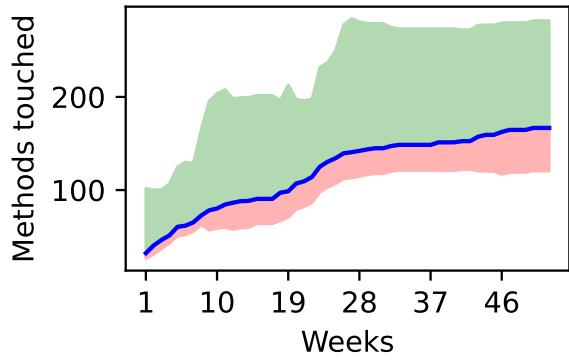


(e) Sustained later joiner developers (21) showing methods touched

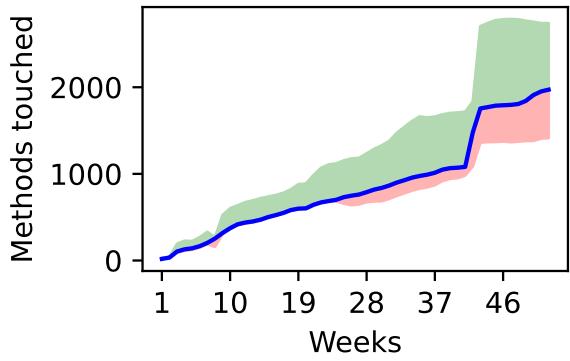
Figure 14: A time series of the number of month (x-axis) against the average (mean) total methods touched (y-axis), with positive (orange) and negative (red) filled standard deviation.



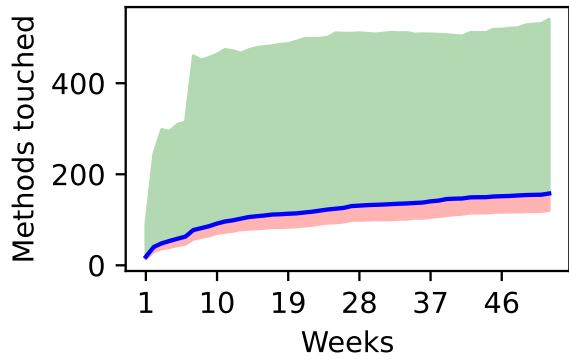
(a) All developers (244) showing methods touched



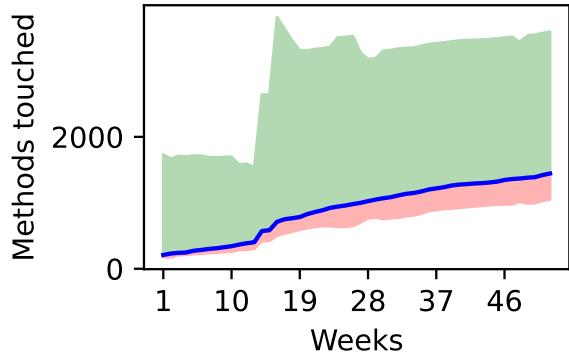
(b) Transient founder developers (13) showing methods touched



(c) Sustained founder developers (6) showing methods touched



(d) Transient later joiner developers (204) showing methods touched



(e) Sustained later joiner developers (21) showing methods touched

Figure 15: A time series of the number of week (x-axis) against the average (mean) total methods touched (y-axis), with positive (orange) and negative (red) filled standard deviation.

#### **4.5 Scatter developer - 14 For developer commits and components touched.**

A scatter plot for the first 20 sustained late joiner developers showing the number of commits to components touched.

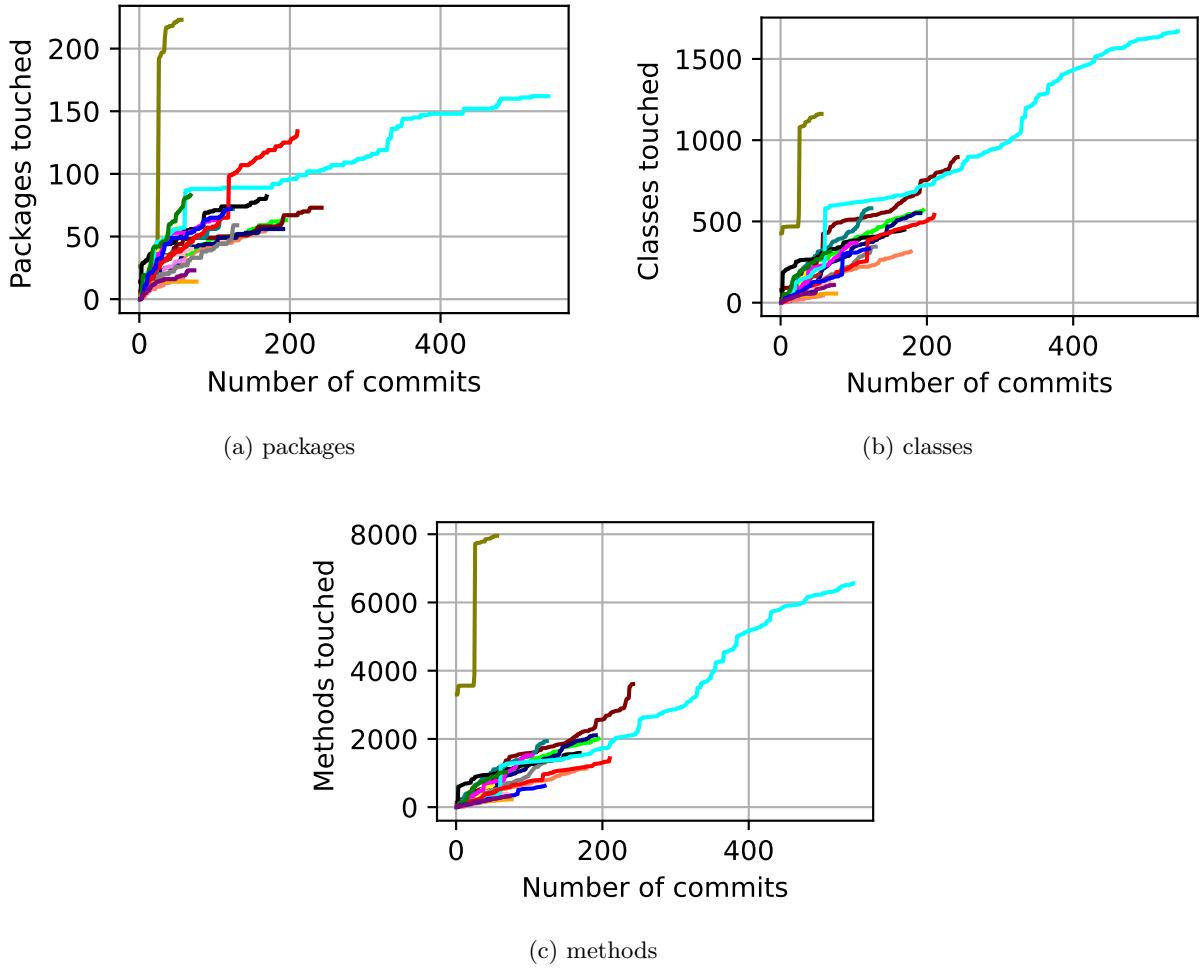


Figure 16: First twenty sustained later joiner developers from this repository. The number of commits against the number of components touched.

- Developer: 1774 in colour Coral. Developer: 2986 in colour Lime.
- Developer: 3000 in colour Maroon. Developer: 3020 in colour Navy.
- Developer: 3037 in colour Teal. Developer: 3050 in colour Olive.
- Developer: 3071 in colour Violet. Developer: 3072 in colour Gray.
- Developer: 3141 in colour Pink. Developer: 3143 in colour Brown.
- Developer: 3163 in colour Black. Developer: 3172 in colour Yellow.
- Developer: 3178 in colour Magenta. Developer: 3216 in colour Cyan.
- Developer: 3217 in colour Salmon. Developer: 3272 in colour Orange.
- Developer: 3339 in colour Red. Developer: 3354 in colour Green.
- Developer: 3456 in colour Blue. Developer: 3473 in colour Purple.

#### **4.6 Scatter developer - 14 For developer day and components touched.**

A scatter plot for the first 20 sustained late joiner developers showing the number of day to components touched.

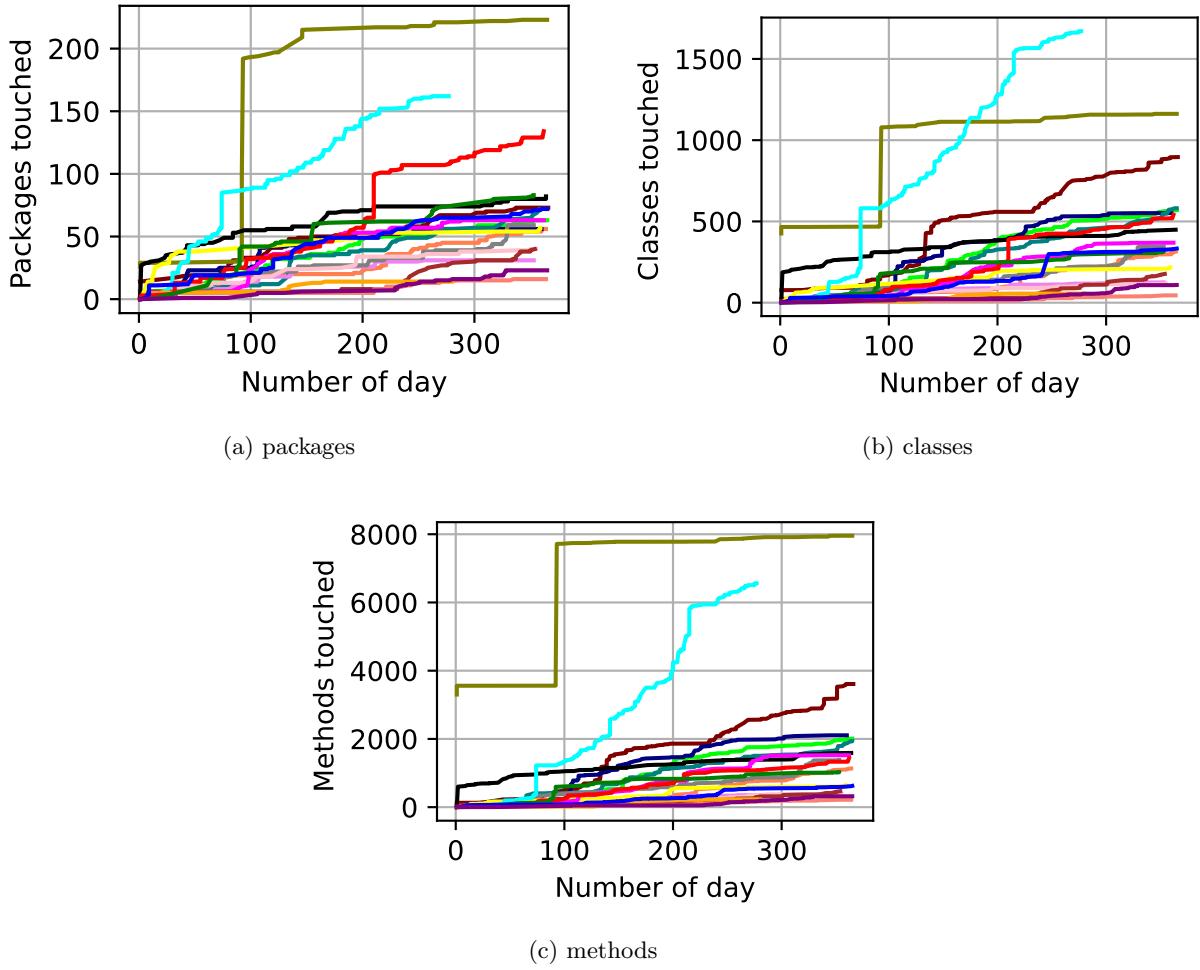
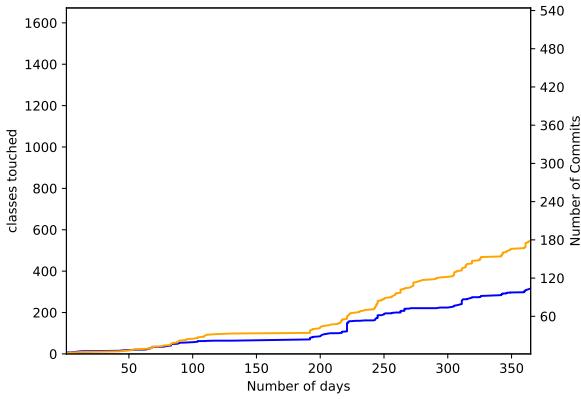


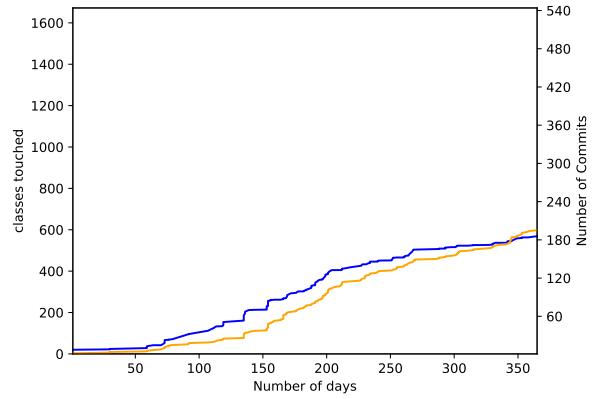
Figure 17: First twenty sustained later joiner developers from this repository. The number of day against the number of components touched.

- Developer: 1774 in colour Coral. Developer: 2986 in colour Lime.
- Developer: 3000 in colour Maroon. Developer: 3020 in colour Navy.
- Developer: 3037 in colour Teal. Developer: 3050 in colour Olive.
- Developer: 3071 in colour Violet. Developer: 3072 in colour Gray.
- Developer: 3141 in colour Pink. Developer: 3143 in colour Brown.
- Developer: 3163 in colour Black. Developer: 3172 in colour Yellow.
- Developer: 3178 in colour Magenta. Developer: 3216 in colour Cyan.
- Developer: 3217 in colour Salmon. Developer: 3272 in colour Orange.
- Developer: 3339 in colour Red. Developer: 3354 in colour Green.
- Developer: 3456 in colour Blue. Developer: 3473 in colour Purple.

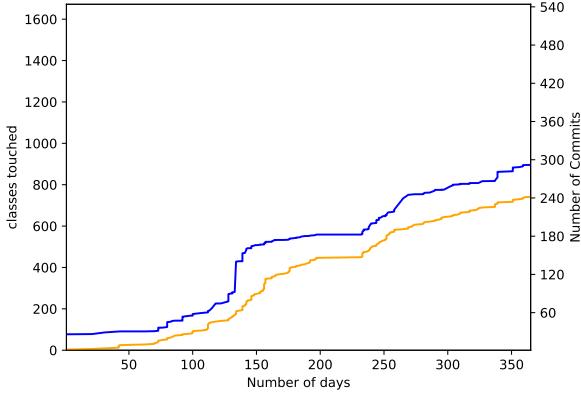
#### 4.7 Developer touched - Repository 14: Developer classes knowledge



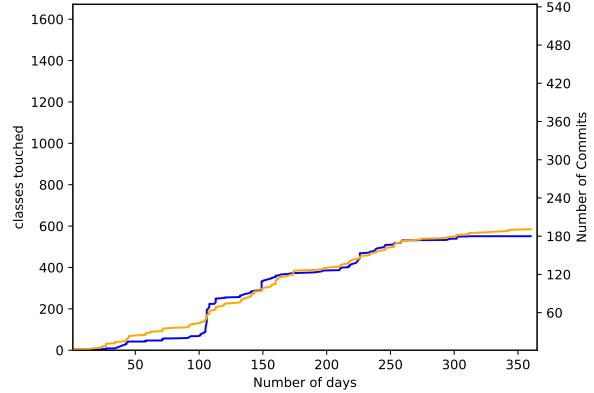
(a) Repository: 14 Developer 1774: Developer touched 314 classes after 178 commits.



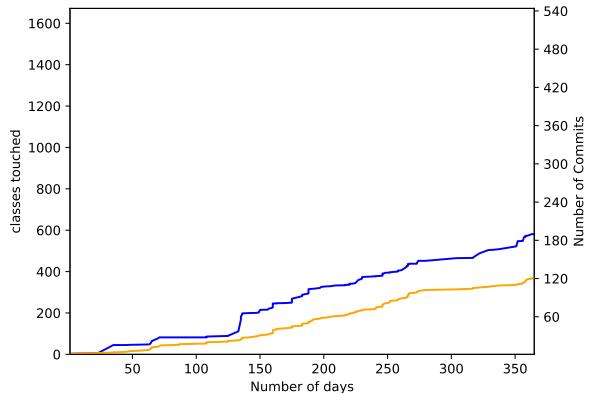
(b) Repository: 14 Developer 2986: Developer touched 569 classes after 195 commits.



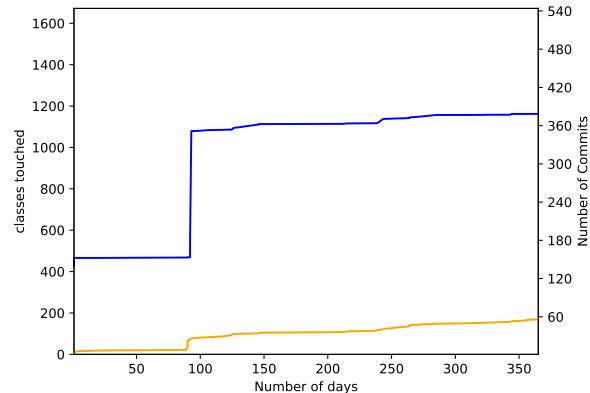
(c) Repository: 14 Developer 3000: Developer touched 896 classes after 242 commits.



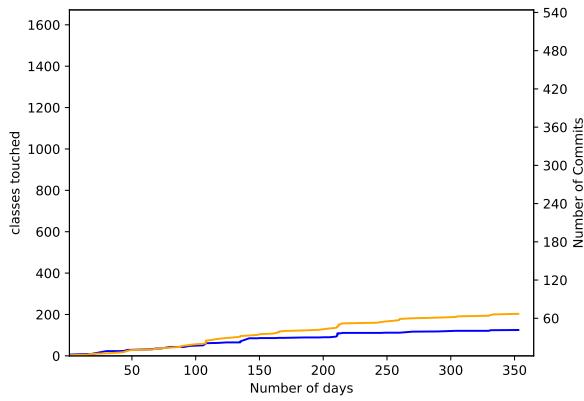
(d) Repository: 14 Developer 3020: Developer touched 551 classes after 191 commits.



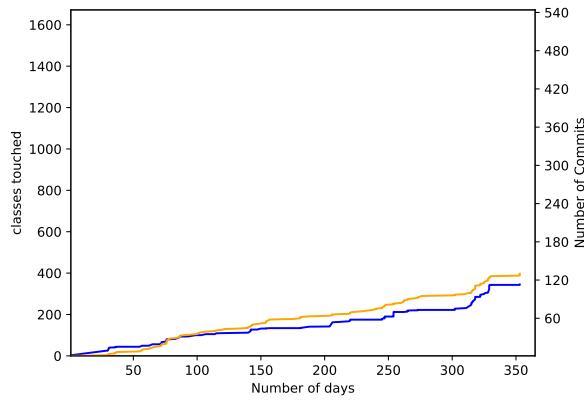
(e) Repository: 14 Developer 3037: Developer touched 581 classes after 124 commits.



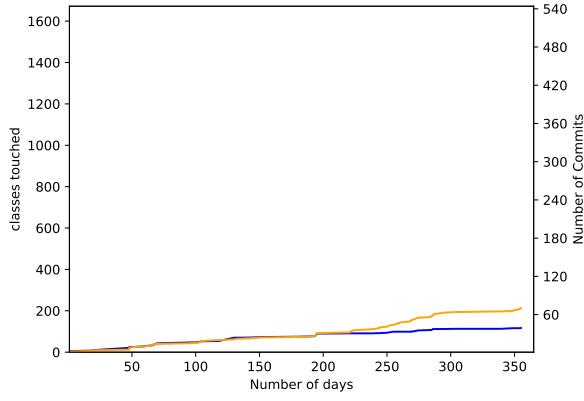
(f) Repository: 14 Developer 3050: Developer touched 1162 classes after 56 commits.



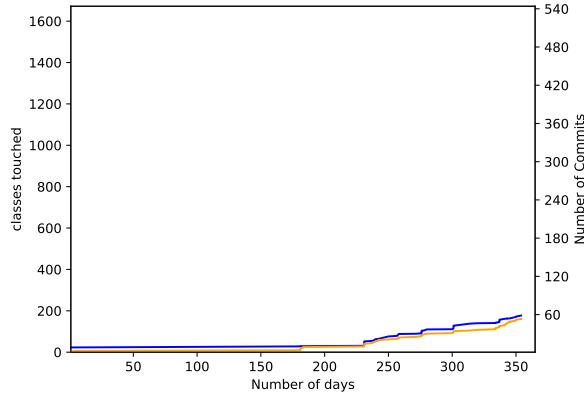
(a) Repository: 14 Developer 3071: Developer touched 125 classes after 67 commits.



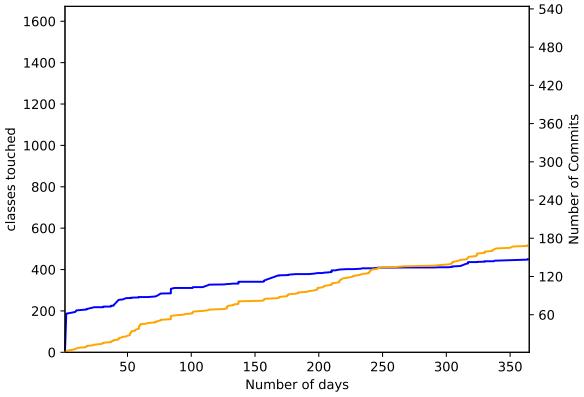
(b) Repository: 14 Developer 3072: Developer touched 345 classes after 130 commits.



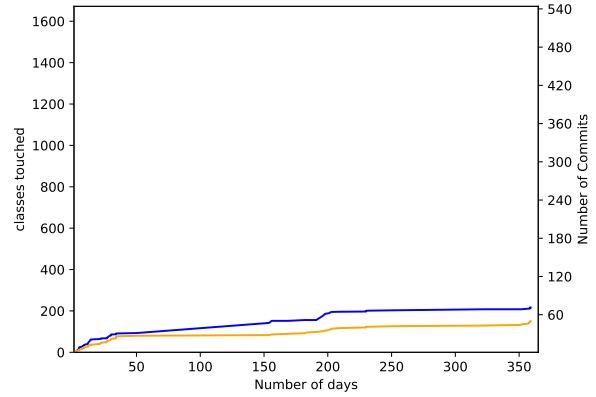
(c) Repository: 14 Developer 3141: Developer touched 117 classes after 70 commits.



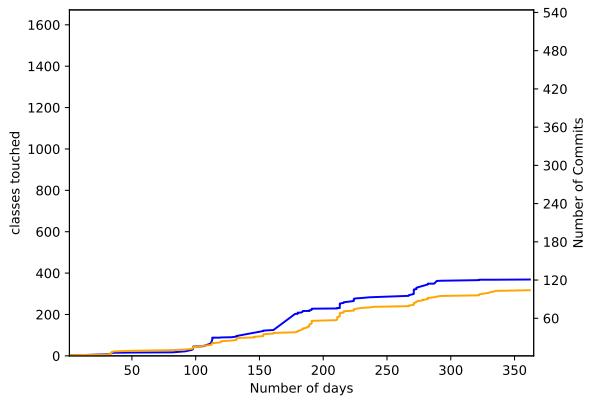
(d) Repository: 14 Developer 3143: Developer touched 177 classes after 53 commits.



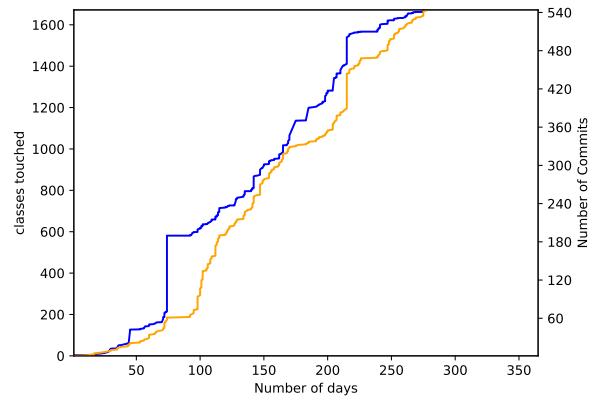
(e) Repository: 14 Developer 3163: Developer touched 449 classes after 169 commits.



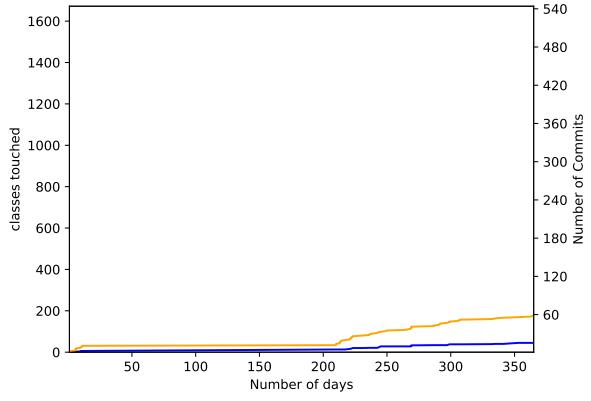
(f) Repository: 14 Developer 3172: Developer touched 217 classes after 50 commits.



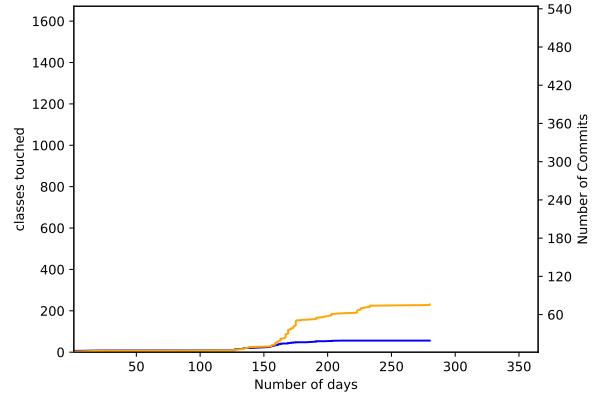
(a) Repository: 14 Developer 3178: Developer touched 369 classes after 104 commits.



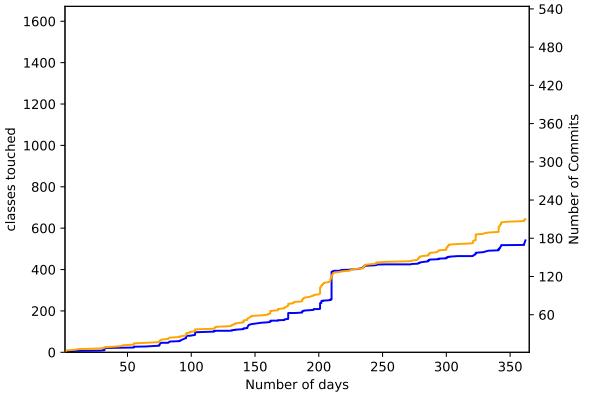
(b) Repository: 14 Developer 3216: Developer touched 1671 classes after 543 commits.



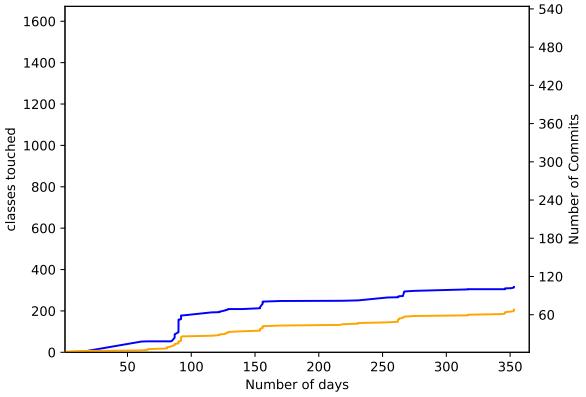
(c) Repository: 14 Developer 3217: Developer touched 45 classes after 58 commits.



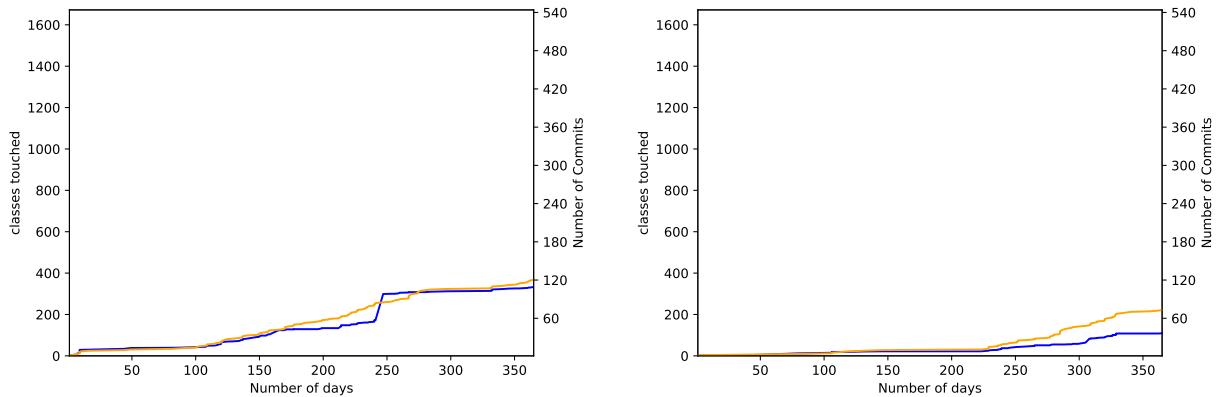
(d) Repository: 14 Developer 3272: Developer touched 56 classes after 76 commits.



(e) Repository: 14 Developer 3339: Developer touched 541 classes after 210 commits.

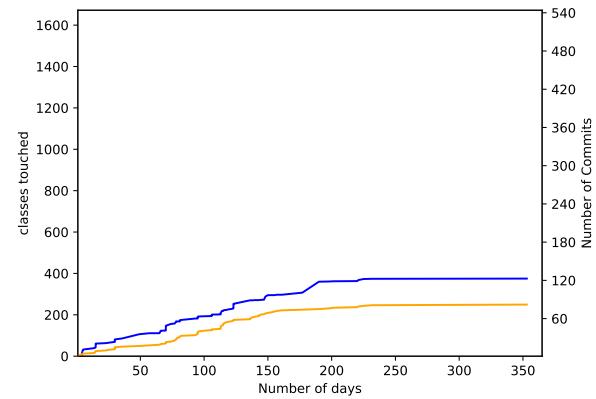


(f) Repository: 14 Developer 3354: Developer touched 316 classes after 68 commits.



(a) Repository: 14 Developer 3456: Developer touched 333 classes after 121 commits.

(b) Repository: 14 Developer 3473: Developer touched 109 classes after 73 commits.

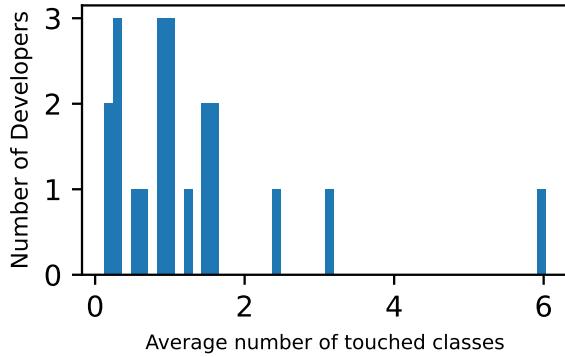


(c) Repository: 14 Developer 3485: Developer touched 375 classes after 82 commits.

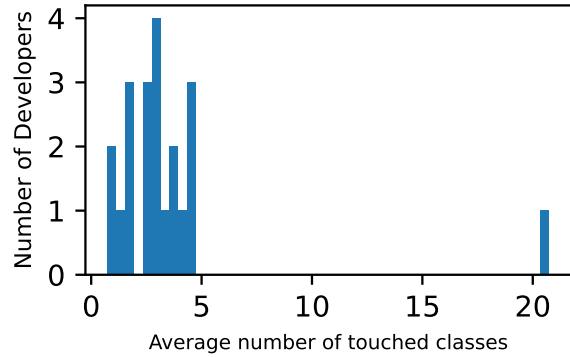
Figure 21: Number of days in the developers first year (x-axis) against classes touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

#### 4.8 Repository histogram commit - 14 For classes with total



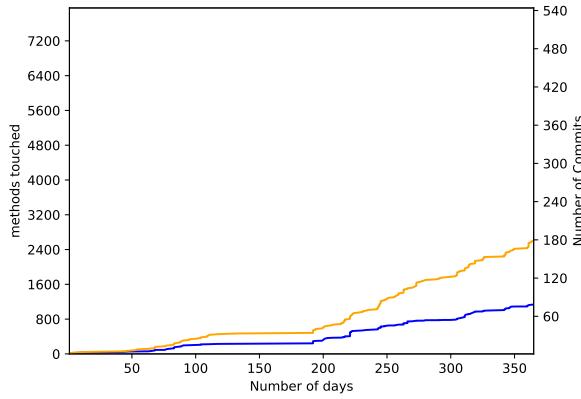
(a) By Day.



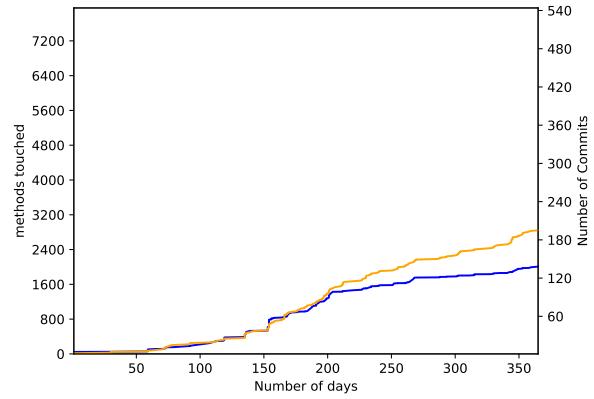
(b) By Commit.

Figure 22: Histogram of new classes touched (x-axis) against number of developers (y-axis). Graphs for 21 sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

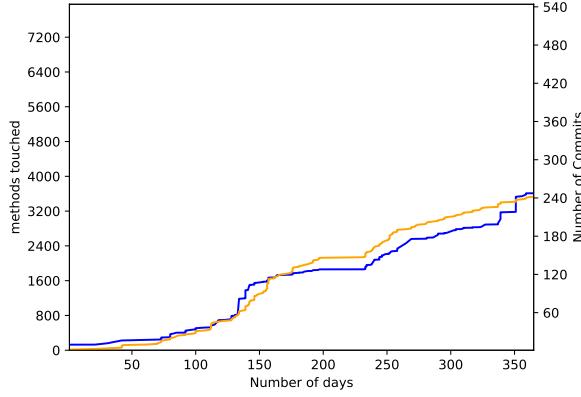
#### **4.9 Developer touched - Repository 14: Developer methods knowledge**



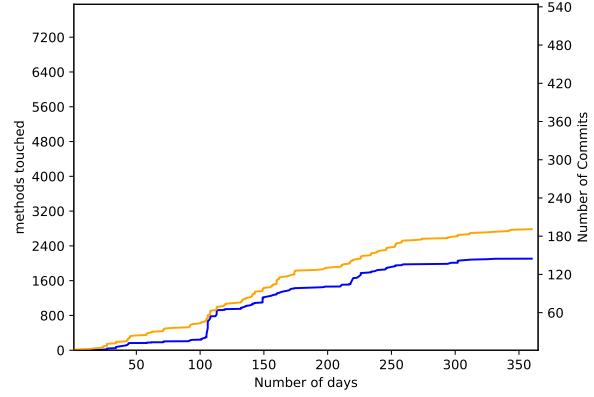
(a) Repository: 14 Developer 1774: Developer touched 1133 methods after 178 commits.



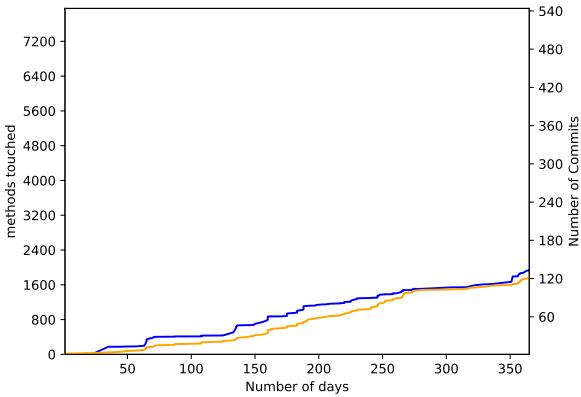
(b) Repository: 14 Developer 2986: Developer touched 2009 methods after 195 commits.



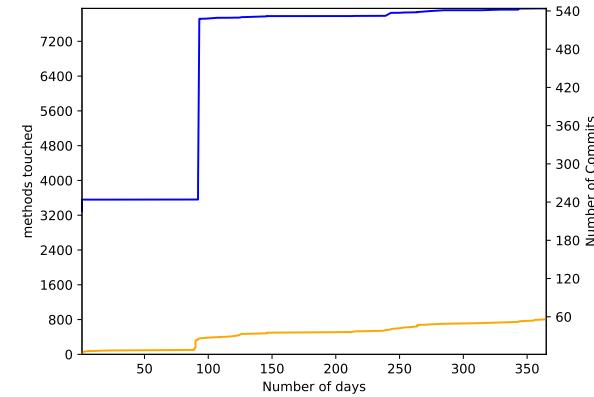
(c) Repository: 14 Developer 3000: Developer touched 3610 methods after 242 commits.



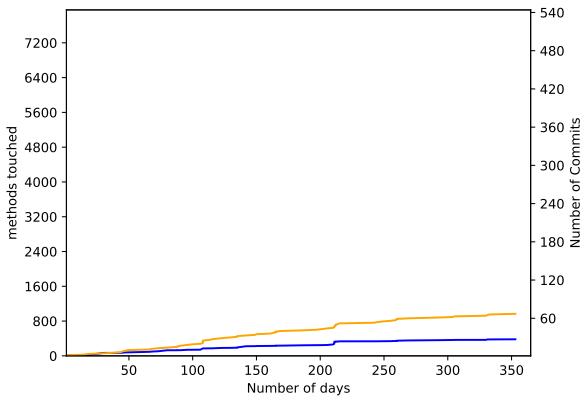
(d) Repository: 14 Developer 3020: Developer touched 2106 methods after 191 commits.



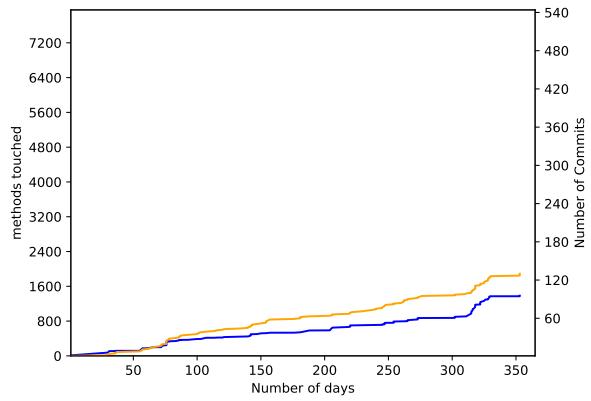
(e) Repository: 14 Developer 3037: Developer touched 1935 methods after 124 commits.



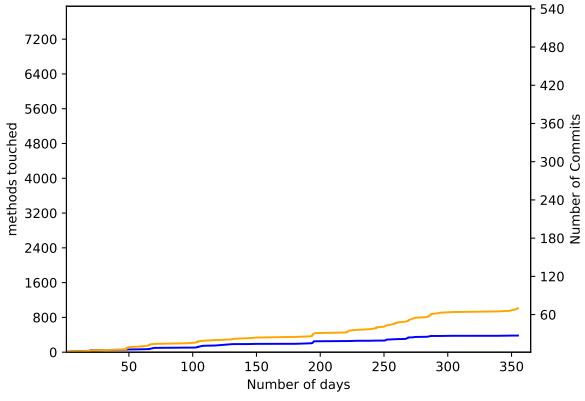
(f) Repository: 14 Developer 3050: Developer touched 7956 methods after 56 commits.



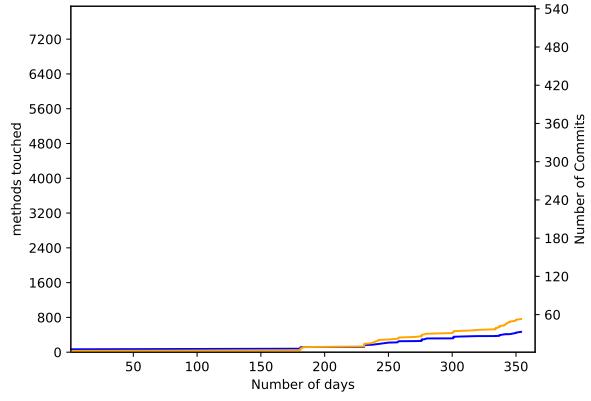
(a) Repository: 14 Developer 3071: Developer touched 381 methods after 67 commits.



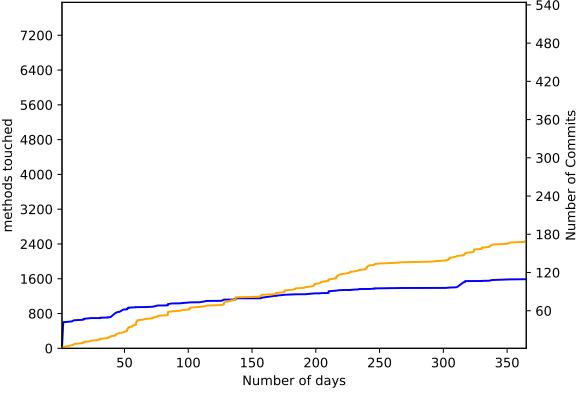
(b) Repository: 14 Developer 3072: Developer touched 1384 methods after 130 commits.



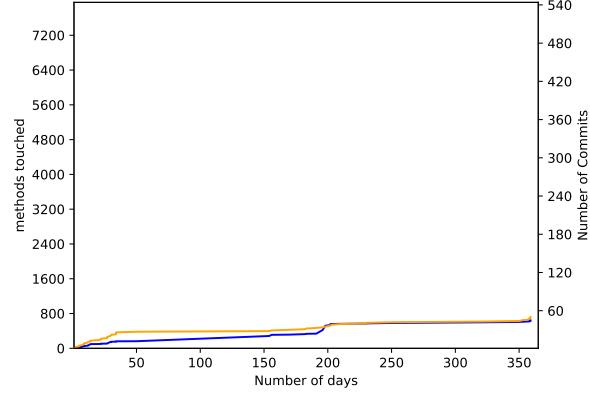
(c) Repository: 14 Developer 3141: Developer touched 383 methods after 70 commits.



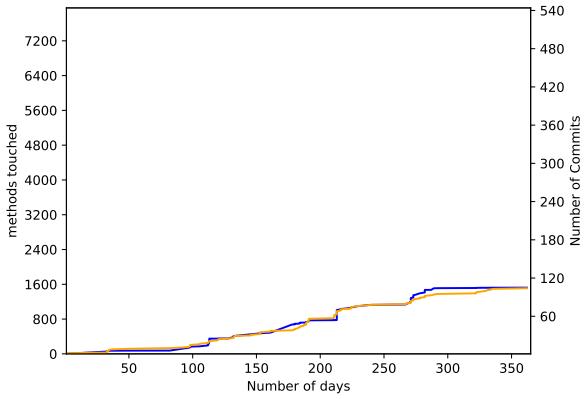
(d) Repository: 14 Developer 3143: Developer touched 468 methods after 53 commits.



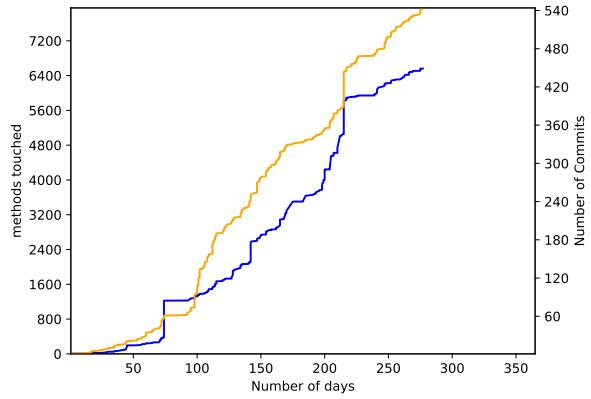
(e) Repository: 14 Developer 3163: Developer touched 1589 methods after 169 commits.



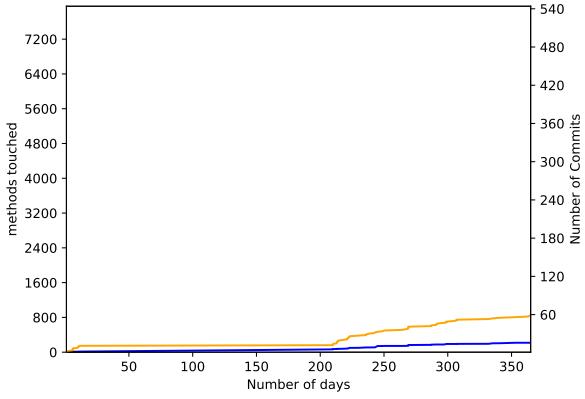
(f) Repository: 14 Developer 3172: Developer touched 643 methods after 50 commits.



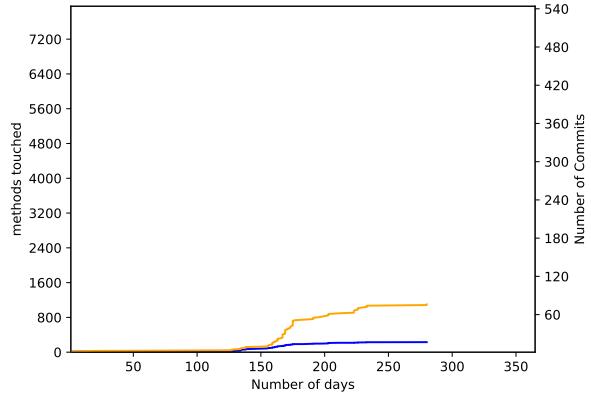
(a) Repository: 14 Developer 3178: Developer touched 1523 methods after 104 commits.



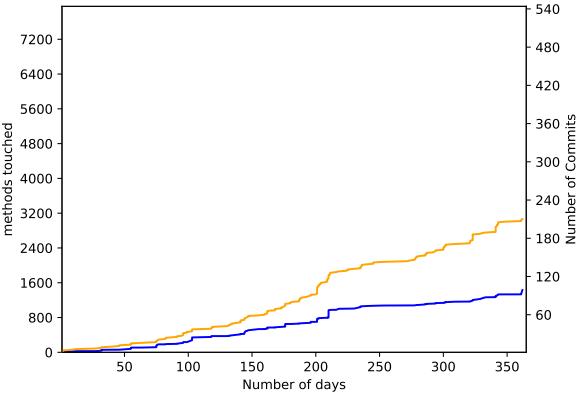
(b) Repository: 14 Developer 3216: Developer touched 6562 methods after 543 commits.



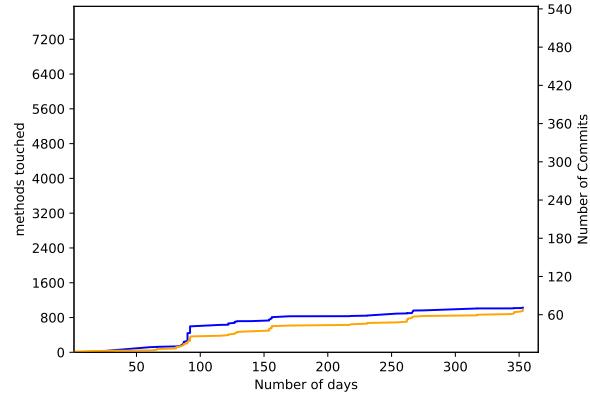
(c) Repository: 14 Developer 3217: Developer touched 217 methods after 58 commits.



(d) Repository: 14 Developer 3272: Developer touched 231 methods after 76 commits.



(e) Repository: 14 Developer 3339: Developer touched 1432 methods after 210 commits.



(f) Repository: 14 Developer 3354: Developer touched 1026 methods after 68 commits.

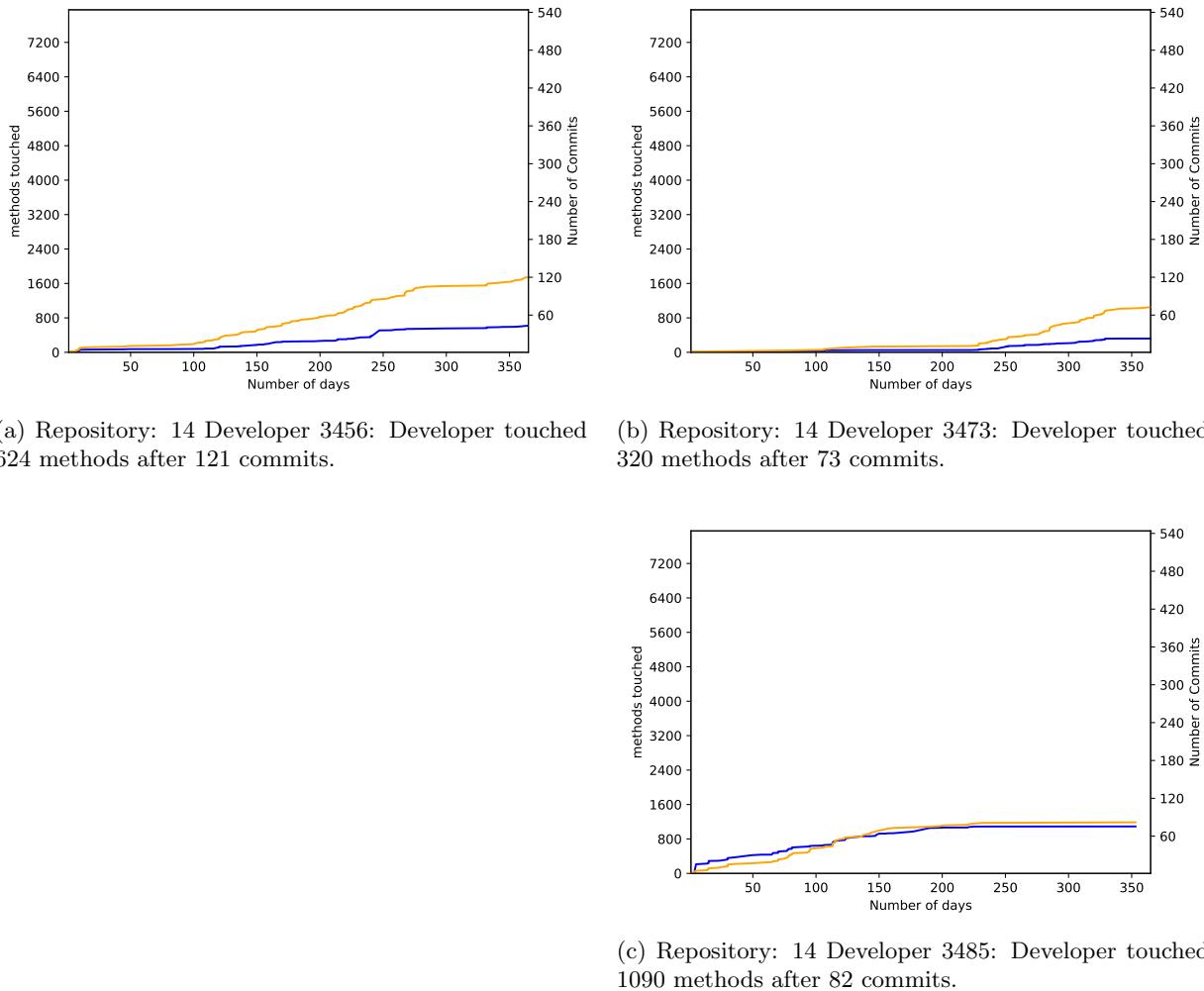


Figure 26: Number of days in the developers first year (x-axis) against methods touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

#### 4.10 Repository histogram commit - 14 For methods with total

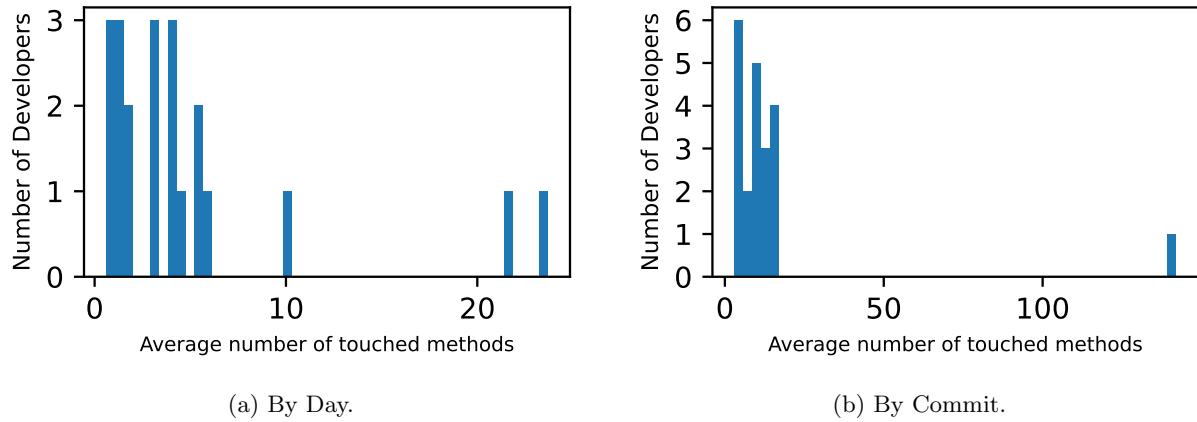
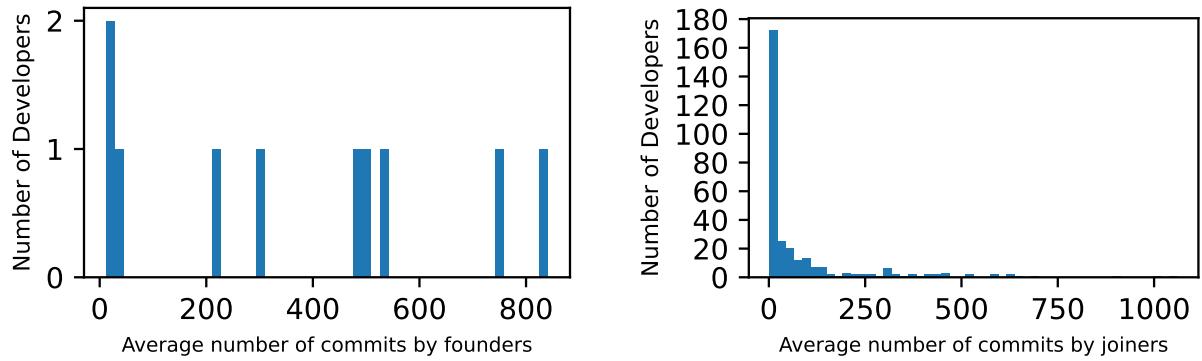


Figure 27: Histogram of new methods touched (x-axis) against number of developers (y-axis). Graphs for 21 sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

## 5 Repository: 21

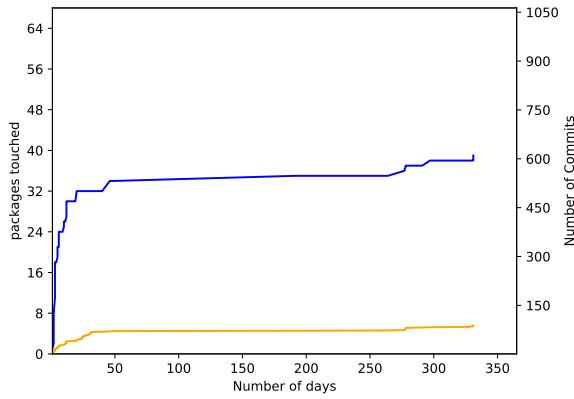
### 5.1 Developer commit - Repository 21 Developer Commits



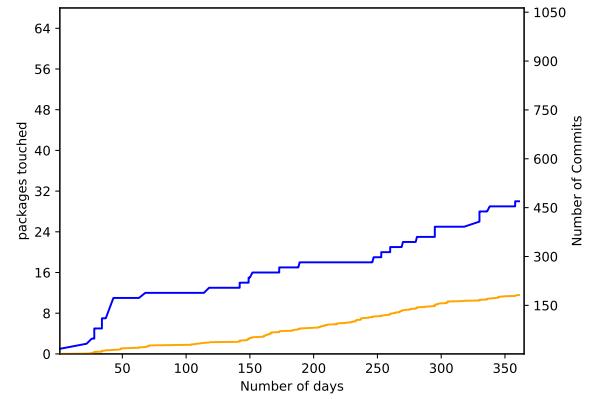
(a) Average number of new commits by 10 (x-axis) against the number of founder developers (y-axis)      (b) Average number of new commits by 299 (x-axis) against the number of joiner developers (y-axis)

Figure 28: The average number of commits made against the number of founder and joiner developers.

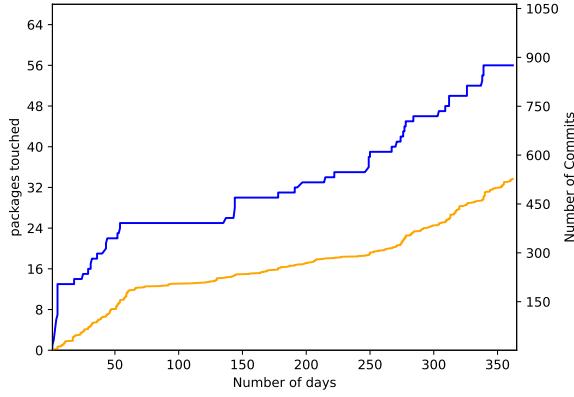
## **5.2 Developer touched - Repository 21: Developer packages knowledge**



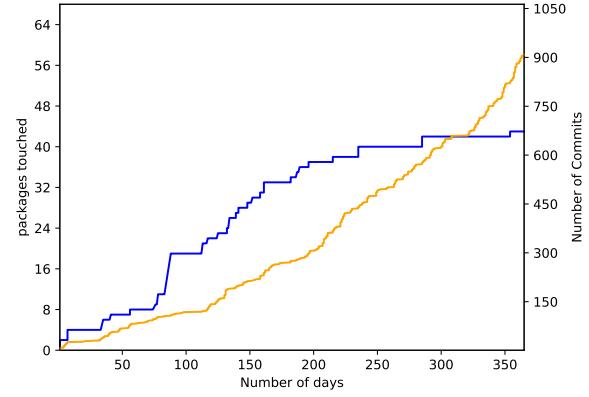
(a) Repository: 21 Developer 199: Developer touched 39 packages after 88 commits.



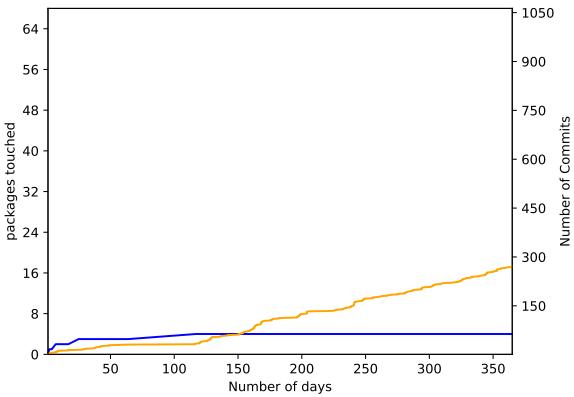
(b) Repository: 21 Developer 6252: Developer touched 30 packages after 182 commits.



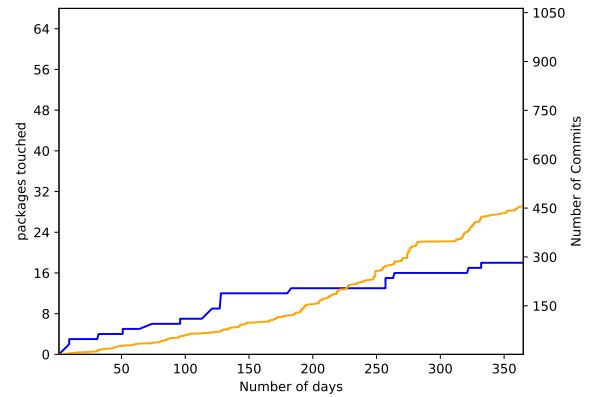
(c) Repository: 21 Developer 6253: Developer touched 56 packages after 527 commits.



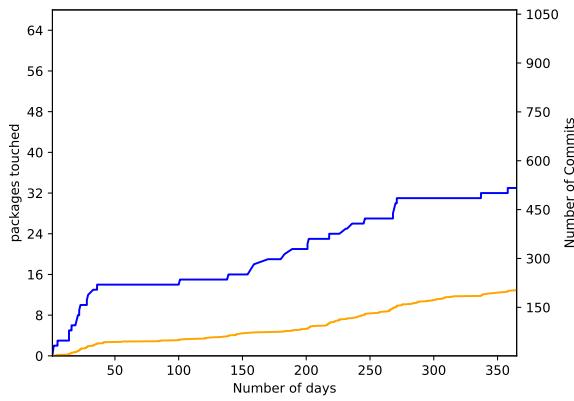
(d) Repository: 21 Developer 6259: Developer touched 43 packages after 911 commits.



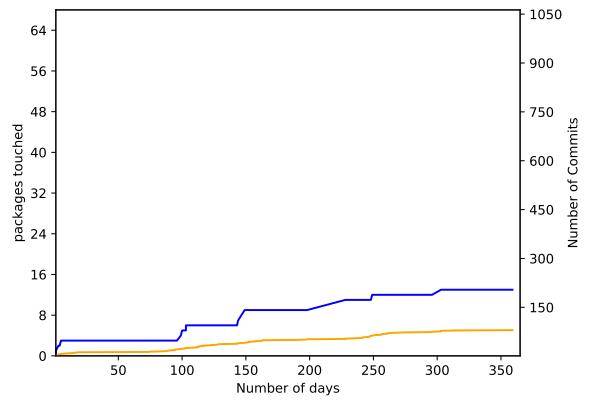
(e) Repository: 21 Developer 6260: Developer touched 4 packages after 272 commits.



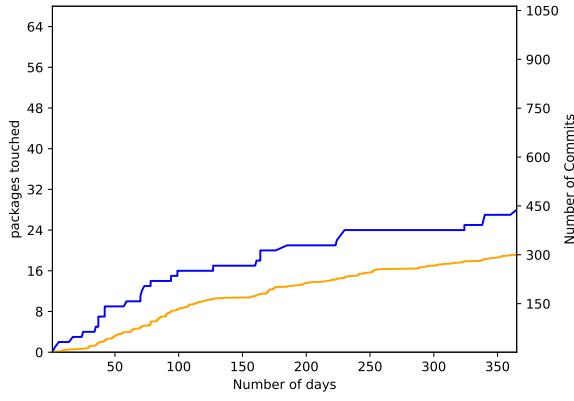
(f) Repository: 21 Developer 6262: Developer touched 18 packages after 455 commits.



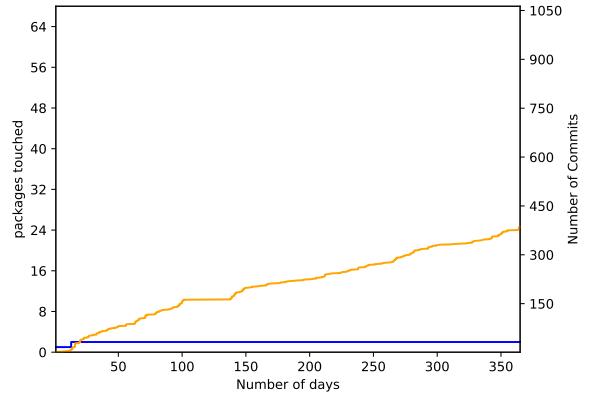
(a) Repository: 21 Developer 6263: Developer touched 33 packages after 205 commits.



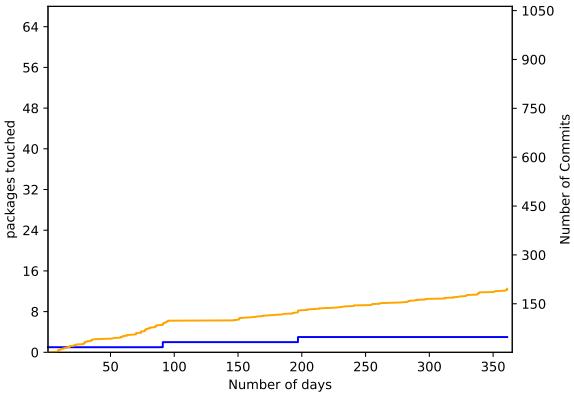
(b) Repository: 21 Developer 6264: Developer touched 13 packages after 80 commits.



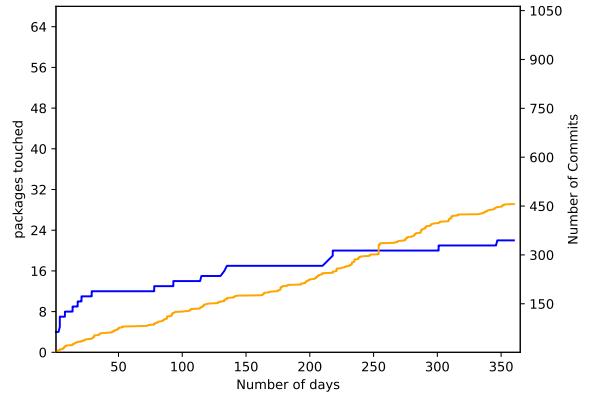
(c) Repository: 21 Developer 6267: Developer touched 28 packages after 301 commits.



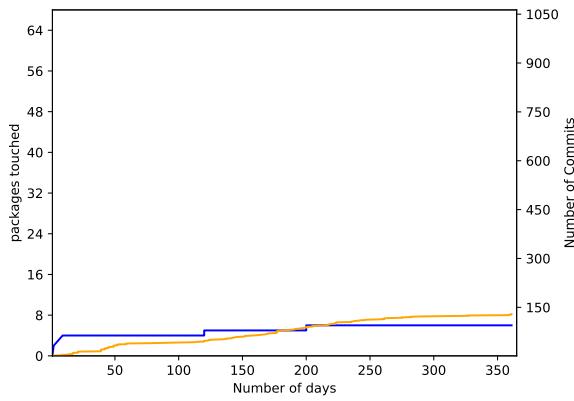
(d) Repository: 21 Developer 6271: Developer touched 2 packages after 385 commits.



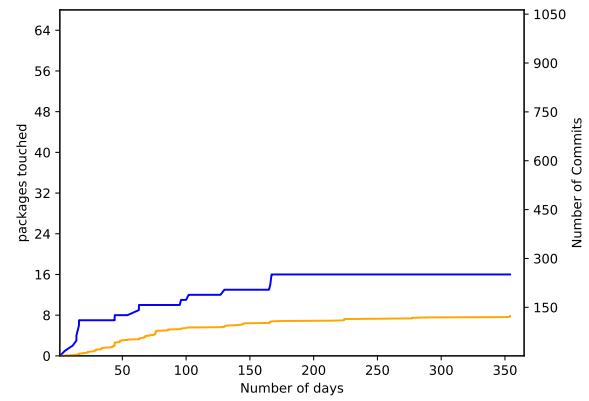
(e) Repository: 21 Developer 6272: Developer touched 3 packages after 196 commits.



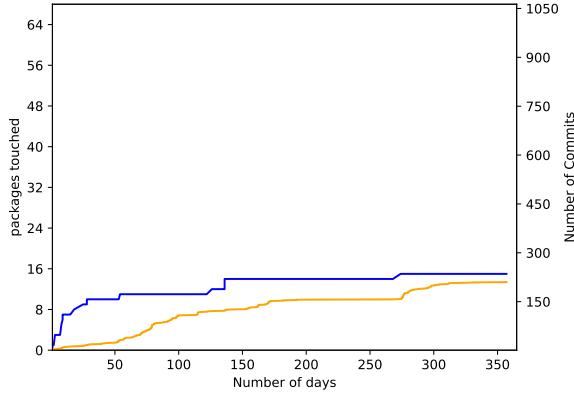
(f) Repository: 21 Developer 6276: Developer touched 22 packages after 456 commits.



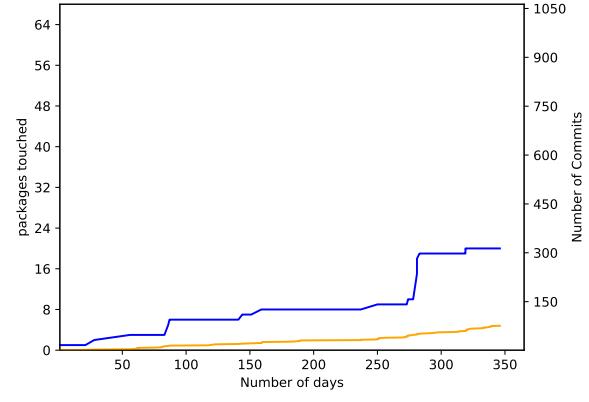
(a) Repository: 21 Developer 6278: Developer touched 6 packages after 129 commits.



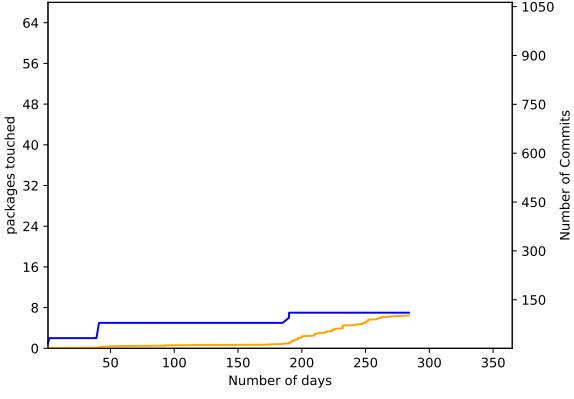
(b) Repository: 21 Developer 6280: Developer touched 16 packages after 123 commits.



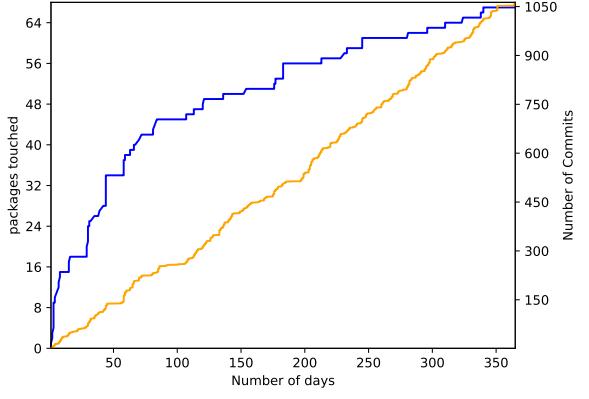
(c) Repository: 21 Developer 6282: Developer touched 15 packages after 210 commits.



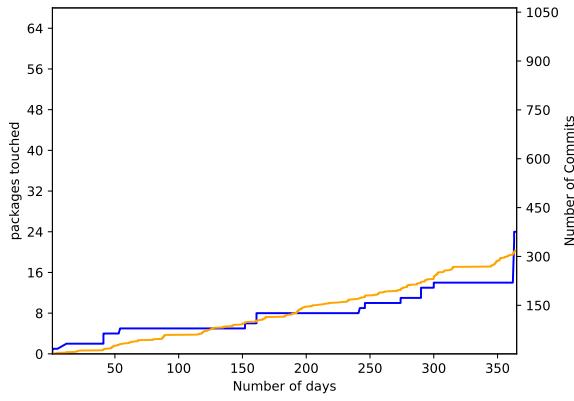
(d) Repository: 21 Developer 6284: Developer touched 20 packages after 76 commits.



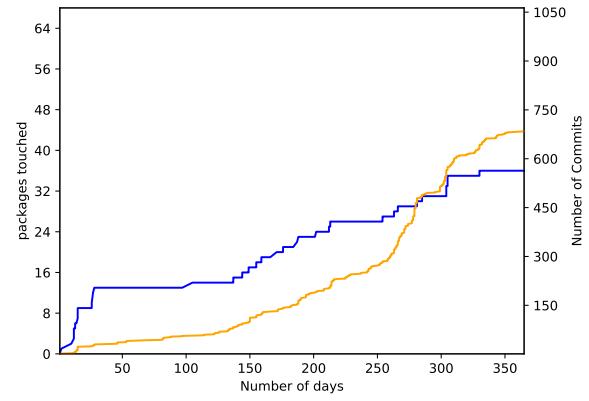
(e) Repository: 21 Developer 6288: Developer touched 7 packages after 102 commits.



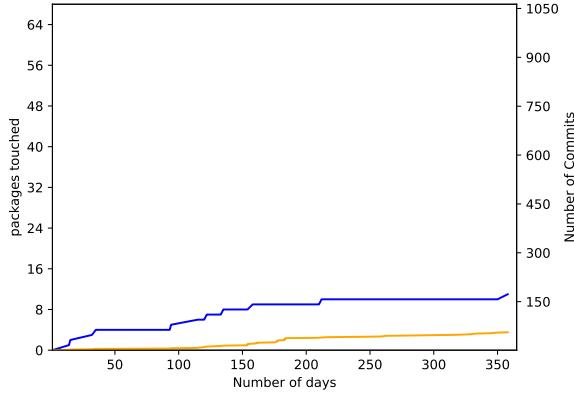
(f) Repository: 21 Developer 6295: Developer touched 67 packages after 1062 commits.



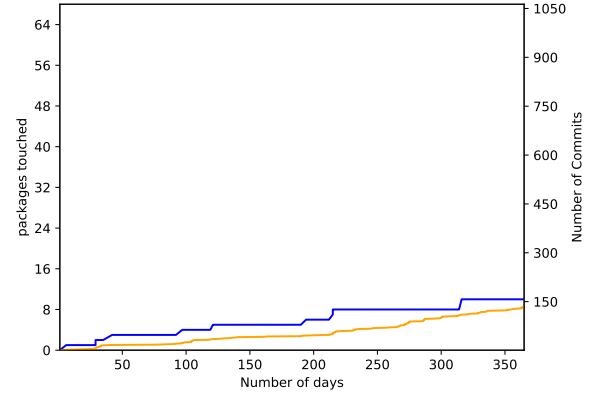
(a) Repository: 21 Developer 6297: Developer touched 24 packages after 324 commits.



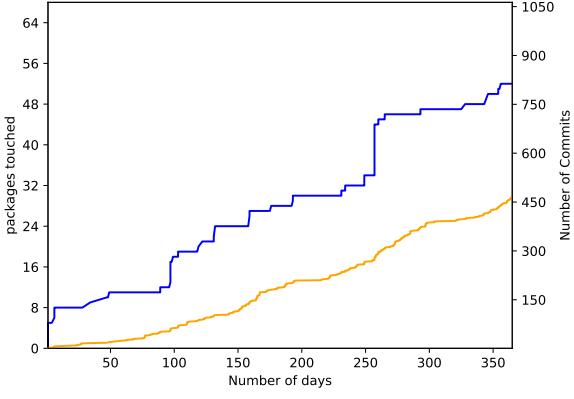
(b) Repository: 21 Developer 6298: Developer touched 36 packages after 684 commits.



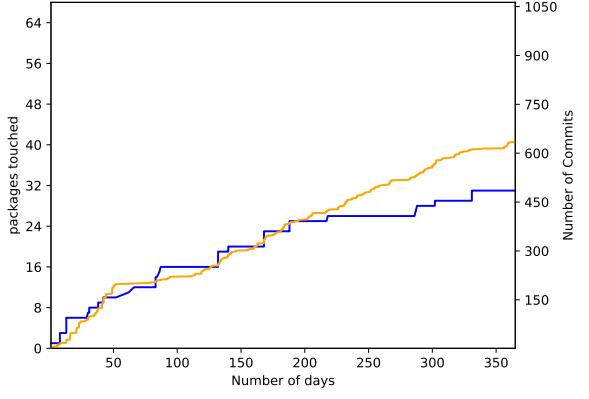
(c) Repository: 21 Developer 6302: Developer touched 11 packages after 56 commits.



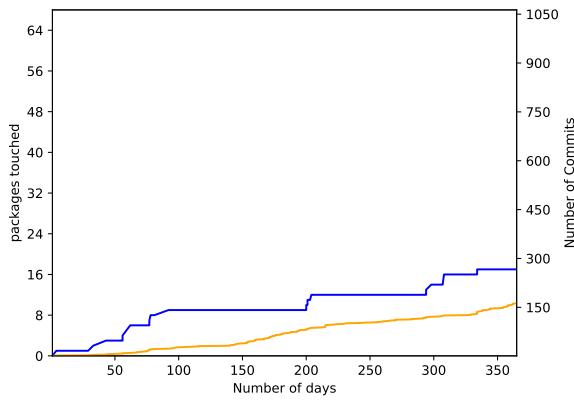
(d) Repository: 21 Developer 6306: Developer touched 10 packages after 134 commits.



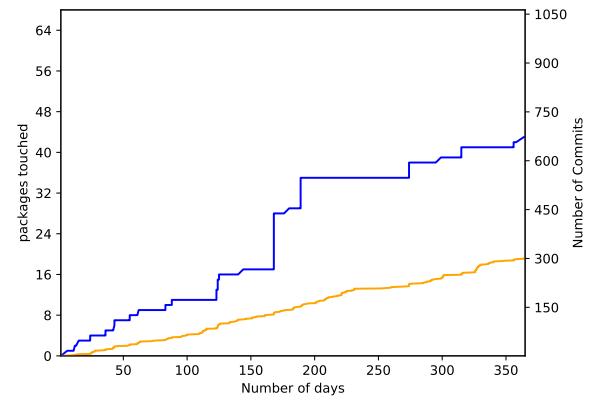
(e) Repository: 21 Developer 6309: Developer touched 52 packages after 463 commits.



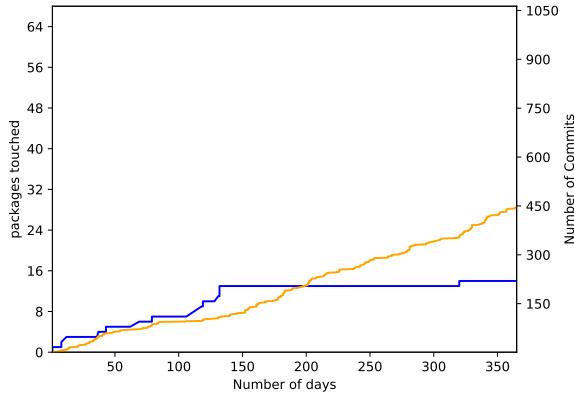
(f) Repository: 21 Developer 6312: Developer touched 31 packages after 635 commits.



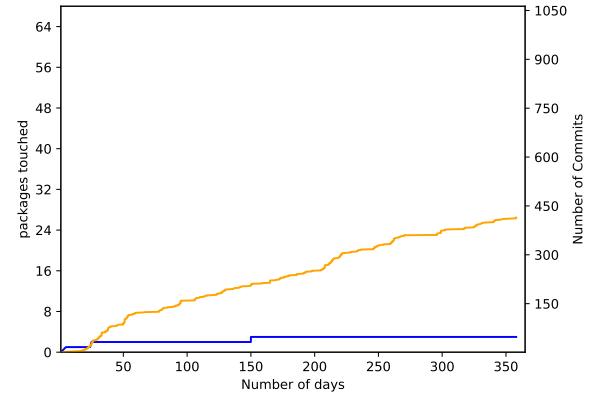
(a) Repository: 21 Developer 6313: Developer touched 17 packages after 163 commits.



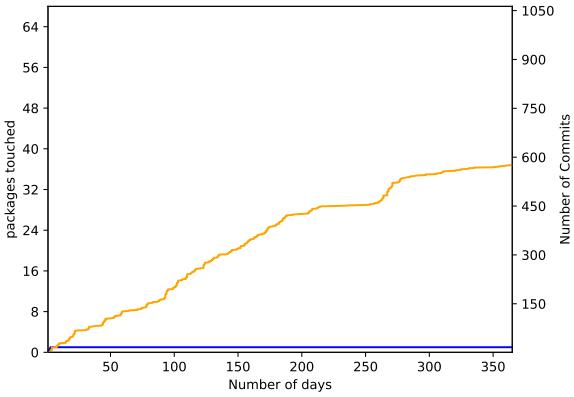
(b) Repository: 21 Developer 6314: Developer touched 43 packages after 300 commits.



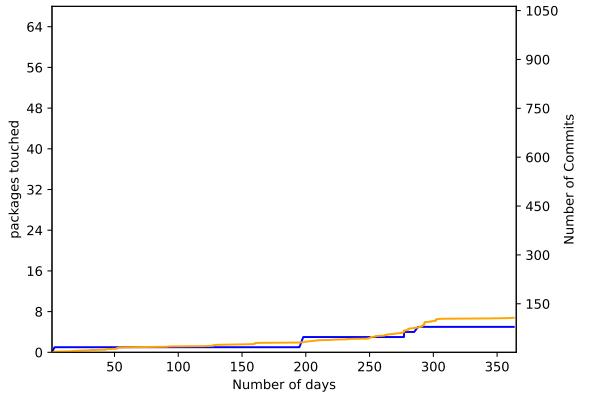
(c) Repository: 21 Developer 6315: Developer touched 14 packages after 446 commits.



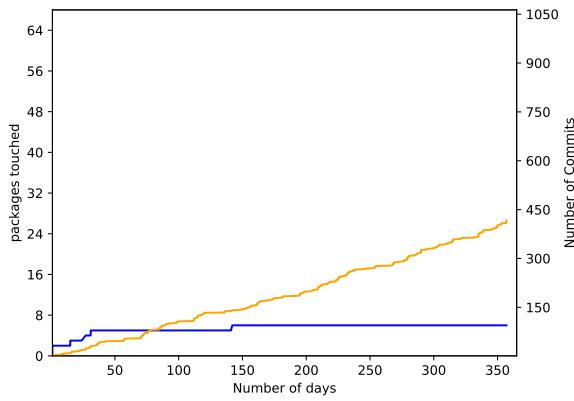
(d) Repository: 21 Developer 6326: Developer touched 3 packages after 414 commits.



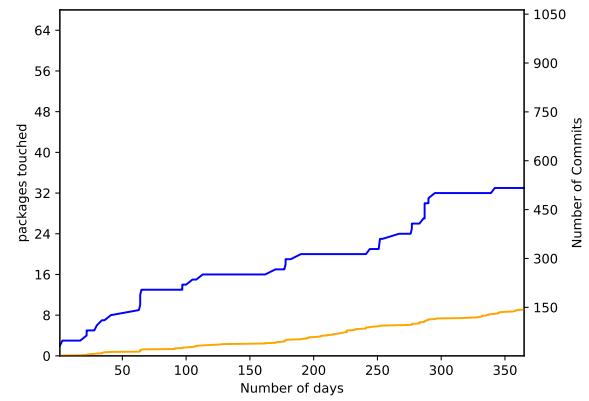
(e) Repository: 21 Developer 6329: Developer touched 1 packages after 576 commits.



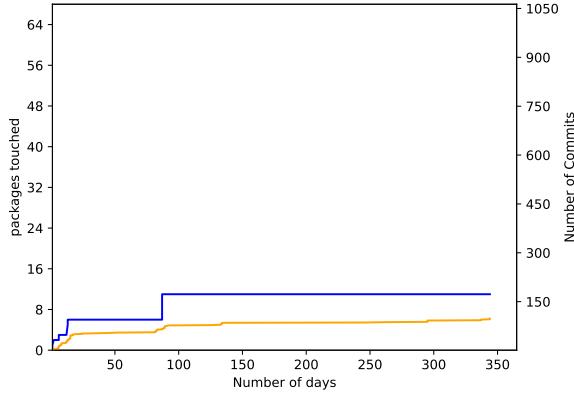
(f) Repository: 21 Developer 6333: Developer touched 5 packages after 107 commits.



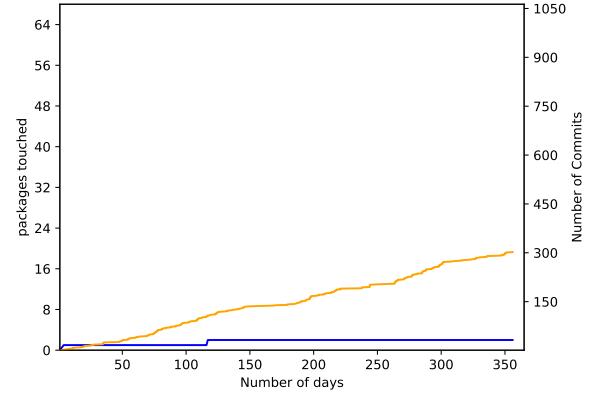
(a) Repository: 21 Developer 6338: Developer touched 6 packages after 417 commits.



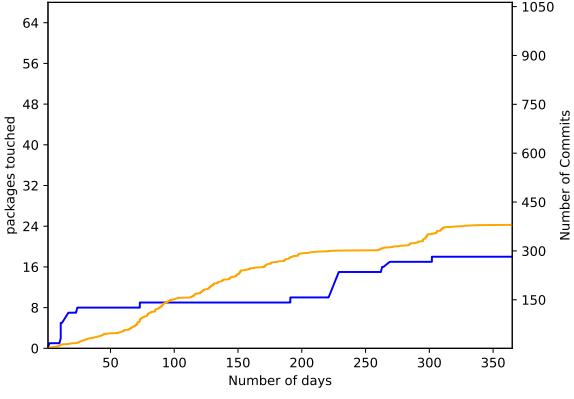
(b) Repository: 21 Developer 6342: Developer touched 33 packages after 144 commits.



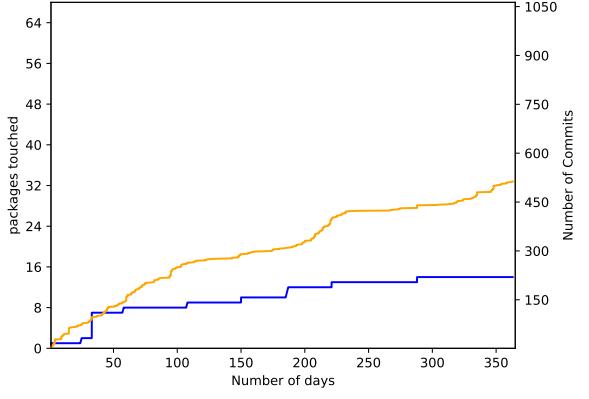
(c) Repository: 21 Developer 6343: Developer touched 11 packages after 98 commits.



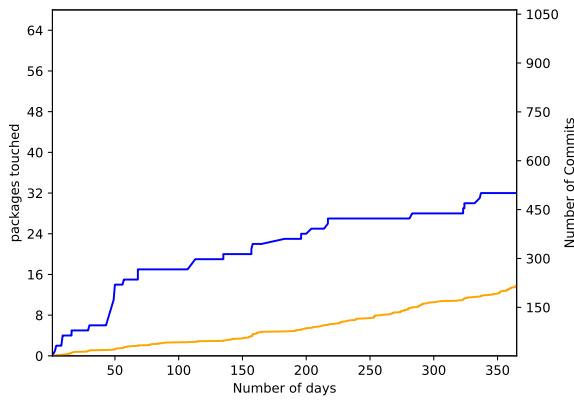
(d) Repository: 21 Developer 6349: Developer touched 2 packages after 302 commits.



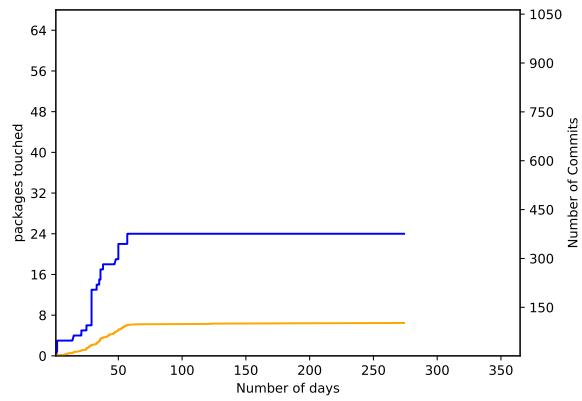
(e) Repository: 21 Developer 6352: Developer touched 18 packages after 382 commits.



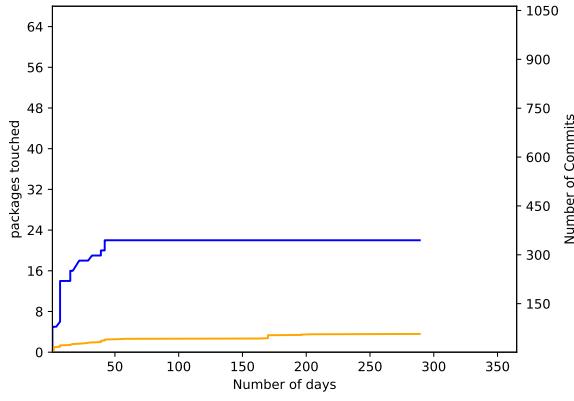
(f) Repository: 21 Developer 6355: Developer touched 14 packages after 513 commits.



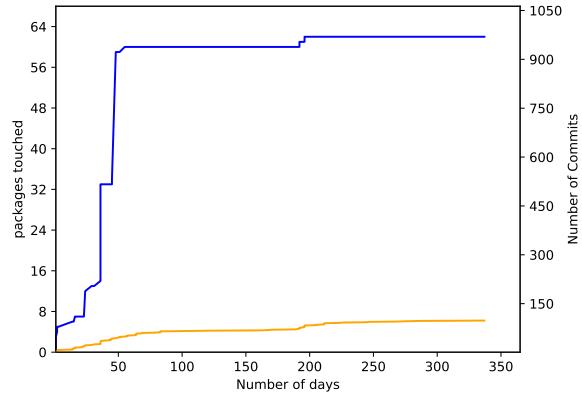
(a) Repository: 21 Developer 6363: Developer touched 32 packages after 226 commits.



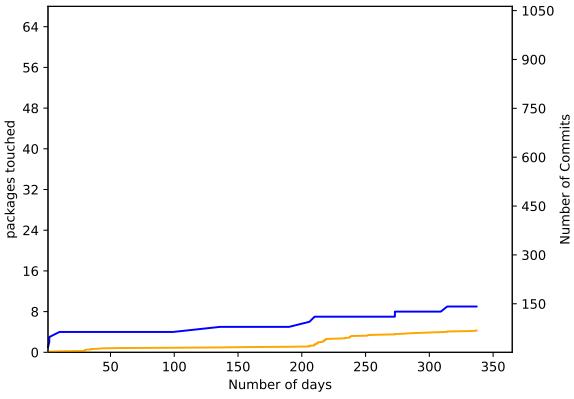
(b) Repository: 21 Developer 6368: Developer touched 24 packages after 102 commits.



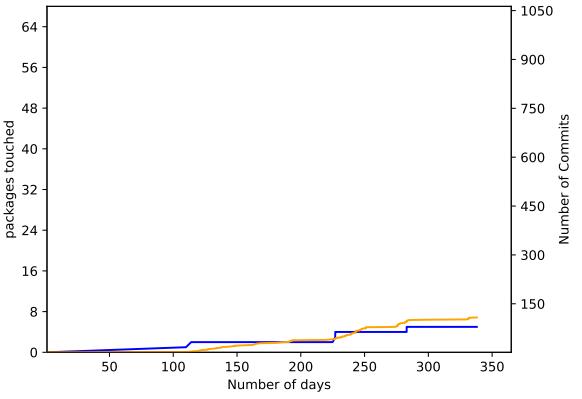
(c) Repository: 21 Developer 6369: Developer touched 22 packages after 57 commits.



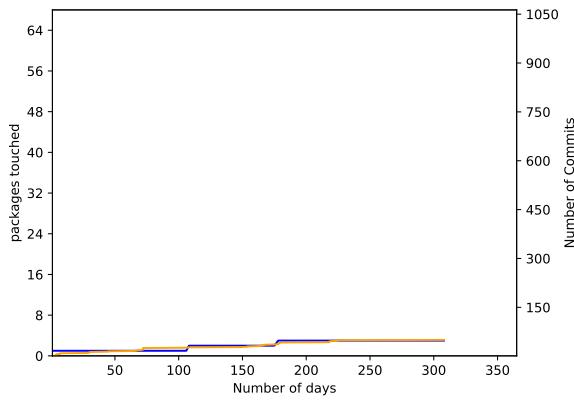
(d) Repository: 21 Developer 6370: Developer touched 62 packages after 98 commits.



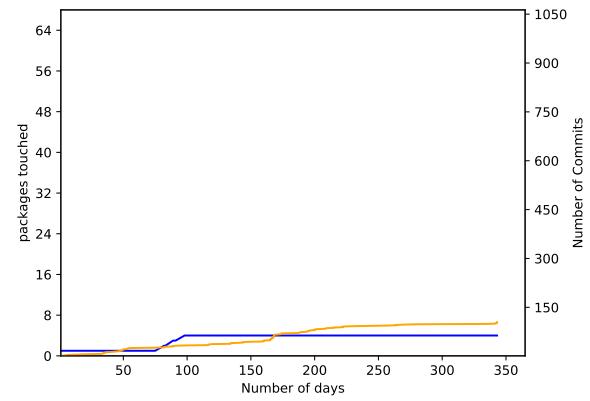
(e) Repository: 21 Developer 6373: Developer touched 9 packages after 68 commits.



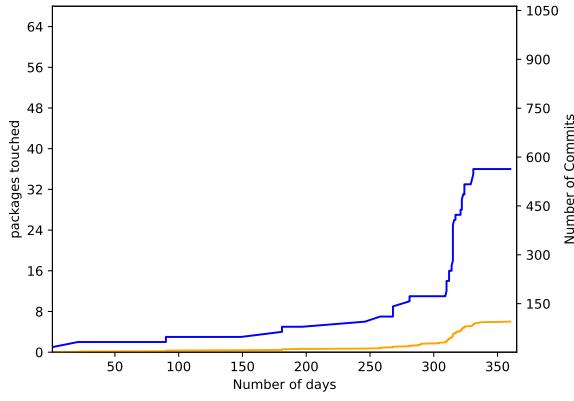
(f) Repository: 21 Developer 6374: Developer touched 5 packages after 108 commits.



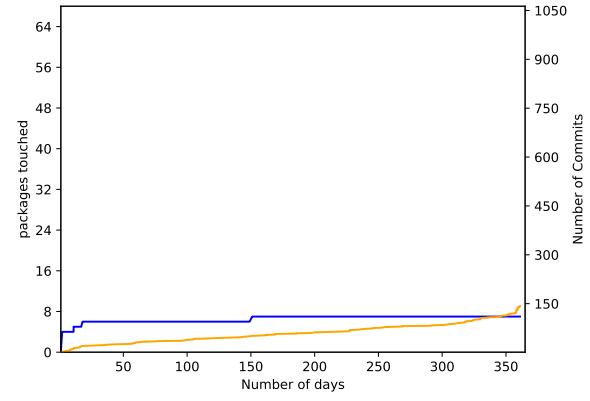
(a) Repository: 21 Developer 6375: Developer touched 3 packages after 50 commits.



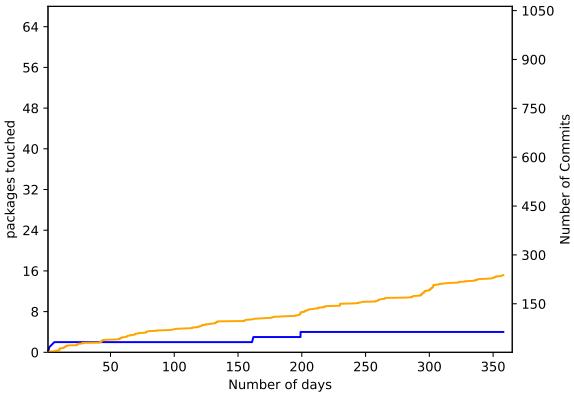
(b) Repository: 21 Developer 6379: Developer touched 4 packages after 104 commits.



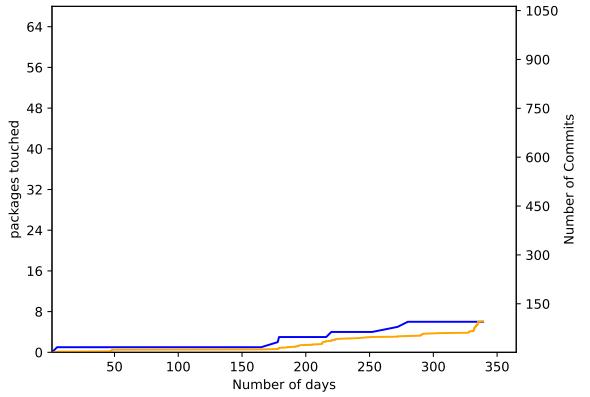
(c) Repository: 21 Developer 6391: Developer touched 36 packages after 95 commits.



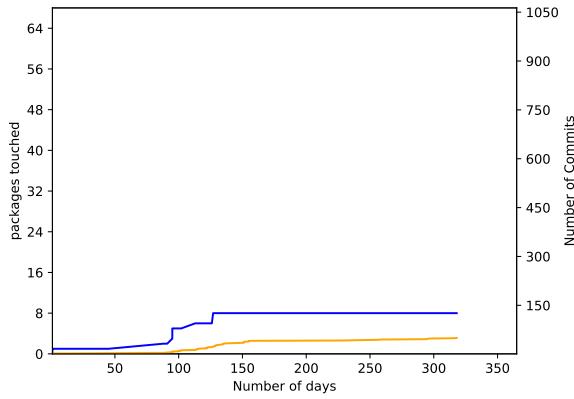
(d) Repository: 21 Developer 6410: Developer touched 7 packages after 142 commits.



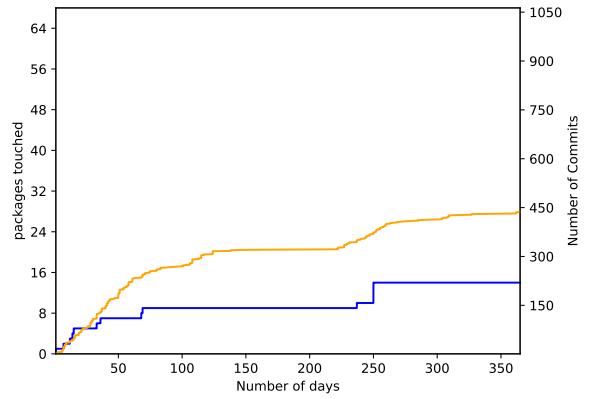
(e) Repository: 21 Developer 6411: Developer touched 4 packages after 238 commits.



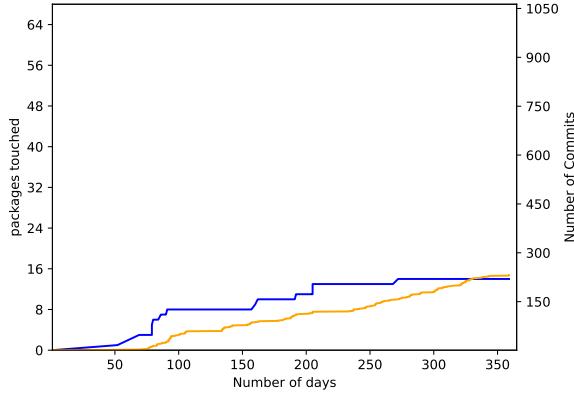
(f) Repository: 21 Developer 6417: Developer touched 6 packages after 96 commits.



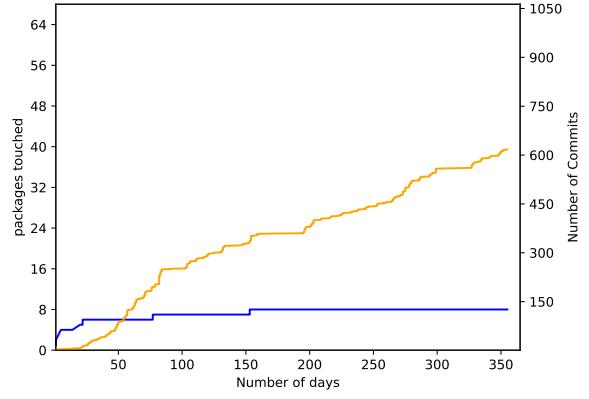
(a) Repository: 21 Developer 6418: Developer touched 8 packages after 50 commits.



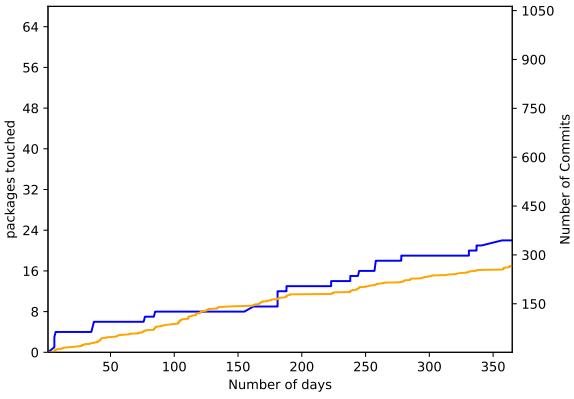
(b) Repository: 21 Developer 6420: Developer touched 14 packages after 437 commits.



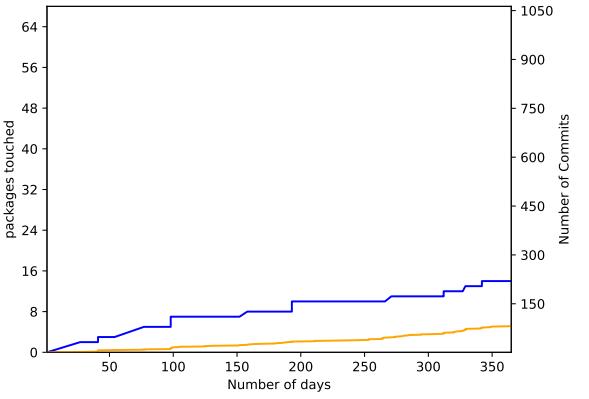
(c) Repository: 21 Developer 6424: Developer touched 14 packages after 231 commits.



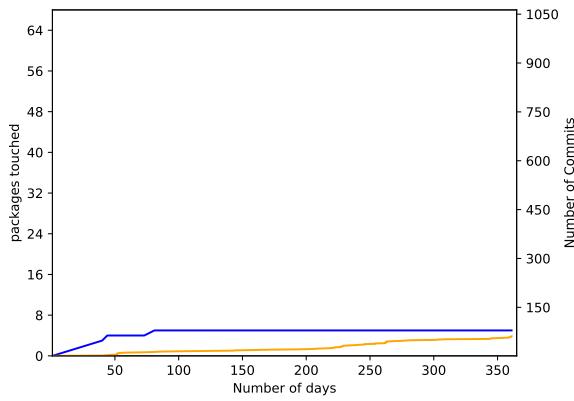
(d) Repository: 21 Developer 6426: Developer touched 8 packages after 617 commits.



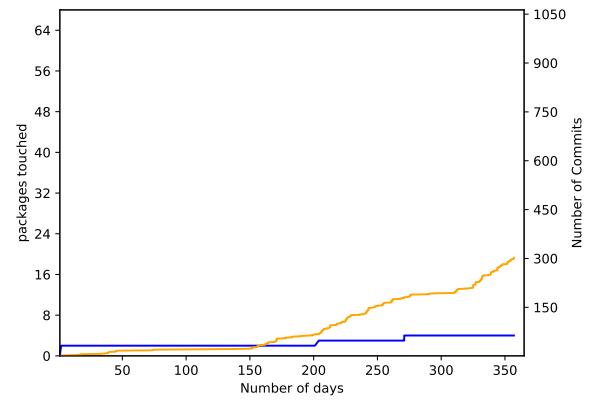
(e) Repository: 21 Developer 6427: Developer touched 22 packages after 267 commits.



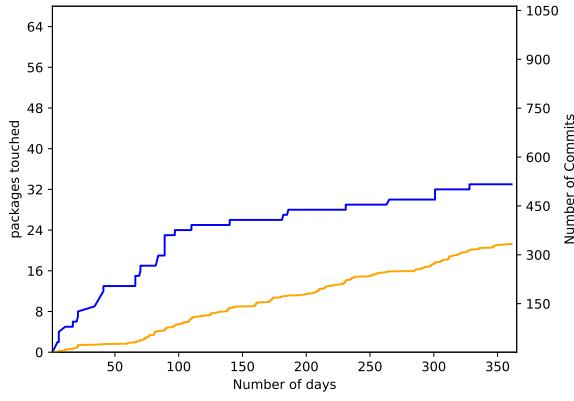
(f) Repository: 21 Developer 6429: Developer touched 14 packages after 82 commits.



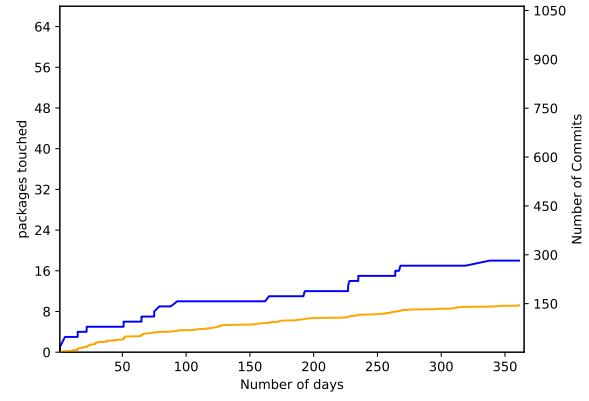
(a) Repository: 21 Developer 6431: Developer touched 5 packages after 61 commits.



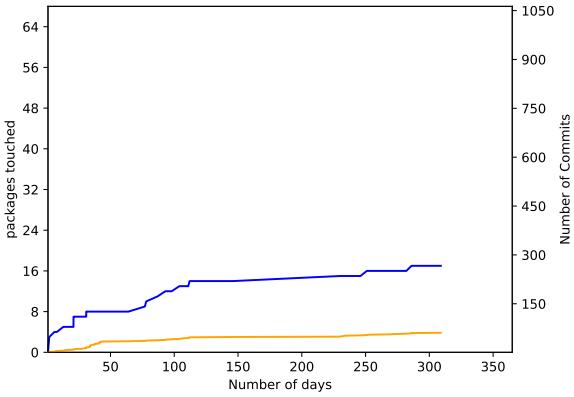
(b) Repository: 21 Developer 6450: Developer touched 4 packages after 302 commits.



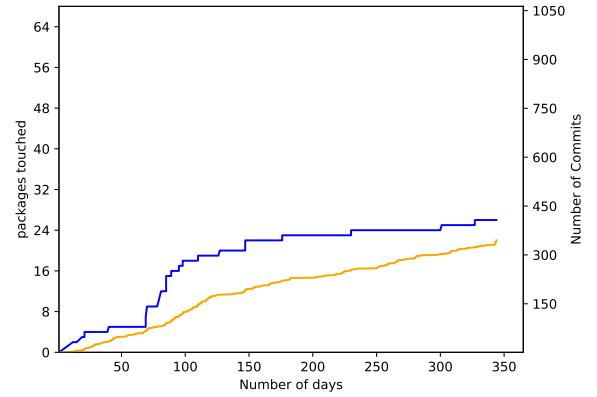
(c) Repository: 21 Developer 6454: Developer touched 33 packages after 333 commits.



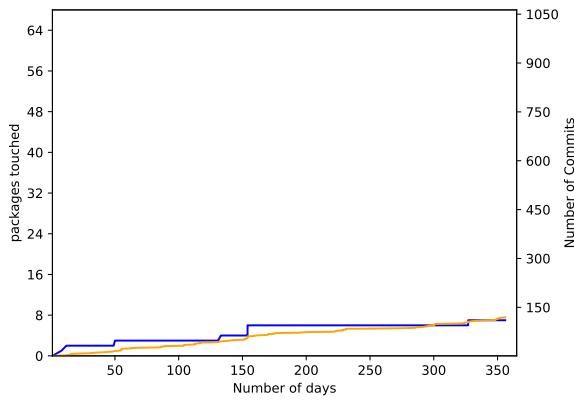
(d) Repository: 21 Developer 6460: Developer touched 18 packages after 145 commits.



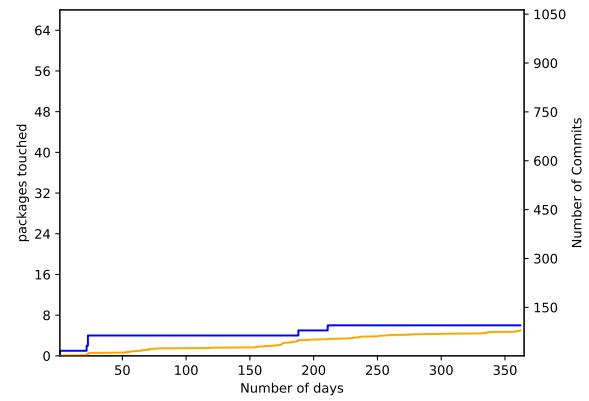
(e) Repository: 21 Developer 6483: Developer touched 17 packages after 61 commits.



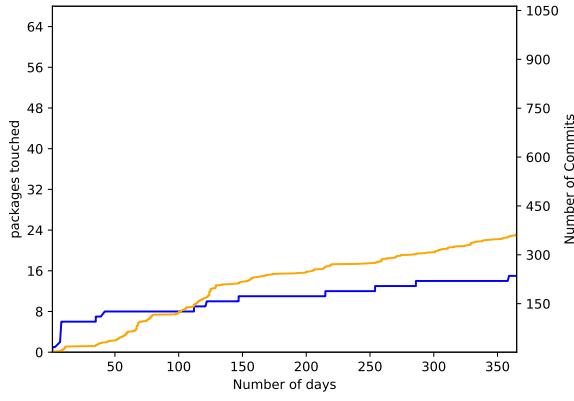
(f) Repository: 21 Developer 6489: Developer touched 26 packages after 345 commits.



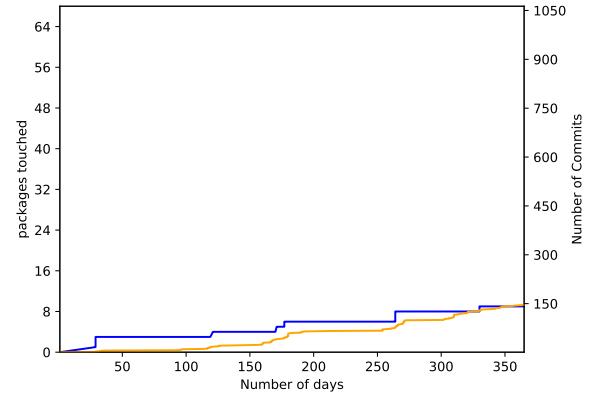
(a) Repository: 21 Developer 6491: Developer touched 7 packages after 119 commits.



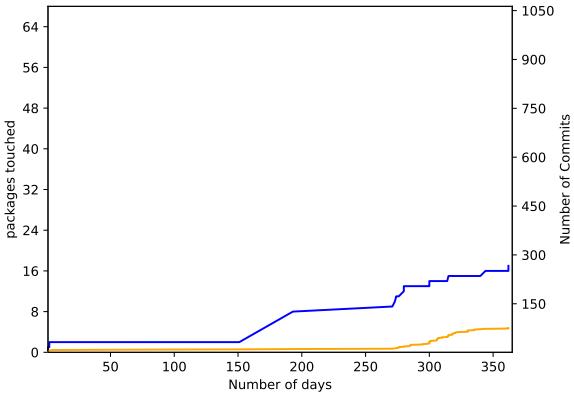
(b) Repository: 21 Developer 6502: Developer touched 6 packages after 79 commits.



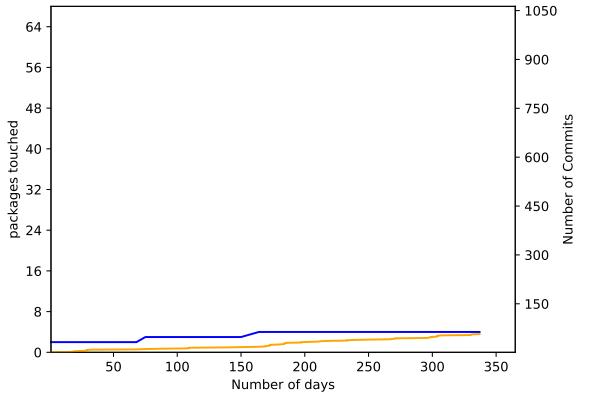
(c) Repository: 21 Developer 6503: Developer touched 15 packages after 363 commits.



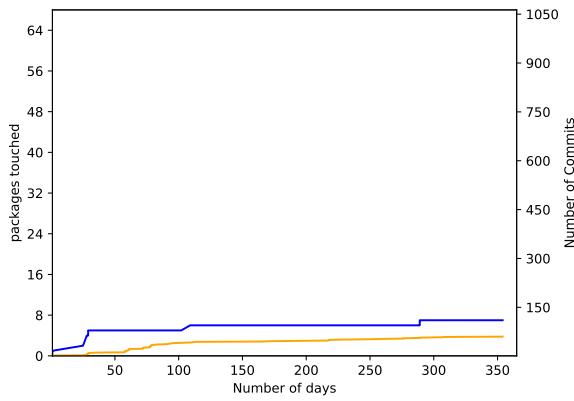
(d) Repository: 21 Developer 6507: Developer touched 9 packages after 146 commits.



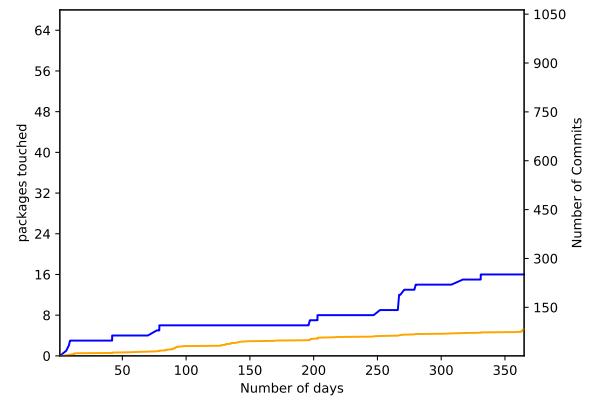
(e) Repository: 21 Developer 6509: Developer touched 17 packages after 75 commits.



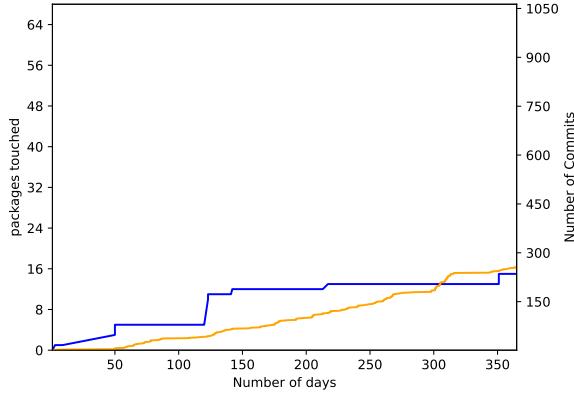
(f) Repository: 21 Developer 6529: Developer touched 4 packages after 57 commits.



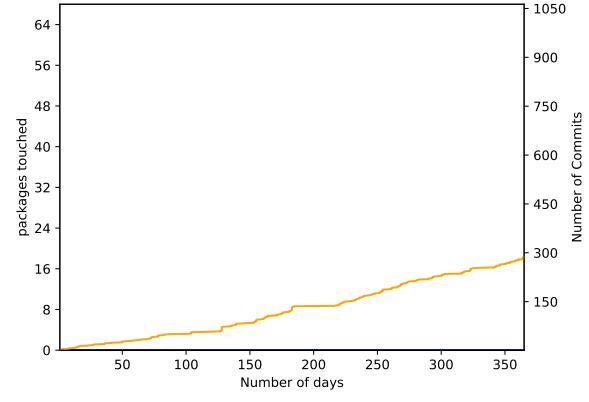
(a) Repository: 21 Developer 6541: Developer touched 7 packages after 60 commits.



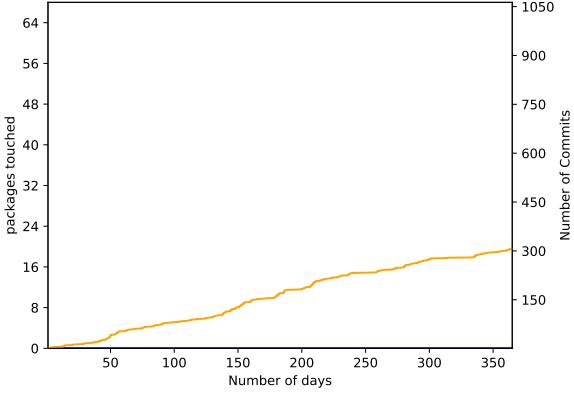
(b) Repository: 21 Developer 6552: Developer touched 16 packages after 83 commits.



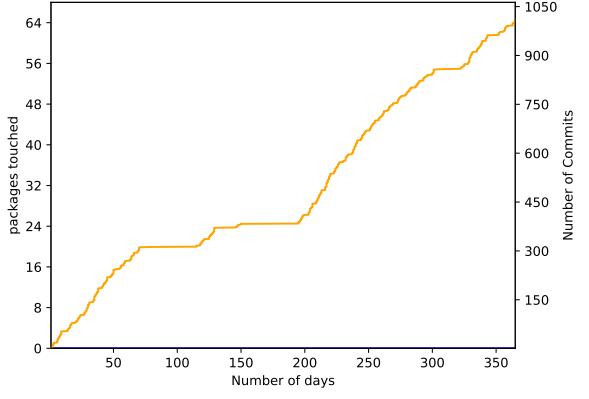
(c) Repository: 21 Developer 6555: Developer touched 15 packages after 256 commits.



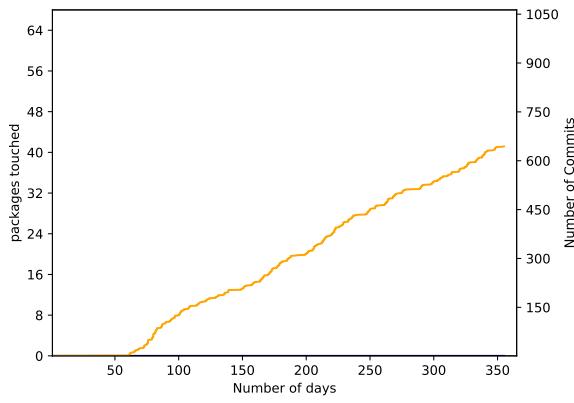
(d) Repository: 21 Developer 6576: Developer touched 0 packages after 287 commits.



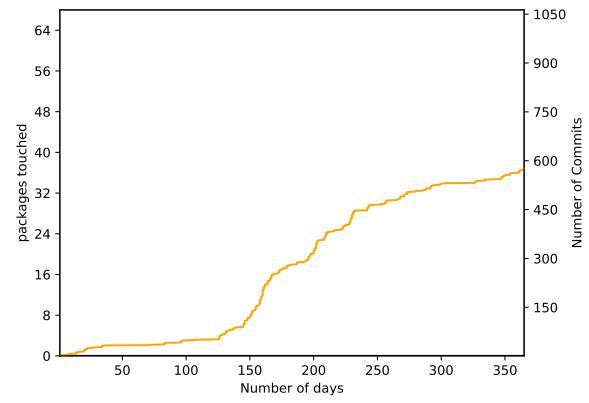
(e) Repository: 21 Developer 6579: Developer touched 0 packages after 307 commits.



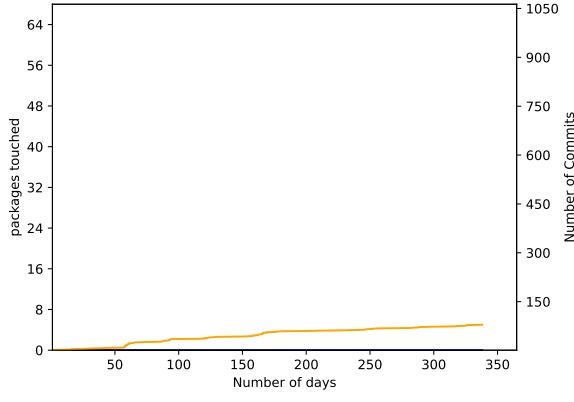
(f) Repository: 21 Developer 6587: Developer touched 0 packages after 1013 commits.



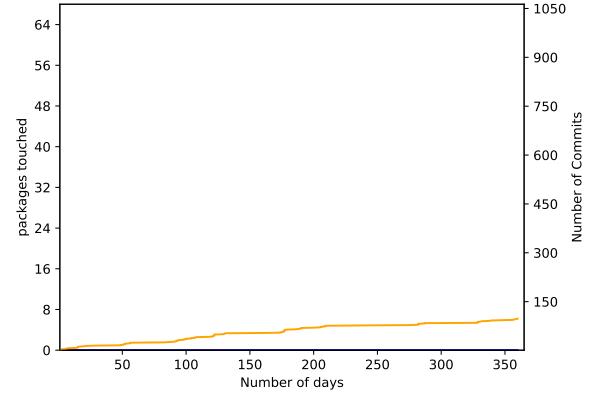
(a) Repository: 21 Developer 6609: Developer touched 0 packages after 644 commits.



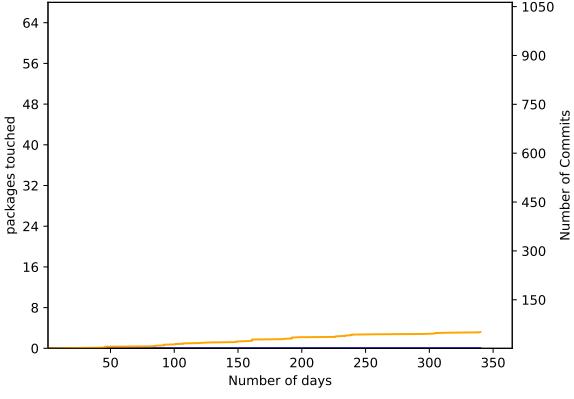
(b) Repository: 21 Developer 6619: Developer touched 0 packages after 576 commits.



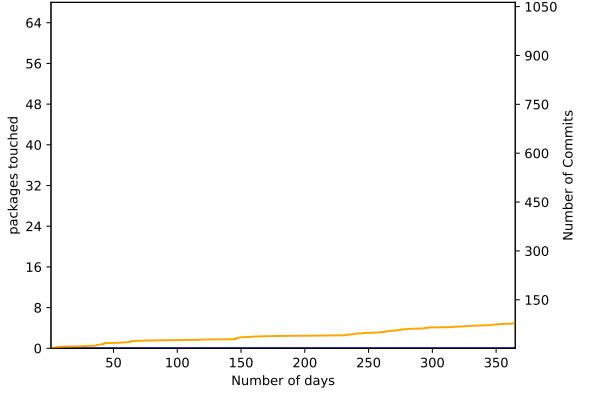
(c) Repository: 21 Developer 6624: Developer touched 0 packages after 79 commits.



(d) Repository: 21 Developer 6631: Developer touched 0 packages after 98 commits.



(e) Repository: 21 Developer 6641: Developer touched 0 packages after 51 commits.



(f) Repository: 21 Developer 6651: Developer touched 0 packages after 78 commits.

### 5.3 Repository histogram commit - 21 For packages with total

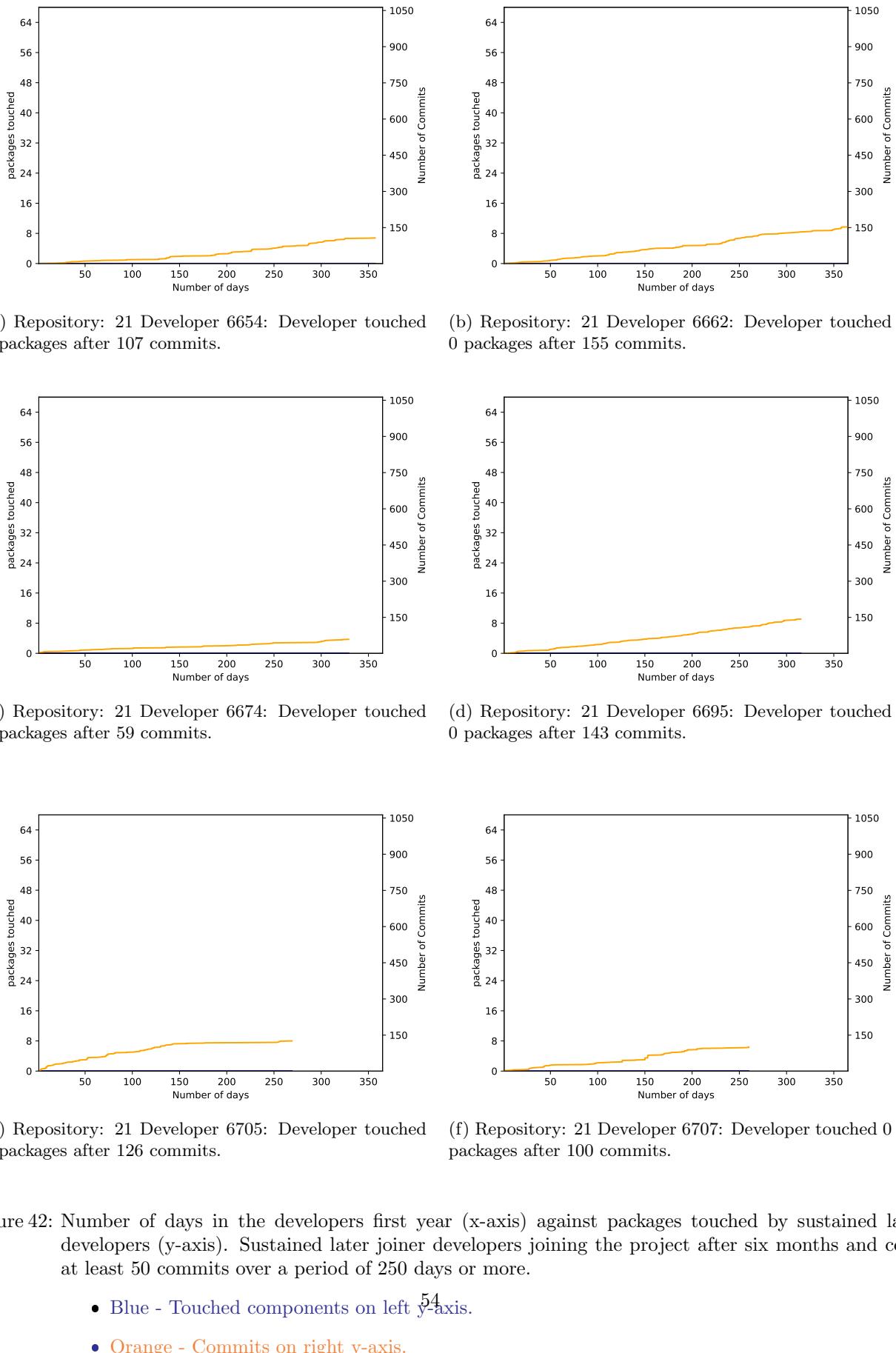


Figure 42: Number of days in the developers first year (x-axis) against packages touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

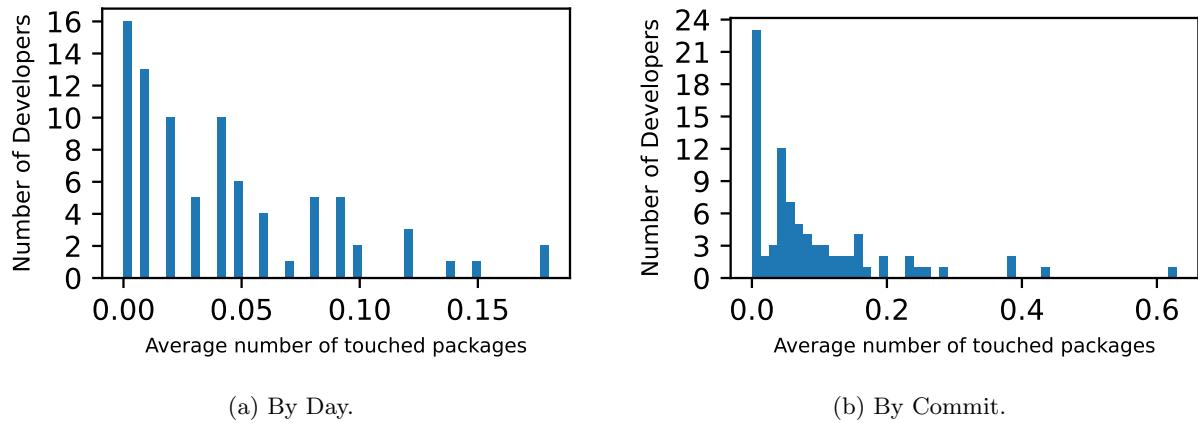
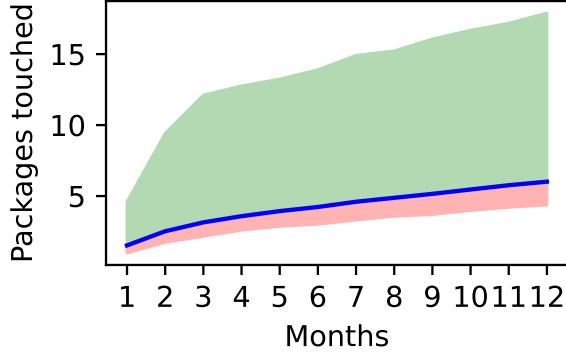


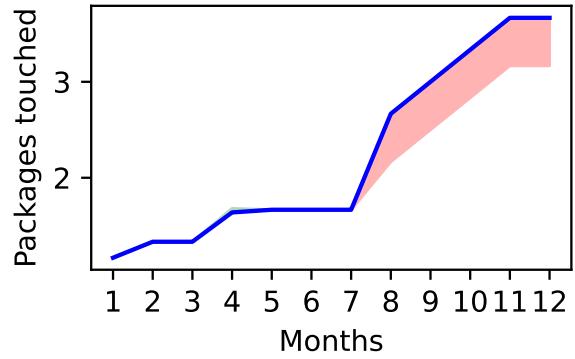
Figure 43: Histogram of new packages touched (x-axis) against number of developers (y-axis). Graphs for 84 sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

#### 5.4 Time series developer - 21 For packages touched for each period

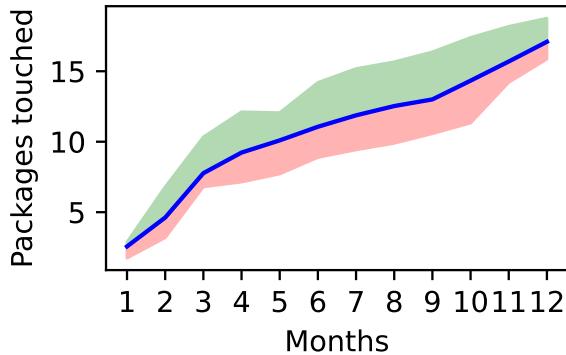
A time series of packages touched on average each month.



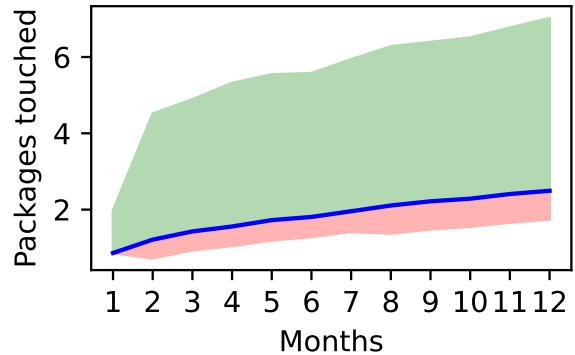
(a) All developers (300) showing packages touched



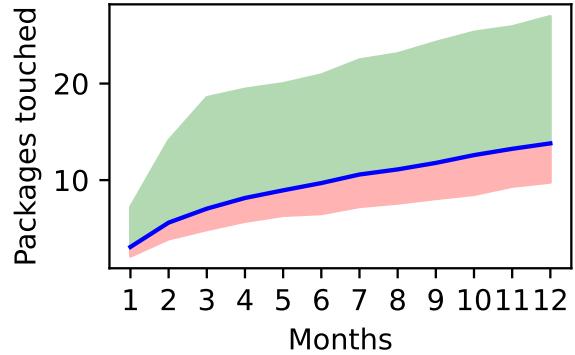
(b) Transient founder developers (3) showing packages touched



(c) Sustained founder developers (7) showing packages touched



(d) Transient later joiner developers (206) showing packages touched



(e) Sustained later joiner developers (84) showing packages touched

Figure 44: A time series of the number of month (x-axis) against the average (mean) total packages touched (y-axis), with positive (orange) and negative (red) filled standard deviation.

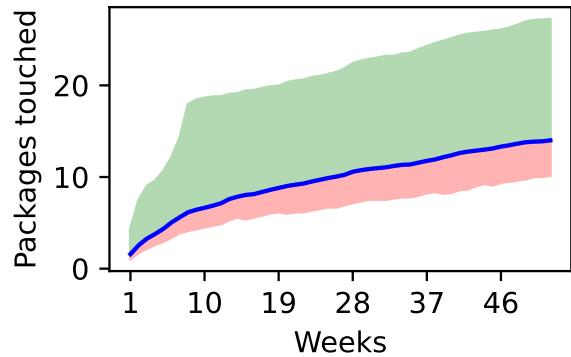
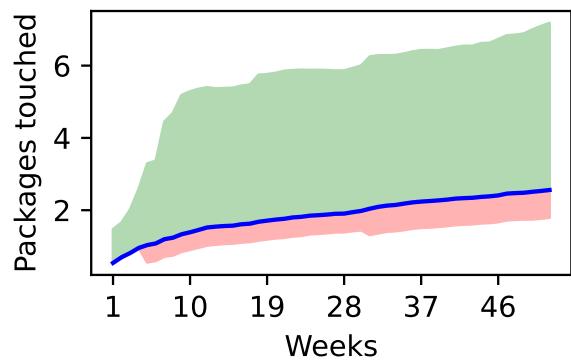
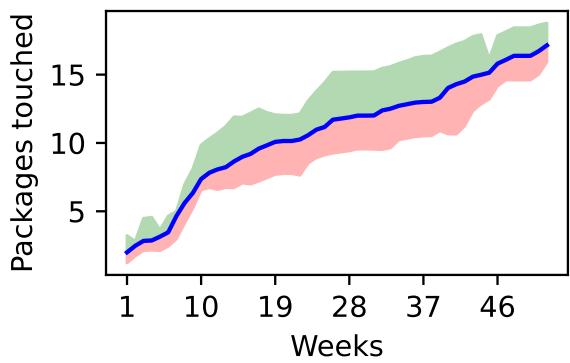
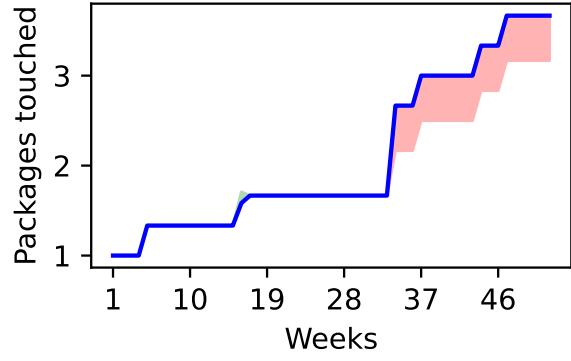
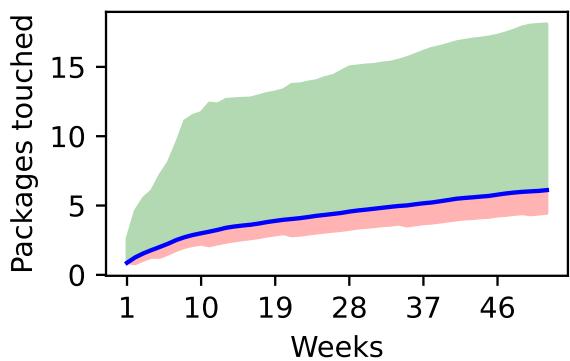
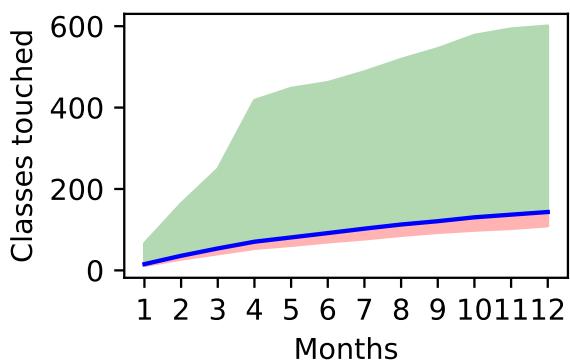
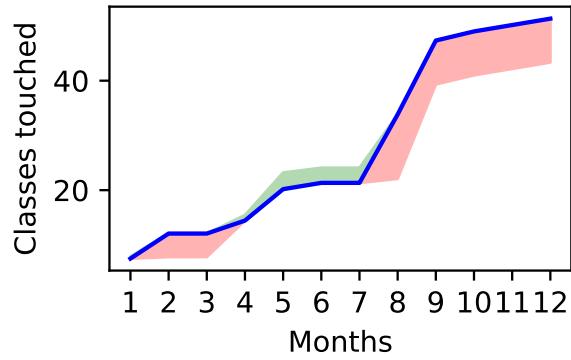


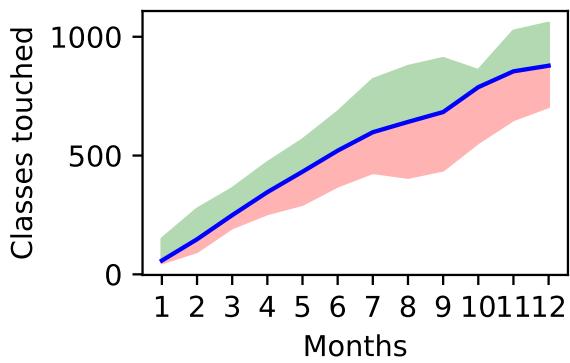
Figure 45: A time series of the number of week (x-axis) against the average (mean) total packages touched (y-axis), with positive (orange) and negative (red) filled standard deviation.



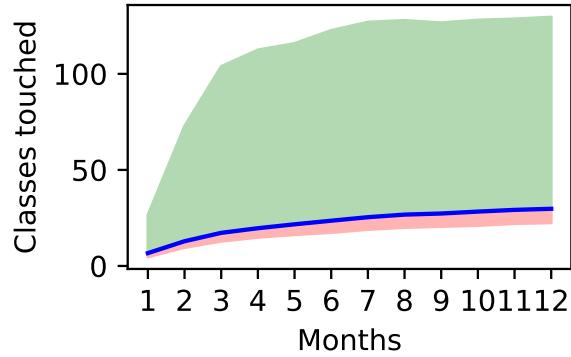
(a) All developers (300) showing classes touched



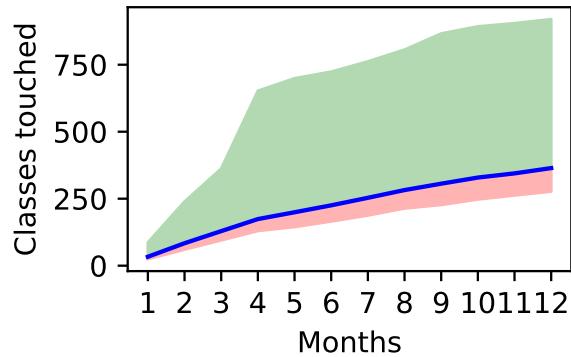
(b) Transient founder developers (3) showing classes touched



(c) Sustained founder developers (7) showing classes touched

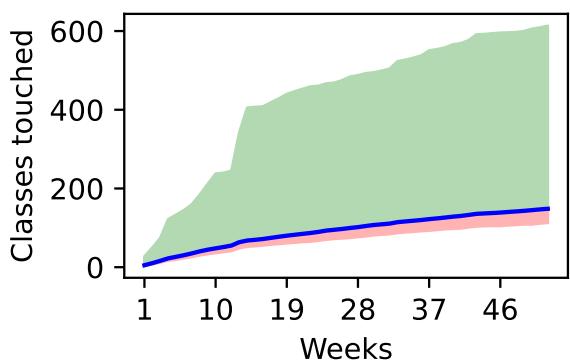


(d) Transient later joiner developers (206) showing classes touched

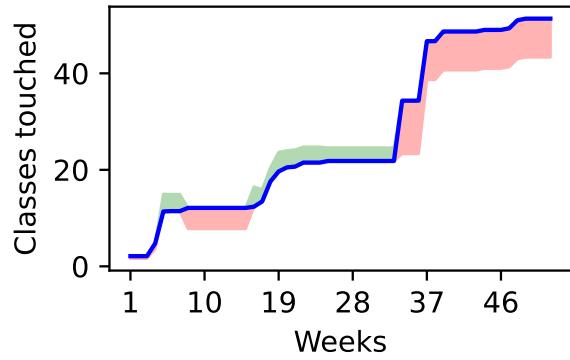


(e) Sustained later joiner developers (84) showing classes touched

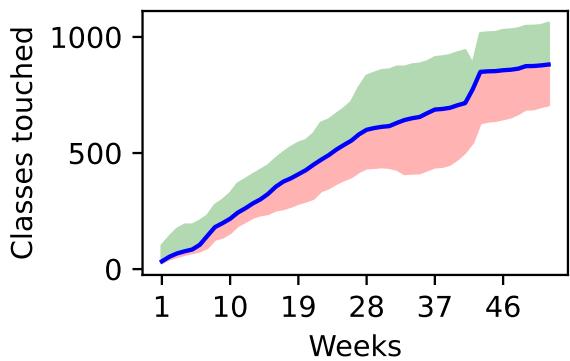
Figure 46: A time series of the number of month (x-axis) against the average (mean) total classes touched (y-axis), with positive (orange) and negative (red) filled standard deviation.



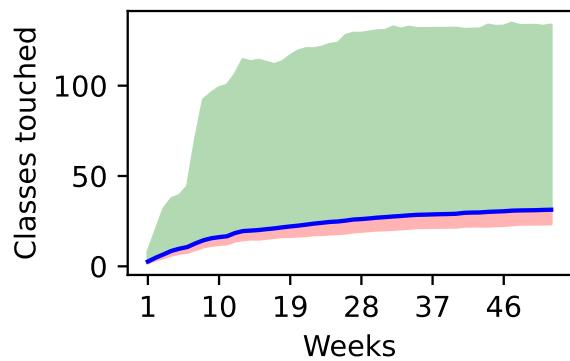
(a) All developers (300) showing classes touched



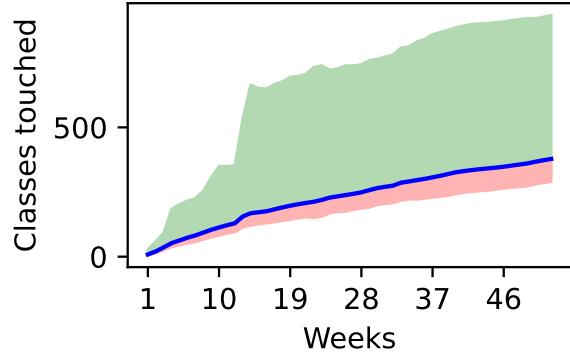
(b) Transient founder developers (3) showing classes touched



(c) Sustained founder developers (7) showing classes touched

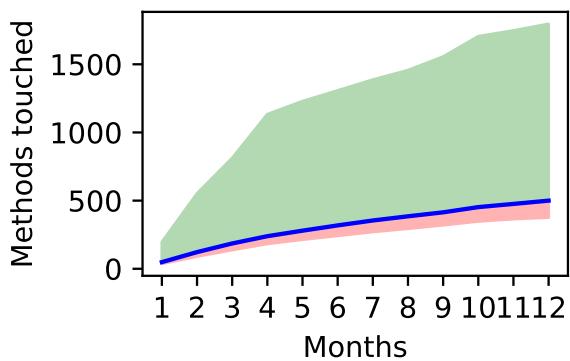


(d) Transient later joiner developers (206) showing classes touched

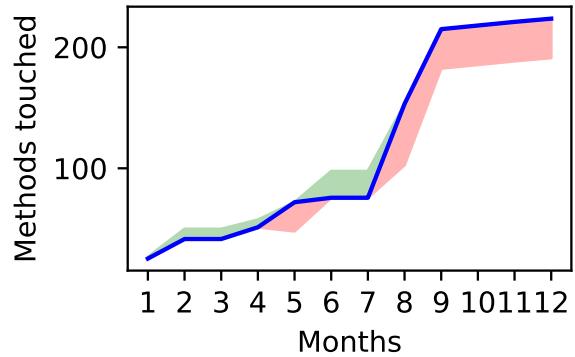


(e) Sustained later joiner developers (84) showing classes touched

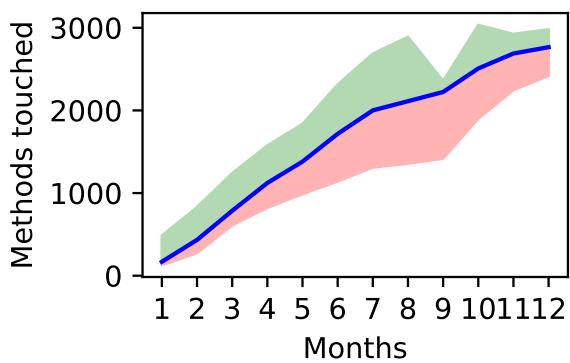
Figure 47: A time series of the number of week (x-axis) against the average (mean) total classes touched (y-axis), with positive (orange) and negative (red) filled standard deviation.



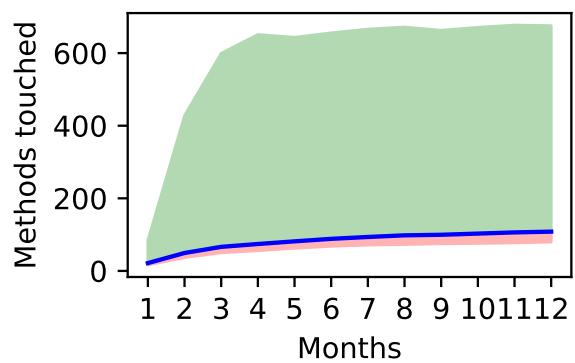
(a) All developers (300) showing methods touched



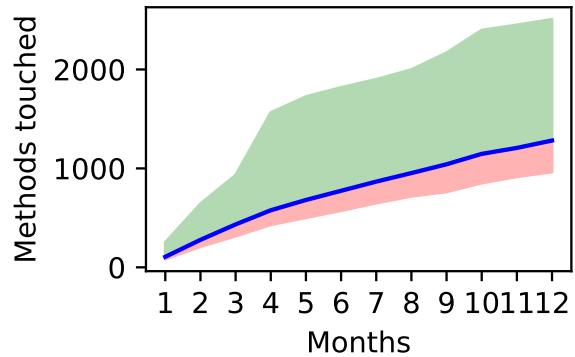
(b) Transient founder developers (3) showing methods touched



(c) Sustained founder developers (7) showing methods touched

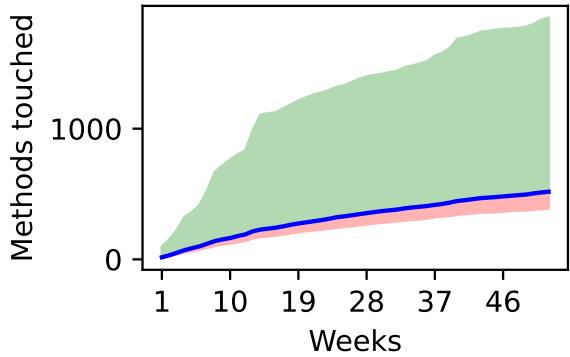


(d) Transient later joiner developers (206) showing methods touched

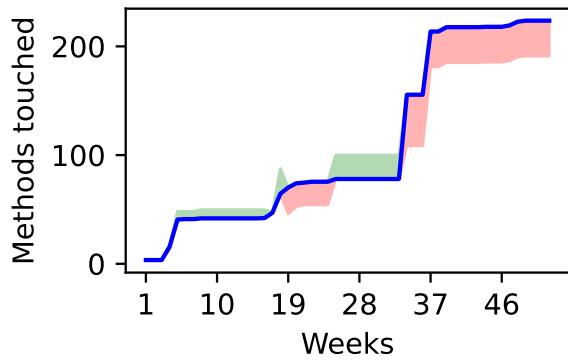


(e) Sustained later joiner developers (84) showing methods touched

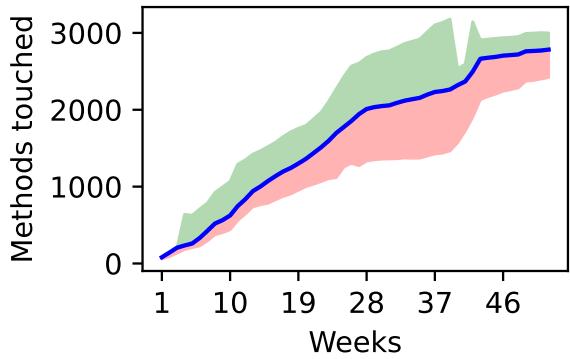
Figure 48: A time series of the number of month (x-axis) against the average (mean) total methods touched (y-axis), with positive (orange) and negative (red) filled standard deviation.



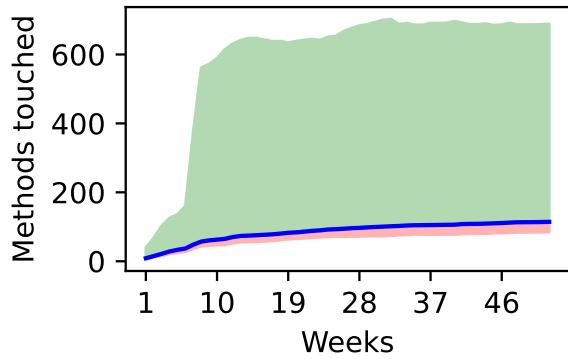
(a) All developers (300) showing methods touched



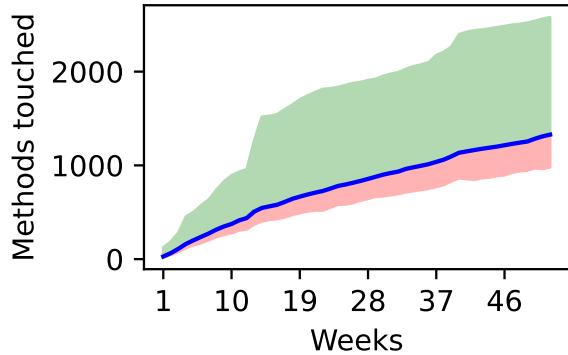
(b) Transient founder developers (3) showing methods touched



(c) Sustained founder developers (7) showing methods touched



(d) Transient later joiner developers (206) showing methods touched



(e) Sustained later joiner developers (84) showing methods touched

Figure 49: A time series of the number of week (x-axis) against the average (mean) total methods touched (y-axis), with positive (orange) and negative (red) filled standard deviation.

## 5.5 Scatter developer - 21 For developer commits and components touched.

A scatter plot for the first 20 sustained late joiner developers showing the number of commits to components touched.

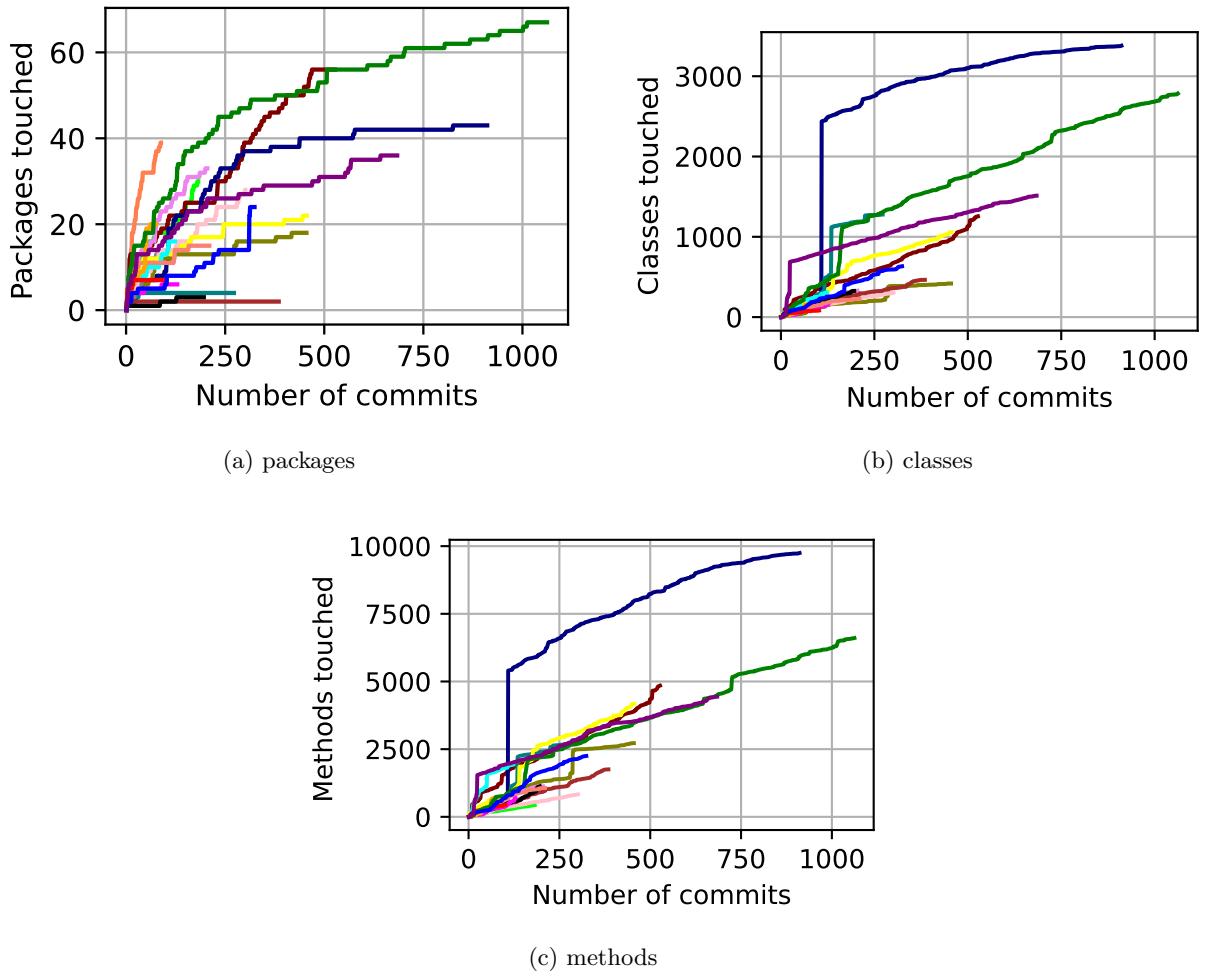


Figure 50: First twenty sustained later joiner developers from this repository. The number of commits against the number of components touched.

- Developer: 199 in colour Coral. Developer: 6252 in colour Lime.
- Developer: 6253 in colour Maroon. Developer: 6259 in colour Navy.
- Developer: 6260 in colour Teal. Developer: 6262 in colour Olive.
- Developer: 6263 in colour Violet. Developer: 6264 in colour Gray.
- Developer: 6267 in colour Pink. Developer: 6271 in colour Brown.
- Developer: 6272 in colour Black. Developer: 6276 in colour Yellow.
- Developer: 6278 in colour Magenta. Developer: 6280 in colour Cyan.
- Developer: 6282 in colour Salmon. Developer: 6284 in colour Orange.
- Developer: 6288 in colour Red. Developer: 6295 in colour Green.
- Developer: 6297 in colour Blue. Developer: 6298 in colour Purple.

## **5.6 Scatter developer - 21 For developer day and components touched.**

A scatter plot for the first 20 sustained late joiner developers showing the number of day to components touched.

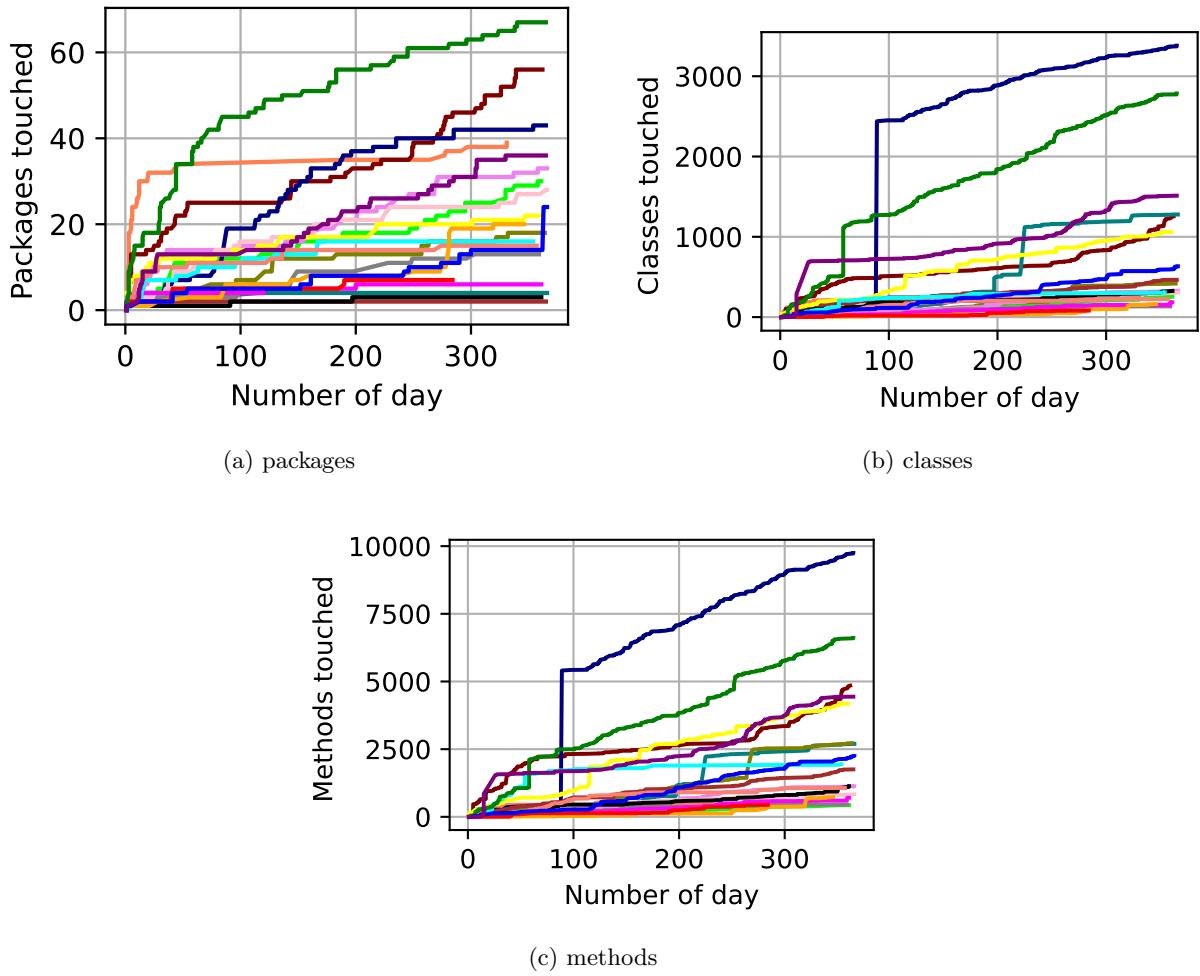
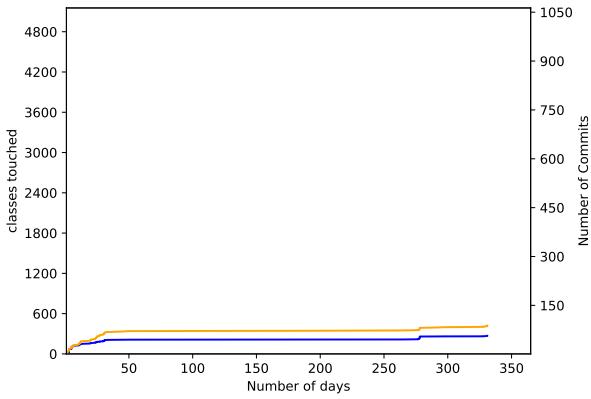


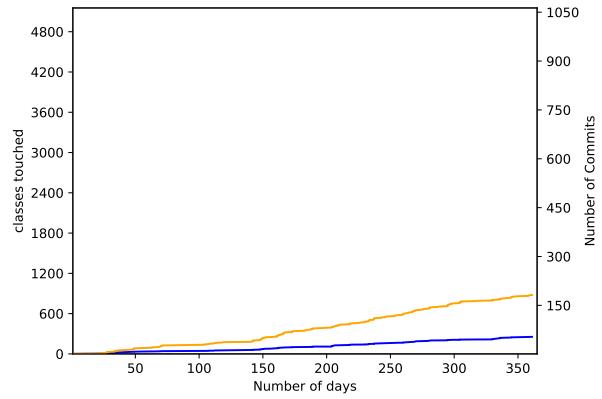
Figure 51: First twenty sustained later joiner developers from this repository. The number of day against the number of components touched.

- Developer: 199 in colour Coral. Developer: 6252 in colour Lime.
- Developer: 6253 in colour Maroon. Developer: 6259 in colour Navy.
- Developer: 6260 in colour Teal. Developer: 6262 in colour Olive.
- Developer: 6263 in colour Violet. Developer: 6264 in colour Gray.
- Developer: 6267 in colour Pink. Developer: 6271 in colour Brown.
- Developer: 6272 in colour Black. Developer: 6276 in colour Yellow.
- Developer: 6278 in colour Magenta. Developer: 6280 in colour Cyan.
- Developer: 6282 in colour Salmon. Developer: 6284 in colour Orange.
- Developer: 6288 in colour Red. Developer: 6295 in colour Green.
- Developer: 6297 in colour Blue. Developer: 6298 in colour Purple.

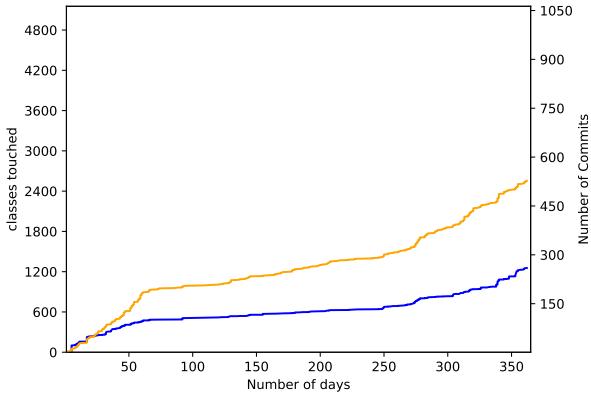
## 5.7 Developer touched - Repository 21: Developer classes knowledge



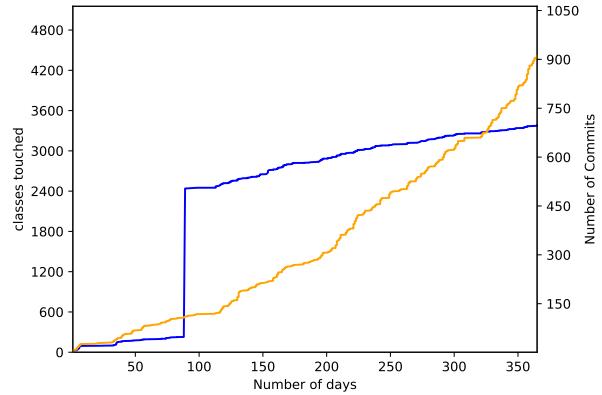
(a) Repository: 21 Developer 199: Developer touched 270 classes after 88 commits.



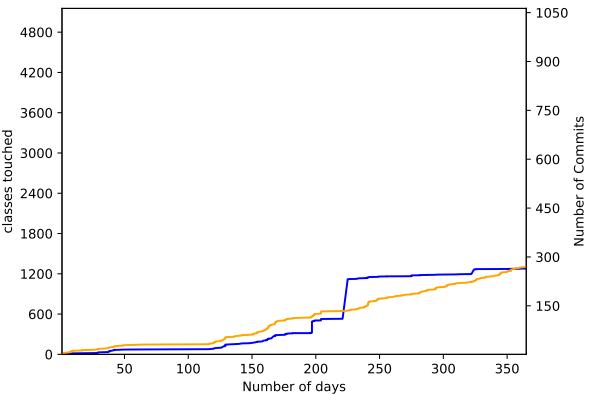
(b) Repository: 21 Developer 6252: Developer touched 254 classes after 182 commits.



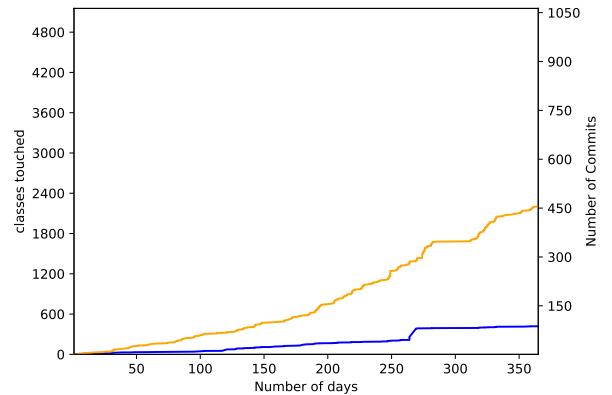
(c) Repository: 21 Developer 6253: Developer touched 1255 classes after 527 commits.



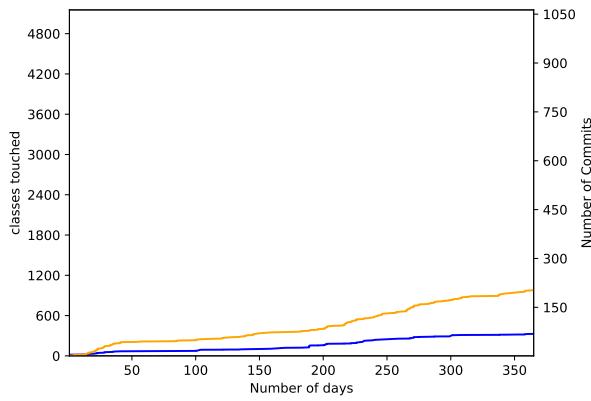
(d) Repository: 21 Developer 6259: Developer touched 3380 classes after 911 commits.



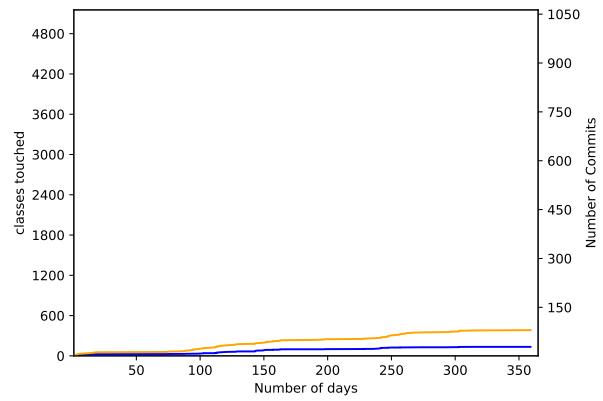
(e) Repository: 21 Developer 6260: Developer touched 1278 classes after 272 commits.



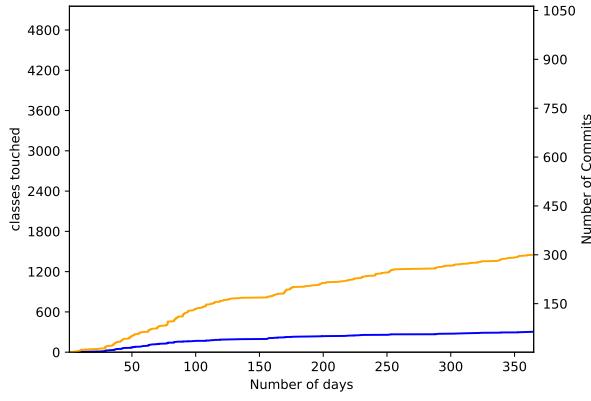
(f) Repository: 21 Developer 6262: Developer touched 418 classes after 455 commits.



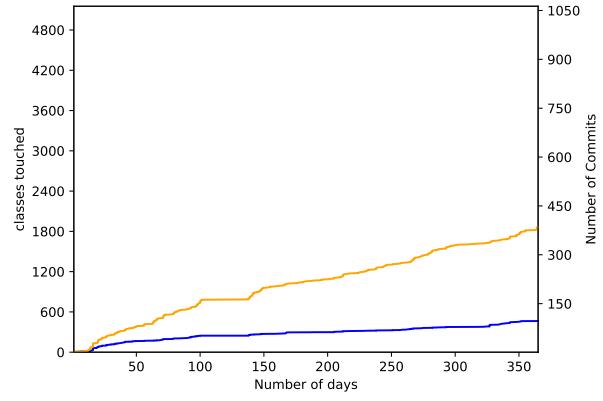
(a) Repository: 21 Developer 6263: Developer touched 328 classes after 205 commits.



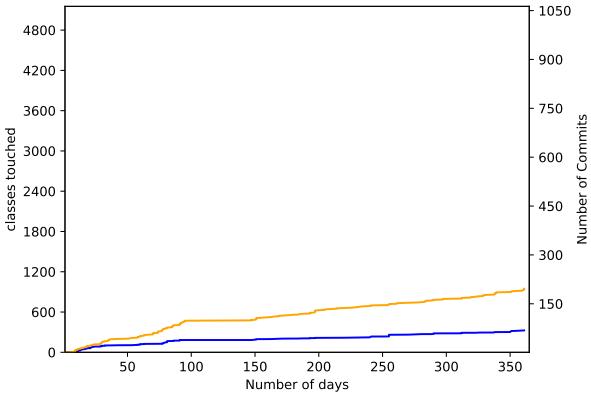
(b) Repository: 21 Developer 6264: Developer touched 134 classes after 80 commits.



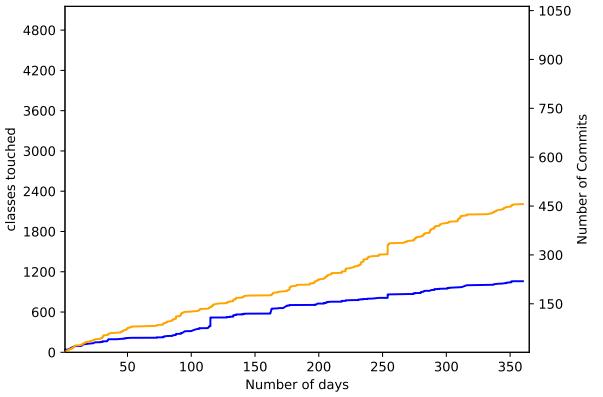
(c) Repository: 21 Developer 6267: Developer touched 305 classes after 301 commits.



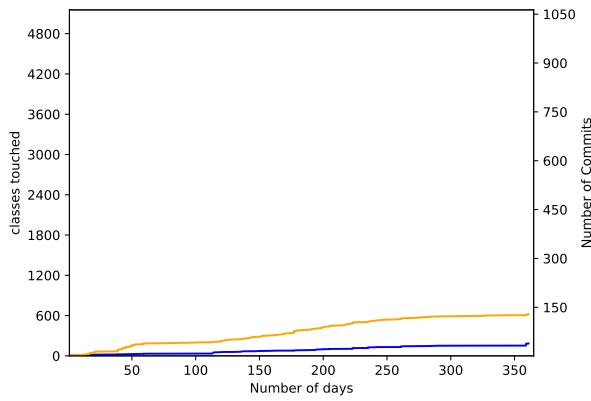
(d) Repository: 21 Developer 6271: Developer touched 464 classes after 385 commits.



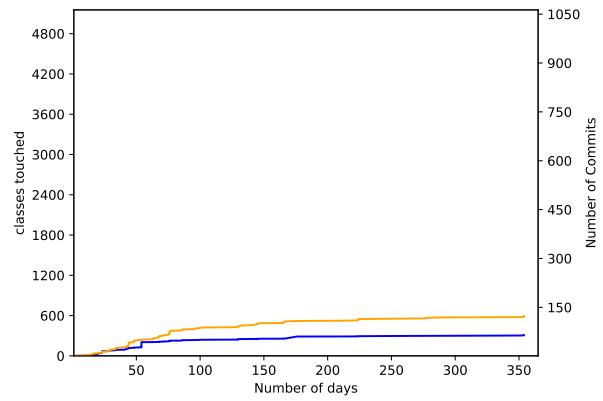
(e) Repository: 21 Developer 6272: Developer touched 326 classes after 196 commits.



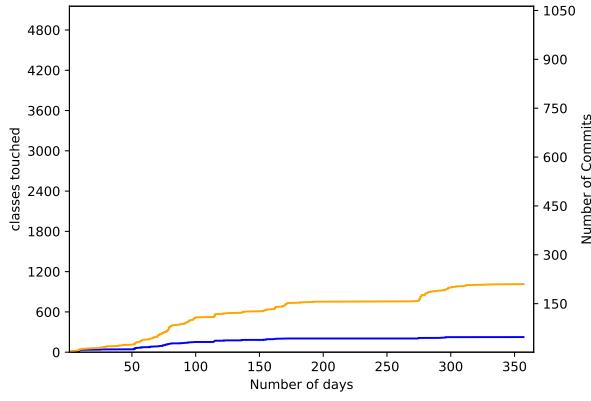
(f) Repository: 21 Developer 6276: Developer touched 1059 classes after 456 commits.



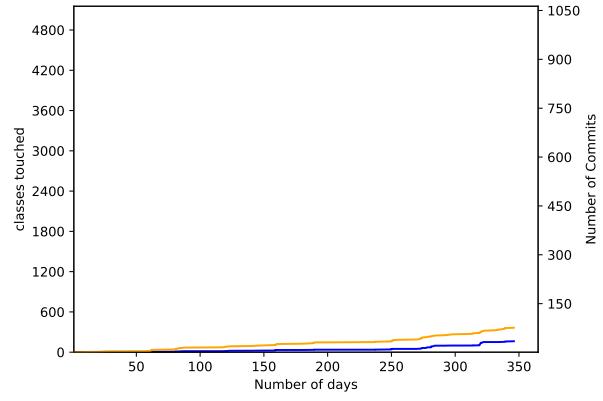
(a) Repository: 21 Developer 6278: Developer touched 183 classes after 129 commits.



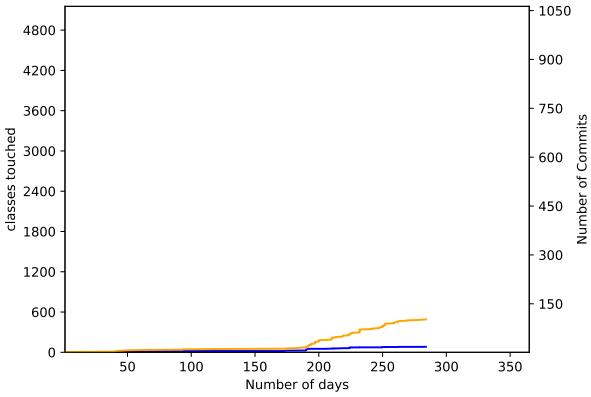
(b) Repository: 21 Developer 6280: Developer touched 307 classes after 123 commits.



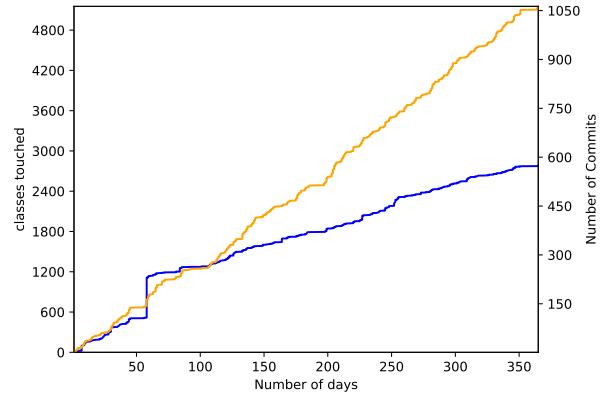
(c) Repository: 21 Developer 6282: Developer touched 225 classes after 210 commits.



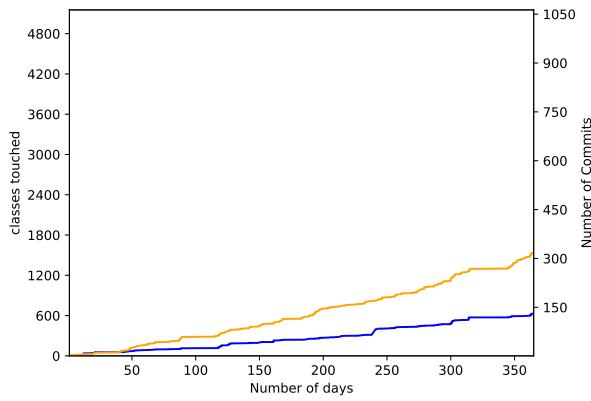
(d) Repository: 21 Developer 6284: Developer touched 163 classes after 76 commits.



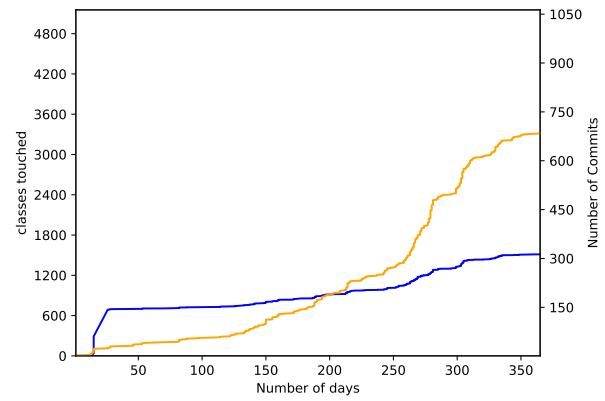
(e) Repository: 21 Developer 6288: Developer touched 82 classes after 102 commits.



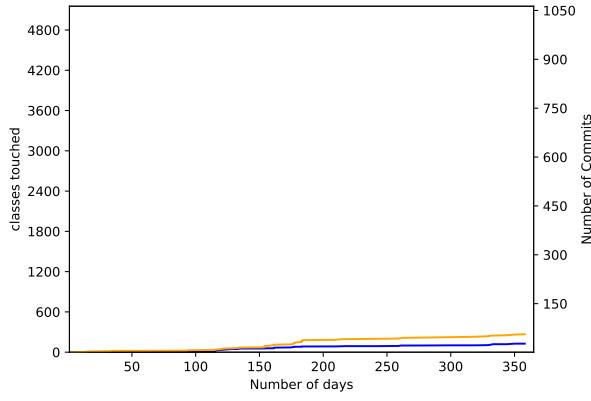
(f) Repository: 21 Developer 6295: Developer touched 2784 classes after 1062 commits.



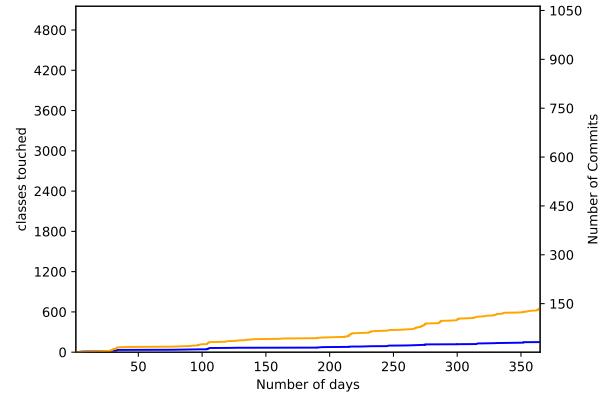
(a) Repository: 21 Developer 6297: Developer touched 633 classes after 324 commits.



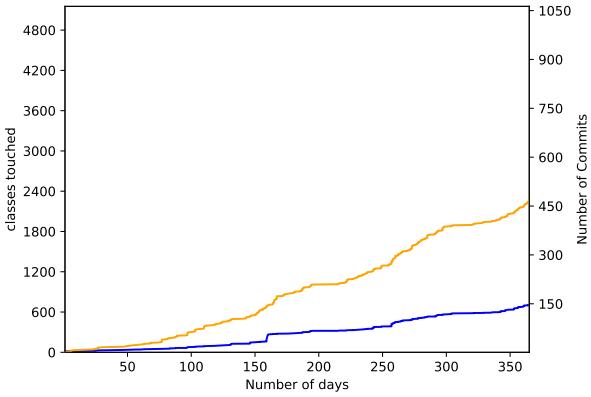
(b) Repository: 21 Developer 6298: Developer touched 1512 classes after 684 commits.



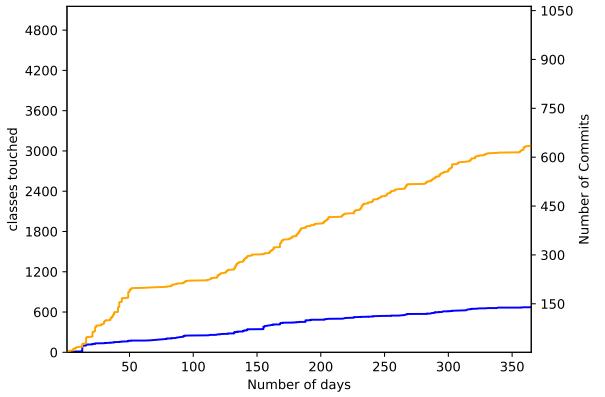
(c) Repository: 21 Developer 6302: Developer touched 127 classes after 56 commits.



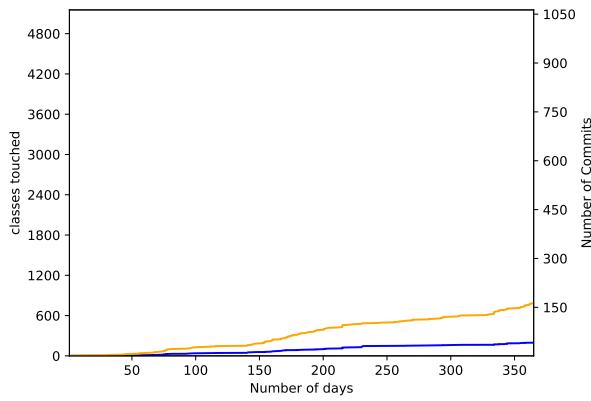
(d) Repository: 21 Developer 6306: Developer touched 150 classes after 134 commits.



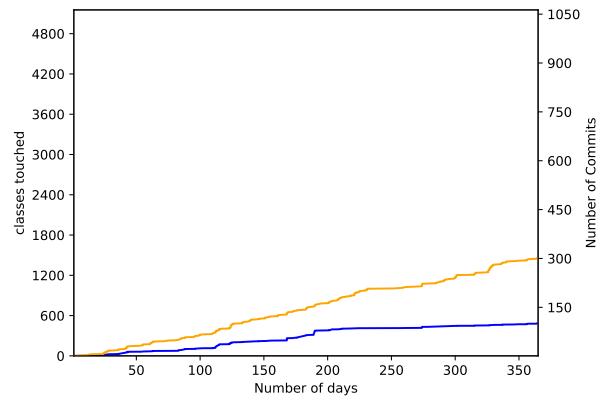
(e) Repository: 21 Developer 6309: Developer touched 702 classes after 463 commits.



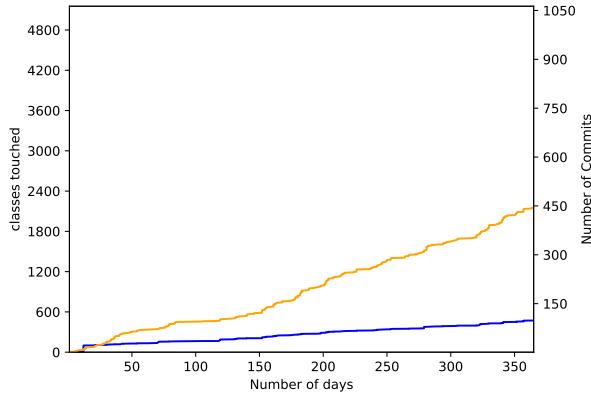
(f) Repository: 21 Developer 6312: Developer touched 671 classes after 635 commits.



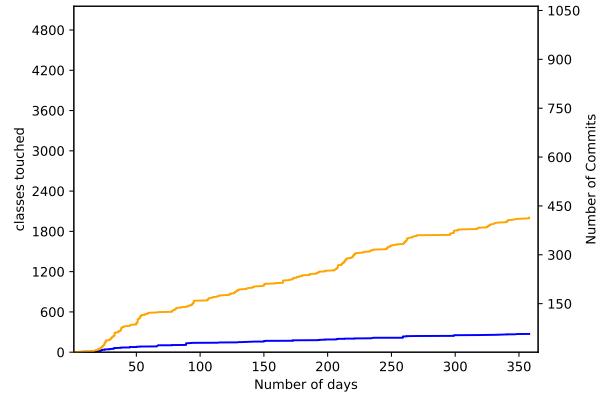
(a) Repository: 21 Developer 6313: Developer touched 196 classes after 163 commits.



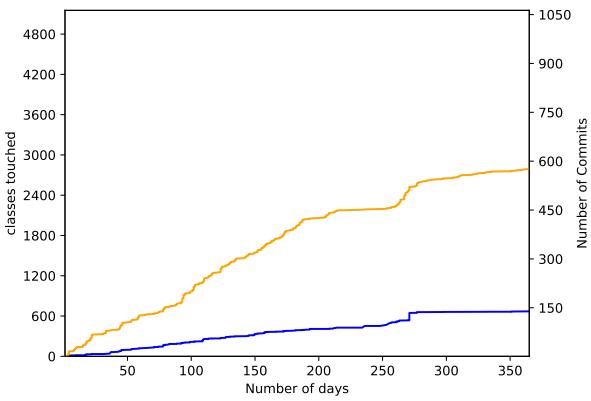
(b) Repository: 21 Developer 6314: Developer touched 480 classes after 300 commits.



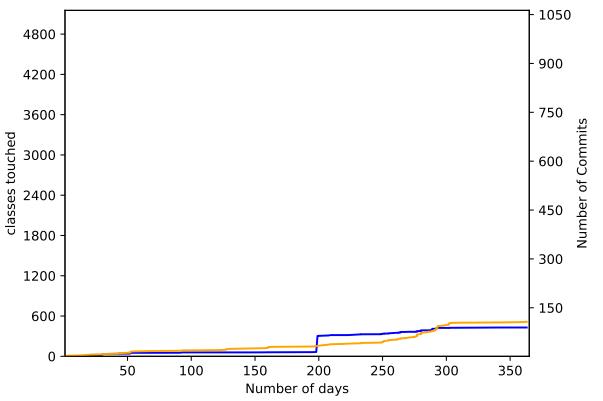
(c) Repository: 21 Developer 6315: Developer touched 472 classes after 446 commits.



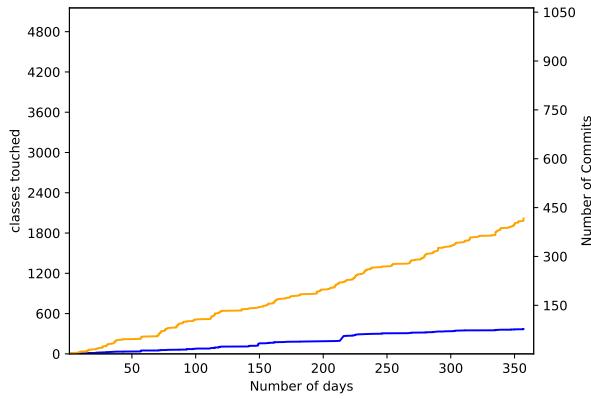
(d) Repository: 21 Developer 6326: Developer touched 272 classes after 414 commits.



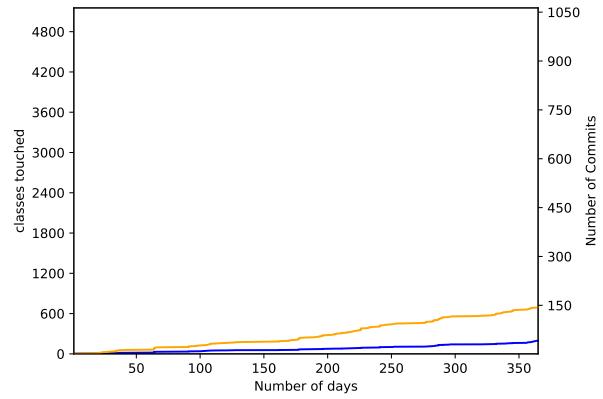
(e) Repository: 21 Developer 6329: Developer touched 670 classes after 576 commits.



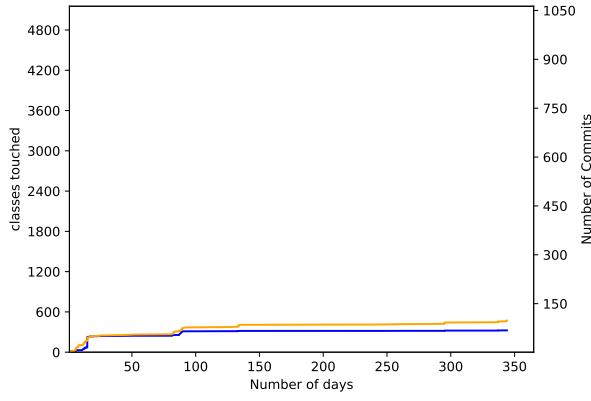
(f) Repository: 21 Developer 6333: Developer touched 429 classes after 107 commits.



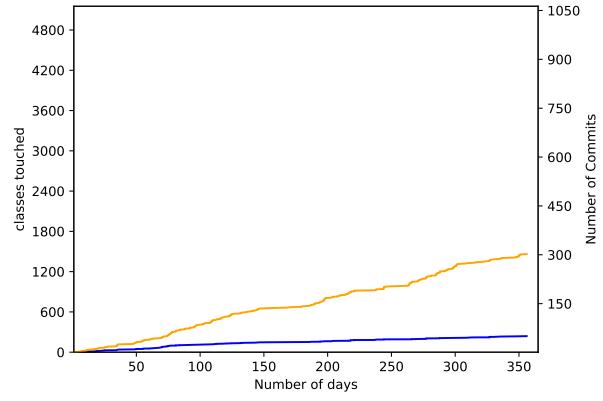
(a) Repository: 21 Developer 6338: Developer touched 368 classes after 417 commits.



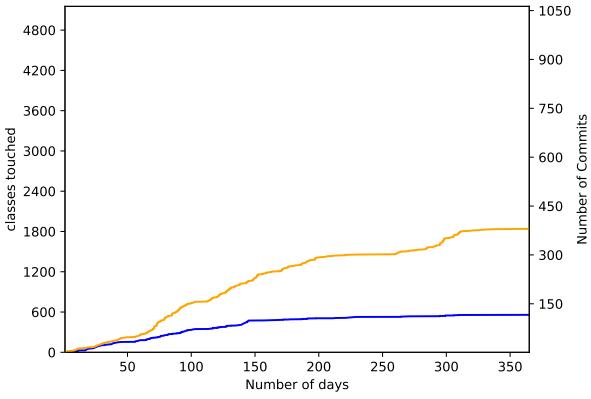
(b) Repository: 21 Developer 6342: Developer touched 195 classes after 144 commits.



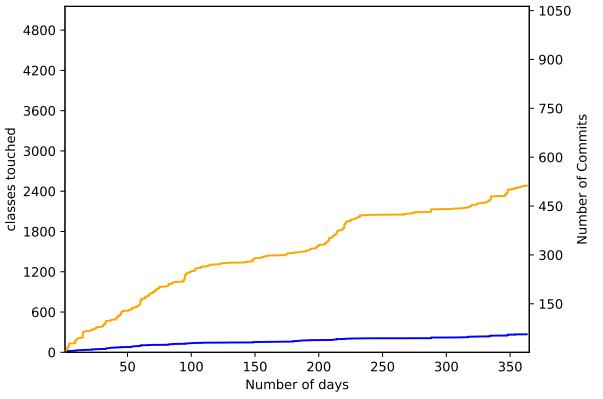
(c) Repository: 21 Developer 6343: Developer touched 325 classes after 98 commits.



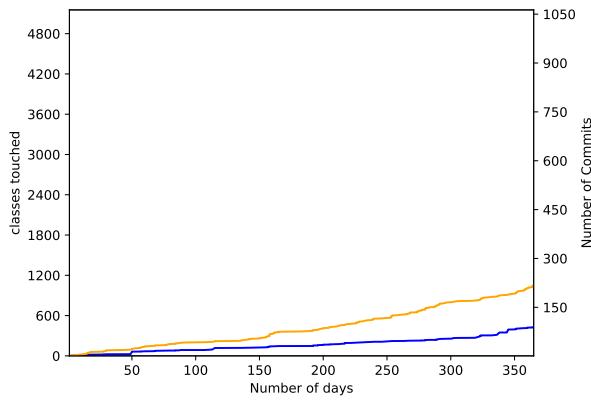
(d) Repository: 21 Developer 6349: Developer touched 239 classes after 302 commits.



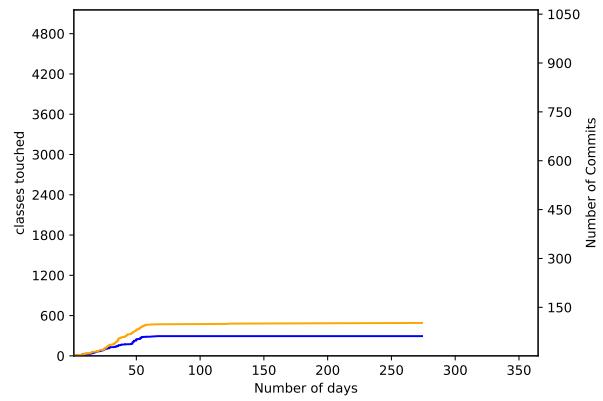
(e) Repository: 21 Developer 6352: Developer touched 558 classes after 382 commits.



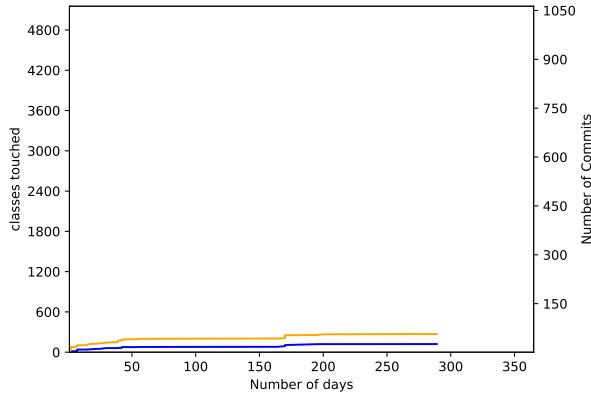
(f) Repository: 21 Developer 6355: Developer touched 268 classes after 513 commits.



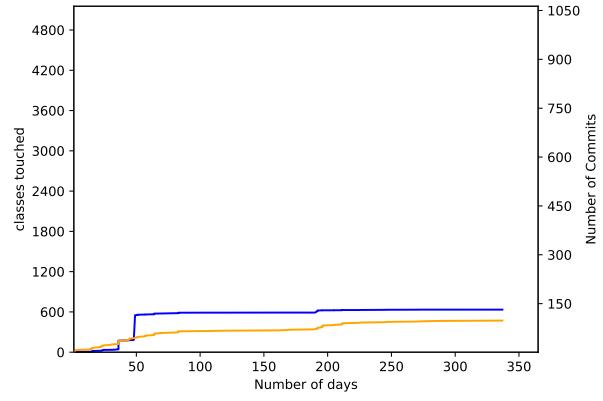
(a) Repository: 21 Developer 6363: Developer touched 428 classes after 226 commits.



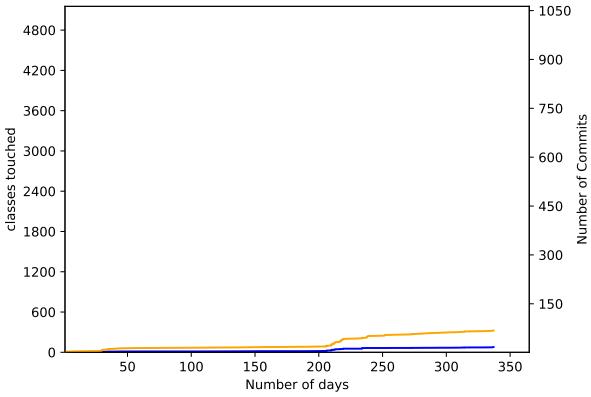
(b) Repository: 21 Developer 6368: Developer touched 294 classes after 102 commits.



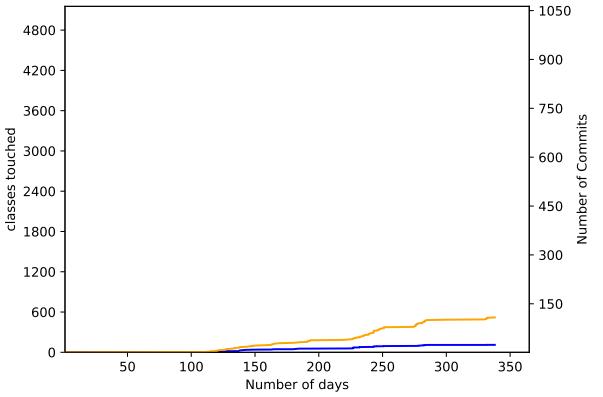
(c) Repository: 21 Developer 6369: Developer touched 121 classes after 57 commits.



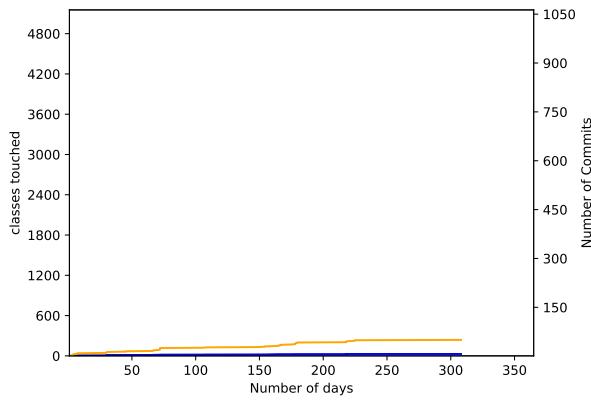
(d) Repository: 21 Developer 6370: Developer touched 634 classes after 98 commits.



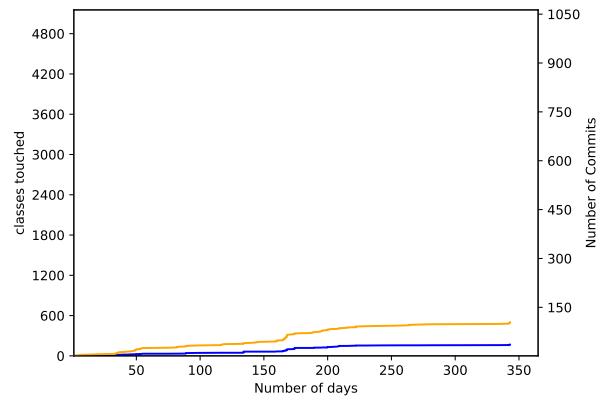
(e) Repository: 21 Developer 6373: Developer touched 79 classes after 68 commits.



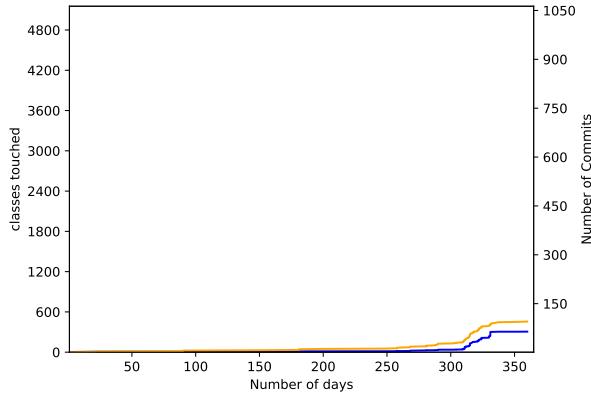
(f) Repository: 21 Developer 6374: Developer touched 111 classes after 108 commits.



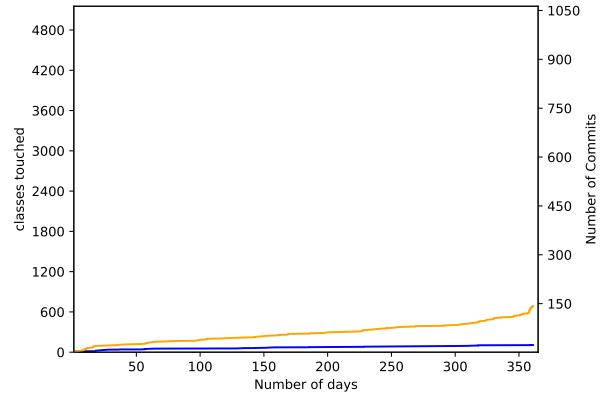
(a) Repository: 21 Developer 6375: Developer touched 28 classes after 50 commits.



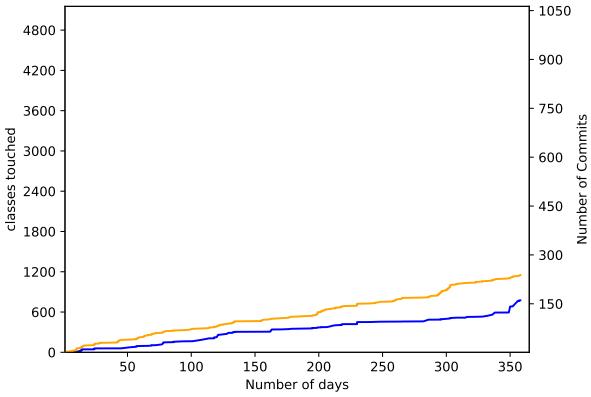
(b) Repository: 21 Developer 6379: Developer touched 167 classes after 104 commits.



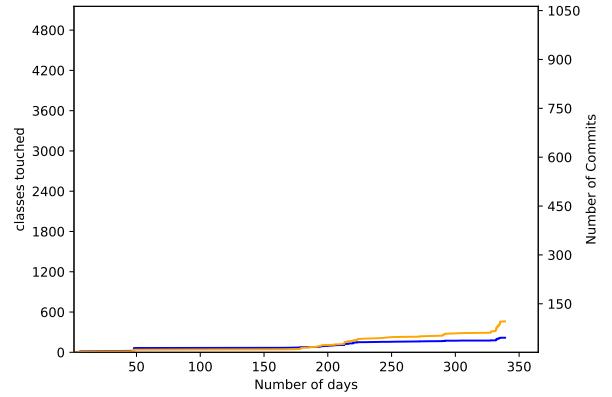
(c) Repository: 21 Developer 6391: Developer touched 306 classes after 95 commits.



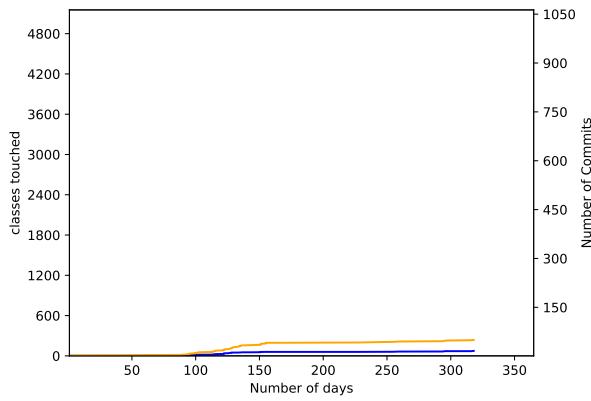
(d) Repository: 21 Developer 6410: Developer touched 107 classes after 142 commits.



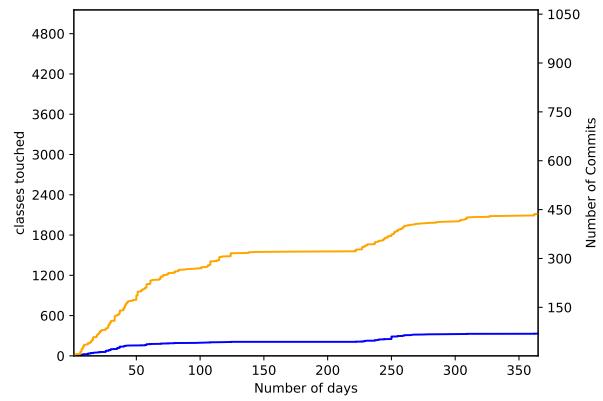
(e) Repository: 21 Developer 6411: Developer touched 774 classes after 238 commits.



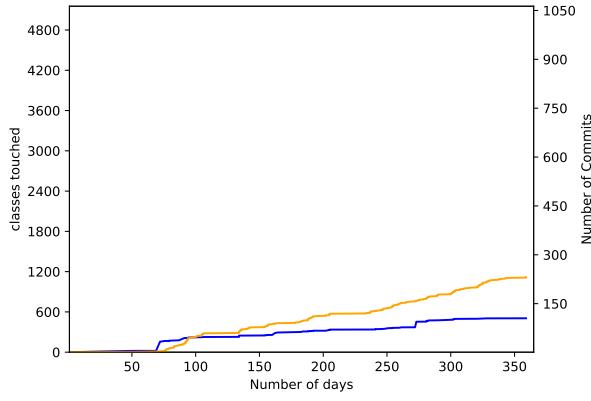
(f) Repository: 21 Developer 6417: Developer touched 217 classes after 96 commits.



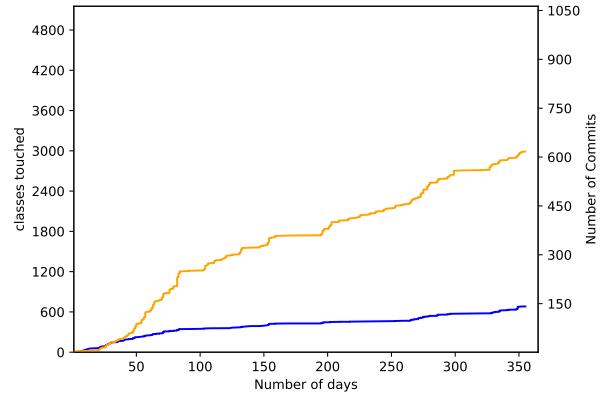
(a) Repository: 21 Developer 6418: Developer touched 74 classes after 50 commits.



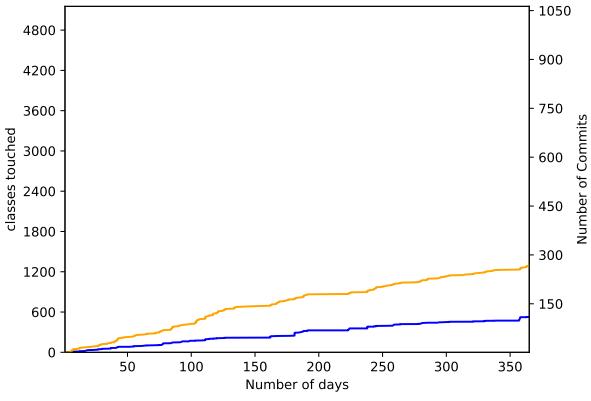
(b) Repository: 21 Developer 6420: Developer touched 331 classes after 437 commits.



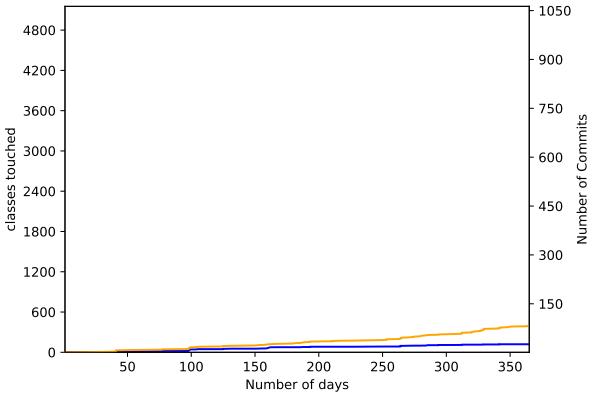
(c) Repository: 21 Developer 6424: Developer touched 505 classes after 231 commits.



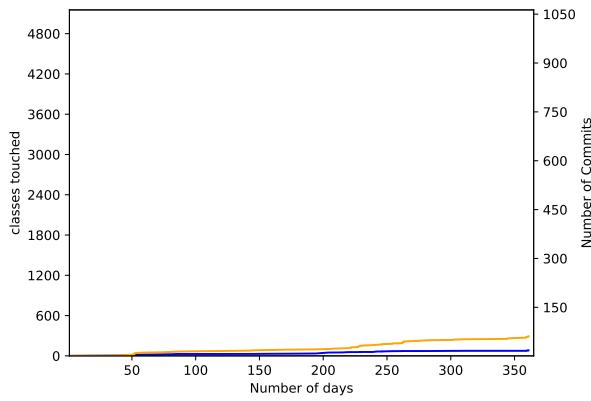
(d) Repository: 21 Developer 6426: Developer touched 681 classes after 617 commits.



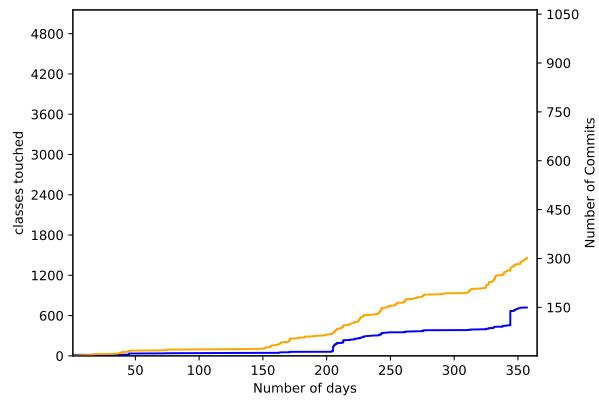
(e) Repository: 21 Developer 6427: Developer touched 527 classes after 267 commits.



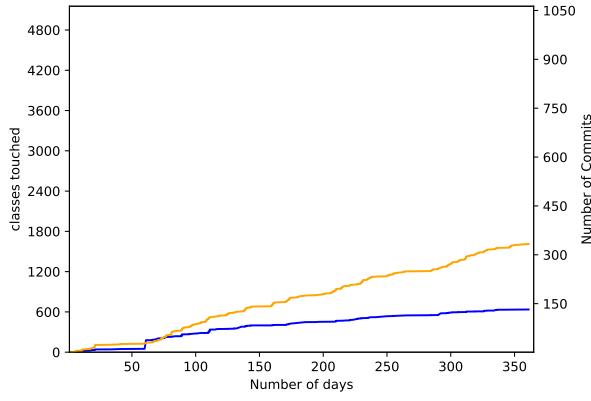
(f) Repository: 21 Developer 6429: Developer touched 120 classes after 82 commits.



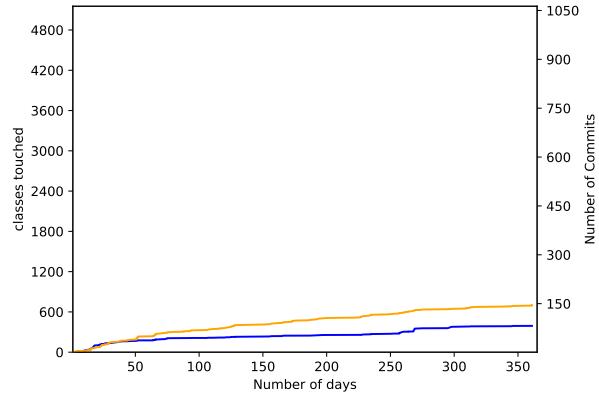
(a) Repository: 21 Developer 6431: Developer touched 81 classes after 61 commits.



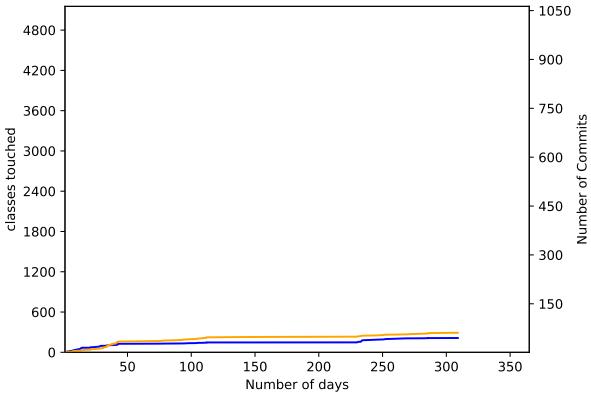
(b) Repository: 21 Developer 6450: Developer touched 720 classes after 302 commits.



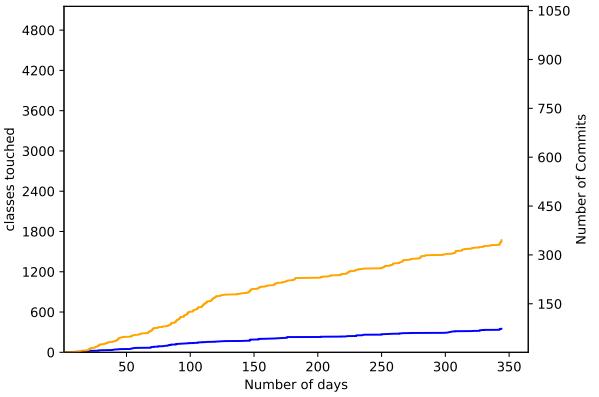
(c) Repository: 21 Developer 6454: Developer touched 636 classes after 333 commits.



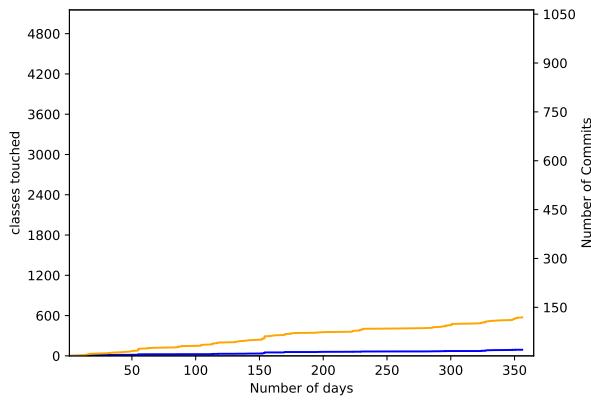
(d) Repository: 21 Developer 6460: Developer touched 392 classes after 145 commits.



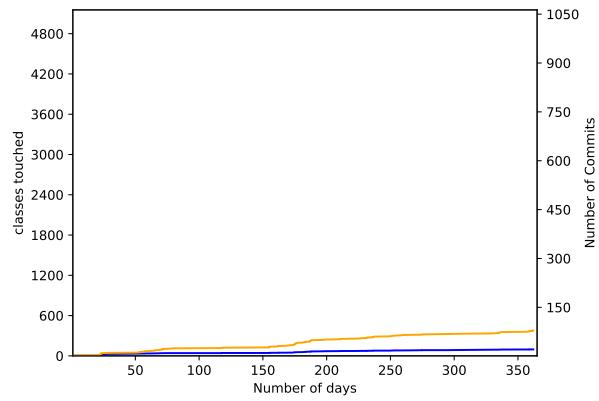
(e) Repository: 21 Developer 6483: Developer touched 213 classes after 61 commits.



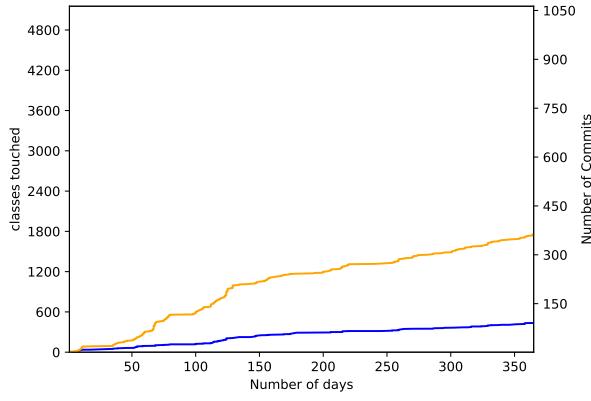
(f) Repository: 21 Developer 6489: Developer touched 350 classes after 345 commits.



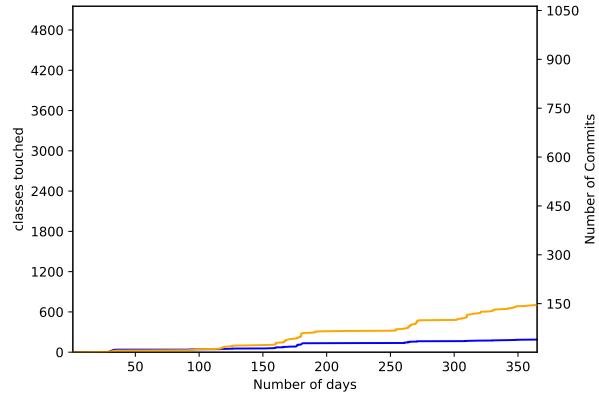
(a) Repository: 21 Developer 6491: Developer touched 91 classes after 119 commits.



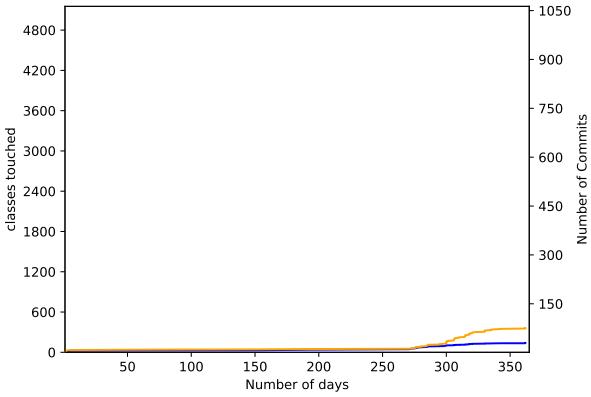
(b) Repository: 21 Developer 6502: Developer touched 96 classes after 79 commits.



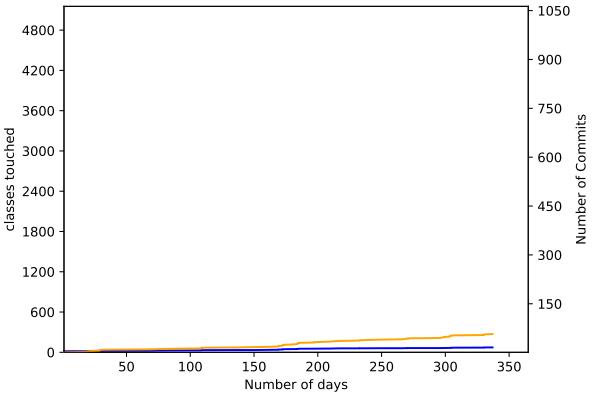
(c) Repository: 21 Developer 6503: Developer touched 435 classes after 363 commits.



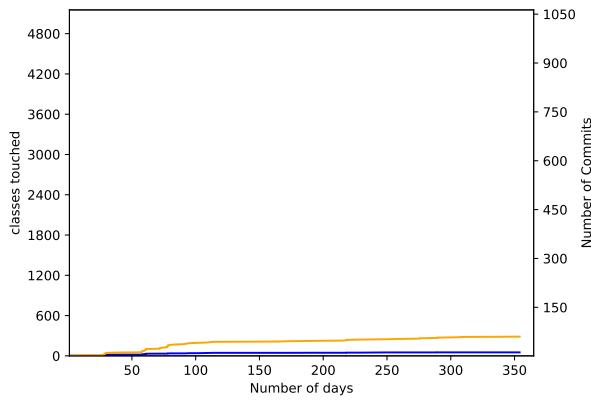
(d) Repository: 21 Developer 6507: Developer touched 188 classes after 146 commits.



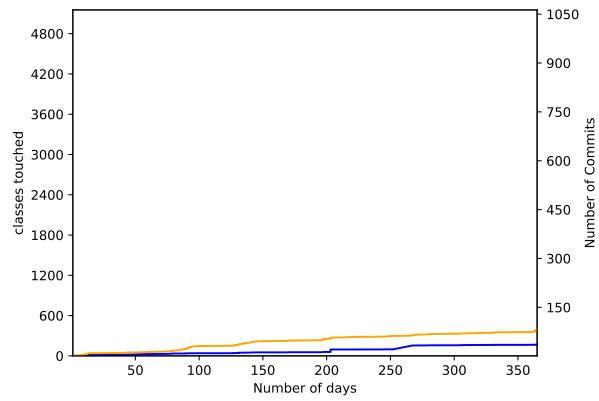
(e) Repository: 21 Developer 6509: Developer touched 140 classes after 75 commits.



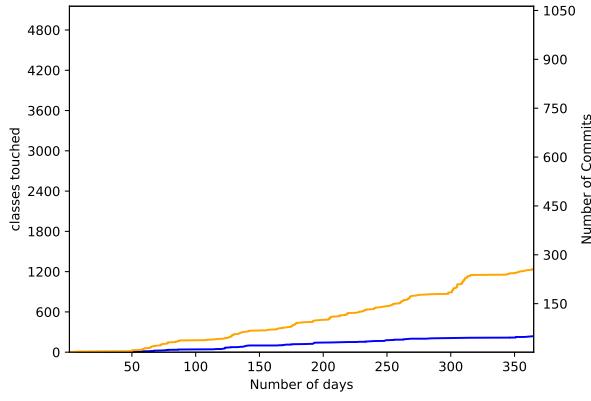
(f) Repository: 21 Developer 6529: Developer touched 73 classes after 57 commits.



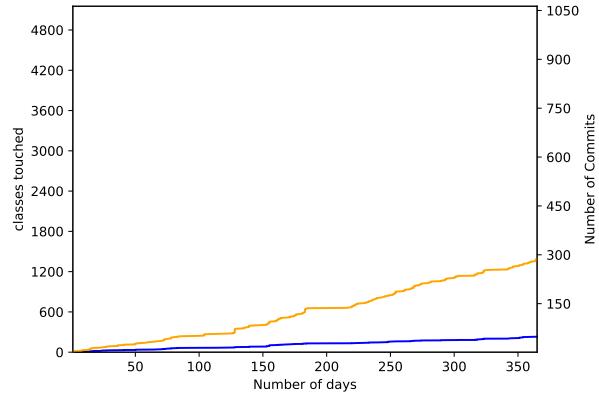
(a) Repository: 21 Developer 6541: Developer touched 52 classes after 60 commits.



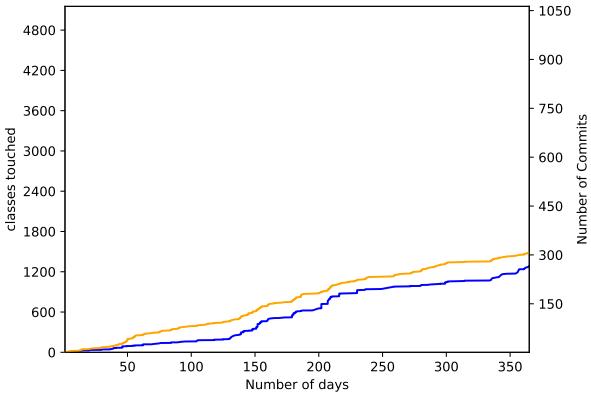
(b) Repository: 21 Developer 6552: Developer touched 168 classes after 83 commits.



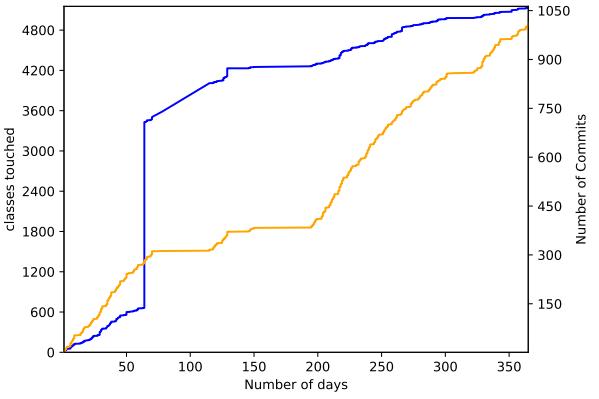
(c) Repository: 21 Developer 6555: Developer touched 237 classes after 256 commits.



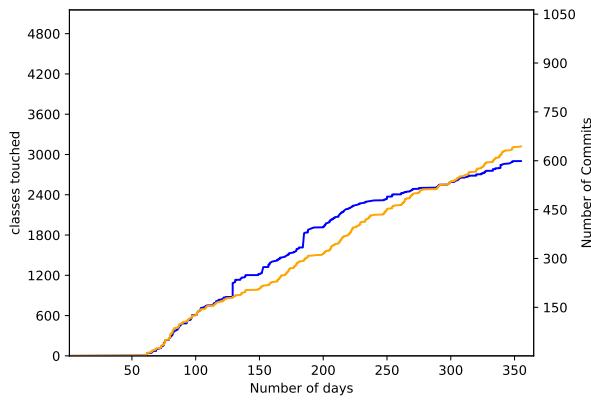
(d) Repository: 21 Developer 6576: Developer touched 231 classes after 287 commits.



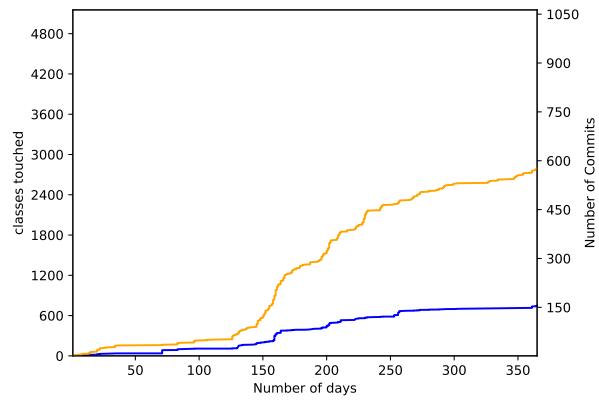
(e) Repository: 21 Developer 6579: Developer touched 1287 classes after 307 commits.



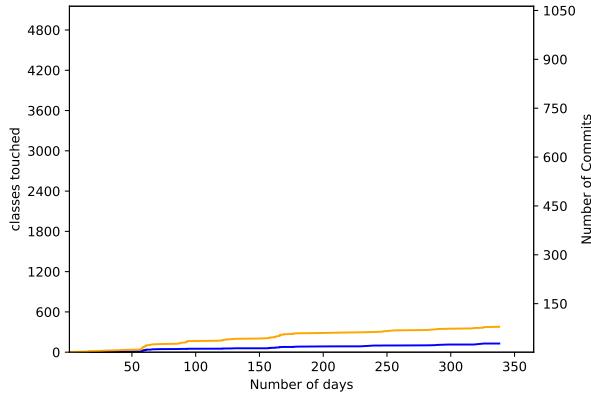
(f) Repository: 21 Developer 6587: Developer touched 5153 classes after 1013 commits.



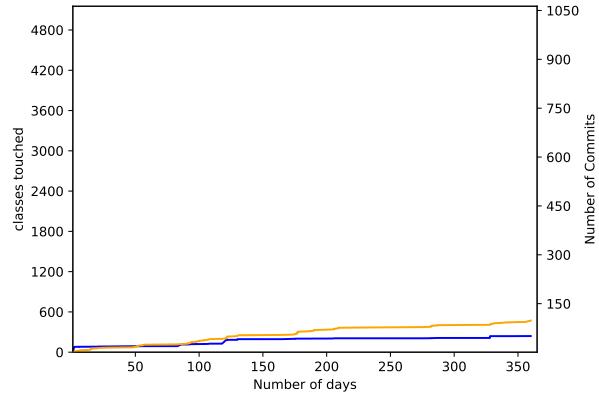
(a) Repository: 21 Developer 6609: Developer touched 2902 classes after 644 commits.



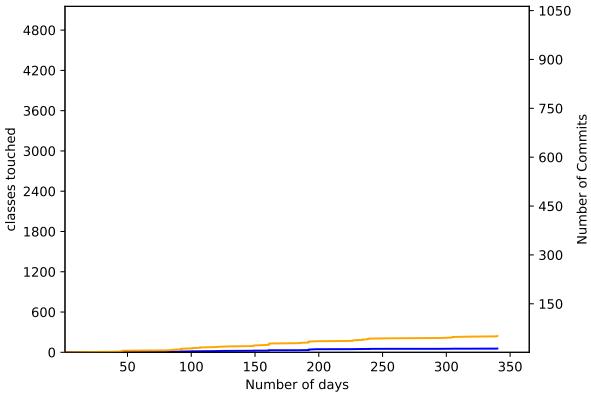
(b) Repository: 21 Developer 6619: Developer touched 749 classes after 576 commits.



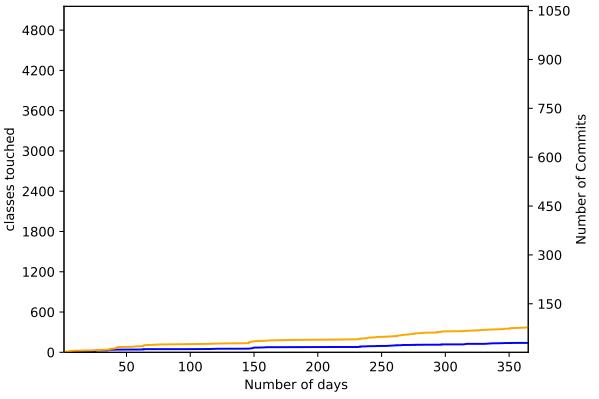
(c) Repository: 21 Developer 6624: Developer touched 129 classes after 79 commits.



(d) Repository: 21 Developer 6631: Developer touched 240 classes after 98 commits.



(e) Repository: 21 Developer 6641: Developer touched 56 classes after 51 commits.



(f) Repository: 21 Developer 6651: Developer touched 140 classes after 78 commits.

## 5.8 Repository histogram commit - 21 For classes with total

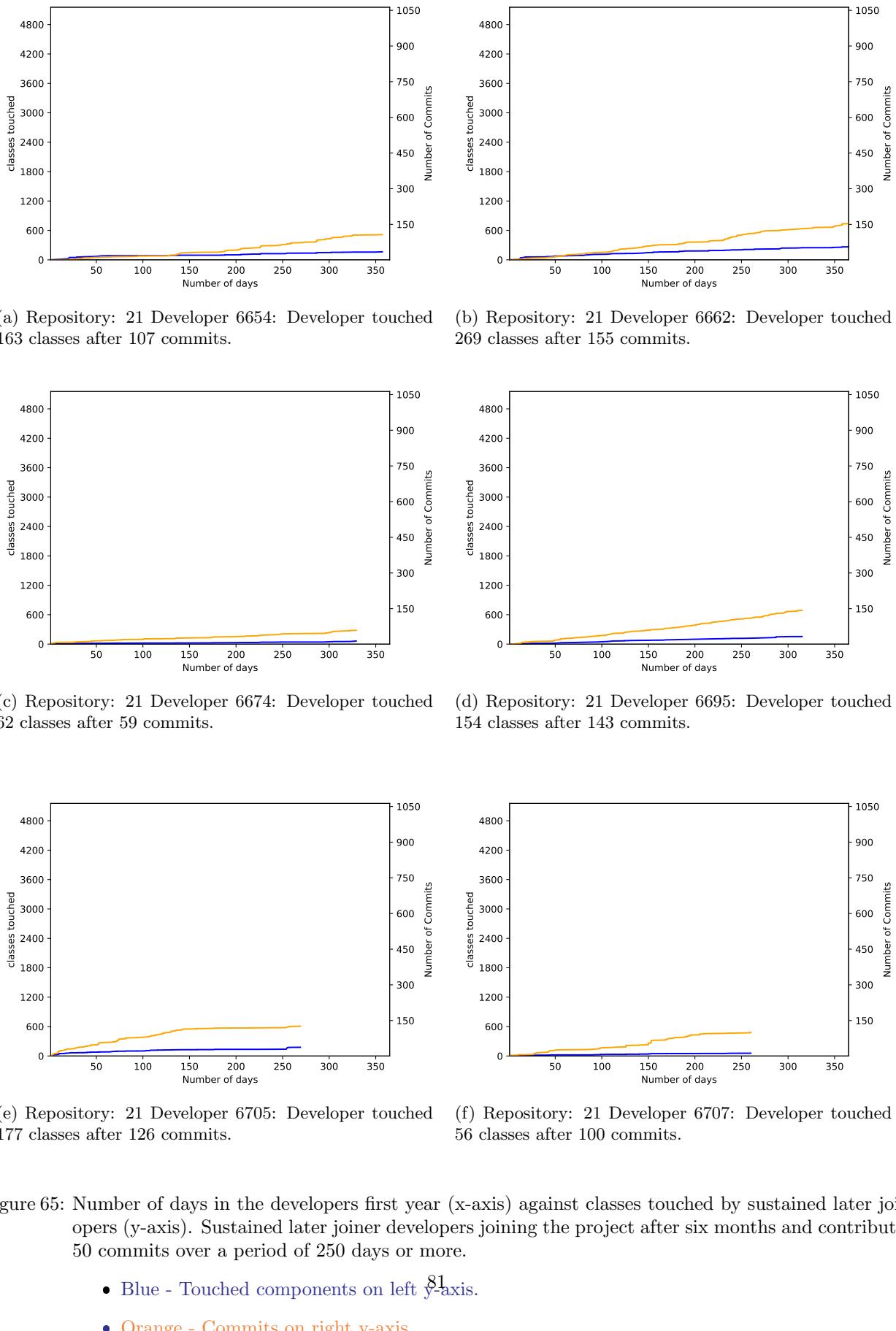


Figure 65: Number of days in the developers first year (x-axis) against classes touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

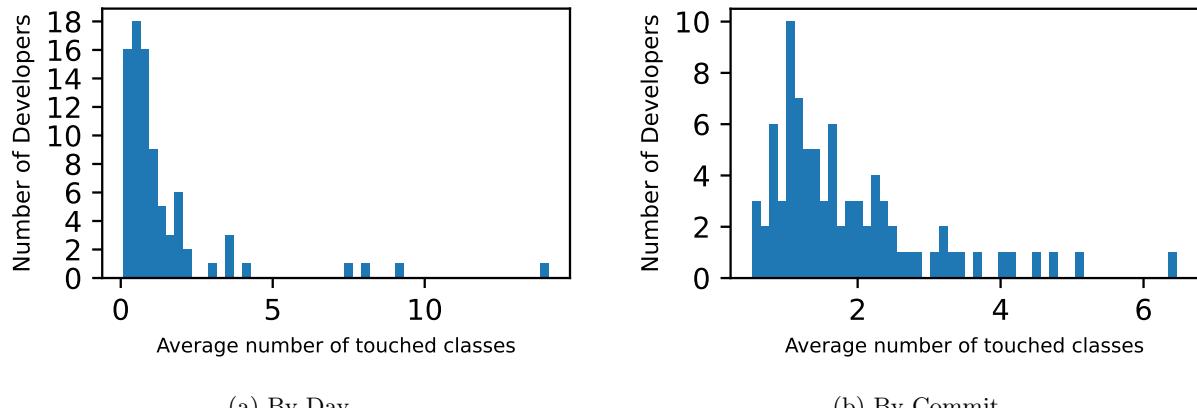
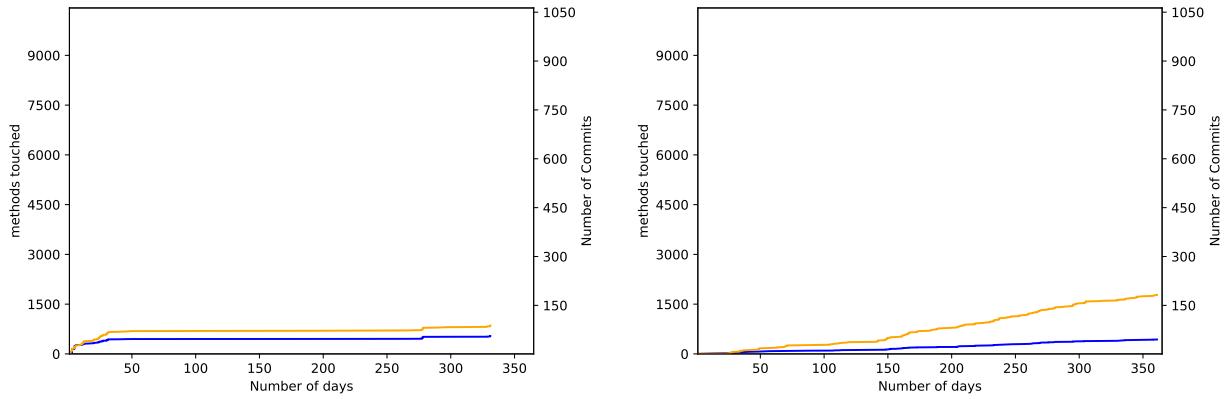


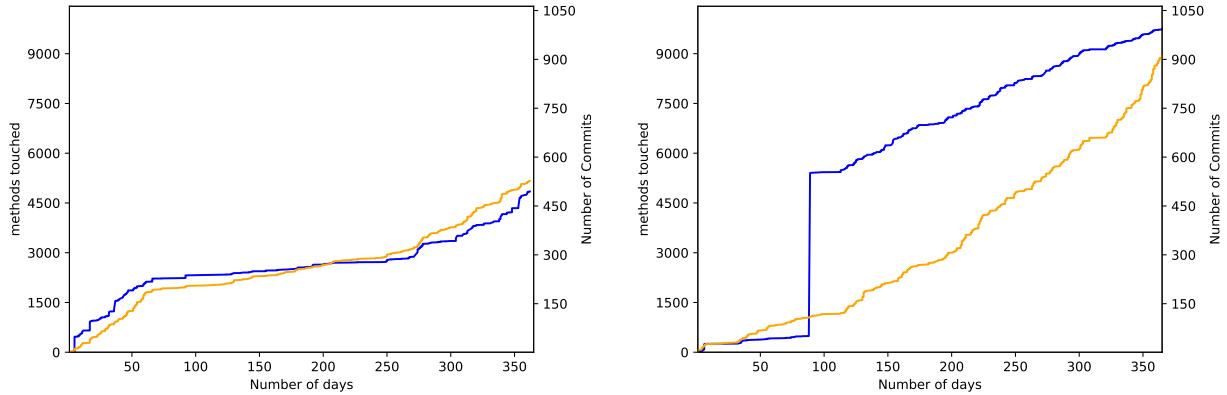
Figure 66: Histogram of new classes touched (x-axis) against number of developers (y-axis). Graphs for 84 sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

## 5.9 Developer touched - Repository 21: Developer methods knowledge



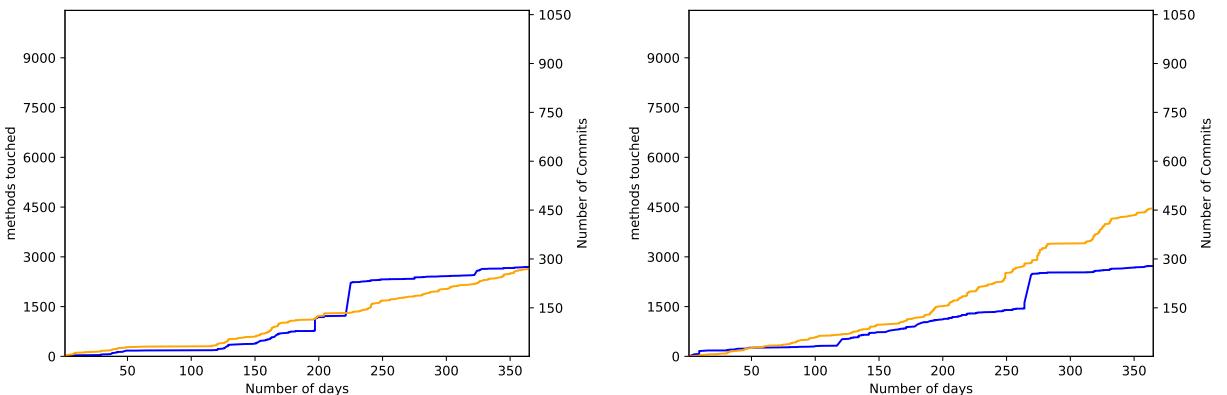
(a) Repository: 21 Developer 199: Developer touched 540 methods after 88 commits.

(b) Repository: 21 Developer 6252: Developer touched 434 methods after 182 commits.



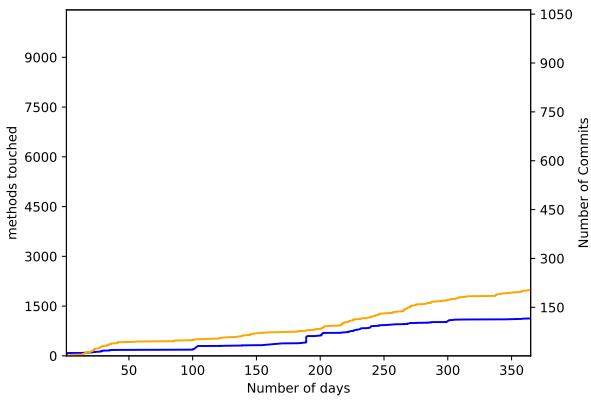
(c) Repository: 21 Developer 6253: Developer touched 4847 methods after 527 commits.

(d) Repository: 21 Developer 6259: Developer touched 9747 methods after 911 commits.

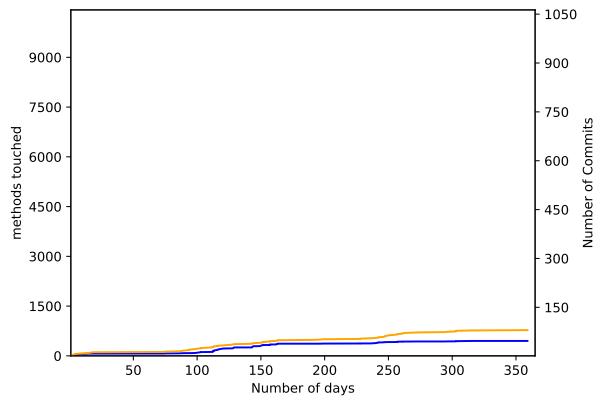


(e) Repository: 21 Developer 6260: Developer touched 2694 methods after 272 commits.

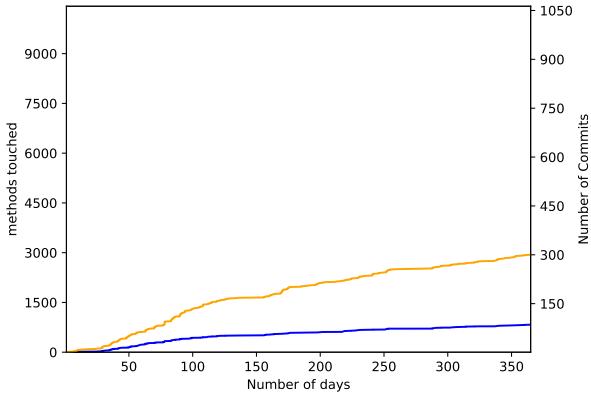
(f) Repository: 21 Developer 6262: Developer touched 2722 methods after 455 commits.



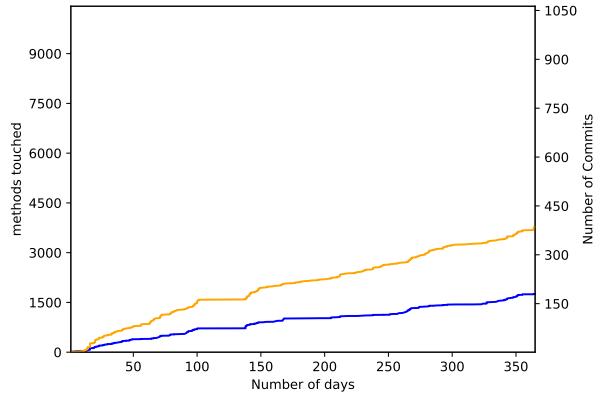
(a) Repository: 21 Developer 6263: Developer touched 1128 methods after 205 commits.



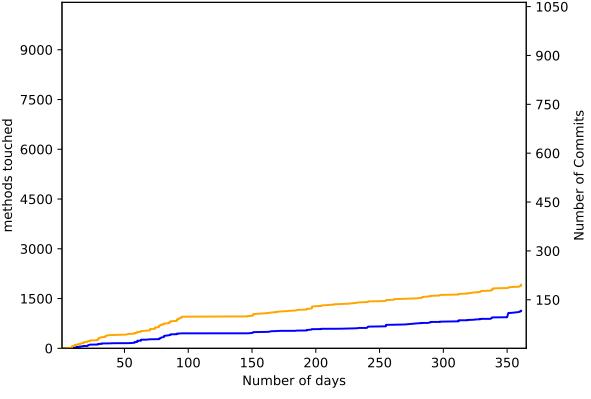
(b) Repository: 21 Developer 6264: Developer touched 450 methods after 80 commits.



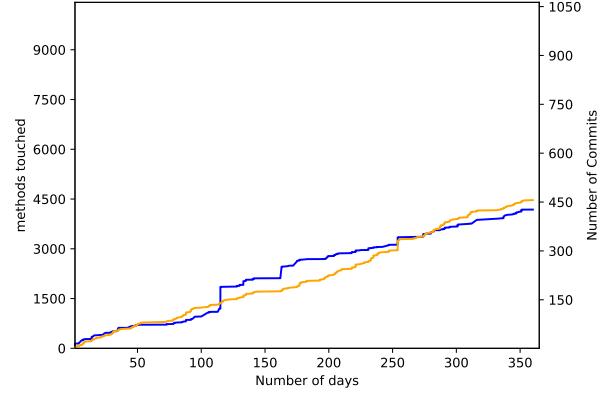
(c) Repository: 21 Developer 6267: Developer touched 831 methods after 301 commits.



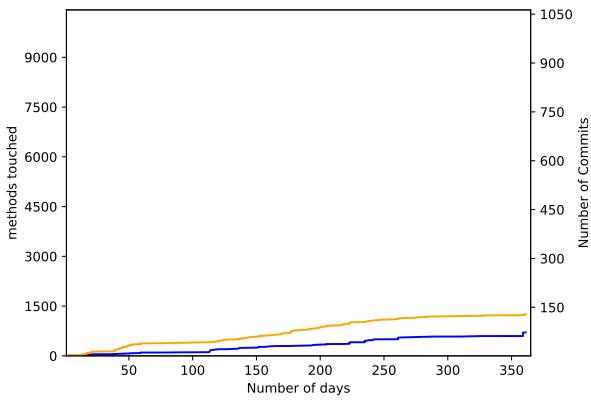
(d) Repository: 21 Developer 6271: Developer touched 1753 methods after 385 commits.



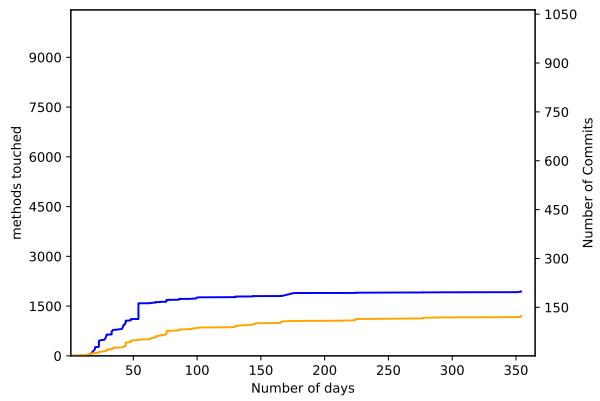
(e) Repository: 21 Developer 6272: Developer touched 1131 methods after 196 commits.



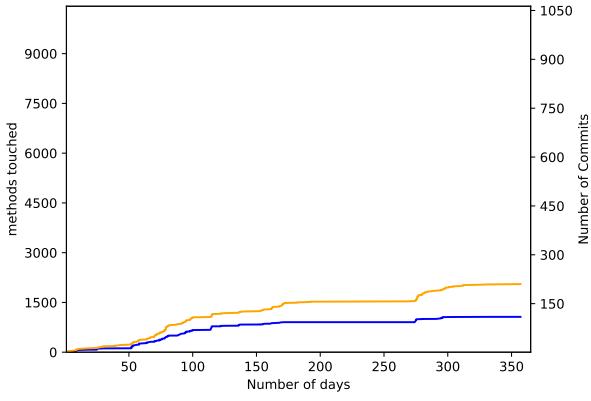
(f) Repository: 21 Developer 6276: Developer touched 4182 methods after 456 commits.



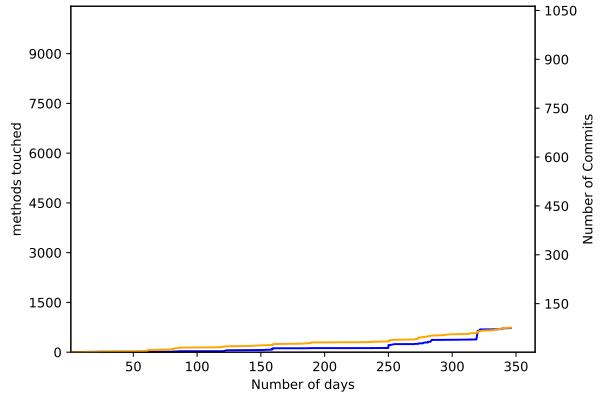
(a) Repository: 21 Developer 6278: Developer touched 705 methods after 129 commits.



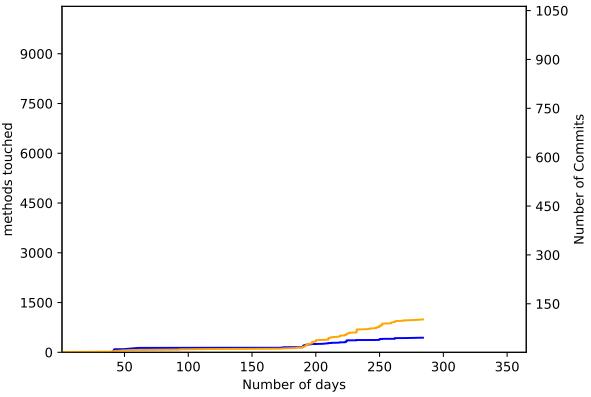
(b) Repository: 21 Developer 6280: Developer touched 1937 methods after 123 commits.



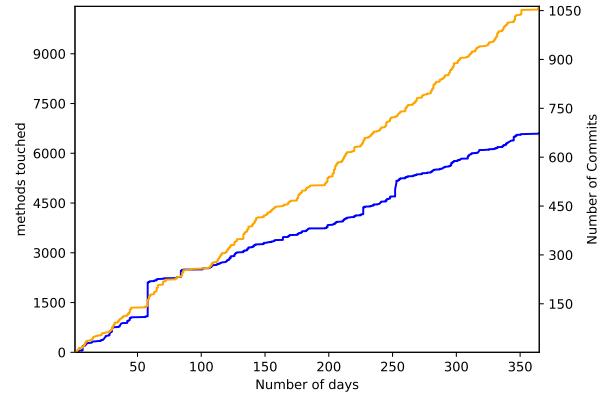
(c) Repository: 21 Developer 6282: Developer touched 1065 methods after 210 commits.



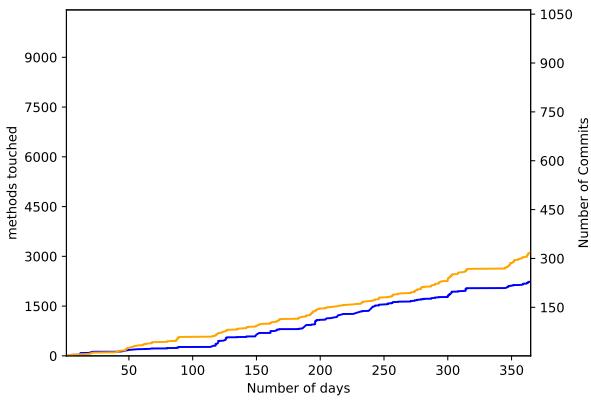
(d) Repository: 21 Developer 6284: Developer touched 726 methods after 76 commits.



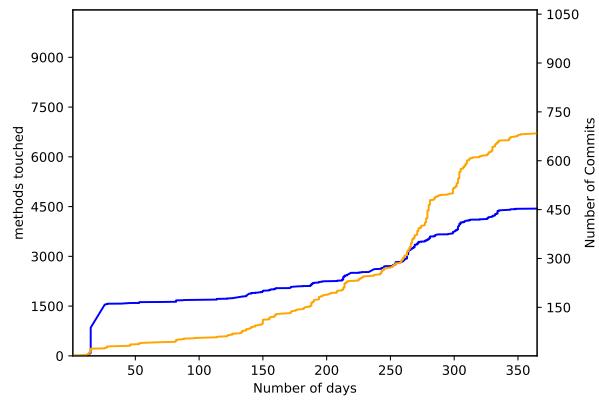
(e) Repository: 21 Developer 6288: Developer touched 440 methods after 102 commits.



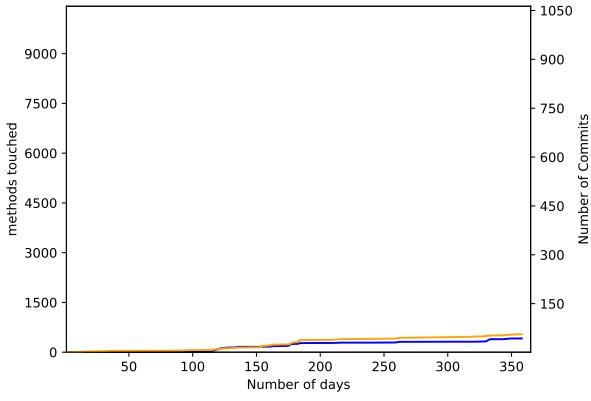
(f) Repository: 21 Developer 6295: Developer touched 6605 methods after 1062 commits.



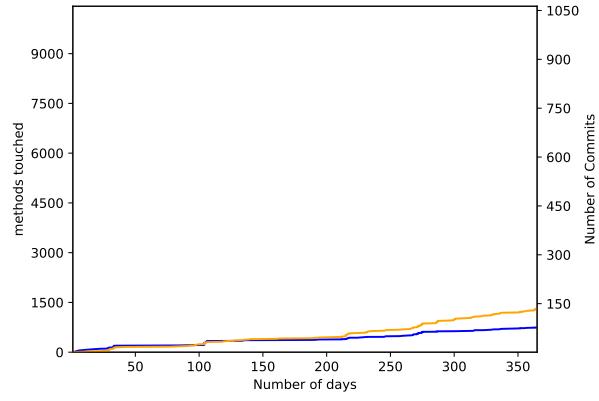
(a) Repository: 21 Developer 6297: Developer touched 2249 methods after 324 commits.



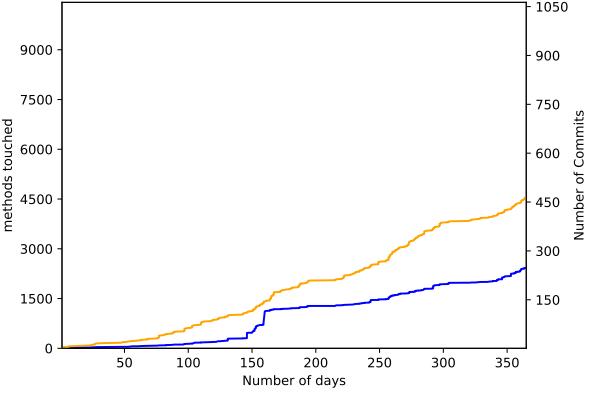
(b) Repository: 21 Developer 6298: Developer touched 4439 methods after 684 commits.



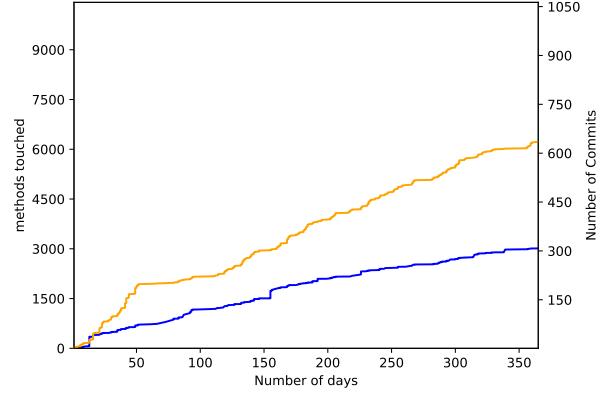
(c) Repository: 21 Developer 6302: Developer touched 413 methods after 56 commits.



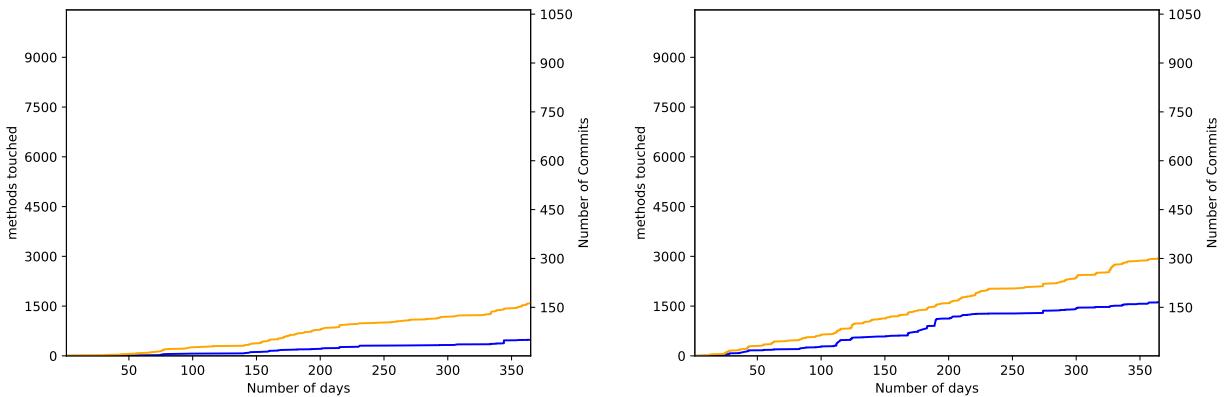
(d) Repository: 21 Developer 6306: Developer touched 743 methods after 134 commits.



(e) Repository: 21 Developer 6309: Developer touched 2419 methods after 463 commits.

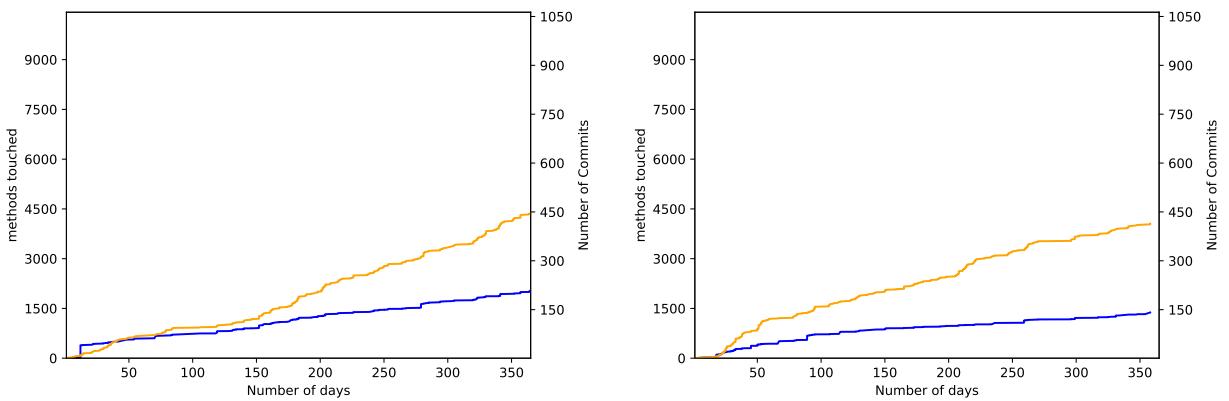


(f) Repository: 21 Developer 6312: Developer touched 3011 methods after 635 commits.



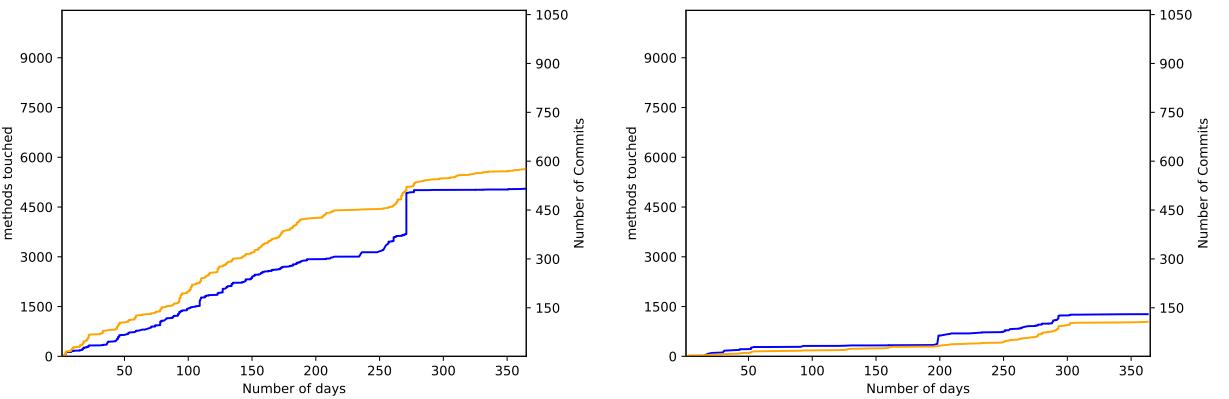
(a) Repository: 21 Developer 6313: Developer touched 484 methods after 163 commits.

(b) Repository: 21 Developer 6314: Developer touched 1612 methods after 300 commits.



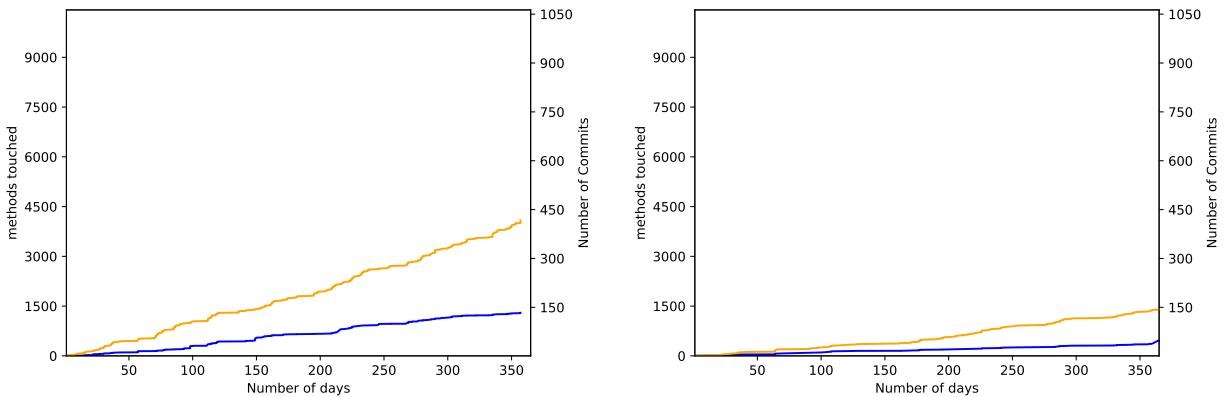
(c) Repository: 21 Developer 6315: Developer touched 2025 methods after 446 commits.

(d) Repository: 21 Developer 6326: Developer touched 1378 methods after 414 commits.



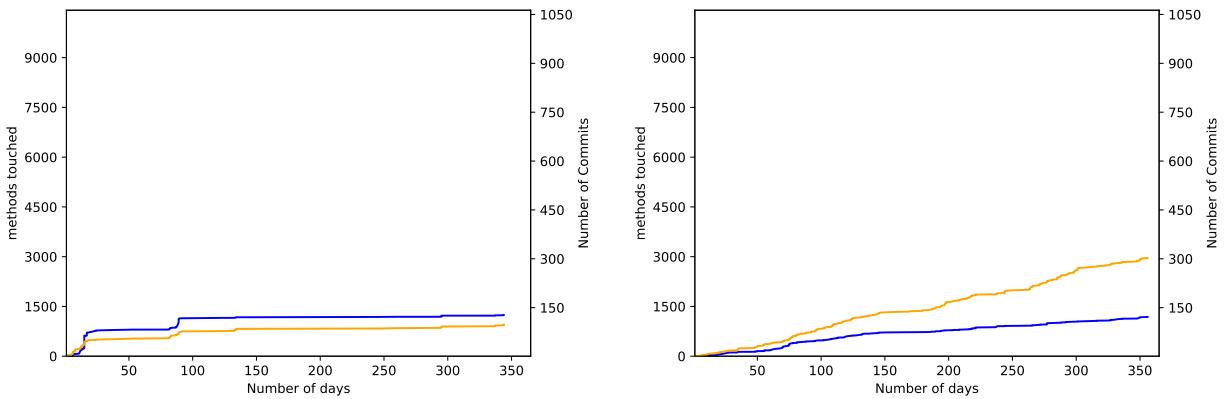
(e) Repository: 21 Developer 6329: Developer touched 5053 methods after 576 commits.

(f) Repository: 21 Developer 6333: Developer touched 1270 methods after 107 commits.



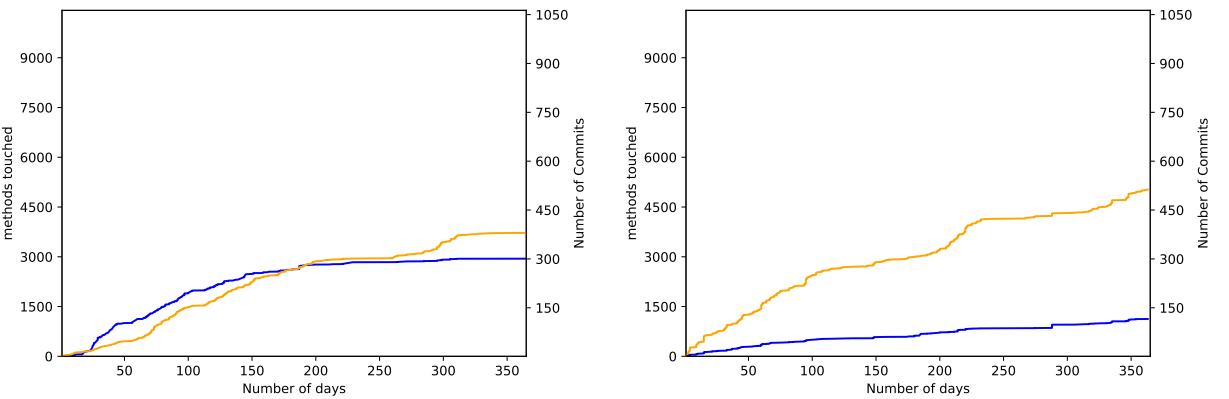
(a) Repository: 21 Developer 6338: Developer touched 1300 methods after 417 commits.

(b) Repository: 21 Developer 6342: Developer touched 455 methods after 144 commits.



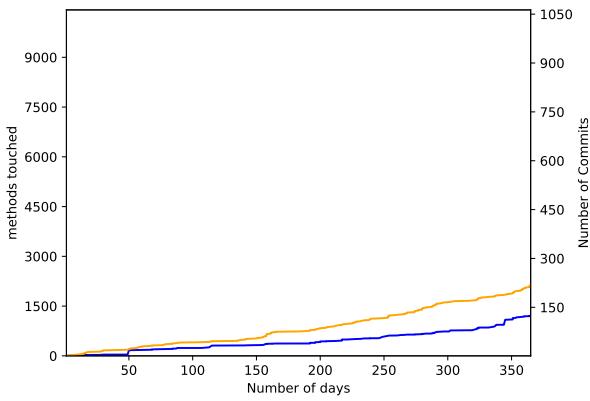
(c) Repository: 21 Developer 6343: Developer touched 1236 methods after 98 commits.

(d) Repository: 21 Developer 6349: Developer touched 1183 methods after 302 commits.

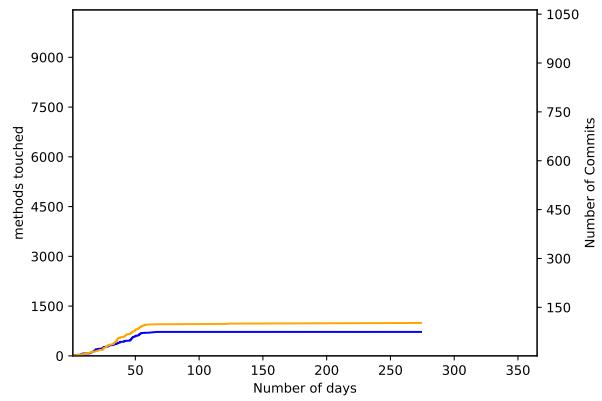


(e) Repository: 21 Developer 6352: Developer touched 2946 methods after 382 commits.

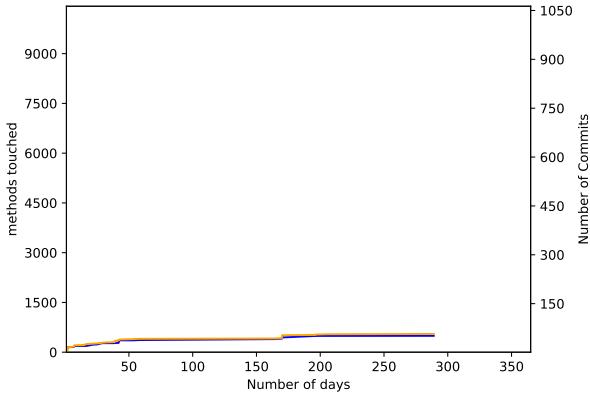
(f) Repository: 21 Developer 6355: Developer touched 1125 methods after 513 commits.



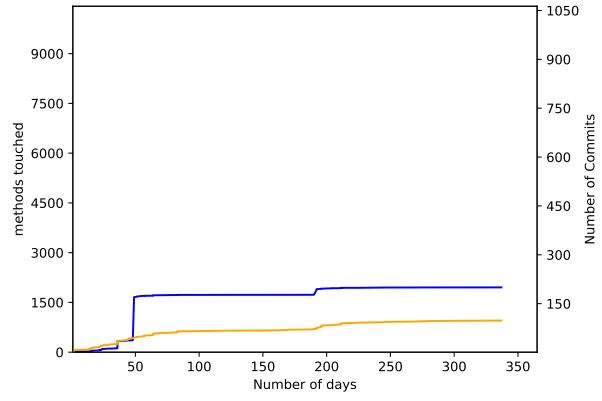
(a) Repository: 21 Developer 6363: Developer touched 1228 methods after 226 commits.



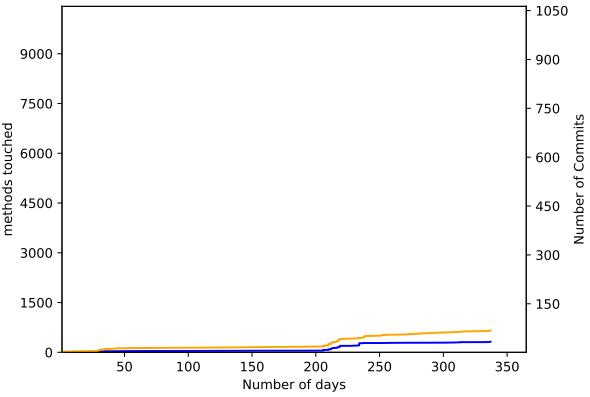
(b) Repository: 21 Developer 6368: Developer touched 722 methods after 102 commits.



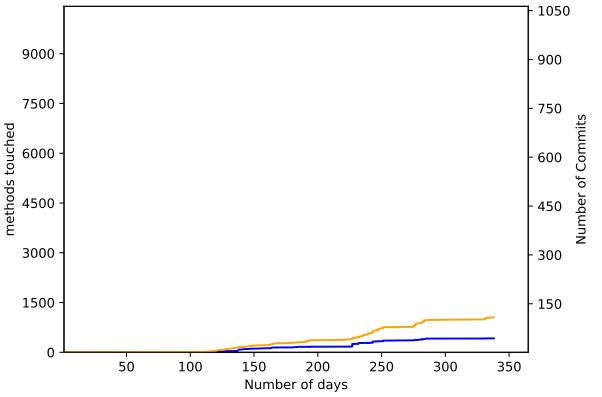
(c) Repository: 21 Developer 6369: Developer touched 493 methods after 57 commits.



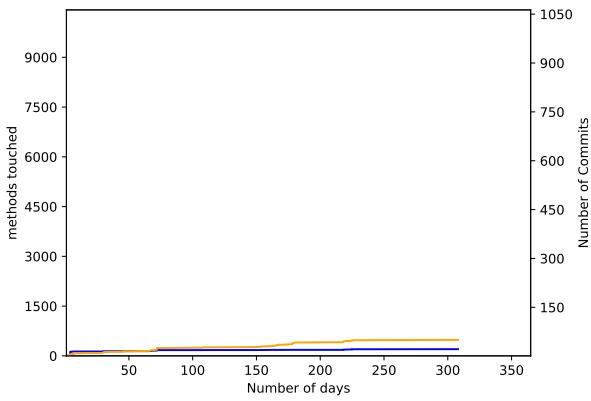
(d) Repository: 21 Developer 6370: Developer touched 1953 methods after 98 commits.



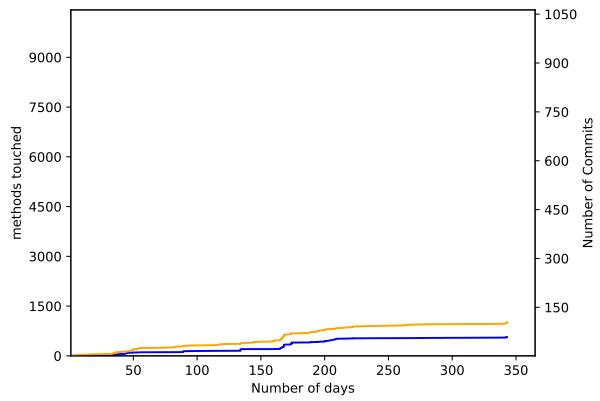
(e) Repository: 21 Developer 6373: Developer touched 320 methods after 68 commits.



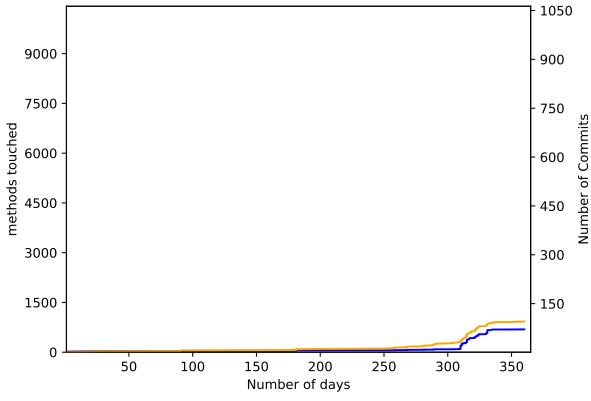
(f) Repository: 21 Developer 6374: Developer touched 421 methods after 108 commits.



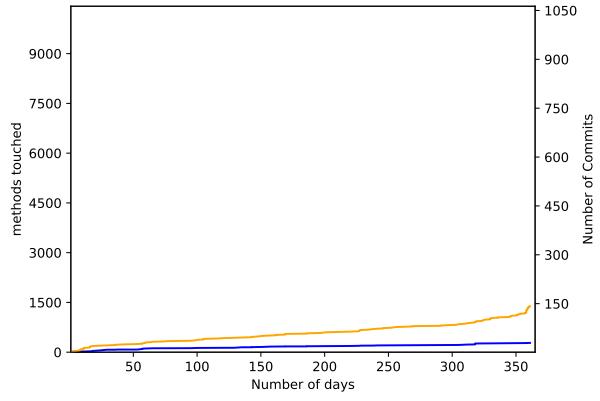
(a) Repository: 21 Developer 6375: Developer touched 202 methods after 50 commits.



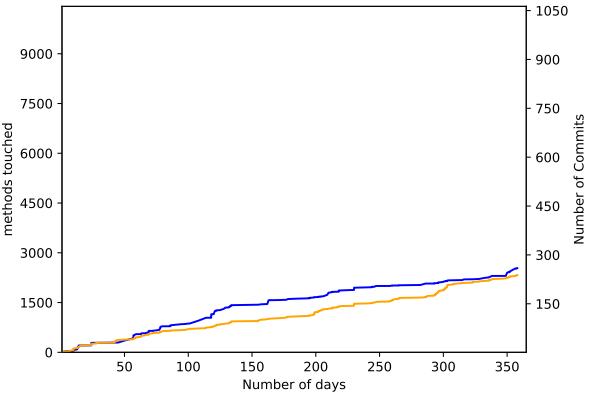
(b) Repository: 21 Developer 6379: Developer touched 564 methods after 104 commits.



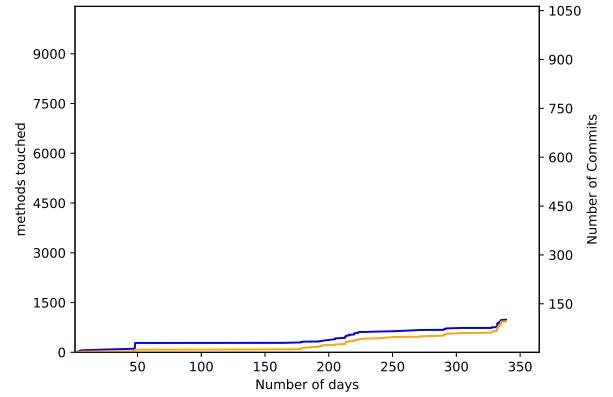
(c) Repository: 21 Developer 6391: Developer touched 687 methods after 95 commits.



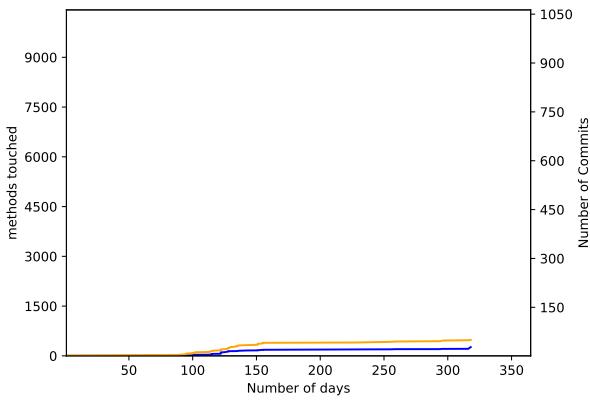
(d) Repository: 21 Developer 6410: Developer touched 280 methods after 142 commits.



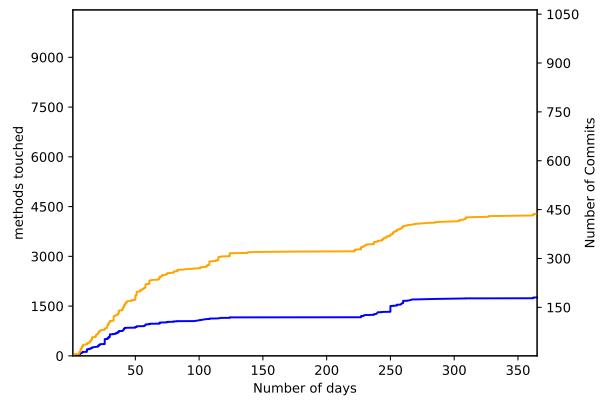
(e) Repository: 21 Developer 6411: Developer touched 2537 methods after 238 commits.



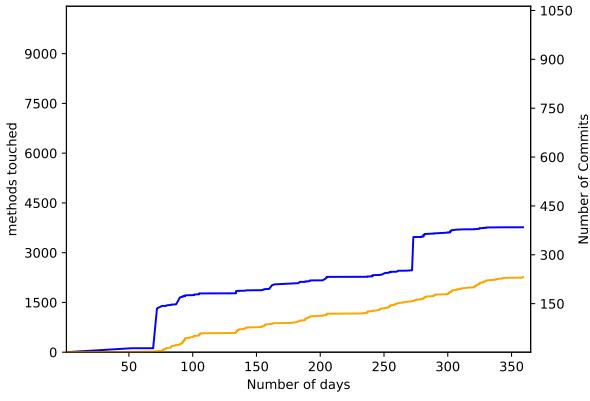
(f) Repository: 21 Developer 6417: Developer touched 981 methods after 96 commits.



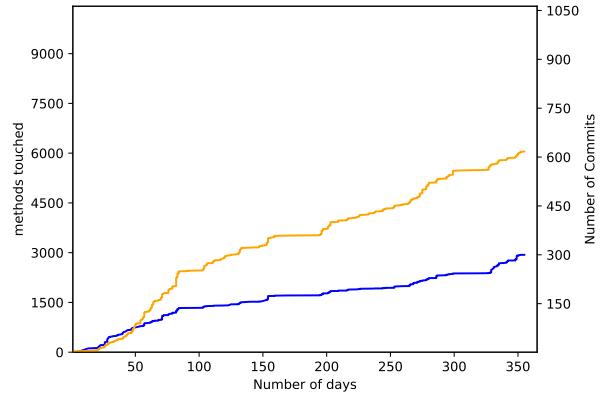
(a) Repository: 21 Developer 6418: Developer touched 264 methods after 50 commits.



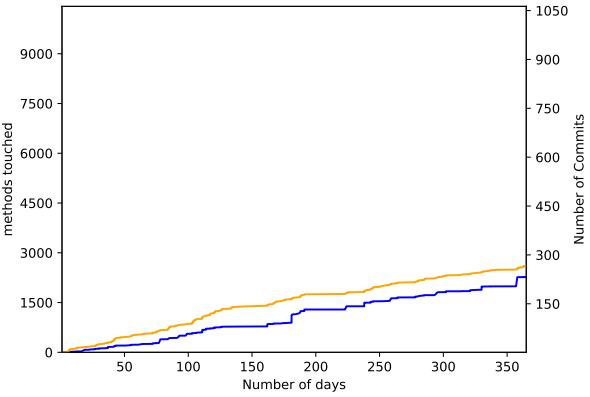
(b) Repository: 21 Developer 6420: Developer touched 1760 methods after 437 commits.



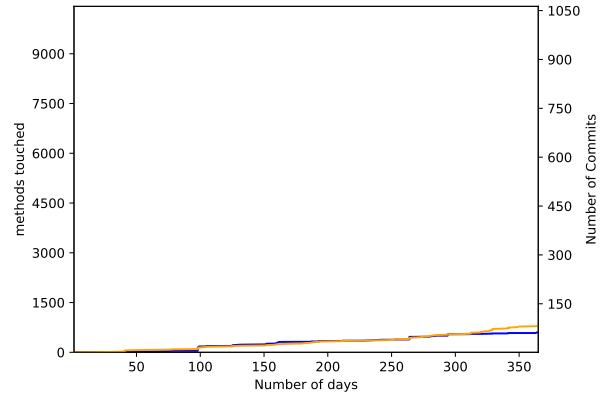
(c) Repository: 21 Developer 6424: Developer touched 3765 methods after 231 commits.



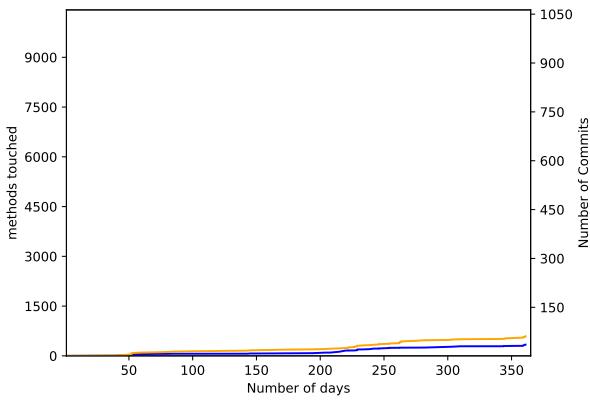
(d) Repository: 21 Developer 6426: Developer touched 2935 methods after 617 commits.



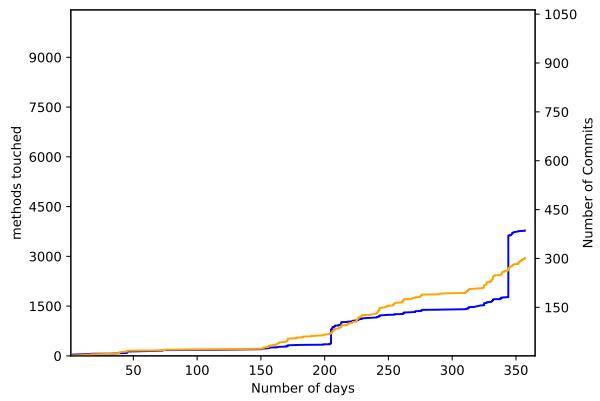
(e) Repository: 21 Developer 6427: Developer touched 2273 methods after 267 commits.



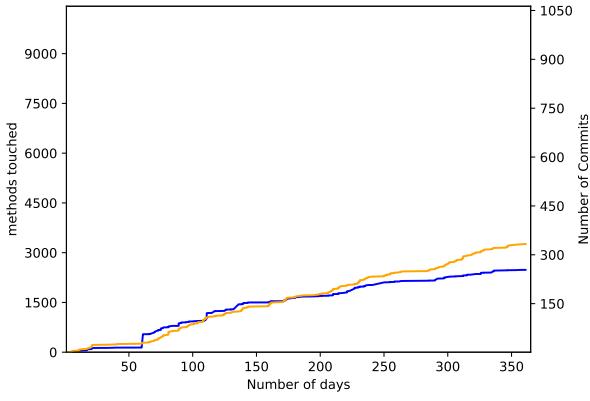
(f) Repository: 21 Developer 6429: Developer touched 600 methods after 82 commits.



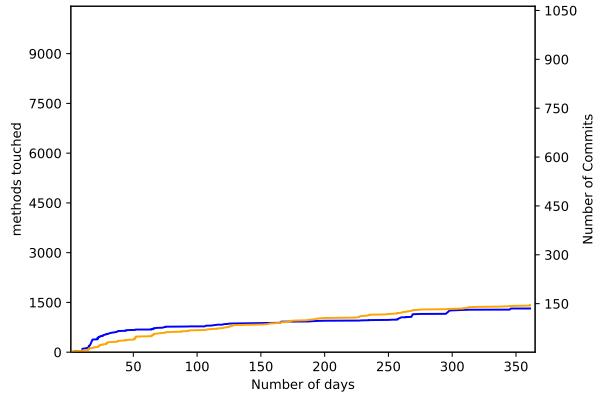
(a) Repository: 21 Developer 6431: Developer touched 337 methods after 61 commits.



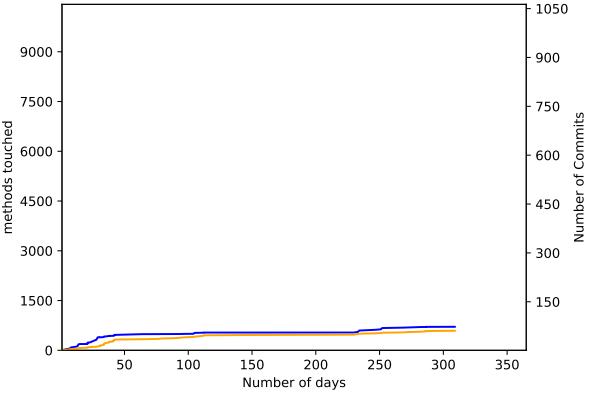
(b) Repository: 21 Developer 6450: Developer touched 3776 methods after 302 commits.



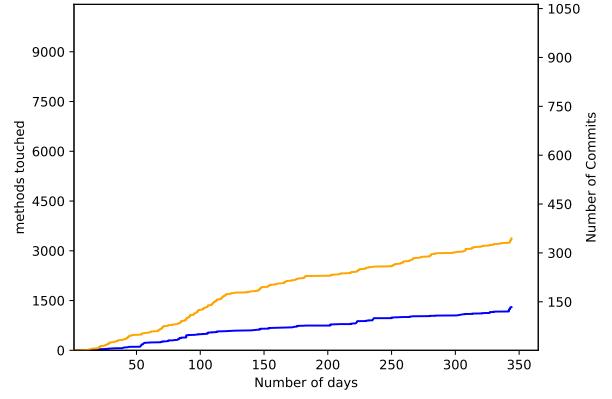
(c) Repository: 21 Developer 6454: Developer touched 2482 methods after 333 commits.



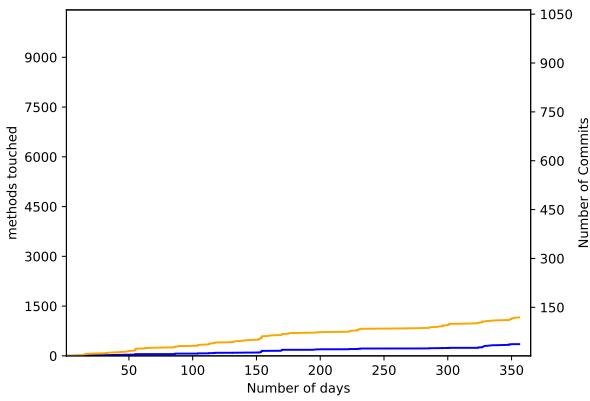
(d) Repository: 21 Developer 6460: Developer touched 1317 methods after 145 commits.



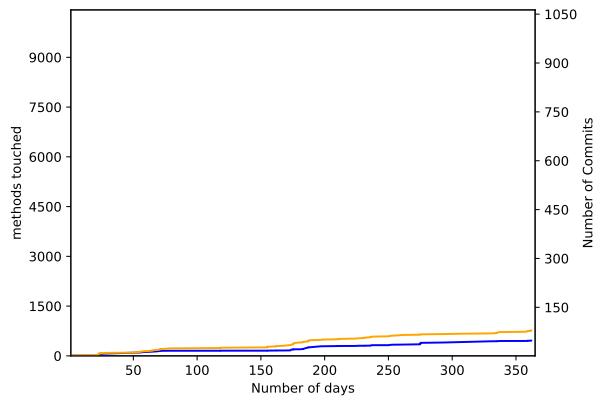
(e) Repository: 21 Developer 6483: Developer touched 709 methods after 61 commits.



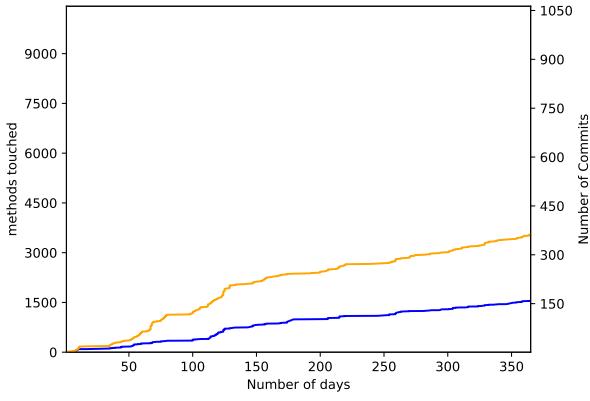
(f) Repository: 21 Developer 6489: Developer touched 1302 methods after 345 commits.



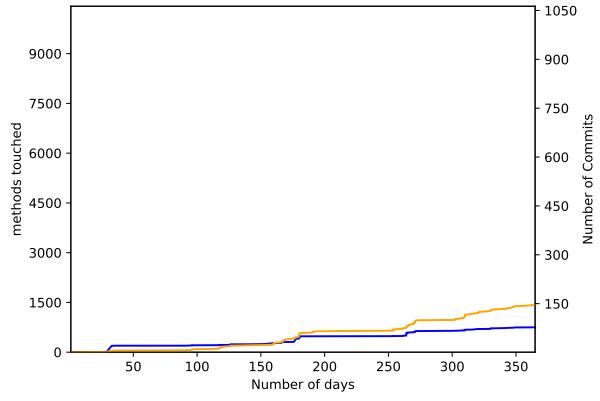
(a) Repository: 21 Developer 6491: Developer touched 353 methods after 119 commits.



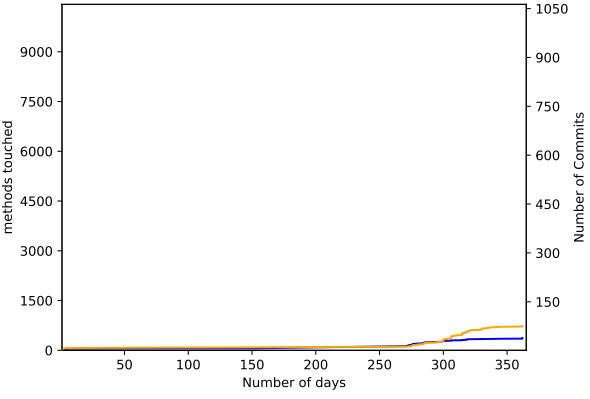
(b) Repository: 21 Developer 6502: Developer touched 457 methods after 79 commits.



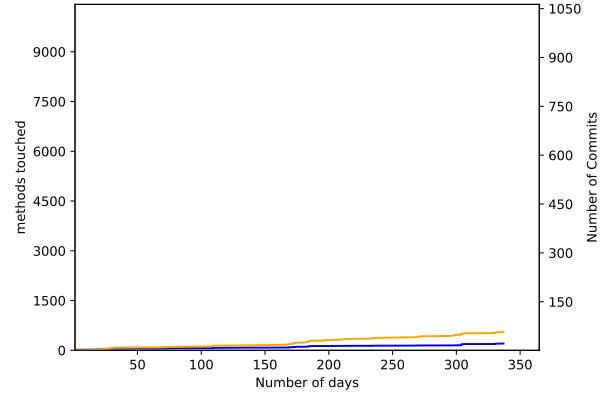
(c) Repository: 21 Developer 6503: Developer touched 1549 methods after 363 commits.



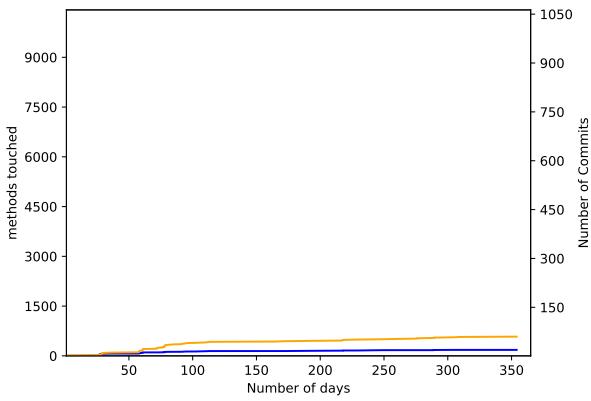
(d) Repository: 21 Developer 6507: Developer touched 750 methods after 146 commits.



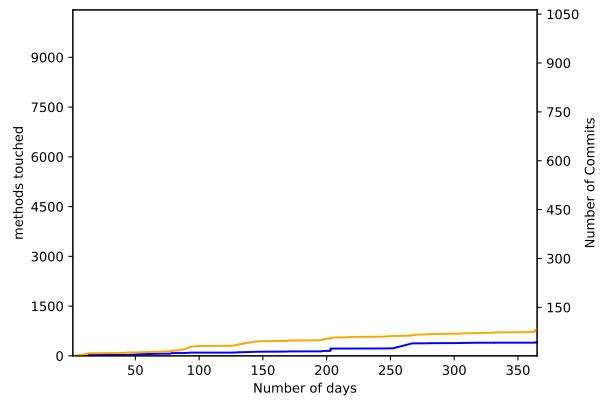
(e) Repository: 21 Developer 6509: Developer touched 368 methods after 75 commits.



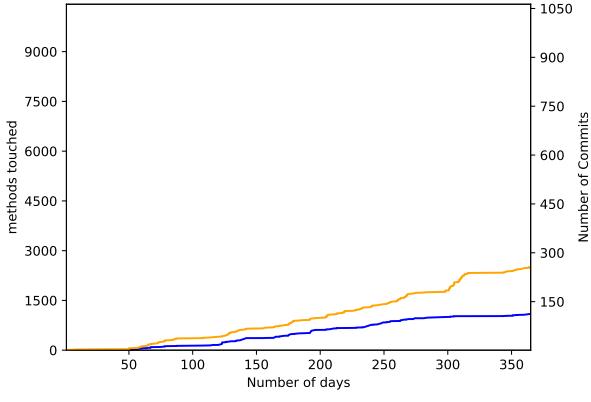
(f) Repository: 21 Developer 6529: Developer touched 204 methods after 57 commits.



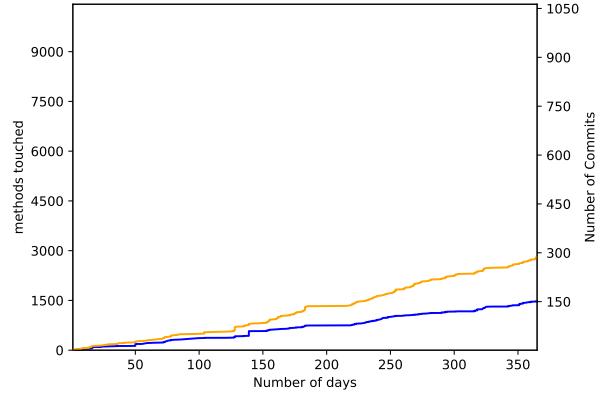
(a) Repository: 21 Developer 6541: Developer touched 180 methods after 60 commits.



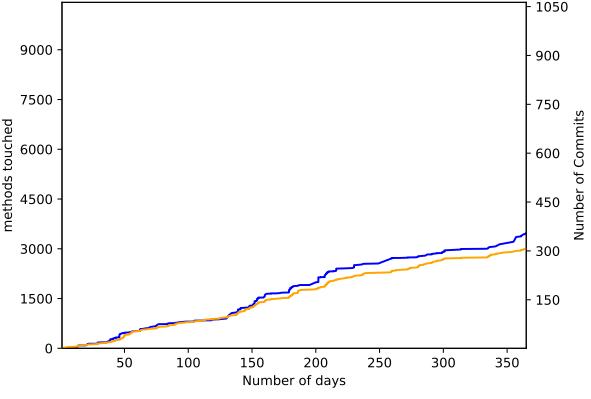
(b) Repository: 21 Developer 6552: Developer touched 407 methods after 83 commits.



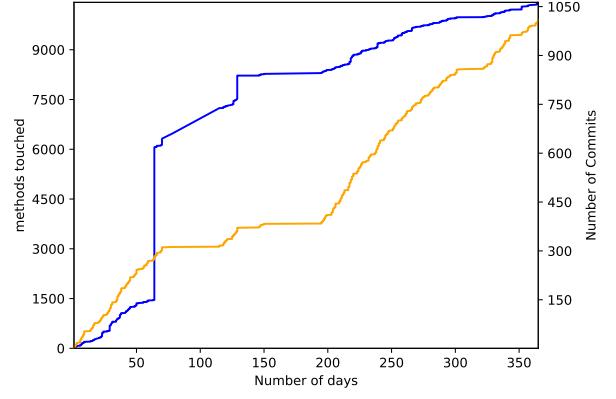
(c) Repository: 21 Developer 6555: Developer touched 1090 methods after 256 commits.



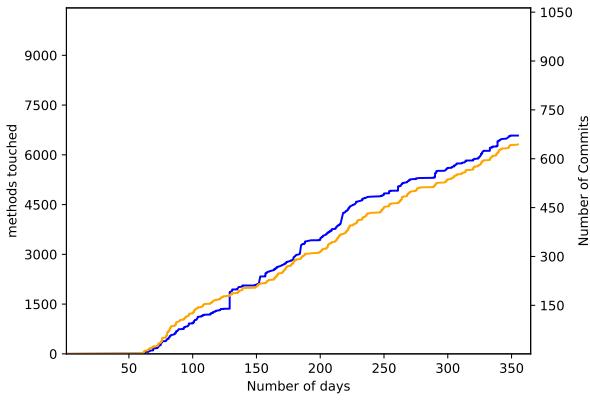
(d) Repository: 21 Developer 6576: Developer touched 1473 methods after 287 commits.



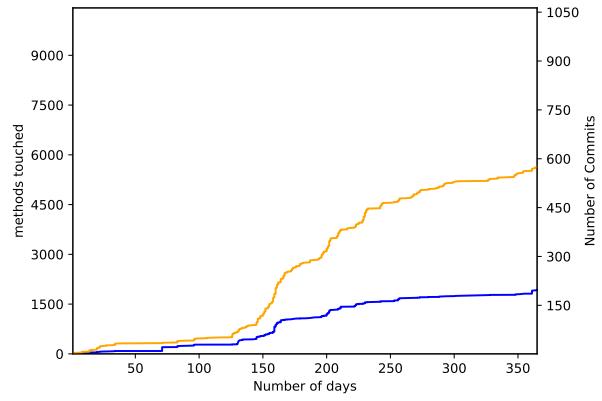
(e) Repository: 21 Developer 6579: Developer touched 3478 methods after 307 commits.



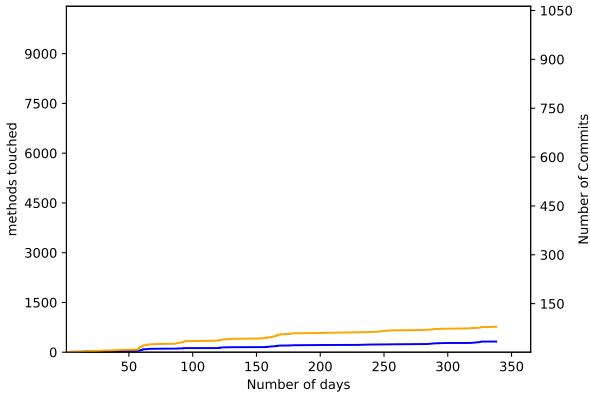
(f) Repository: 21 Developer 6587: Developer touched 10428 methods after 1013 commits.



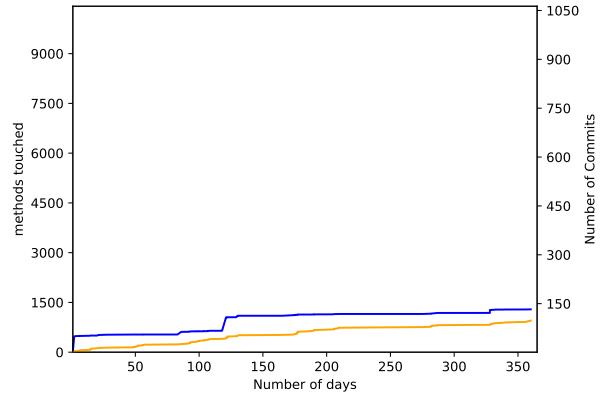
(a) Repository: 21 Developer 6609: Developer touched 6581 methods after 644 commits.



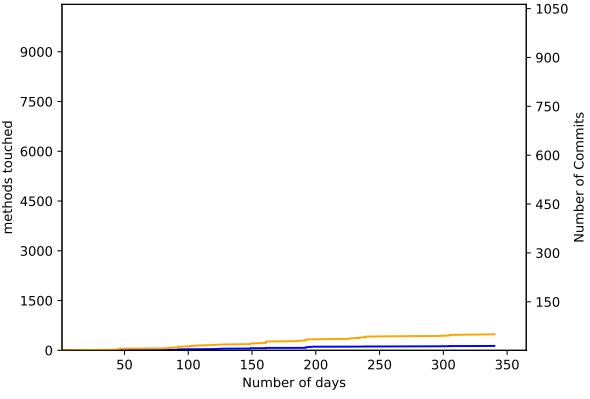
(b) Repository: 21 Developer 6619: Developer touched 1930 methods after 576 commits.



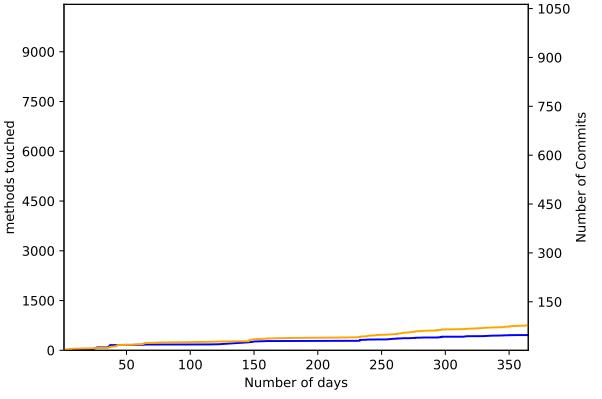
(c) Repository: 21 Developer 6624: Developer touched 320 methods after 79 commits.



(d) Repository: 21 Developer 6631: Developer touched 1291 methods after 98 commits.



(e) Repository: 21 Developer 6641: Developer touched 133 methods after 51 commits.



(f) Repository: 21 Developer 6651: Developer touched 460 methods after 78 commits.

## 5.10 Repository histogram commit - 21 For methods with total

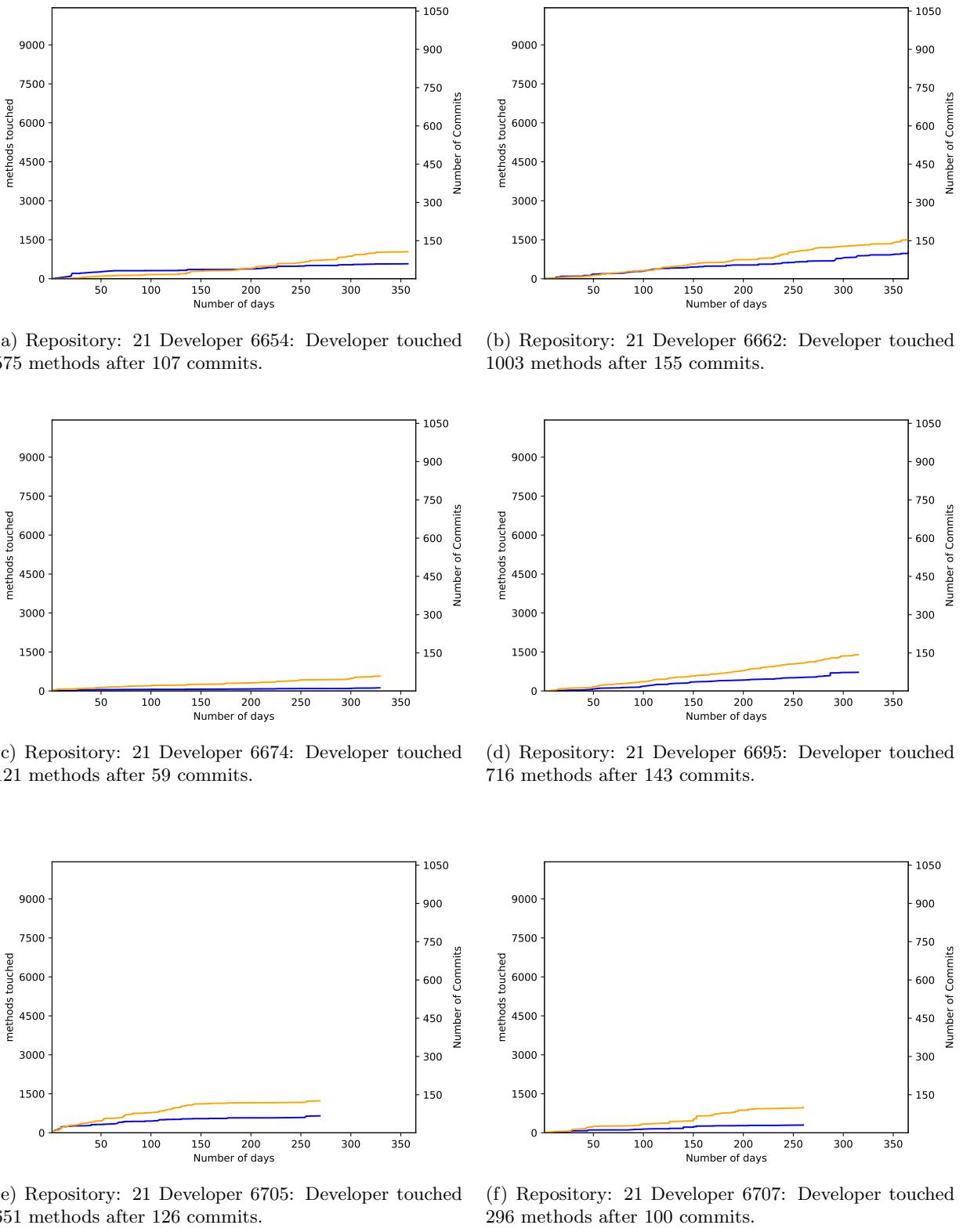


Figure 80: Number of days in the developers first year (x-axis) against methods touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

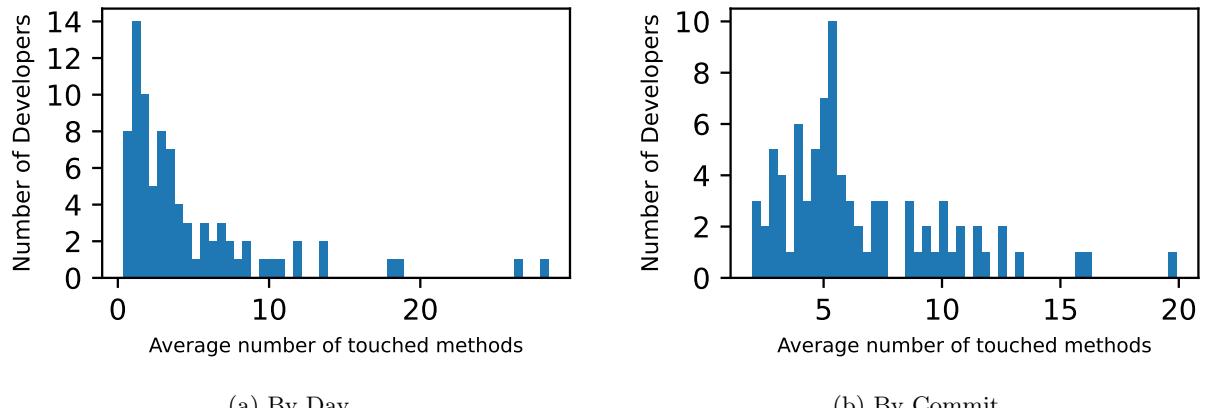


Figure 81: Histogram of new methods touched (x-axis) against number of developers (y-axis). Graphs for 84 sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

## 6 Repository: 3

### 6.1 Developer touched - Repository 3: Developer packages knowledge

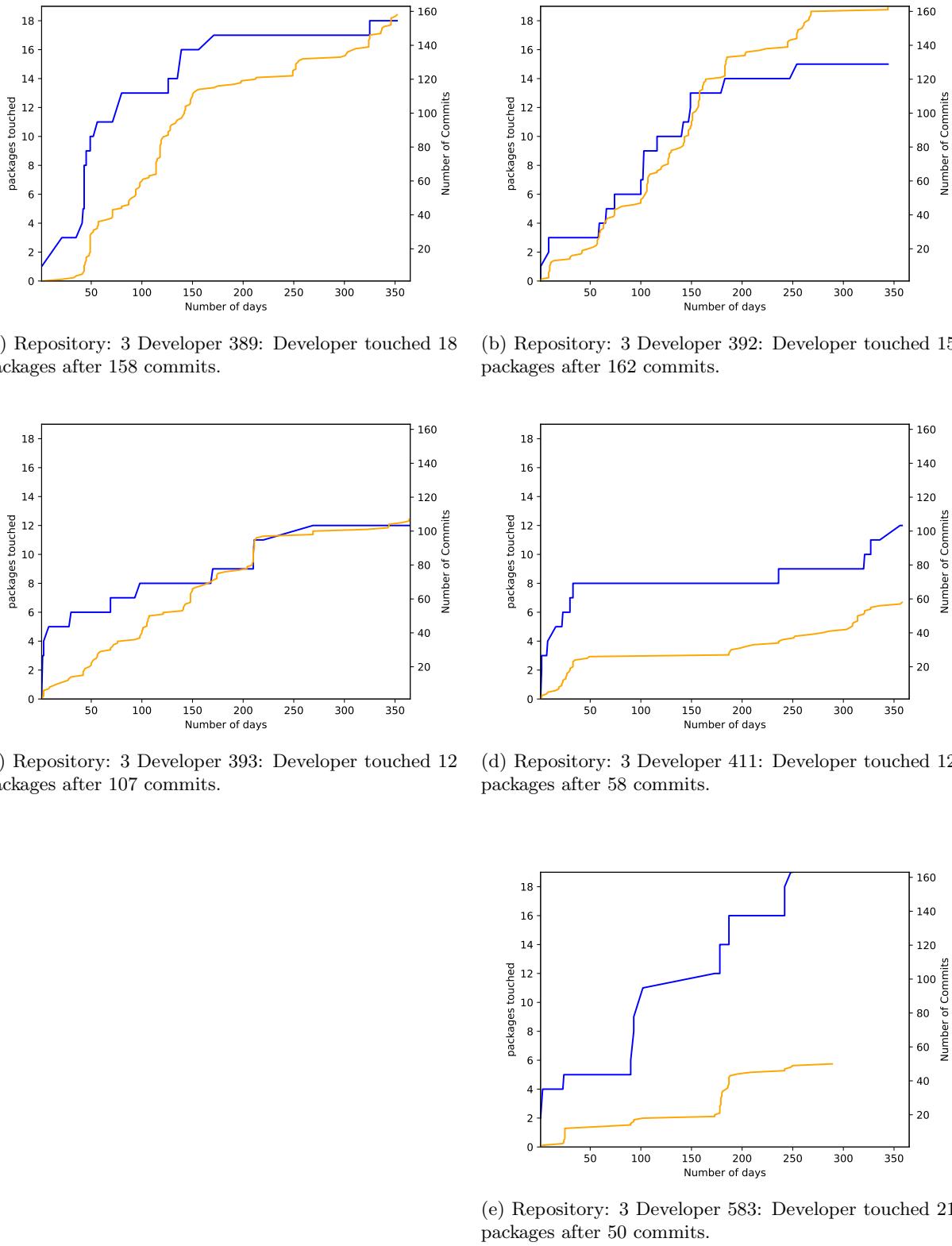
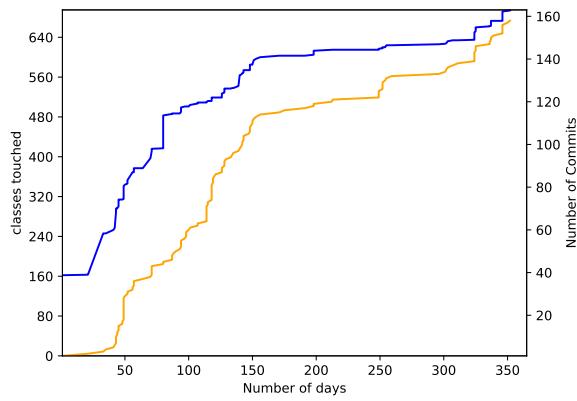


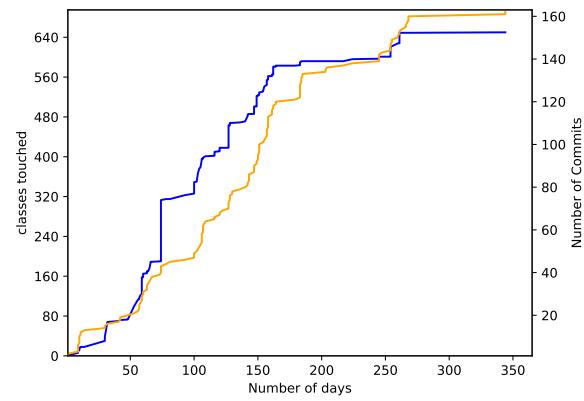
Figure 82: Number of days in the developers first year (x-axis) against packages touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.  
 ● Orange - Commits on right y-axis.

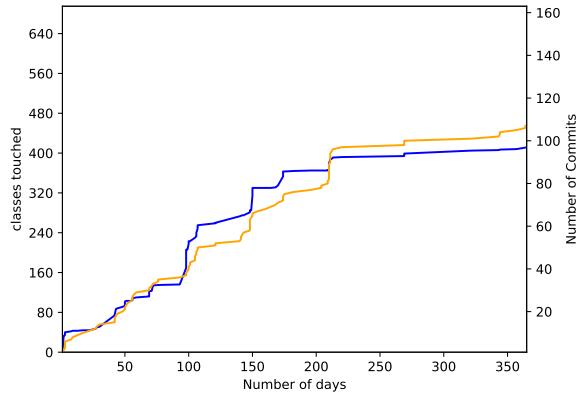
## 6.2 Developer touched - Repository 3: Developer classes knowledge



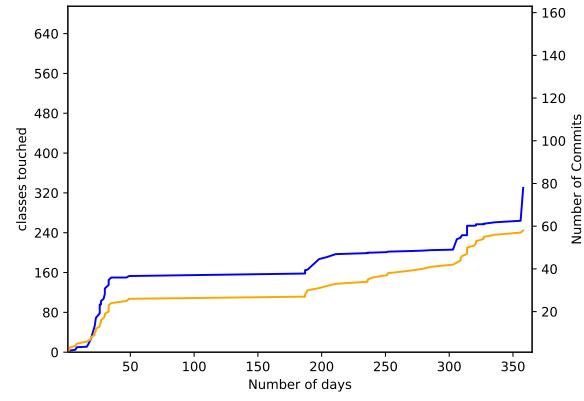
(a) Repository: 3 Developer 389: Developer touched 694 classes after 158 commits.



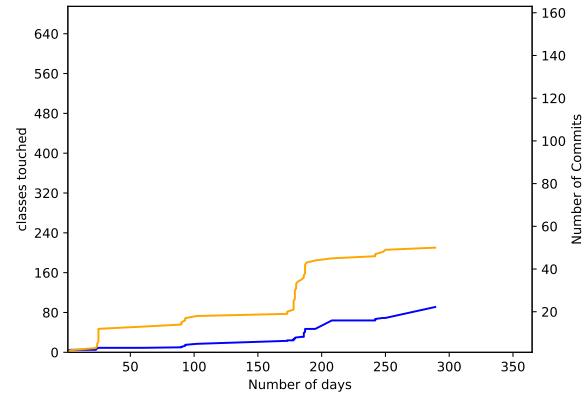
(b) Repository: 3 Developer 392: Developer touched 650 classes after 162 commits.



(c) Repository: 3 Developer 393: Developer touched 411 classes after 107 commits.



(d) Repository: 3 Developer 411: Developer touched 330 classes after 58 commits.



(e) Repository: 3 Developer 583: Developer touched 91 classes after 50 commits.

Figure 83: Number of days in the developers first year (x-axis) against classes touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

### **6.3 Developer touched - Repository 3: Developer methods knowledge**

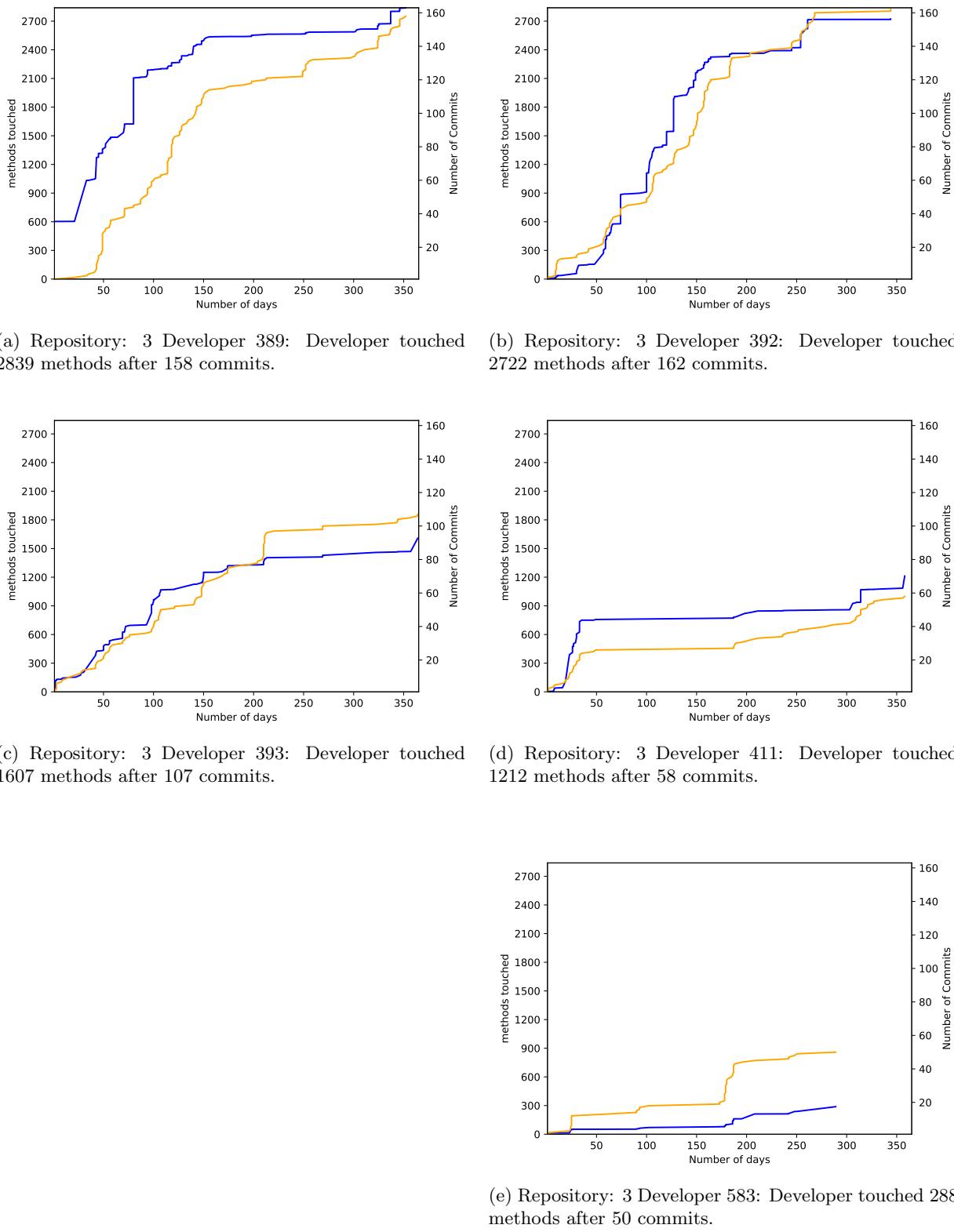


Figure 84: Number of days in the developers first year (x-axis) against methods touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## **7 Repository: 5**

### **7.1 Developer touched - Repository 5: Developer packages knowledge**

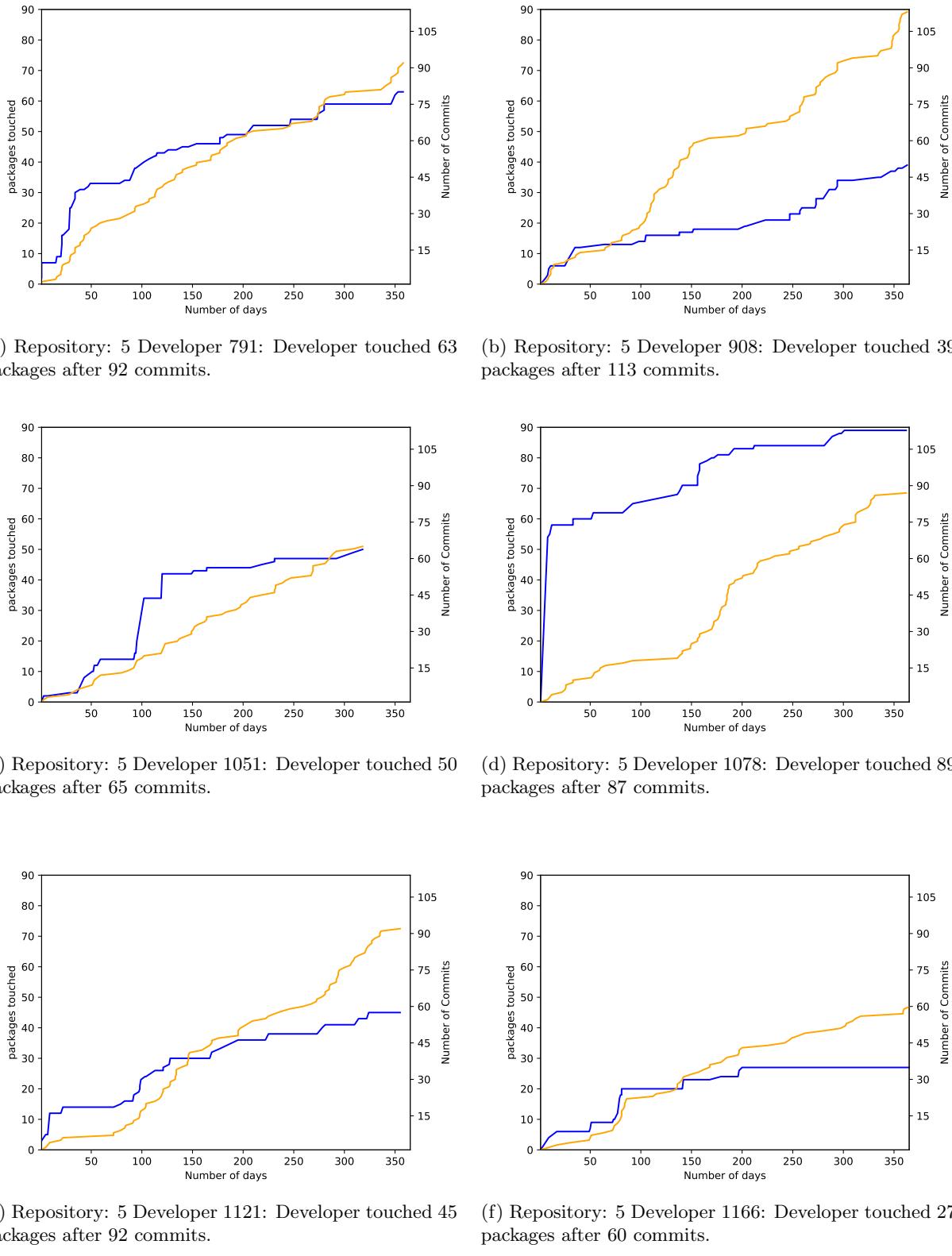
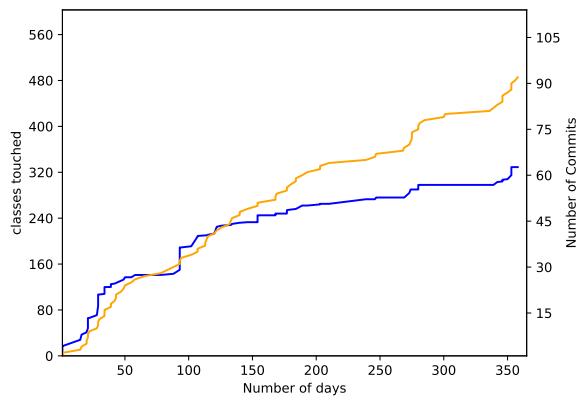


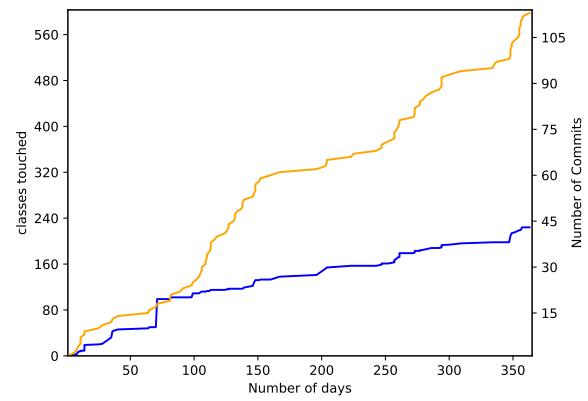
Figure 85: Number of days in the developers first year (x-axis) against packages touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

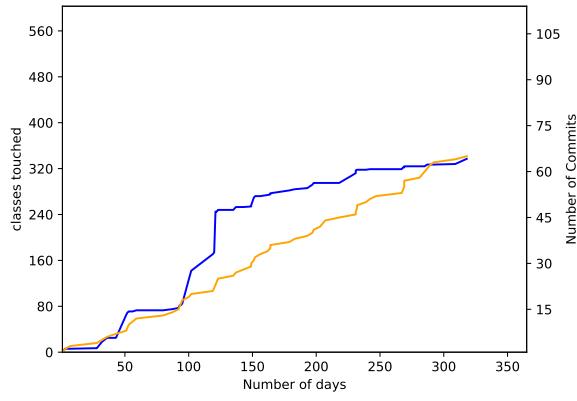
## 7.2 Developer touched - Repository 5: Developer classes knowledge



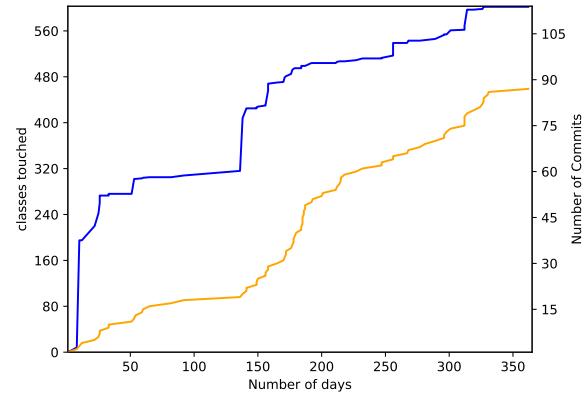
(a) Repository: 5 Developer 791: Developer touched 329 classes after 92 commits.



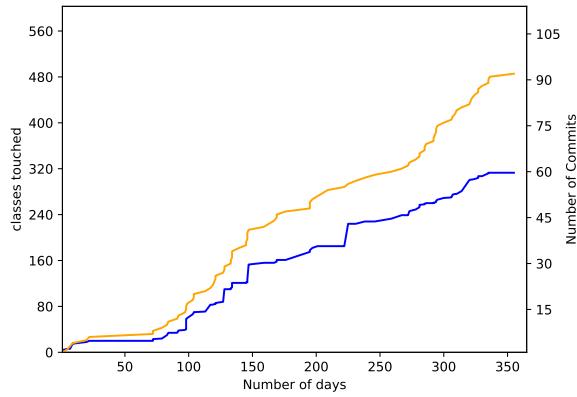
(b) Repository: 5 Developer 908: Developer touched 224 classes after 113 commits.



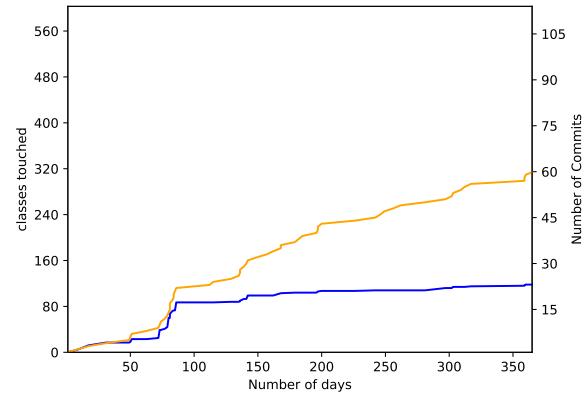
(c) Repository: 5 Developer 1051: Developer touched 337 classes after 65 commits.



(d) Repository: 5 Developer 1078: Developer touched 602 classes after 87 commits.



(e) Repository: 5 Developer 1121: Developer touched 313 classes after 92 commits.



(f) Repository: 5 Developer 1166: Developer touched 118 classes after 60 commits.

Figure 86: Number of days in the developers first year (x-axis) against classes touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

### **7.3 Developer touched - Repository 5: Developer methods knowledge**

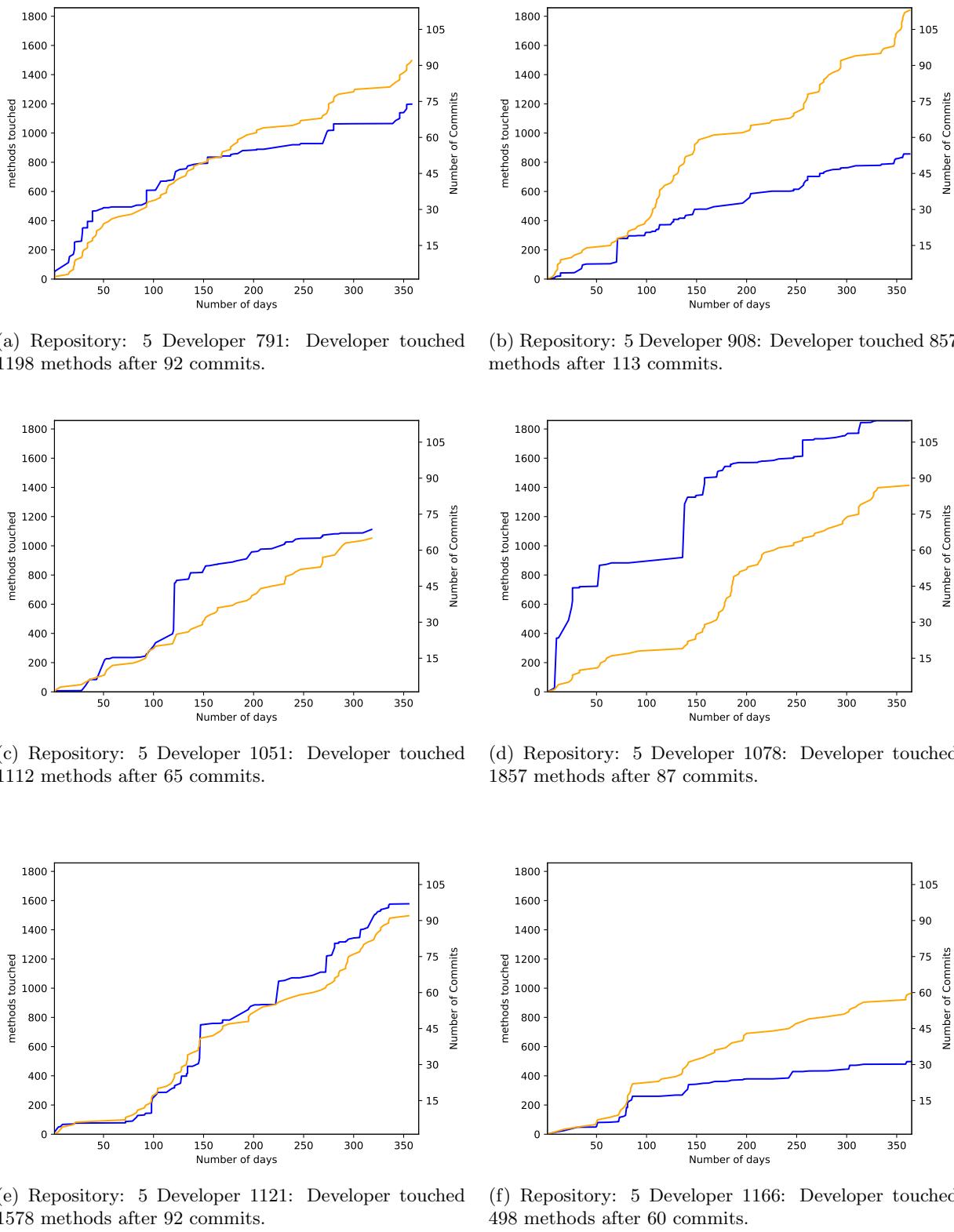
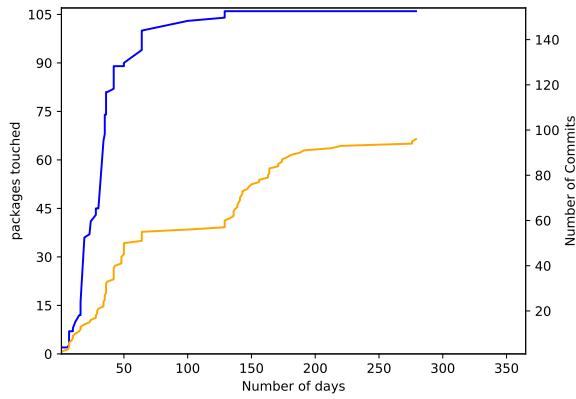


Figure 87: Number of days in the developers first year (x-axis) against methods touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

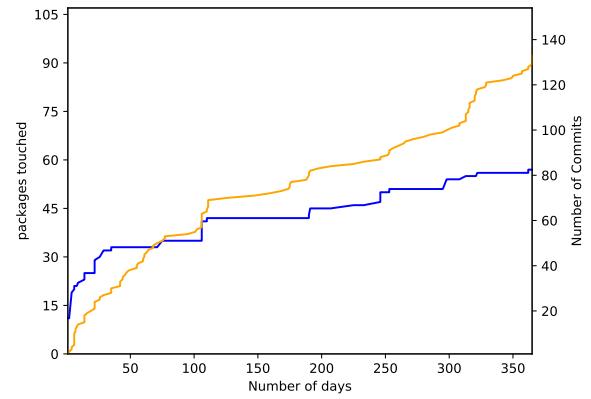
- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## **8 Repository: 7**

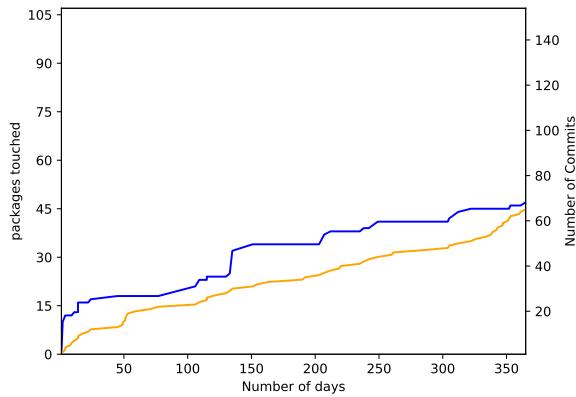
### **8.1 Developer touched - Repository 7: Developer packages knowledge**



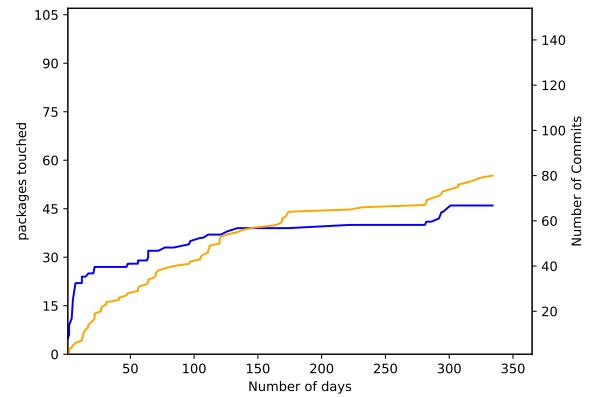
(a) Repository: 7 Developer 1442: Developer touched 106 packages after 96 commits.



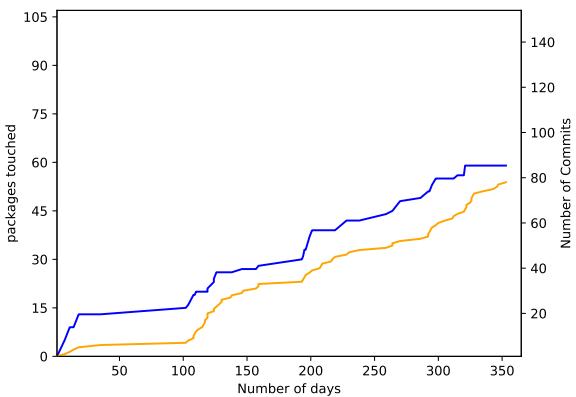
(b) Repository: 7 Developer 1448: Developer touched 57 packages after 133 commits.



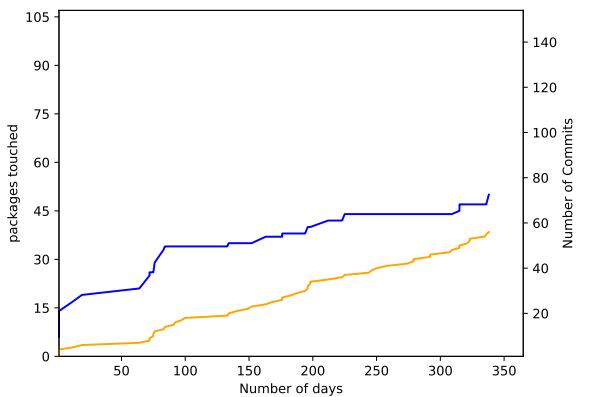
(c) Repository: 7 Developer 1449: Developer touched 47 packages after 65 commits.



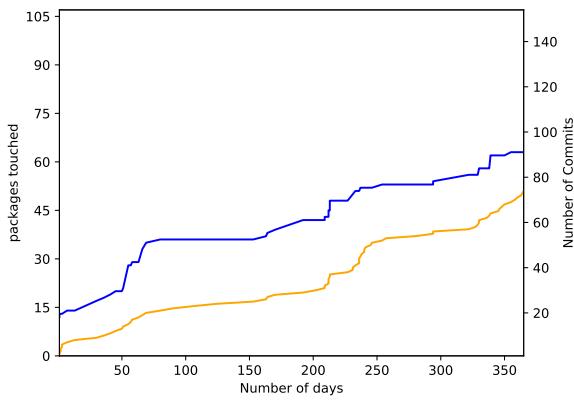
(d) Repository: 7 Developer 1450: Developer touched 46 packages after 80 commits.



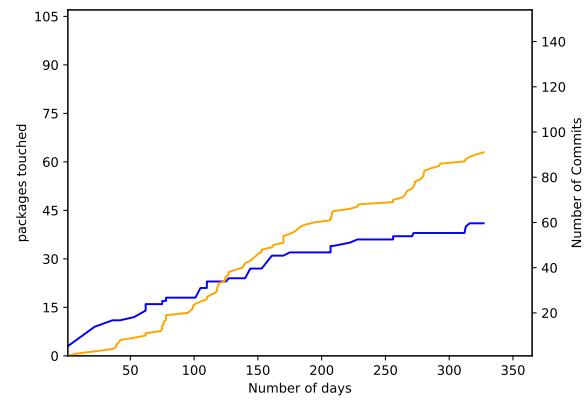
(e) Repository: 7 Developer 1453: Developer touched 59 packages after 78 commits.



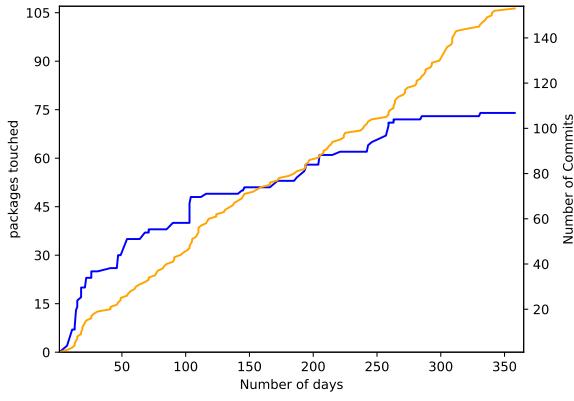
(f) Repository: 7 Developer 1457: Developer touched 50 packages after 56 commits.



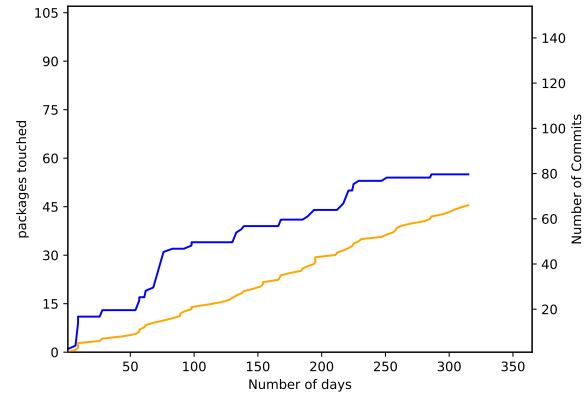
(a) Repository: 7 Developer 1462: Developer touched 63 packages after 74 commits.



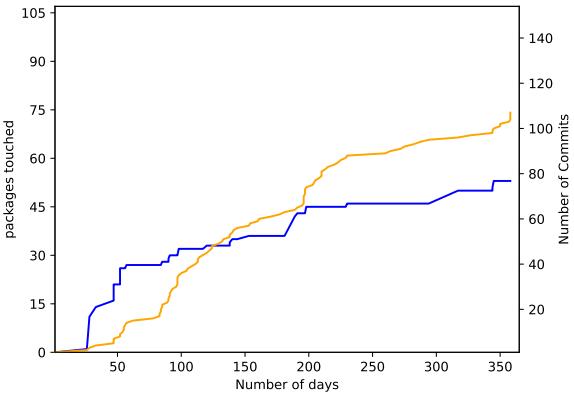
(b) Repository: 7 Developer 1466: Developer touched 41 packages after 91 commits.



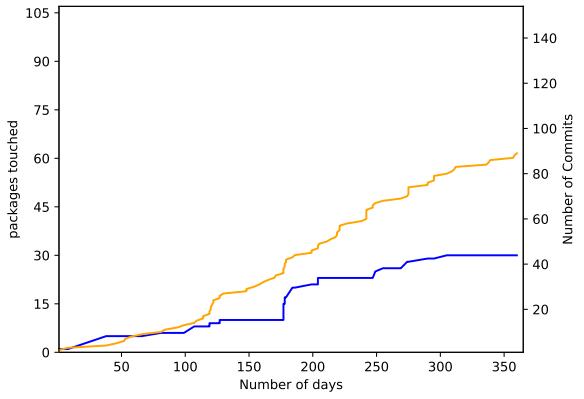
(c) Repository: 7 Developer 1473: Developer touched 74 packages after 153 commits.



(d) Repository: 7 Developer 1476: Developer touched 55 packages after 66 commits.



(e) Repository: 7 Developer 1480: Developer touched 53 packages after 107 commits.



(f) Repository: 7 Developer 1501: Developer touched 30 packages after 89 commits.

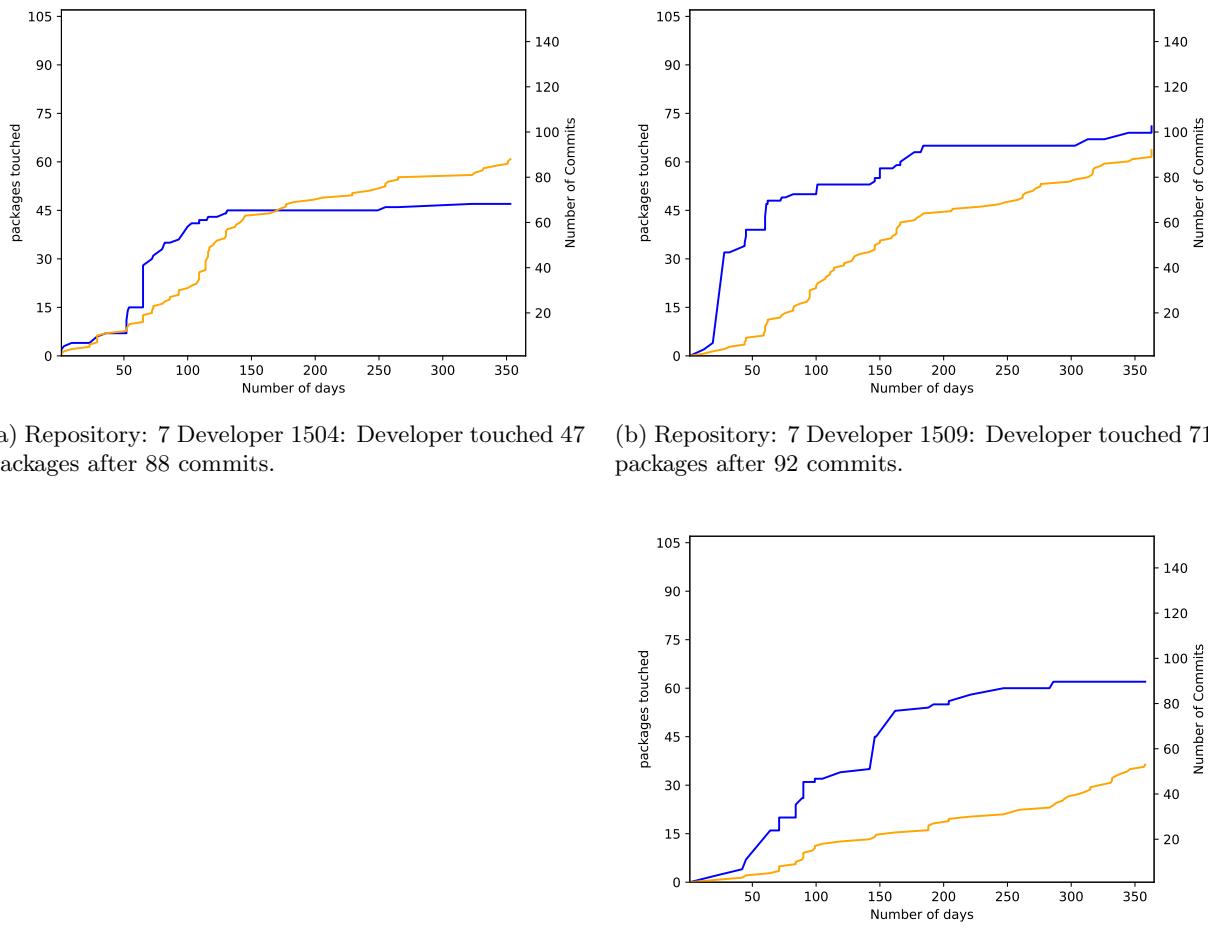
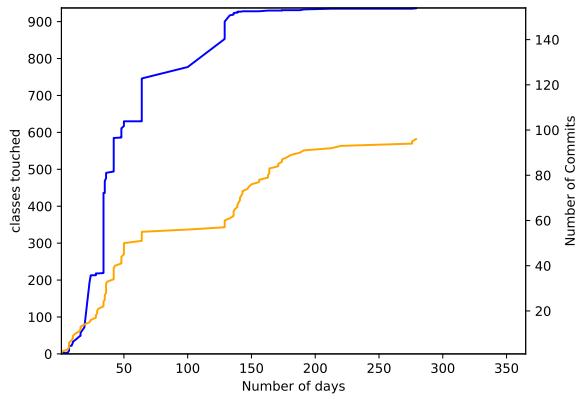


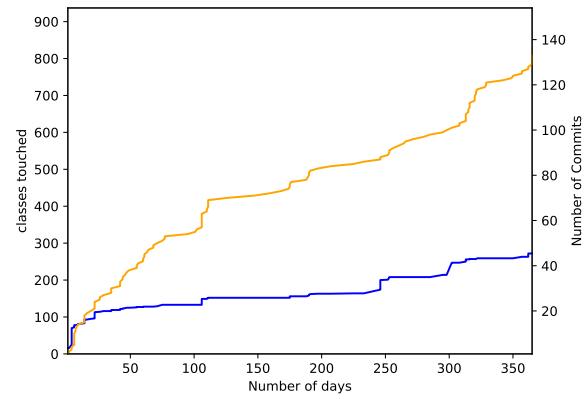
Figure 90: Number of days in the developers first year (x-axis) against packages touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

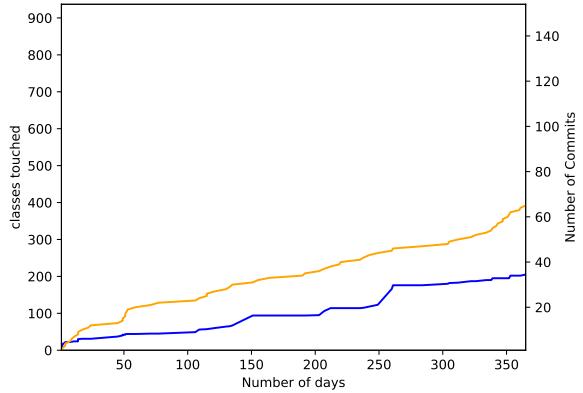
## 8.2 Developer touched - Repository 7: Developer classes knowledge



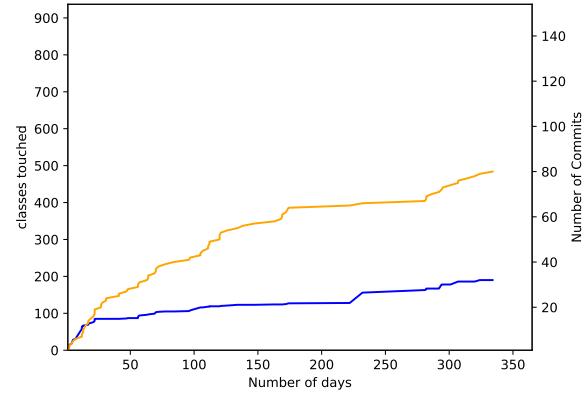
(a) Repository: 7 Developer 1442: Developer touched 936 classes after 96 commits.



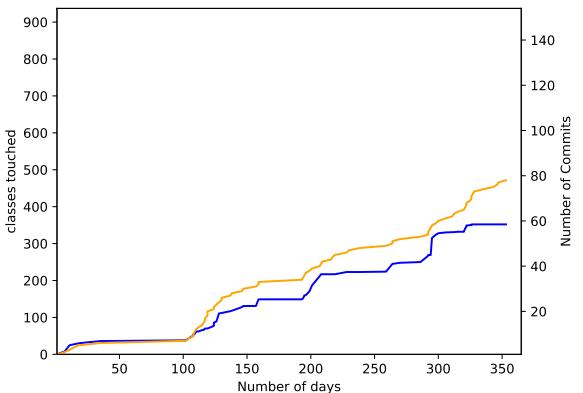
(b) Repository: 7 Developer 1448: Developer touched 272 classes after 133 commits.



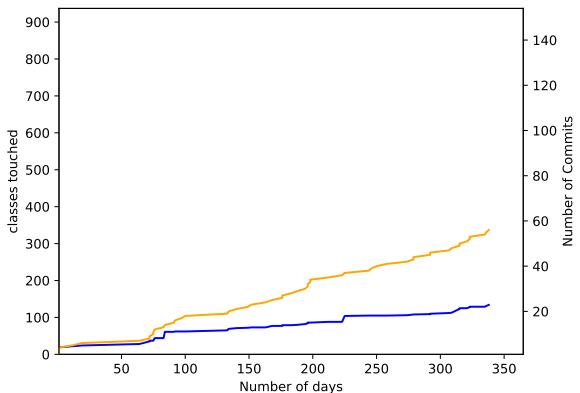
(c) Repository: 7 Developer 1449: Developer touched 205 classes after 65 commits.



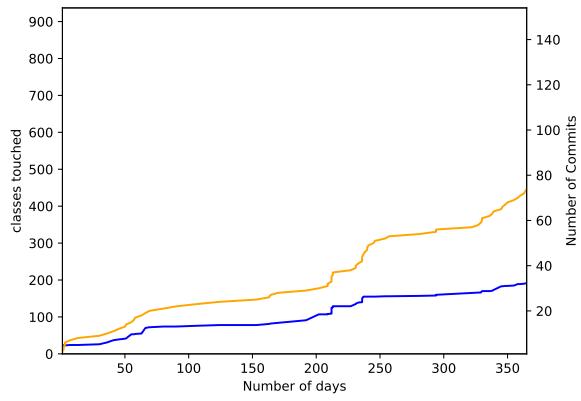
(d) Repository: 7 Developer 1450: Developer touched 190 classes after 80 commits.



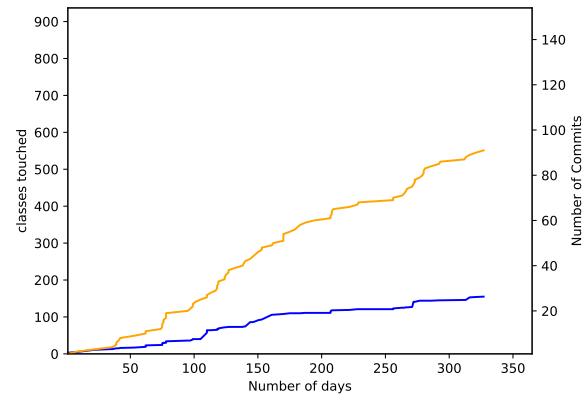
(e) Repository: 7 Developer 1453: Developer touched 352 classes after 78 commits.



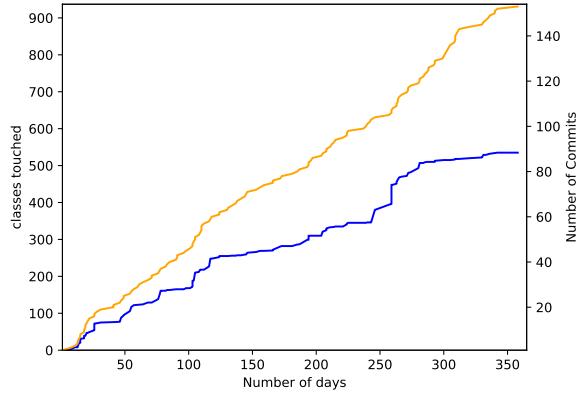
(f) Repository: 7 Developer 1457: Developer touched 134 classes after 56 commits.



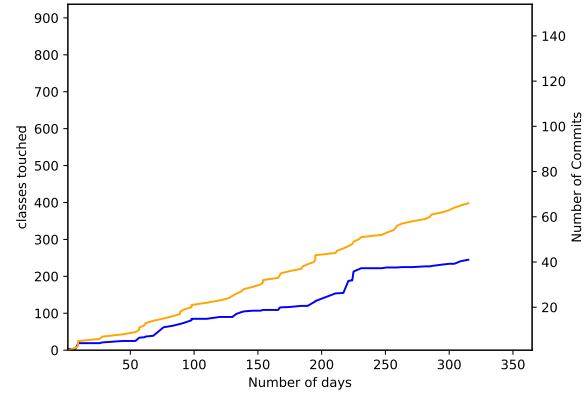
(a) Repository: 7 Developer 1462: Developer touched 191 classes after 74 commits.



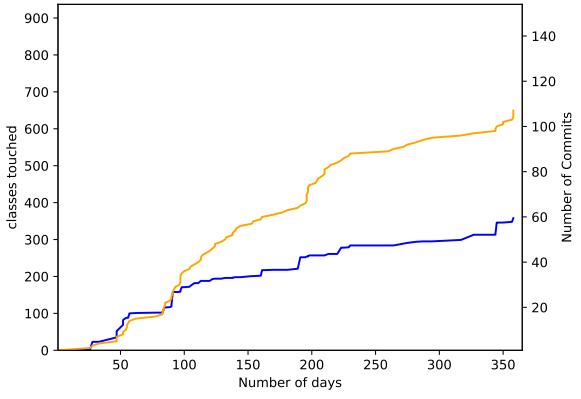
(b) Repository: 7 Developer 1466: Developer touched 155 classes after 91 commits.



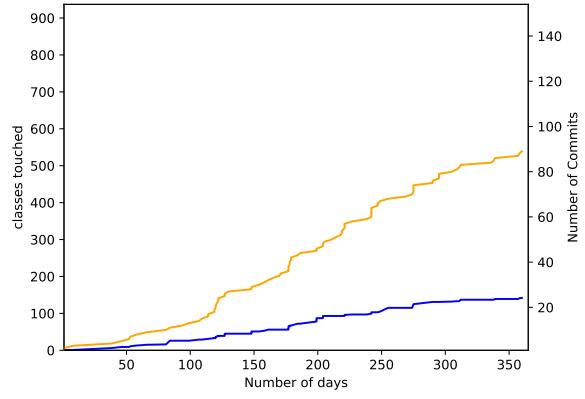
(c) Repository: 7 Developer 1473: Developer touched 535 classes after 153 commits.



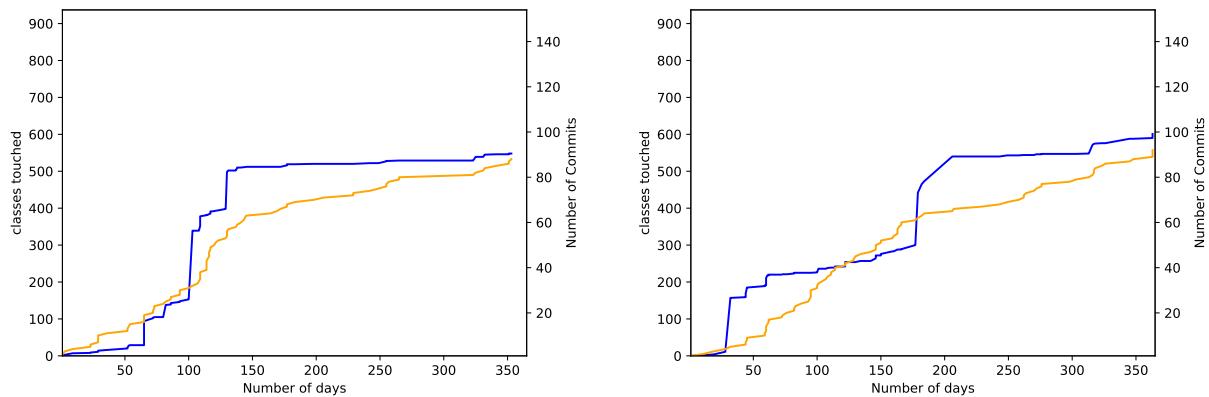
(d) Repository: 7 Developer 1476: Developer touched 245 classes after 66 commits.



(e) Repository: 7 Developer 1480: Developer touched 358 classes after 107 commits.

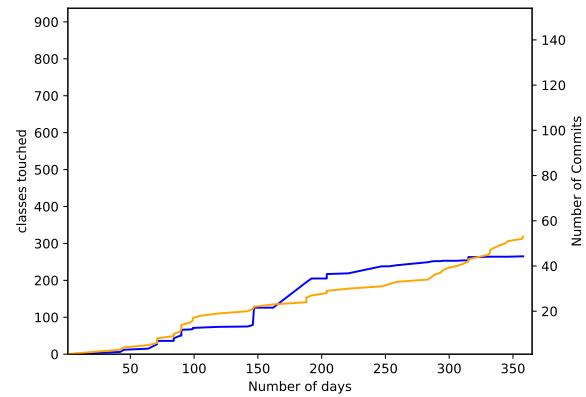


(f) Repository: 7 Developer 1501: Developer touched 142 classes after 89 commits.



(a) Repository: 7 Developer 1504: Developer touched 548 classes after 88 commits.

(b) Repository: 7 Developer 1509: Developer touched 601 classes after 92 commits.

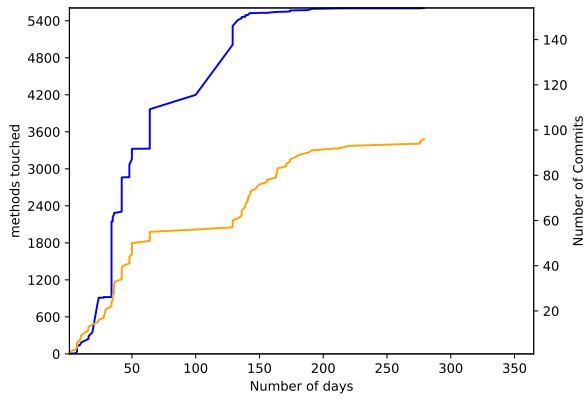


(c) Repository: 7 Developer 1512: Developer touched 265 classes after 53 commits.

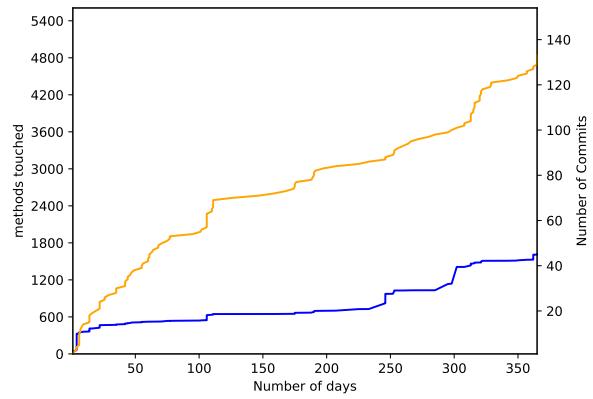
Figure 93: Number of days in the developers first year (x-axis) against classes touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

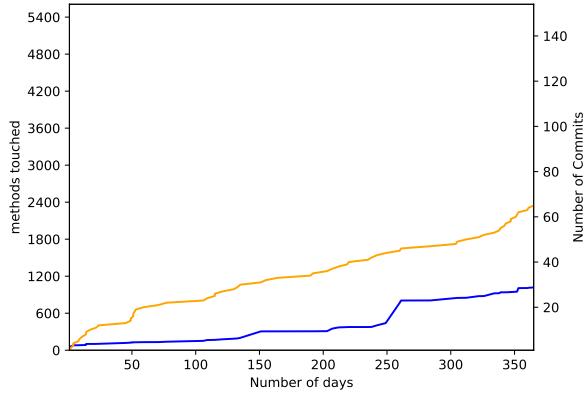
### **8.3 Developer touched - Repository 7: Developer methods knowledge**



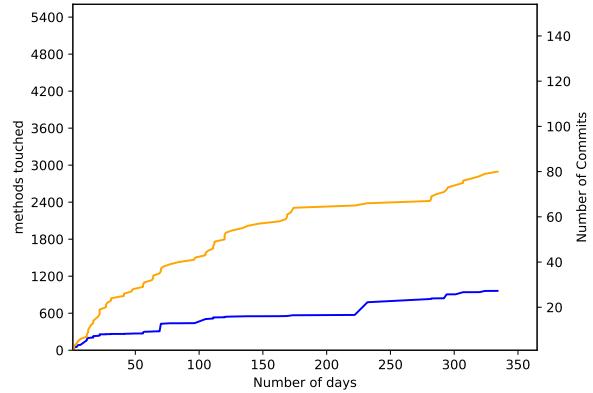
(a) Repository: 7 Developer 1442: Developer touched 5607 methods after 96 commits.



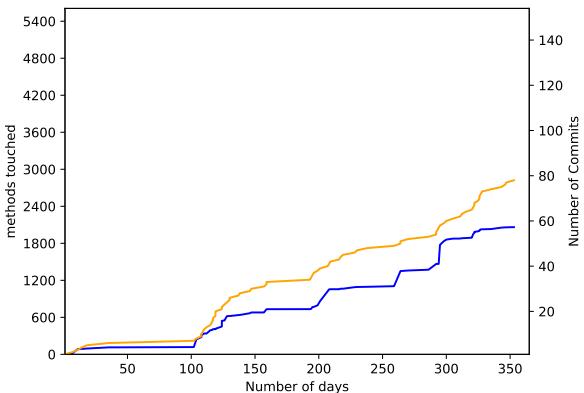
(b) Repository: 7 Developer 1448: Developer touched 1613 methods after 133 commits.



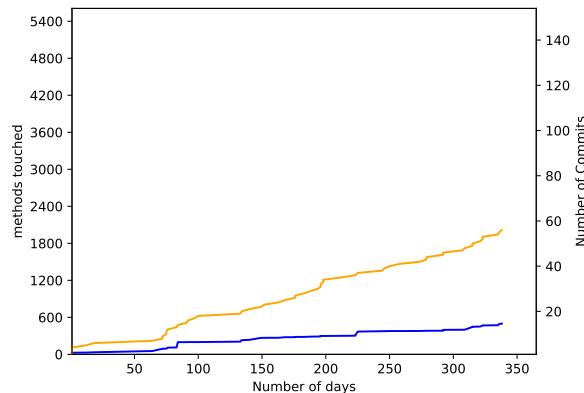
(c) Repository: 7 Developer 1449: Developer touched 1018 methods after 65 commits.



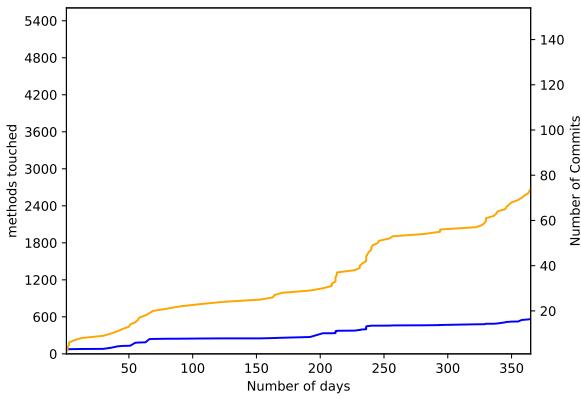
(d) Repository: 7 Developer 1450: Developer touched 962 methods after 80 commits.



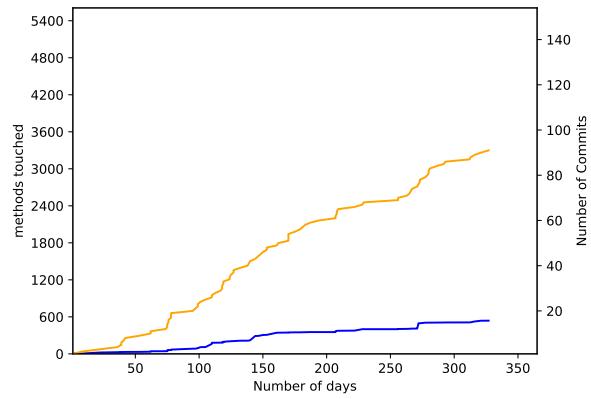
(e) Repository: 7 Developer 1453: Developer touched 2062 methods after 78 commits.



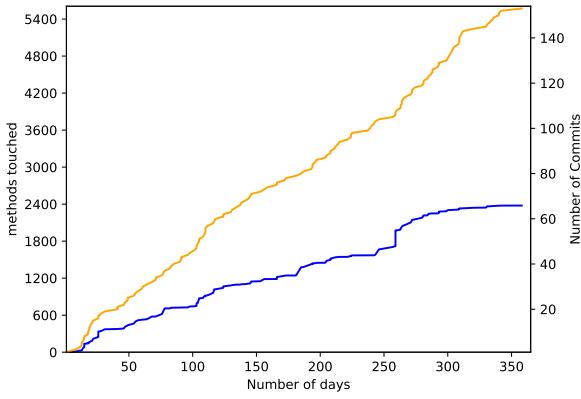
(f) Repository: 7 Developer 1457: Developer touched 498 methods after 56 commits.



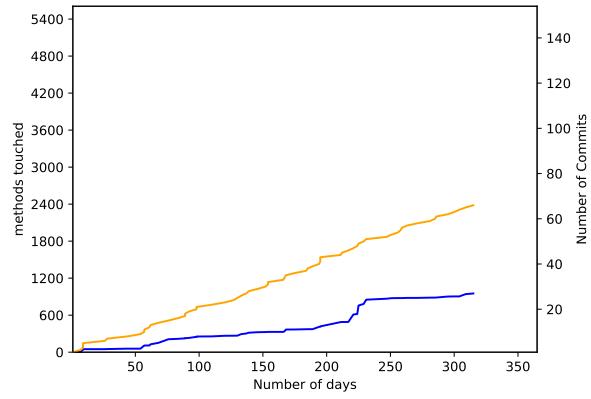
(a) Repository: 7 Developer 1462: Developer touched 562 methods after 74 commits.



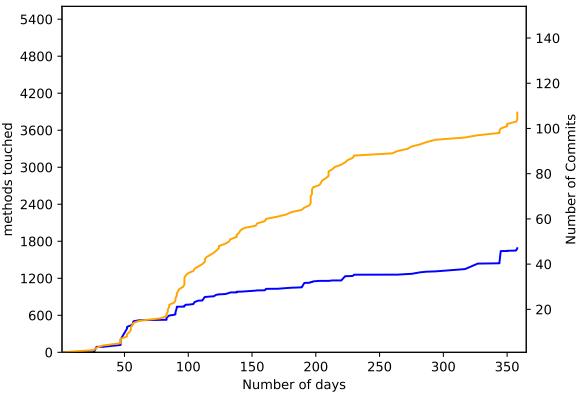
(b) Repository: 7 Developer 1466: Developer touched 538 methods after 91 commits.



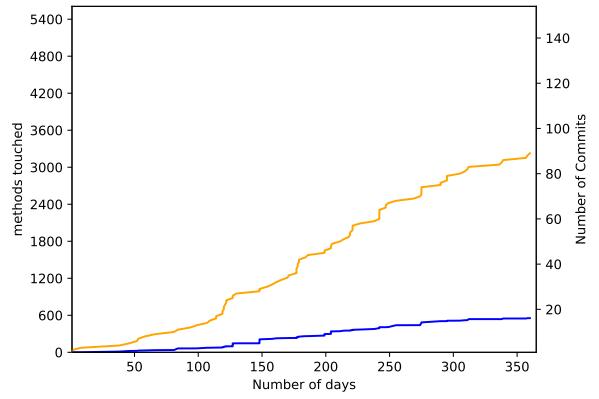
(c) Repository: 7 Developer 1473: Developer touched 2377 methods after 153 commits.



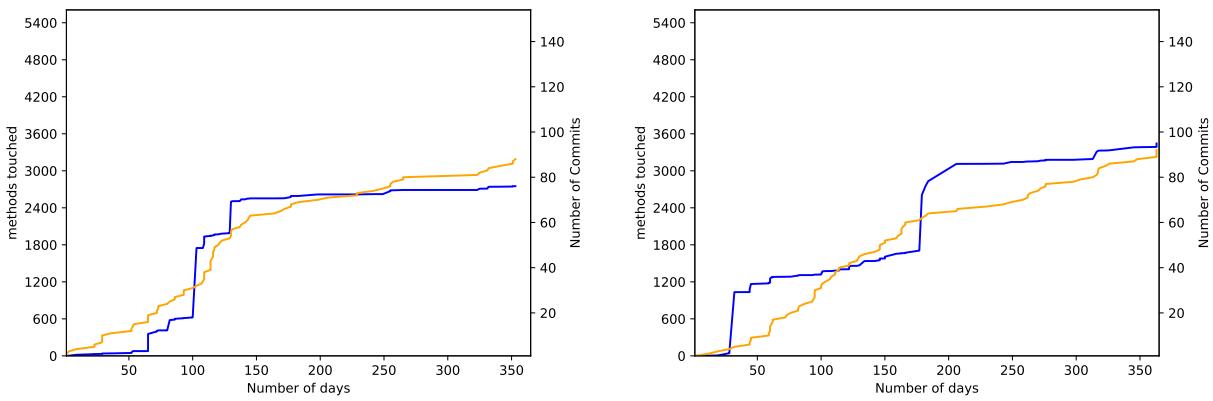
(d) Repository: 7 Developer 1476: Developer touched 952 methods after 66 commits.



(e) Repository: 7 Developer 1480: Developer touched 1687 methods after 107 commits.

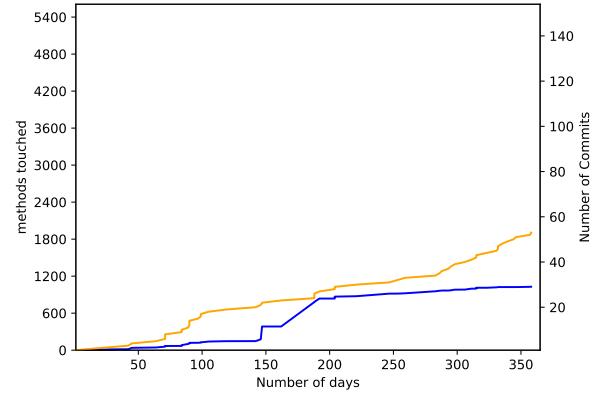


(f) Repository: 7 Developer 1501: Developer touched 554 methods after 89 commits.



(a) Repository: 7 Developer 1504: Developer touched 2751 methods after 88 commits.

(b) Repository: 7 Developer 1509: Developer touched 3443 methods after 92 commits.



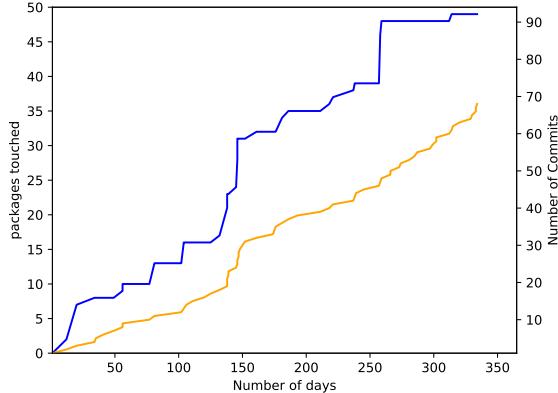
(c) Repository: 7 Developer 1512: Developer touched 1029 methods after 53 commits.

Figure 96: Number of days in the developers first year (x-axis) against methods touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

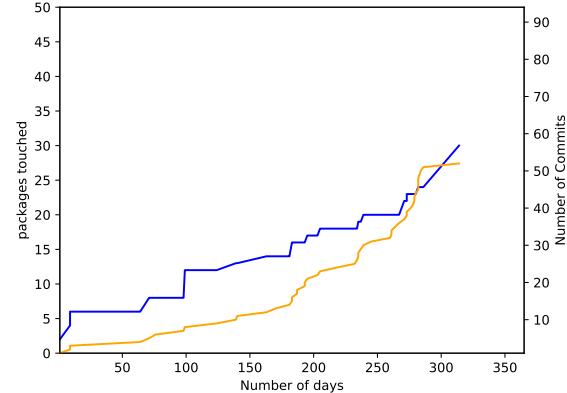
- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## 9 Repository: 10

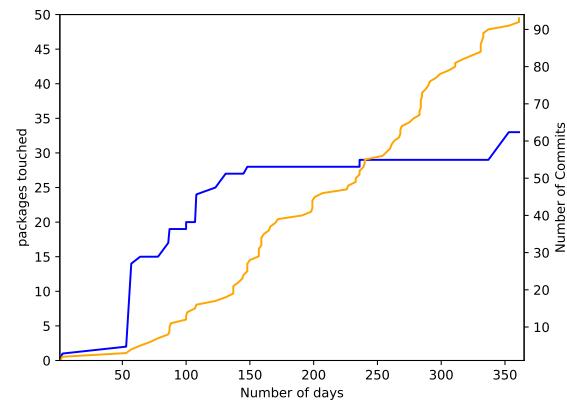
### 9.1 Developer touched - Repository 10: Developer packages knowledge



(a) Repository: 10 Developer 2170: Developer touched 49 packages after 68 commits.



(b) Repository: 10 Developer 2242: Developer touched 30 packages after 52 commits.



(c) Repository: 10 Developer 2254: Developer touched 33 packages after 93 commits.

Figure 97: Number of days in the developers first year (x-axis) against packages touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## 9.2 Developer touched - Repository 10: Developer classes knowledge

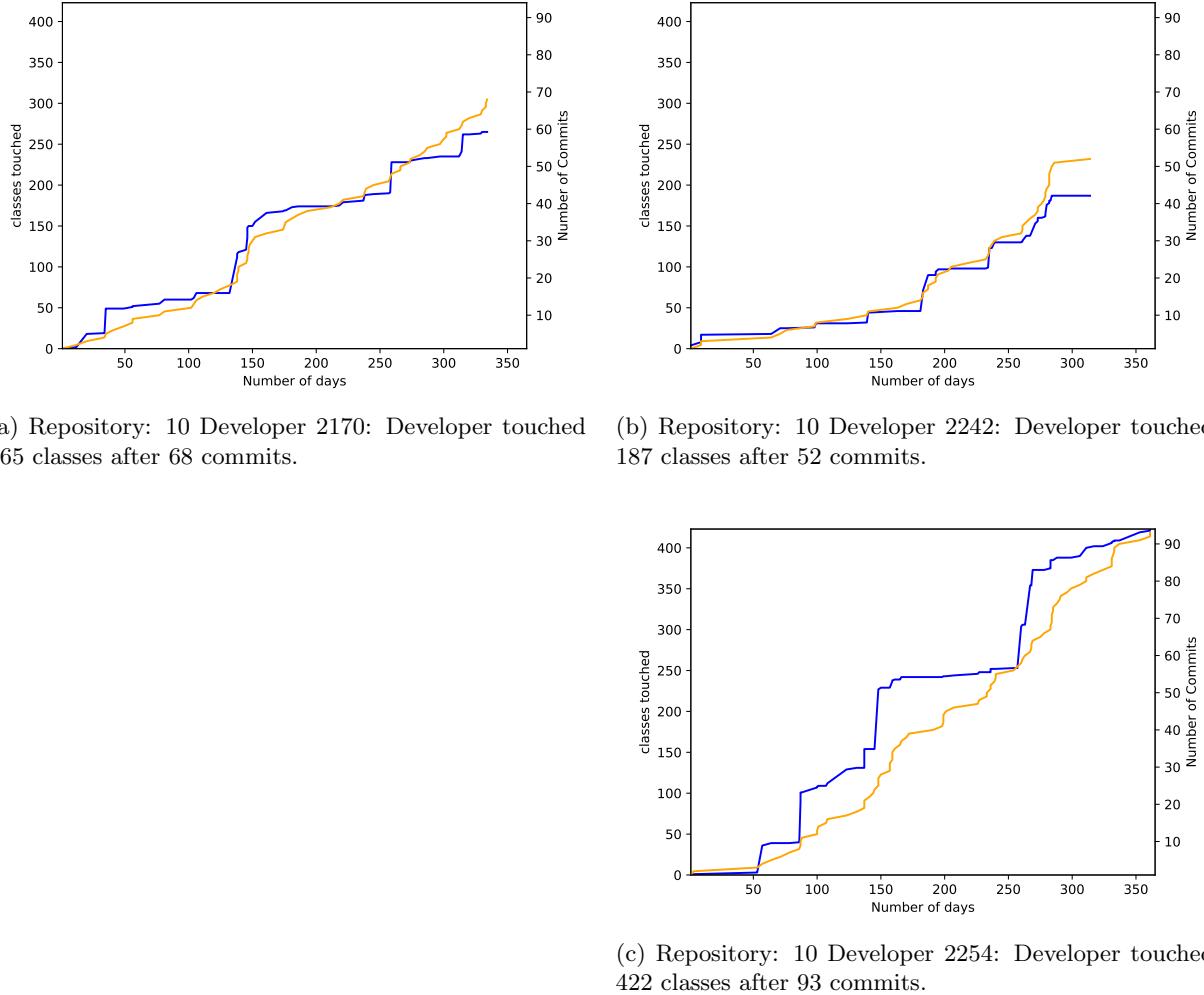


Figure 98: Number of days in the developers first year (x-axis) against classes touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

### 9.3 Developer touched - Repository 10: Developer methods knowledge

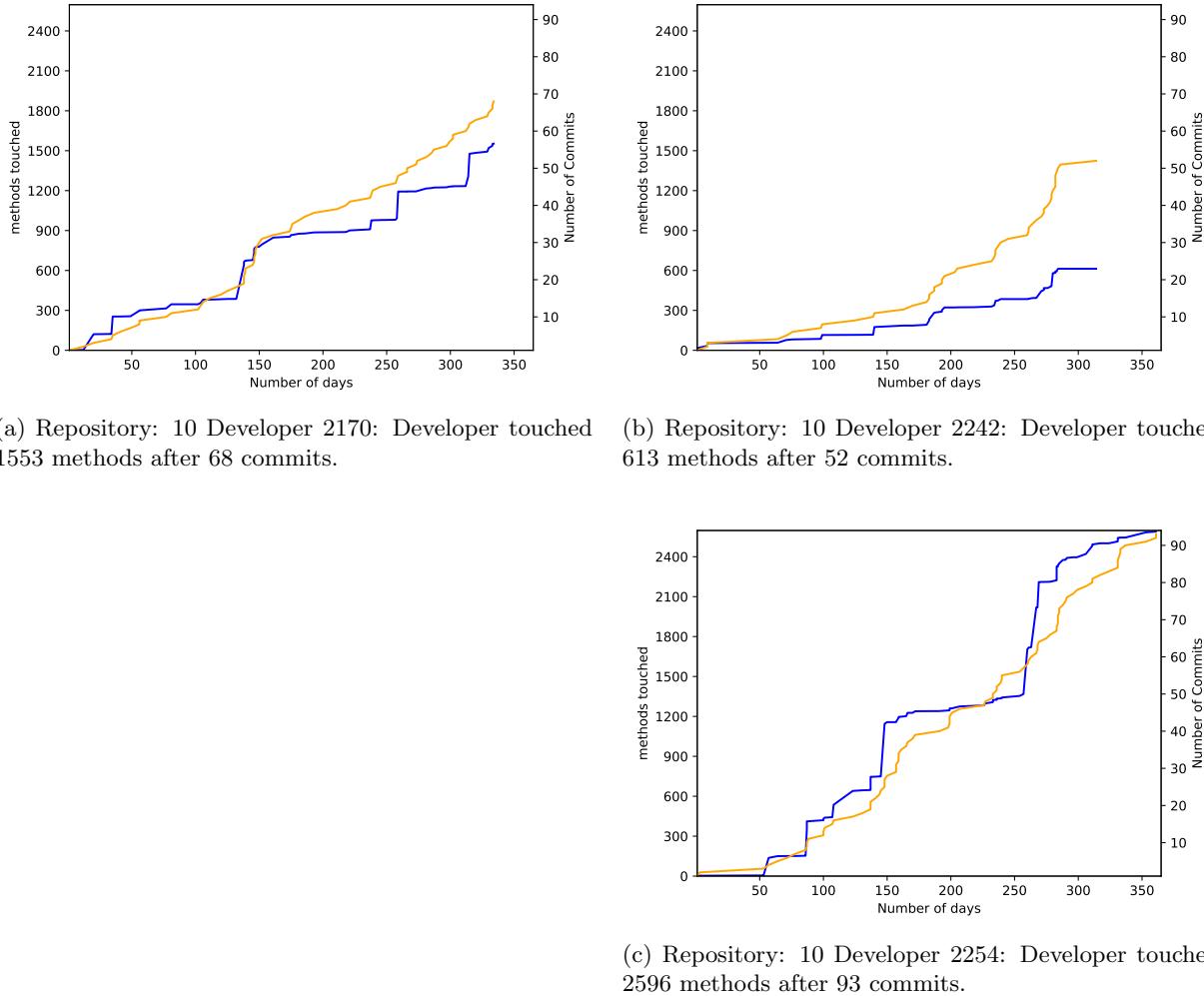
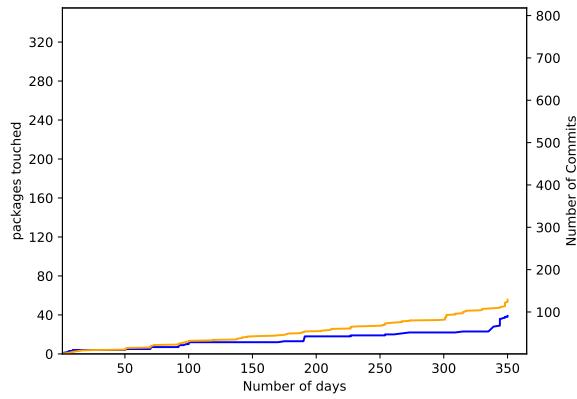


Figure 99: Number of days in the developers first year (x-axis) against methods touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

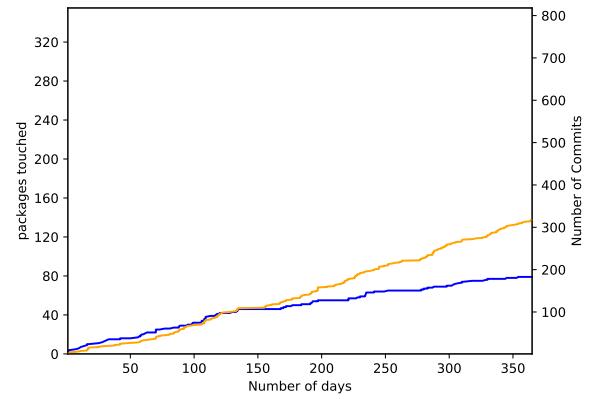
- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## **10 Repository: 15**

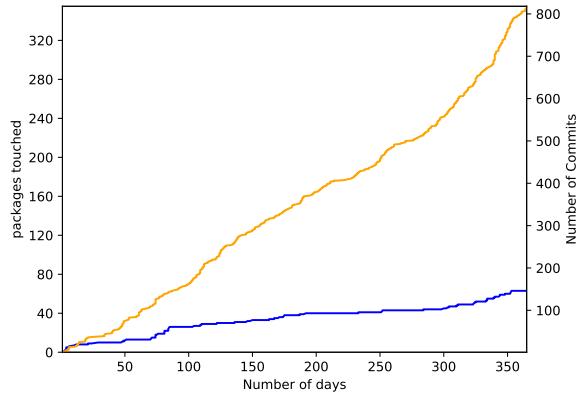
### **10.1 Developer touched - Repository 15: Developer packages knowledge**



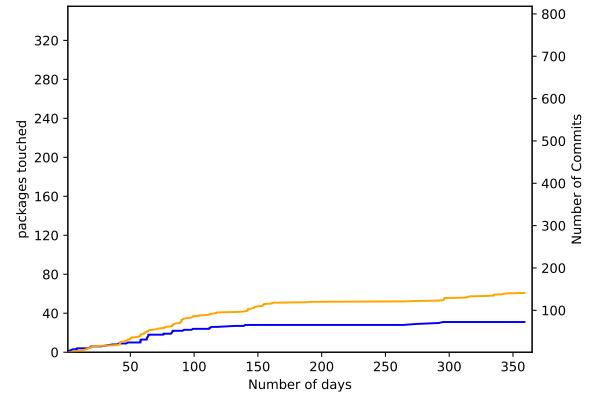
(a) Repository: 15 Developer 3618: Developer touched 39 packages after 129 commits.



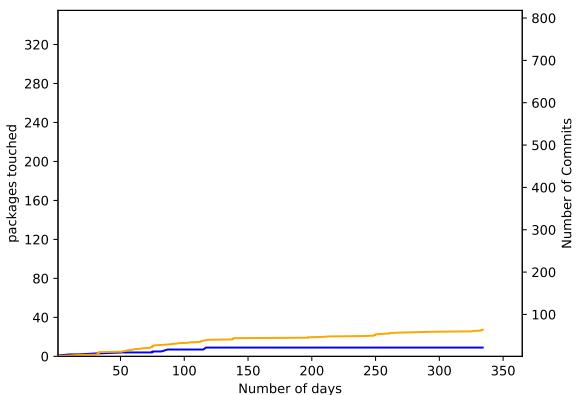
(b) Repository: 15 Developer 3619: Developer touched 79 packages after 318 commits.



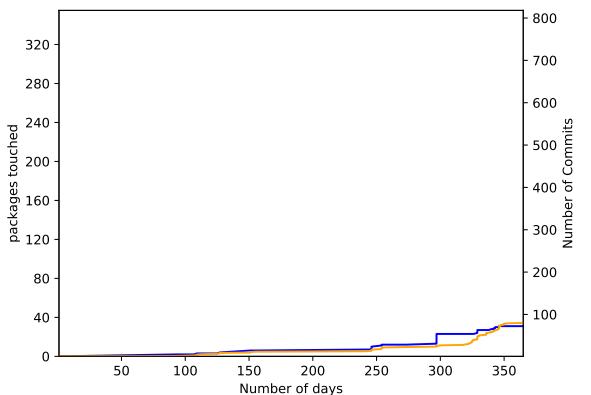
(c) Repository: 15 Developer 3621: Developer touched 63 packages after 817 commits.



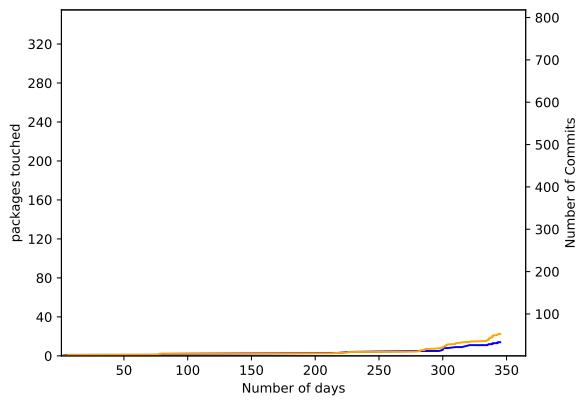
(d) Repository: 15 Developer 3624: Developer touched 31 packages after 141 commits.



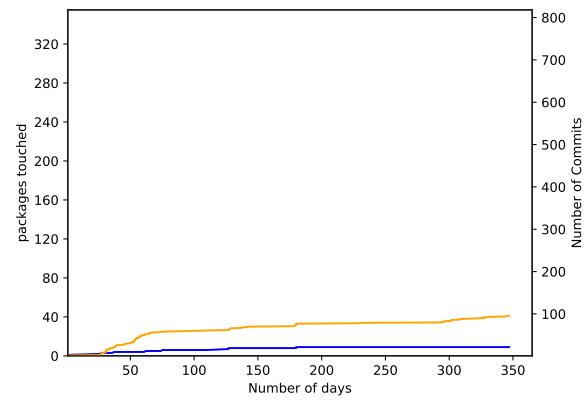
(e) Repository: 15 Developer 3626: Developer touched 9 packages after 64 commits.



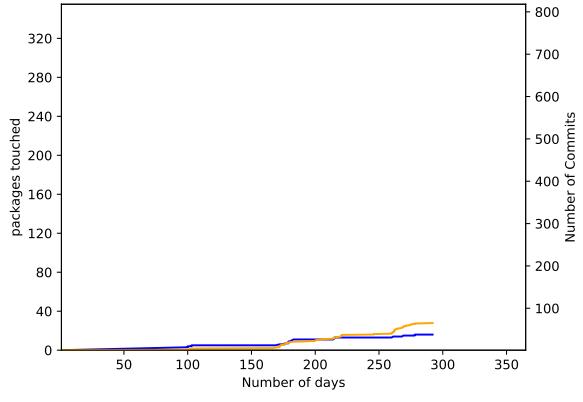
(f) Repository: 15 Developer 3633: Developer touched 31 packages after 82 commits.



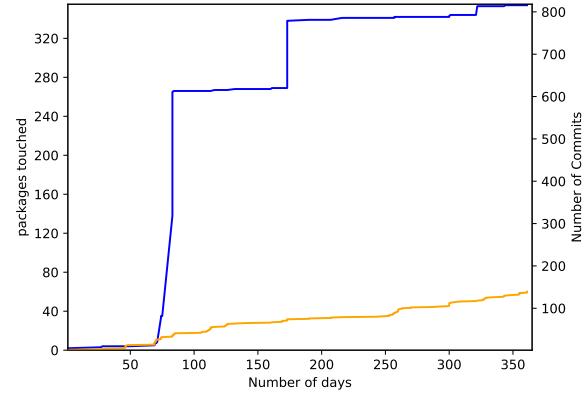
(a) Repository: 15 Developer 3645: Developer touched 14 packages after 53 commits.



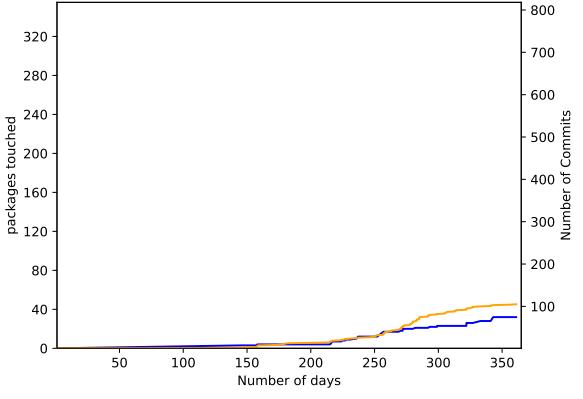
(b) Repository: 15 Developer 3675: Developer touched 9 packages after 96 commits.



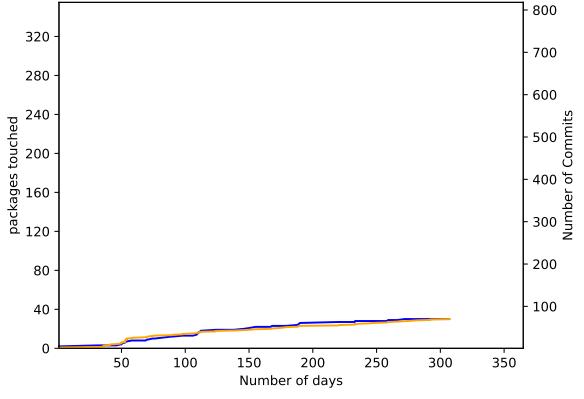
(c) Repository: 15 Developer 3801: Developer touched 16 packages after 65 commits.



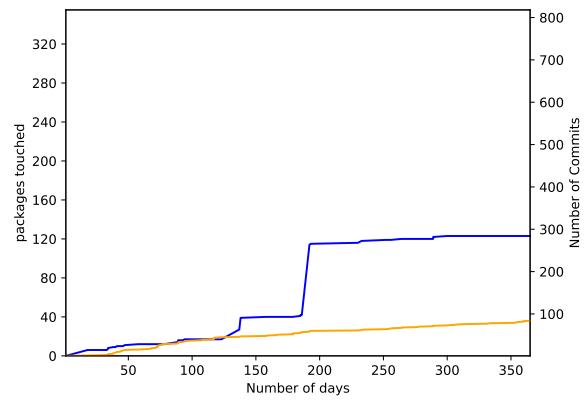
(d) Repository: 15 Developer 3873: Developer touched 354 packages after 139 commits.



(e) Repository: 15 Developer 3883: Developer touched 32 packages after 105 commits.



(f) Repository: 15 Developer 3947: Developer touched 30 packages after 70 commits.

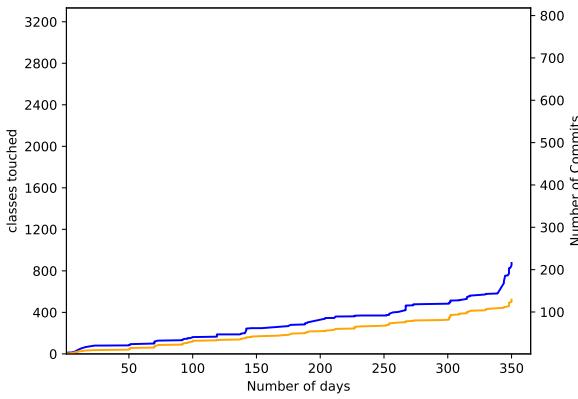


(a) Repository: 15 Developer 4270: Developer touched 123 packages after 84 commits.

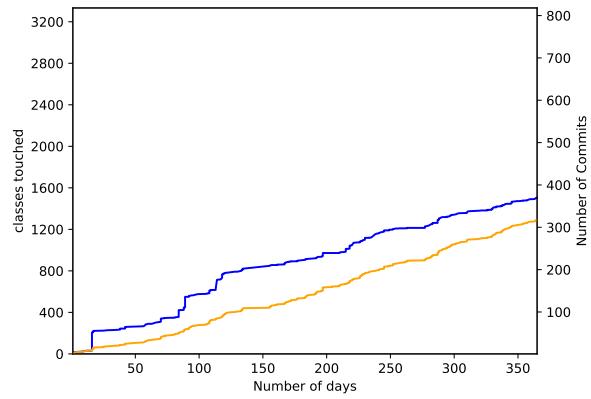
Figure 102: Number of days in the developers first year (x-axis) against packages touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

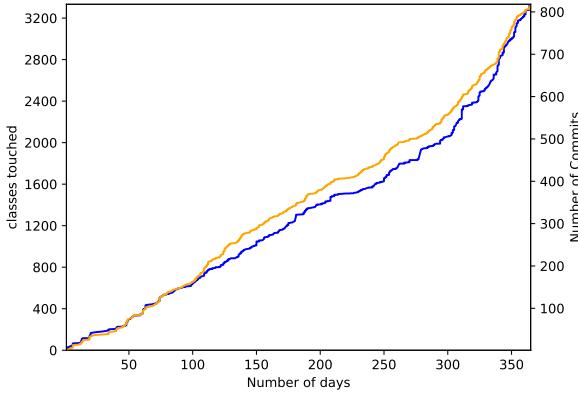
## 10.2 Developer touched - Repository 15: Developer classes knowledge



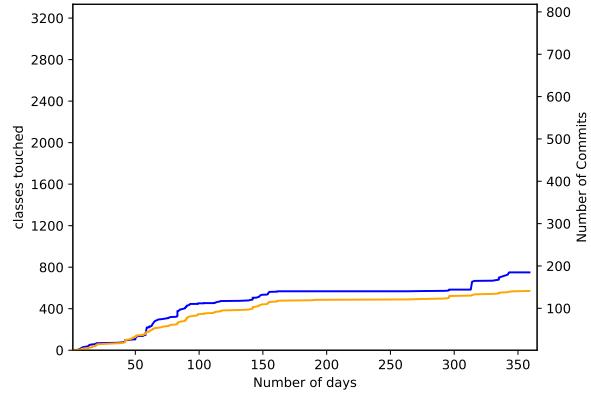
(a) Repository: 15 Developer 3618: Developer touched 876 classes after 129 commits.



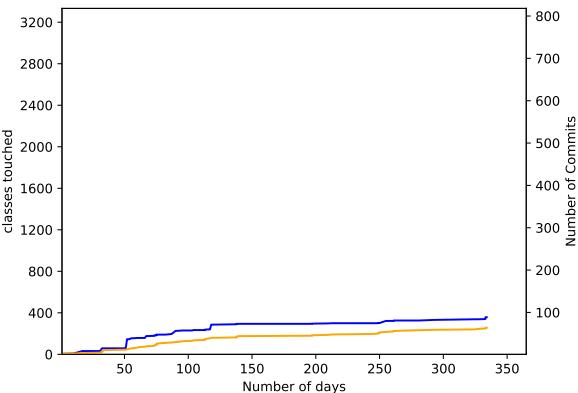
(b) Repository: 15 Developer 3619: Developer touched 1506 classes after 318 commits.



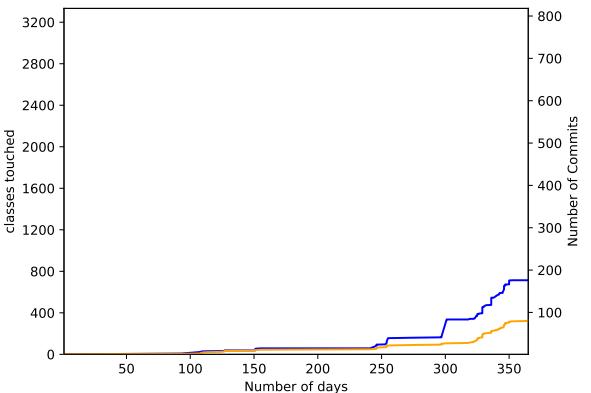
(c) Repository: 15 Developer 3621: Developer touched 3332 classes after 817 commits.



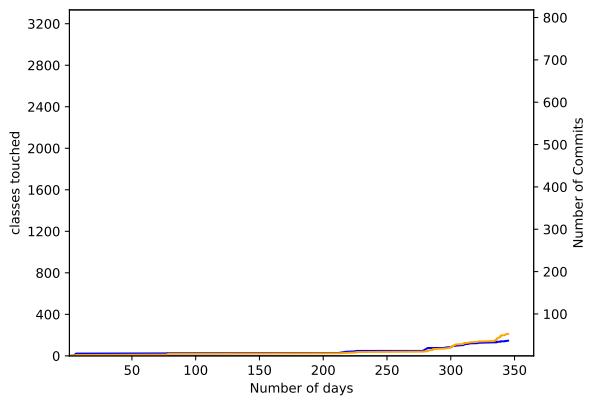
(d) Repository: 15 Developer 3624: Developer touched 750 classes after 141 commits.



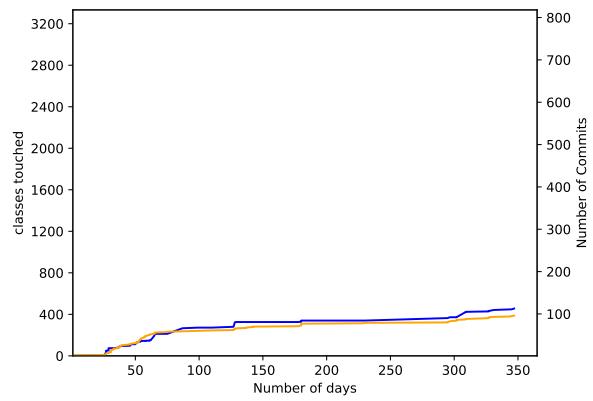
(e) Repository: 15 Developer 3626: Developer touched 358 classes after 64 commits.



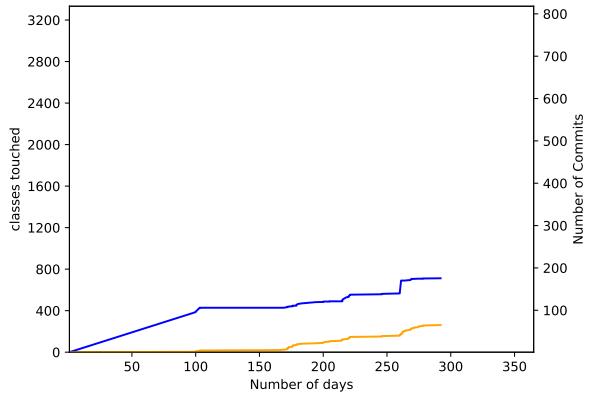
(f) Repository: 15 Developer 3633: Developer touched 720 classes after 82 commits.



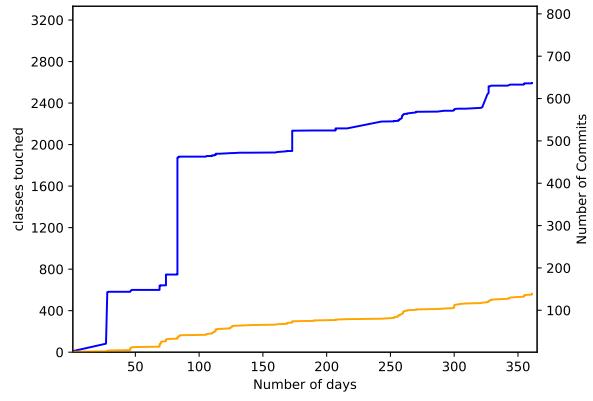
(a) Repository: 15 Developer 3645: Developer touched 146 classes after 53 commits.



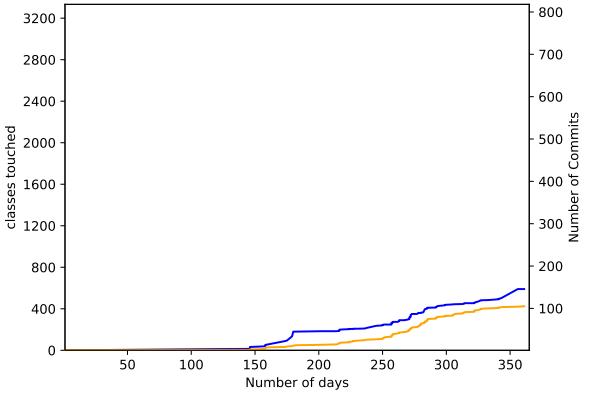
(b) Repository: 15 Developer 3675: Developer touched 456 classes after 96 commits.



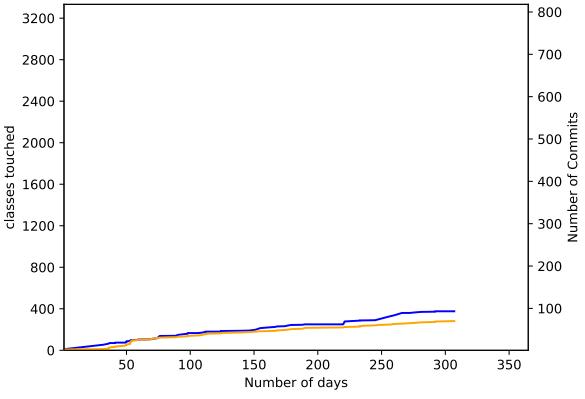
(c) Repository: 15 Developer 3801: Developer touched 712 classes after 65 commits.



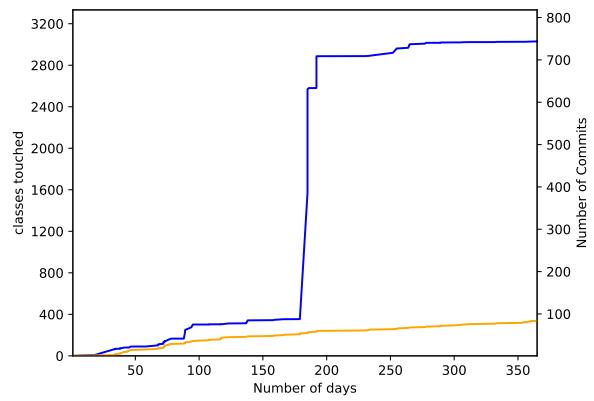
(d) Repository: 15 Developer 3873: Developer touched 2594 classes after 139 commits.



(e) Repository: 15 Developer 3883: Developer touched 590 classes after 105 commits.



(f) Repository: 15 Developer 3947: Developer touched 376 classes after 70 commits.

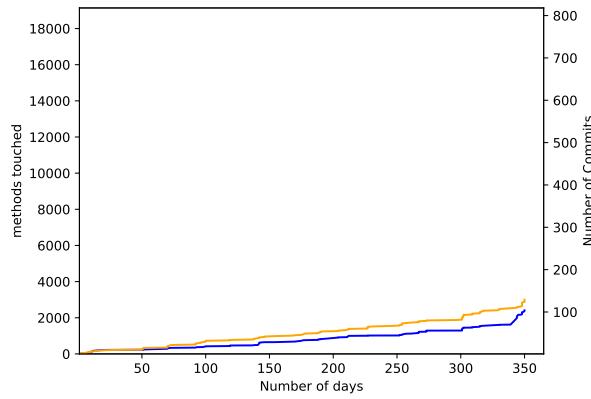


(a) Repository: 15 Developer 4270: Developer touched 3030 classes after 84 commits.

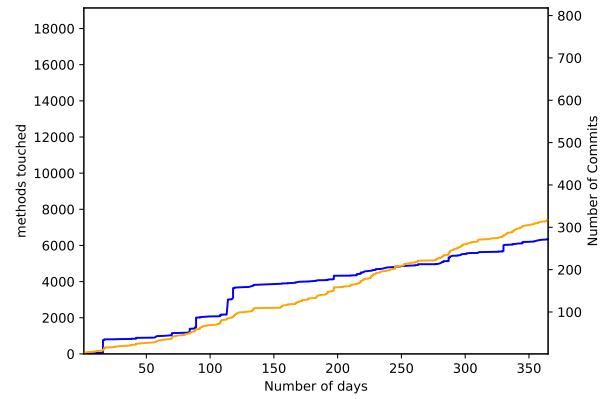
Figure 105: Number of days in the developers first year (x-axis) against classes touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

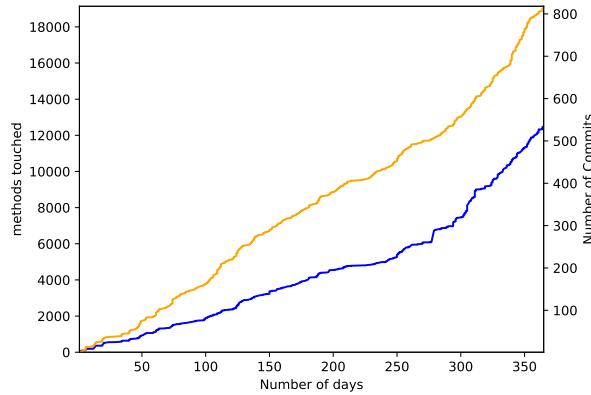
### **10.3 Developer touched - Repository 15: Developer methods knowledge**



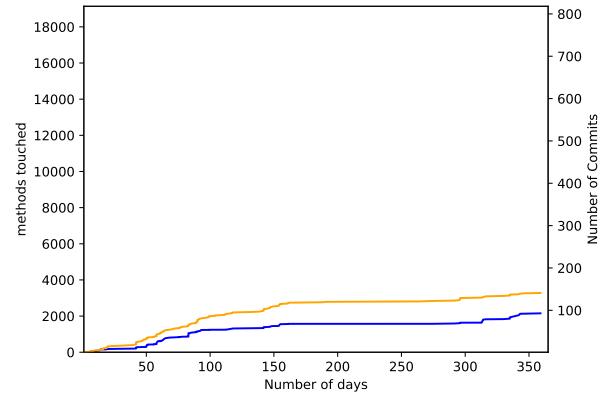
(a) Repository: 15 Developer 3618: Developer touched 2410 methods after 129 commits.



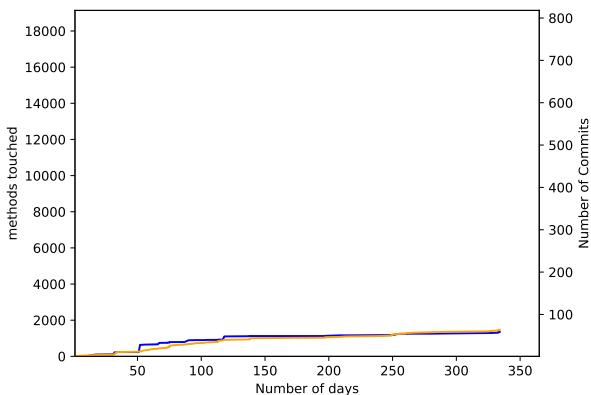
(b) Repository: 15 Developer 3619: Developer touched 6342 methods after 318 commits.



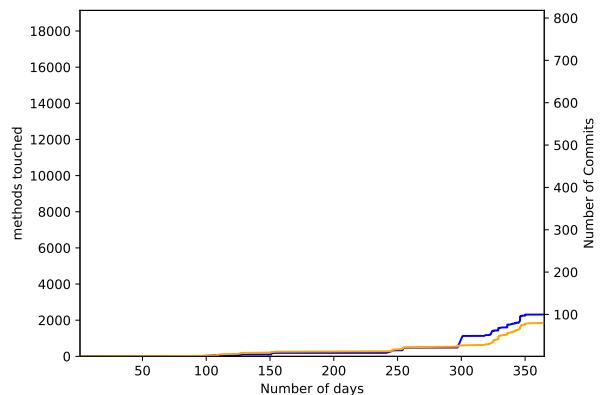
(c) Repository: 15 Developer 3621: Developer touched 12506 methods after 817 commits.



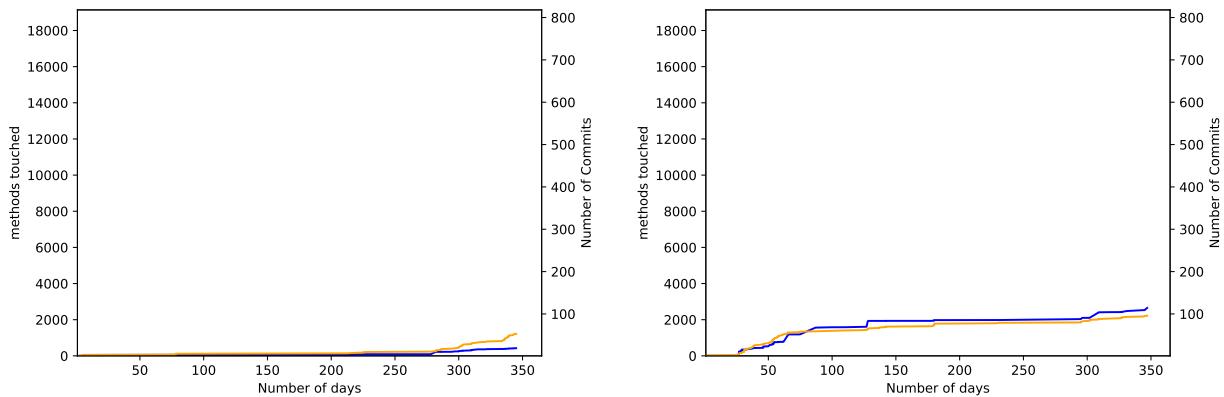
(d) Repository: 15 Developer 3624: Developer touched 2152 methods after 141 commits.



(e) Repository: 15 Developer 3626: Developer touched 1354 methods after 64 commits.

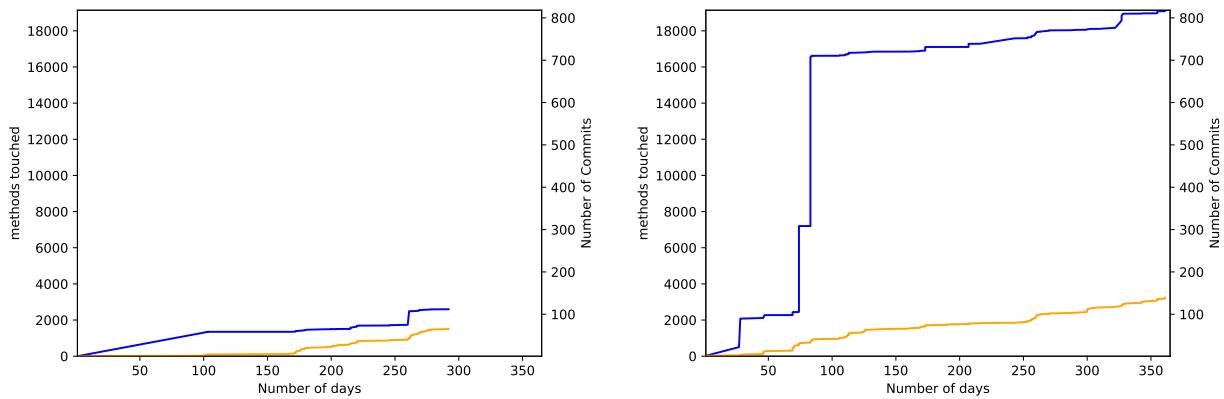


(f) Repository: 15 Developer 3633: Developer touched 2352 methods after 82 commits.



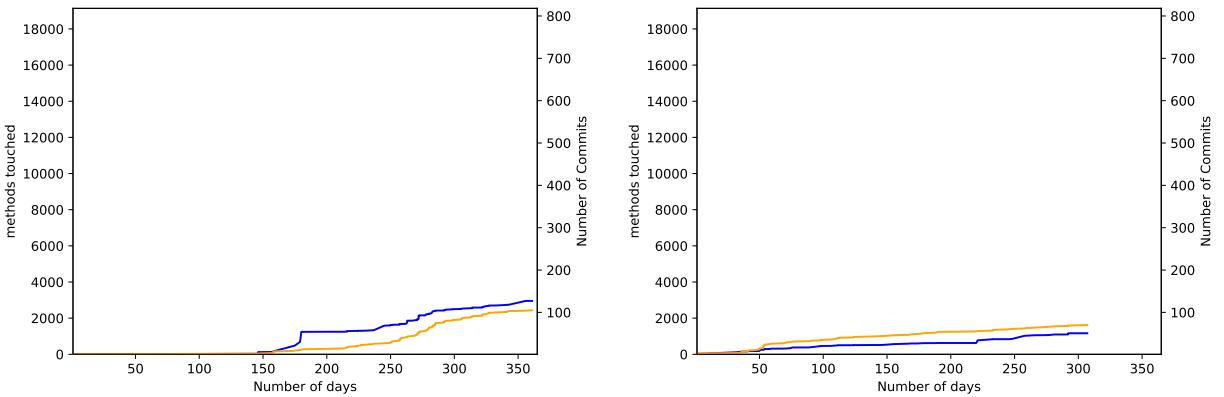
(a) Repository: 15 Developer 3645: Developer touched 422 methods after 53 commits.

(b) Repository: 15 Developer 3675: Developer touched 2650 methods after 96 commits.



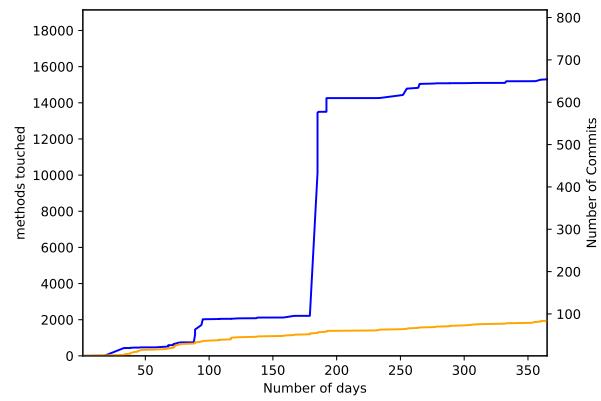
(c) Repository: 15 Developer 3801: Developer touched 2596 methods after 65 commits.

(d) Repository: 15 Developer 3873: Developer touched 19138 methods after 139 commits.



(e) Repository: 15 Developer 3883: Developer touched 2954 methods after 105 commits.

(f) Repository: 15 Developer 3947: Developer touched 1164 methods after 70 commits.



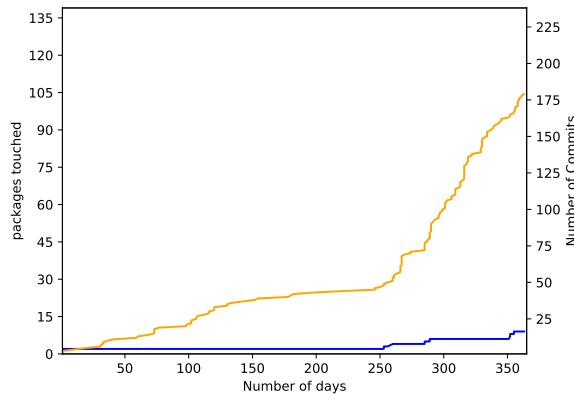
(a) Repository: 15 Developer 4270: Developer touched 15302 methods after 84 commits.

Figure 108: Number of days in the developers first year (x-axis) against methods touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

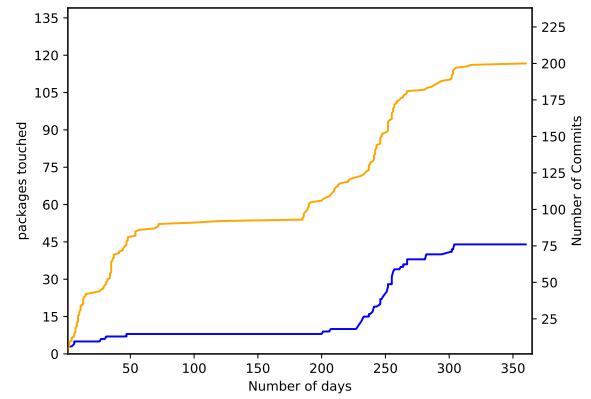
- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## 11 Repository: 18

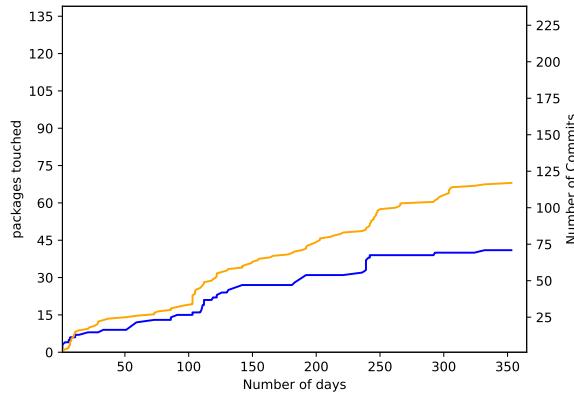
### 11.1 Developer touched - Repository 18: Developer packages knowledge



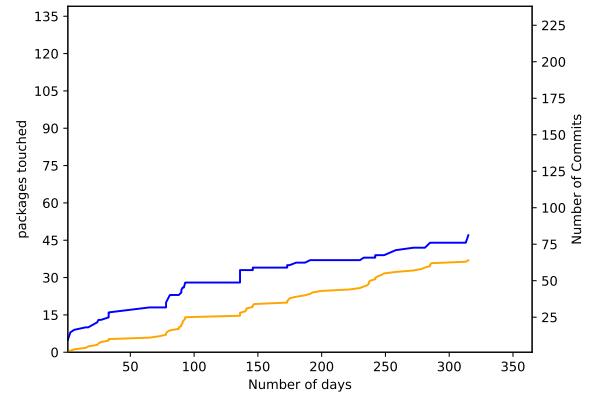
(a) Repository: 18 Developer 5327: Developer touched 9 packages after 179 commits.



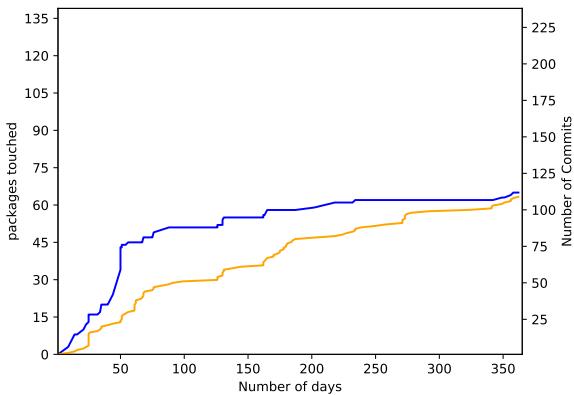
(b) Repository: 18 Developer 5328: Developer touched 44 packages after 200 commits.



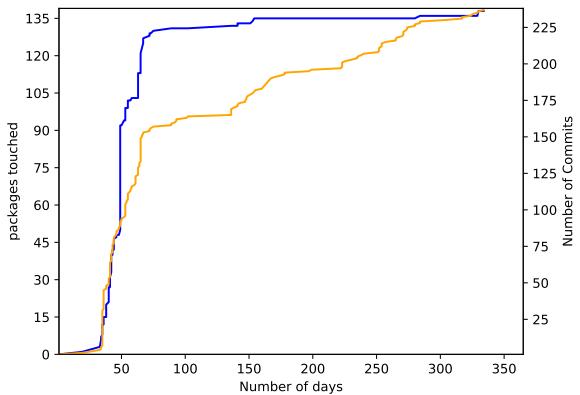
(c) Repository: 18 Developer 5329: Developer touched 41 packages after 117 commits.



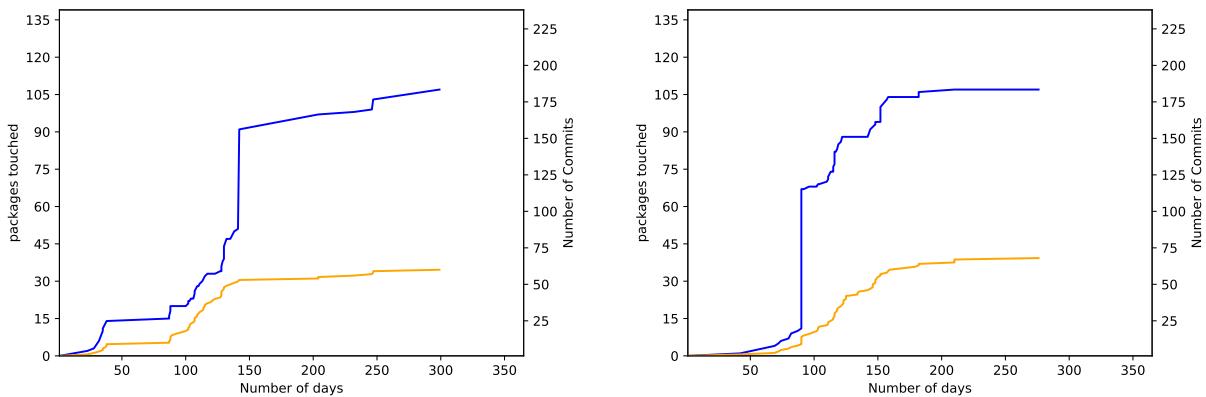
(d) Repository: 18 Developer 5380: Developer touched 47 packages after 64 commits.



(e) Repository: 18 Developer 5381: Developer touched 65 packages after 109 commits.

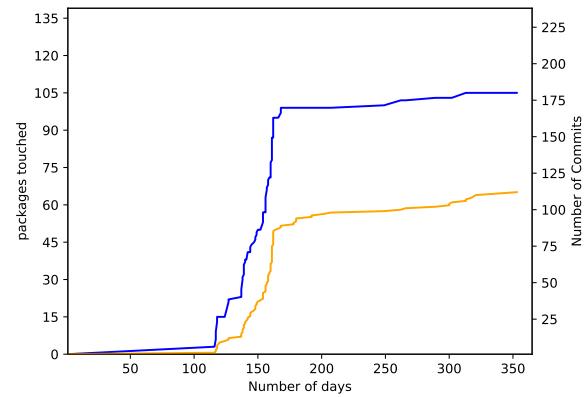


(f) Repository: 18 Developer 5393: Developer touched 138 packages after 237 commits.



(a) Repository: 18 Developer 5456: Developer touched 107 packages after 60 commits.

(b) Repository: 18 Developer 5470: Developer touched 107 packages after 68 commits.

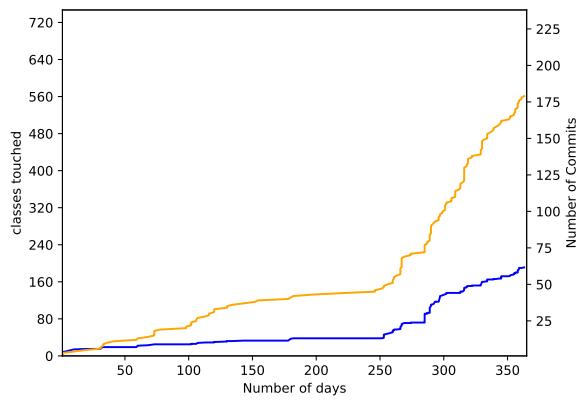


(c) Repository: 18 Developer 5558: Developer touched 105 packages after 112 commits.

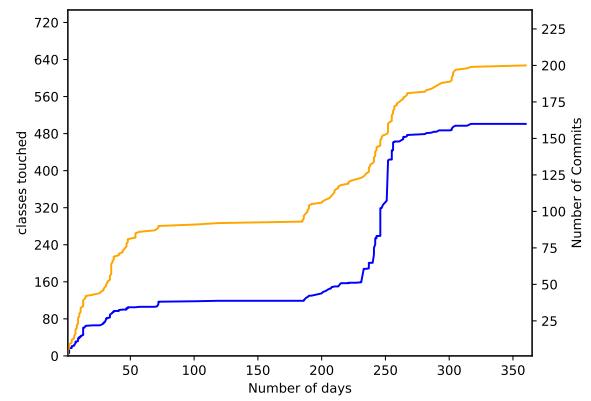
Figure 110: Number of days in the developers first year (x-axis) against packages touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

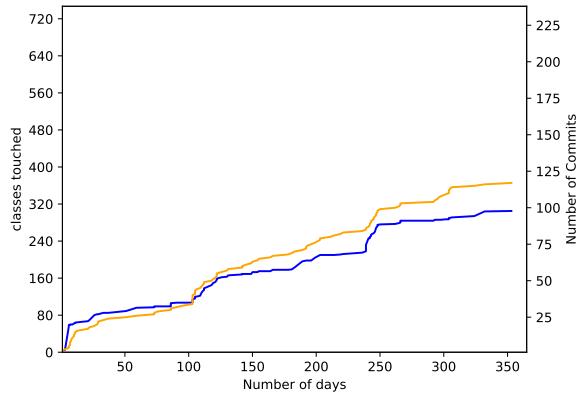
## 11.2 Developer touched - Repository 18: Developer classes knowledge



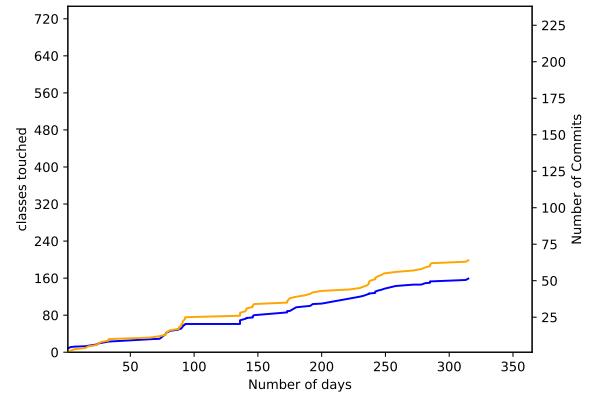
(a) Repository: 18 Developer 5327: Developer touched 191 classes after 179 commits.



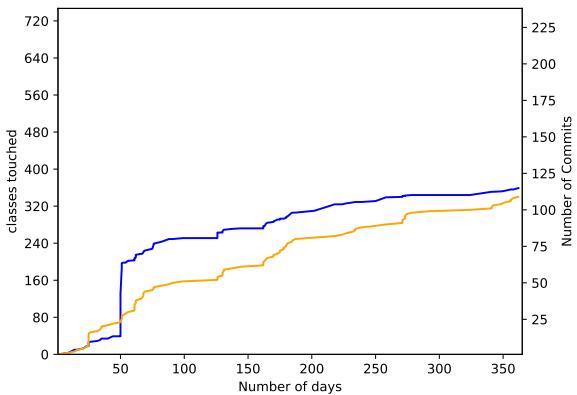
(b) Repository: 18 Developer 5328: Developer touched 501 classes after 200 commits.



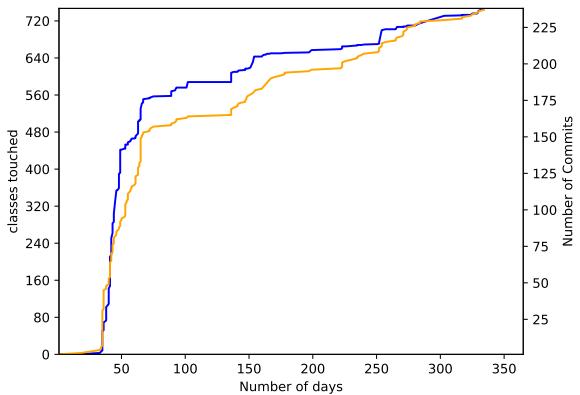
(c) Repository: 18 Developer 5329: Developer touched 305 classes after 117 commits.



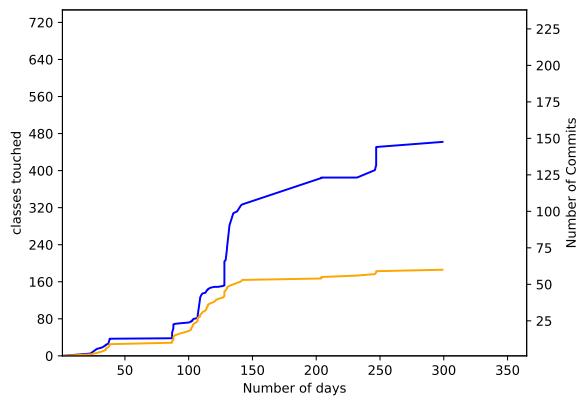
(d) Repository: 18 Developer 5380: Developer touched 159 classes after 64 commits.



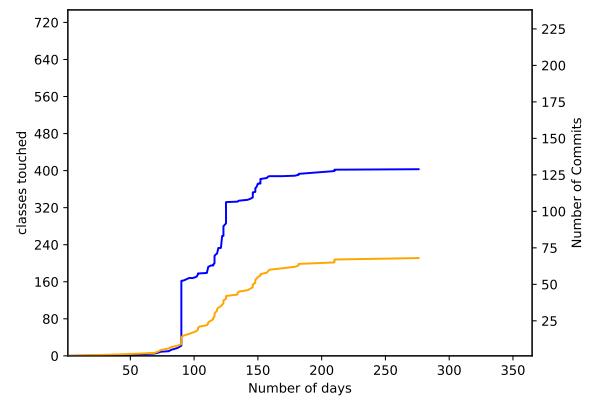
(e) Repository: 18 Developer 5381: Developer touched 359 classes after 109 commits.



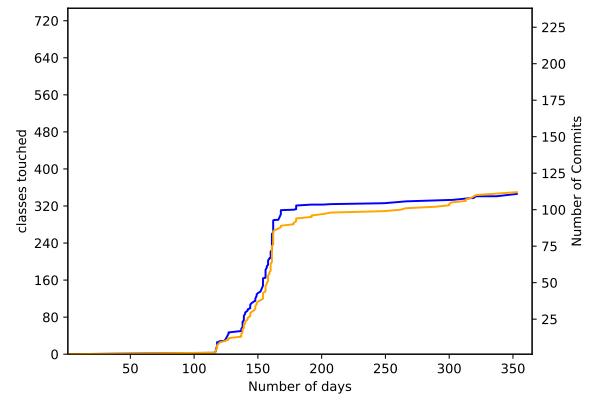
(f) Repository: 18 Developer 5393: Developer touched 746 classes after 237 commits.



(a) Repository: 18 Developer 5456: Developer touched 462 classes after 60 commits.



(b) Repository: 18 Developer 5470: Developer touched 403 classes after 68 commits.

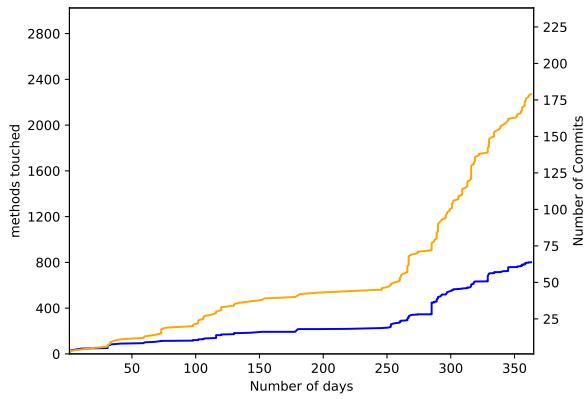


(c) Repository: 18 Developer 5558: Developer touched 346 classes after 112 commits.

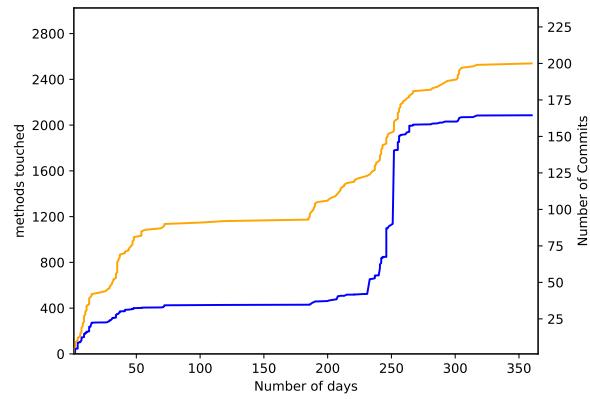
Figure 112: Number of days in the developers first year (x-axis) against classes touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

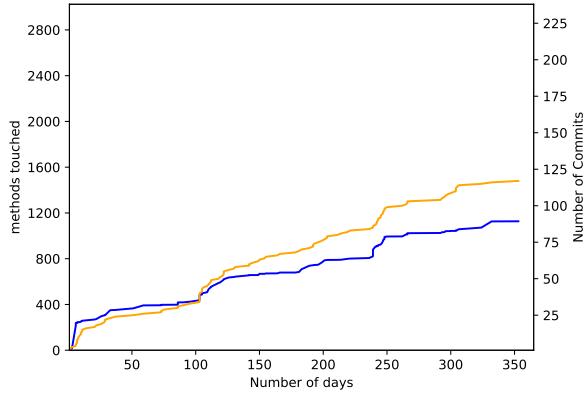
### **11.3 Developer touched - Repository 18: Developer methods knowledge**



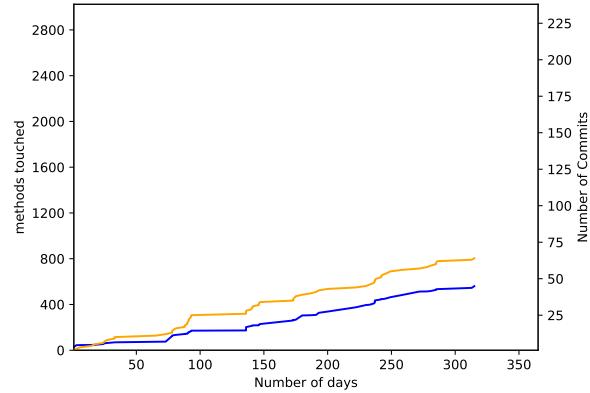
(a) Repository: 18 Developer 5327: Developer touched 801 methods after 179 commits.



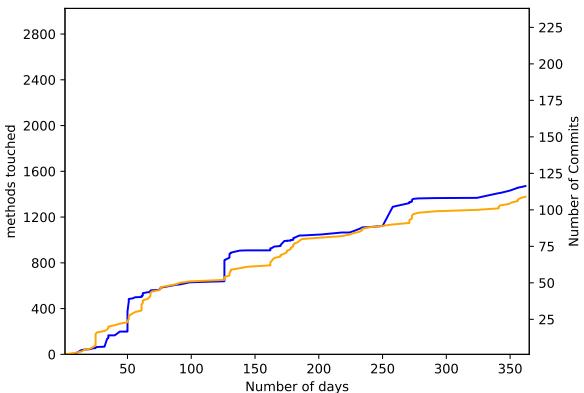
(b) Repository: 18 Developer 5328: Developer touched 2086 methods after 200 commits.



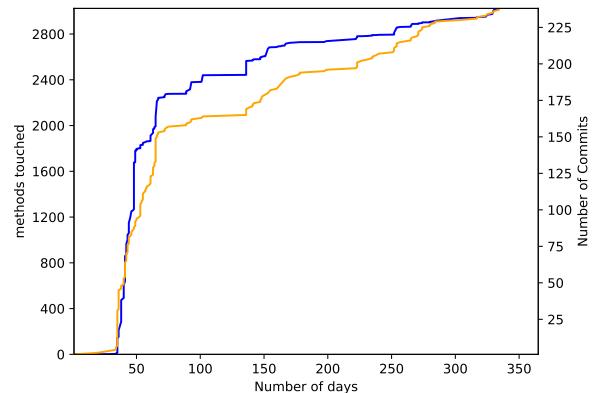
(c) Repository: 18 Developer 5329: Developer touched 1127 methods after 117 commits.



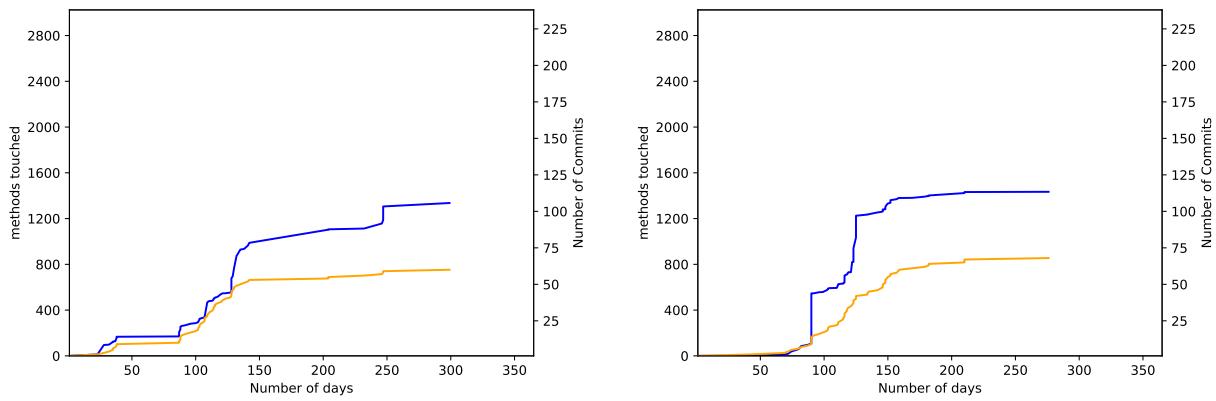
(d) Repository: 18 Developer 5380: Developer touched 560 methods after 64 commits.



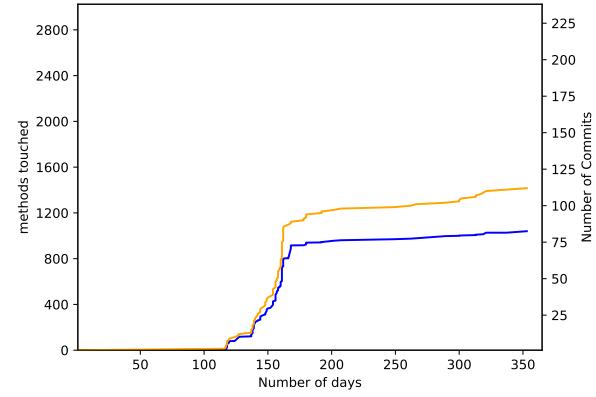
(e) Repository: 18 Developer 5381: Developer touched 1471 methods after 109 commits.



(f) Repository: 18 Developer 5393: Developer touched 3023 methods after 237 commits.



(b) Repository: 18 Developer 5470: Developer touched 1434 methods after 68 commits.



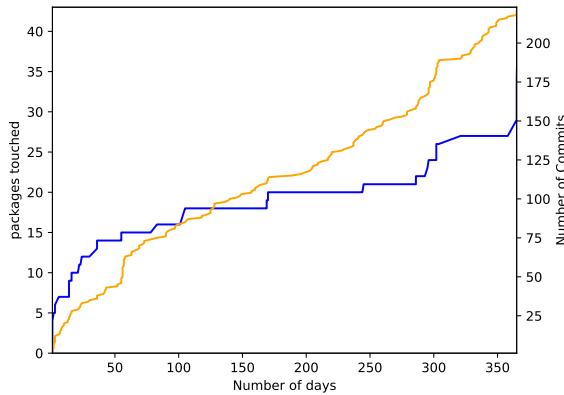
(c) Repository: 18 Developer 5558: Developer touched 1040 methods after 112 commits.

Figure 114: Number of days in the developers first year (x-axis) against methods touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

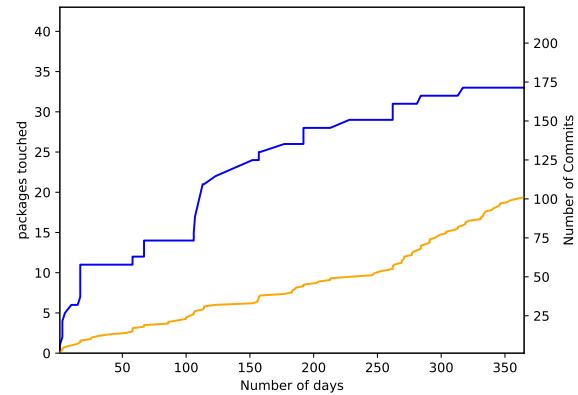
- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## 12 Repository: 20

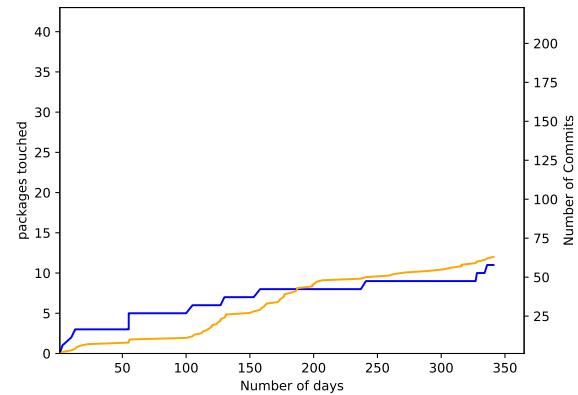
### 12.1 Developer touched - Repository 20: Developer packages knowledge



(a) Repository: 20 Developer 2682: Developer touched 42 packages after 222 commits.



(b) Repository: 20 Developer 3787: Developer touched 33 packages after 101 commits.



(c) Repository: 20 Developer 6056: Developer touched 11 packages after 63 commits.

Figure 115: Number of days in the developers first year (x-axis) against packages touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## 12.2 Developer touched - Repository 20: Developer classes knowledge

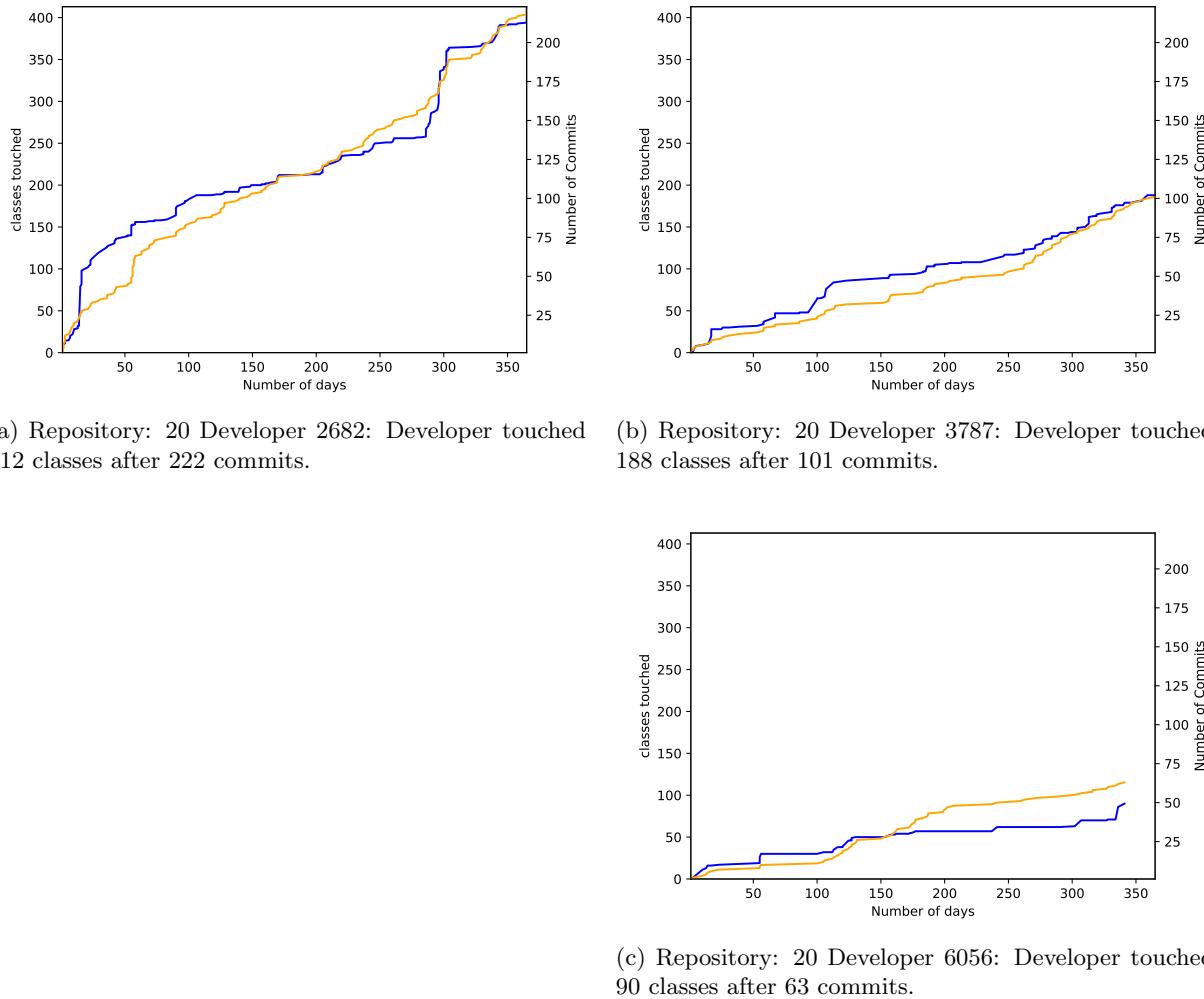


Figure 116: Number of days in the developers first year (x-axis) against classes touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

### 12.3 Developer touched - Repository 20: Developer methods knowledge

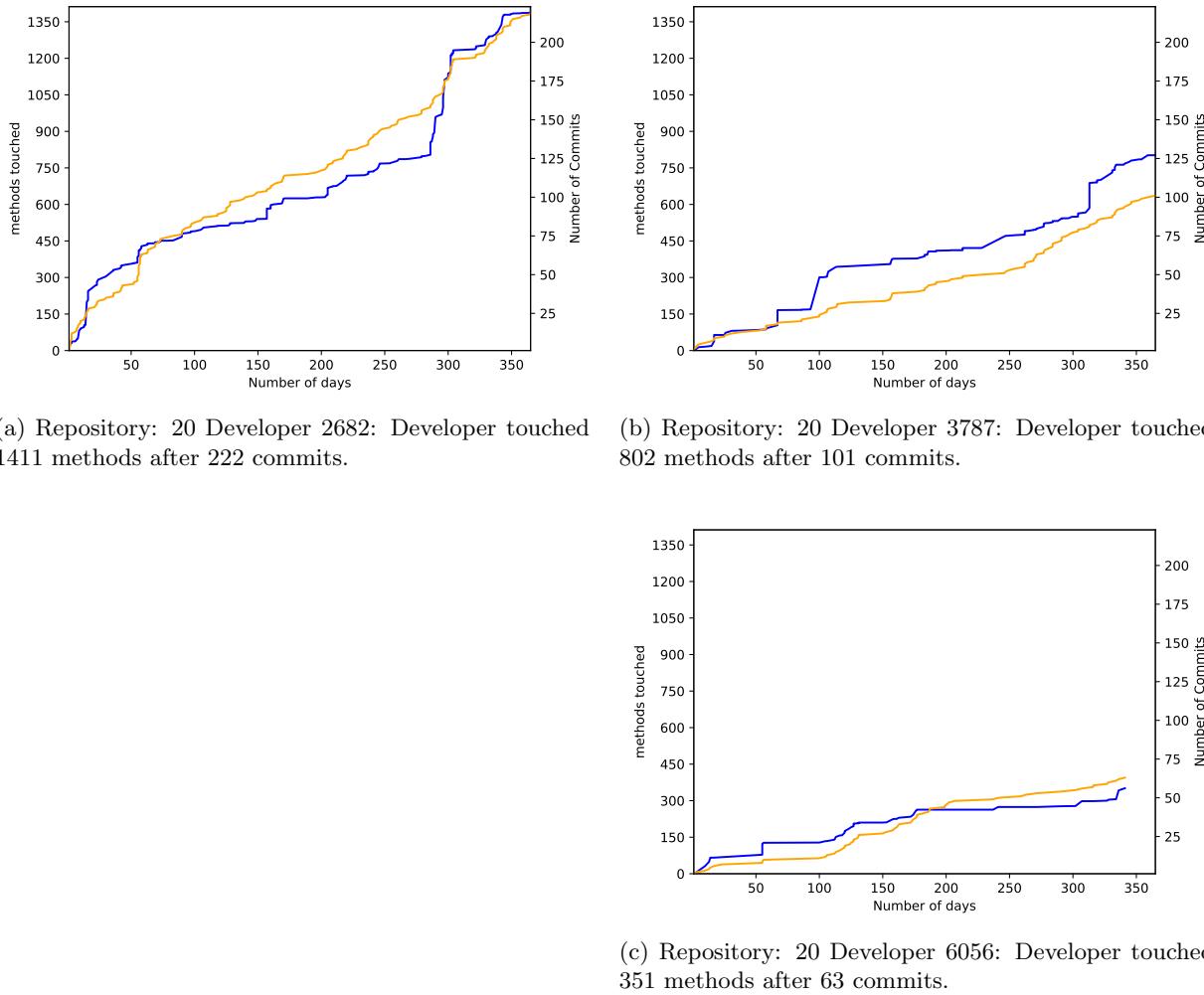


Figure 117: Number of days in the developers first year (x-axis) against methods touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## 13 Repository: 26

### 13.1 Developer touched - Repository 26: Developer packages knowledge

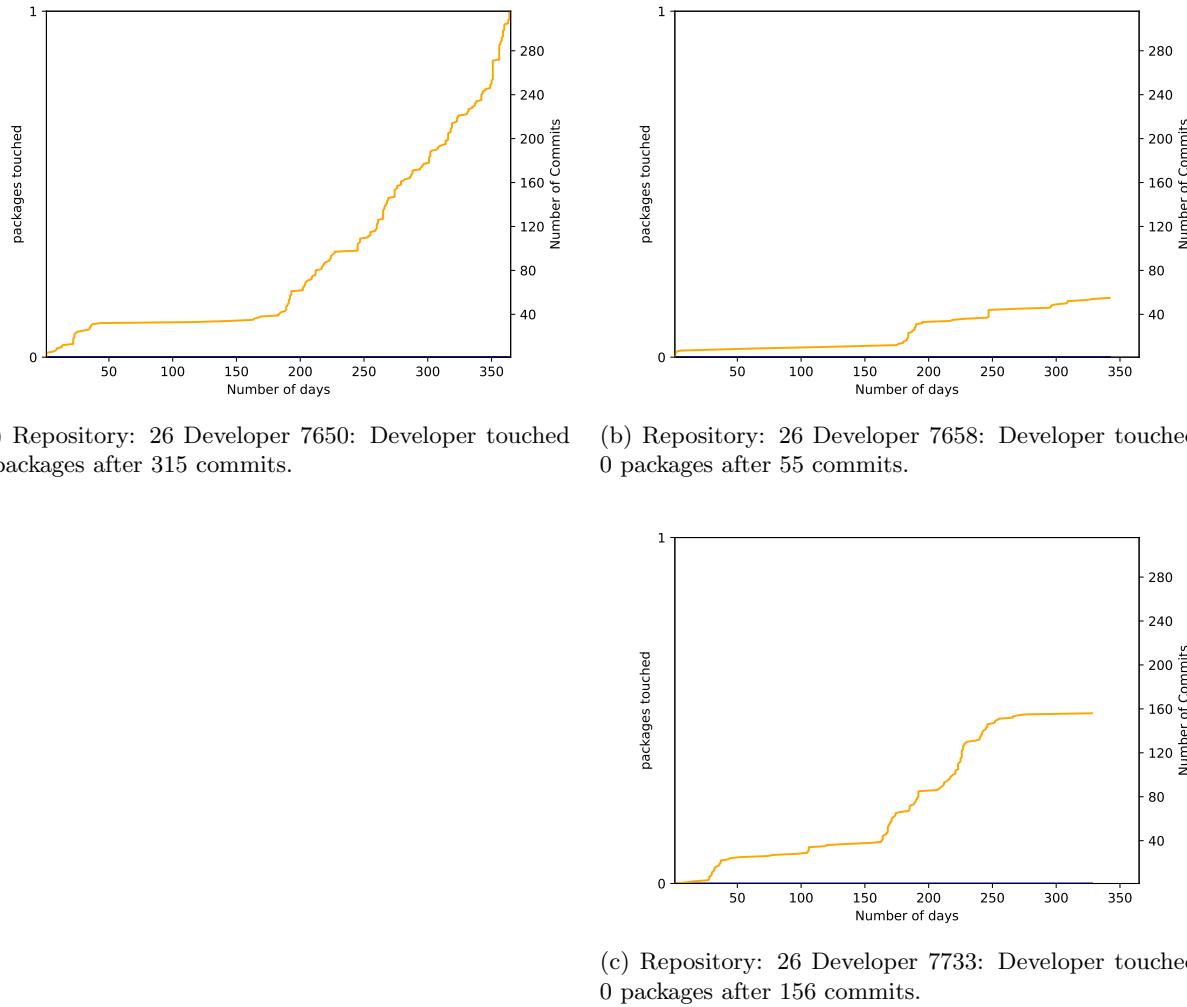


Figure 118: Number of days in the developers first year (x-axis) against packages touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## 13.2 Developer touched - Repository 26: Developer classes knowledge

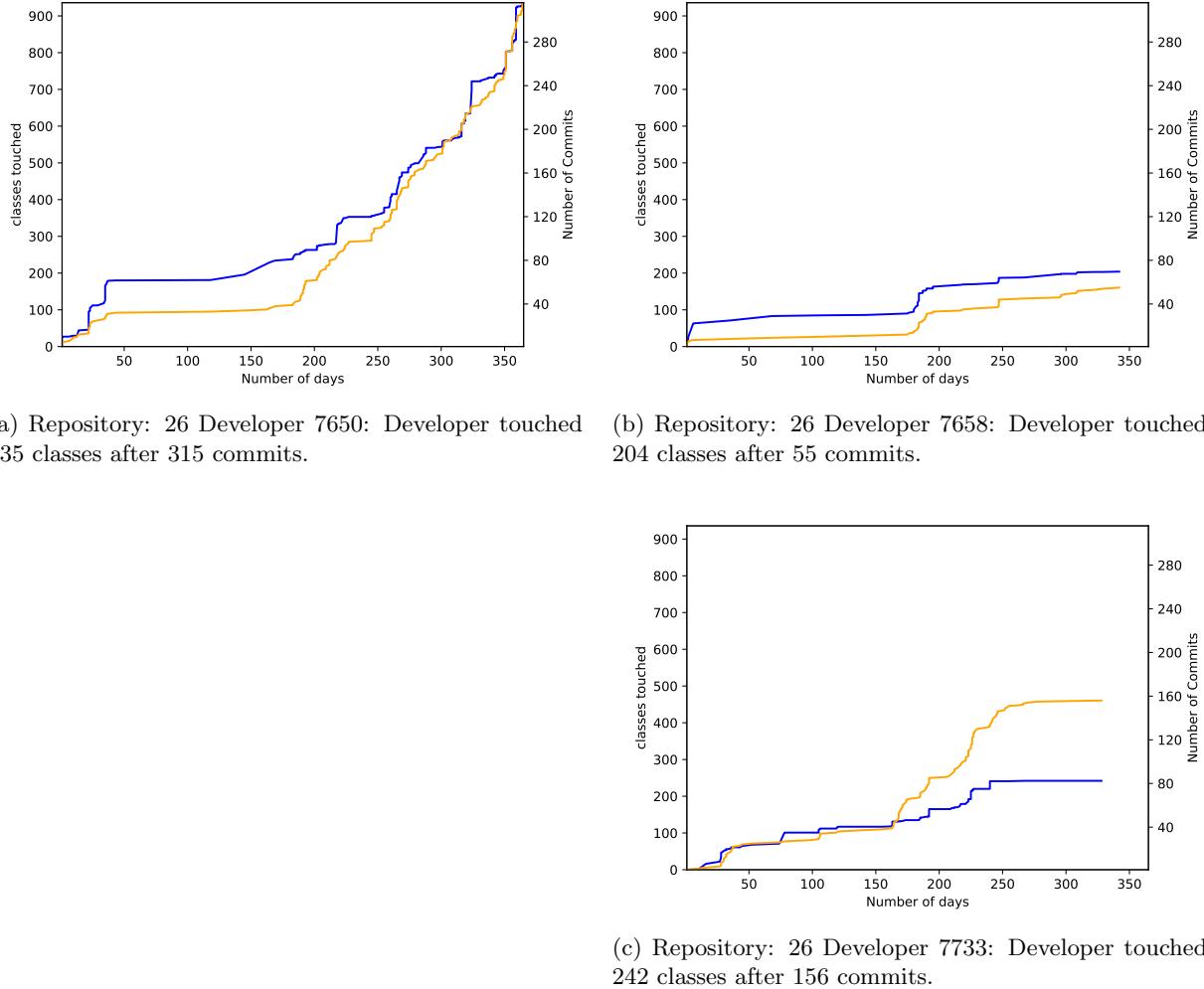


Figure 119: Number of days in the developers first year (x-axis) against classes touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

### 13.3 Developer touched - Repository 26: Developer methods knowledge

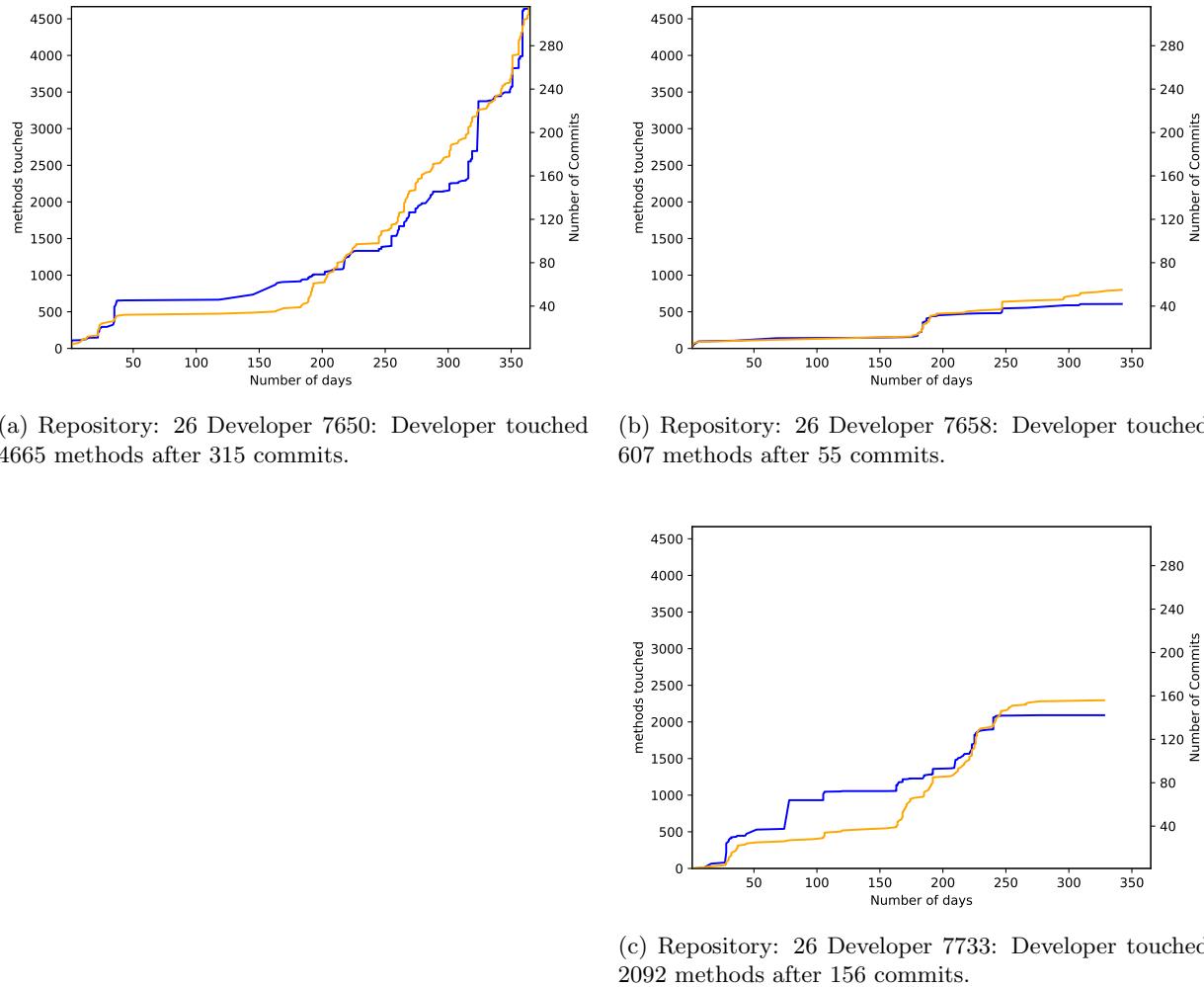


Figure 120: Number of days in the developers first year (x-axis) against methods touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## 14 Repository: 28

### 14.1 Developer touched - Repository 28: Developer packages knowledge

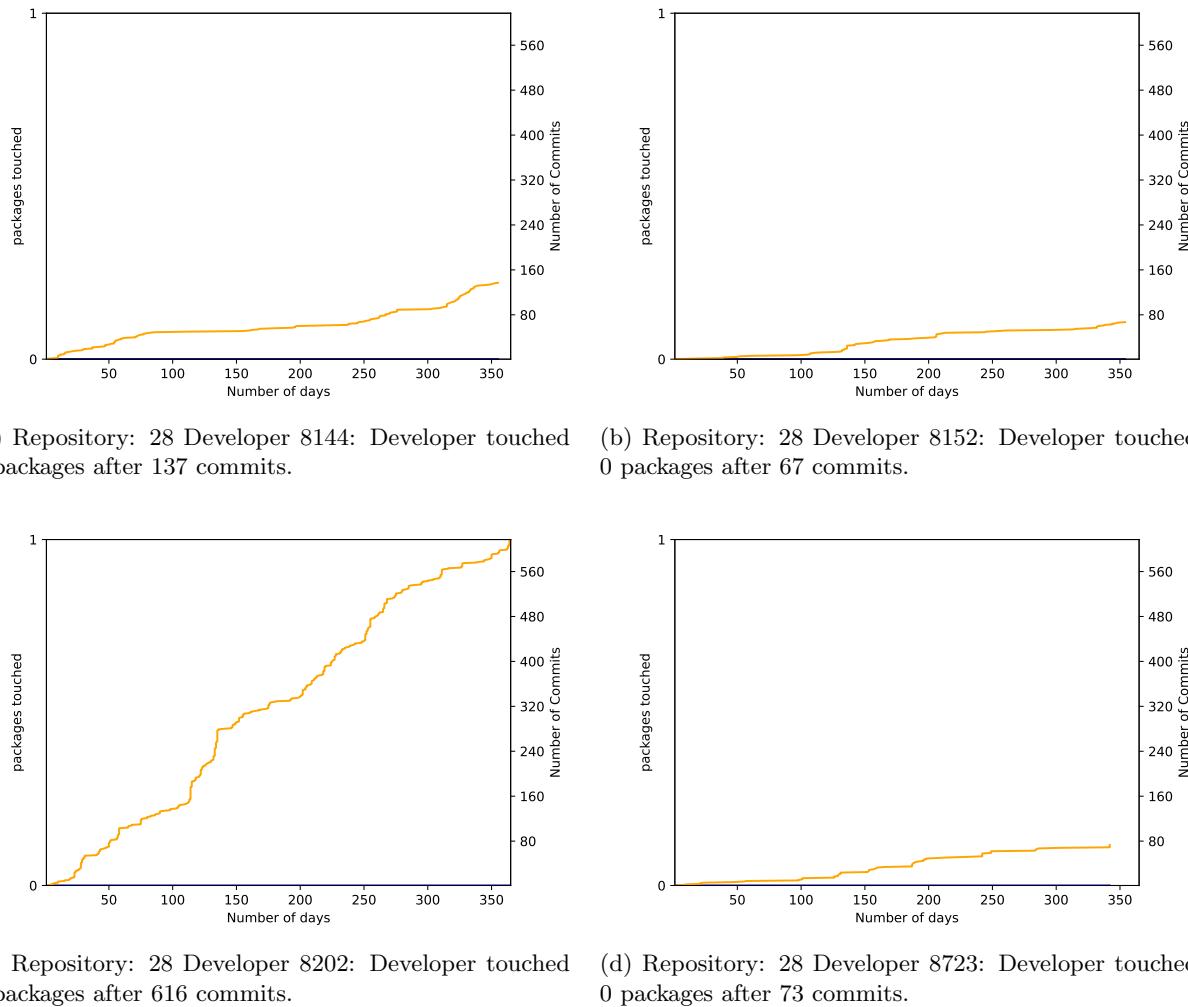


Figure 121: Number of days in the developers first year (x-axis) against packages touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## 14.2 Developer touched - Repository 28: Developer classes knowledge

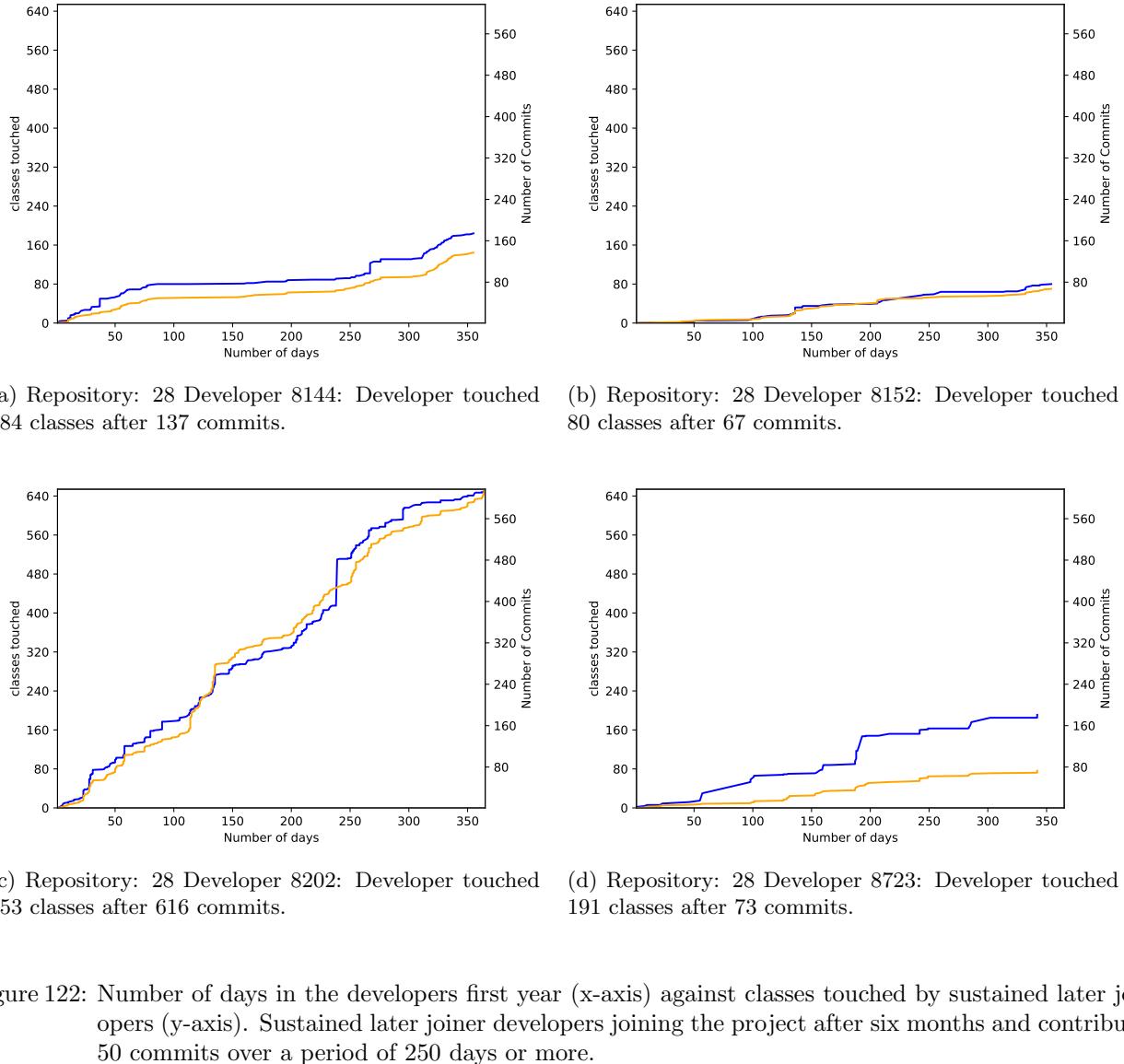


Figure 122: Number of days in the developers first year (x-axis) against classes touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

### 14.3 Developer touched - Repository 28: Developer methods knowledge

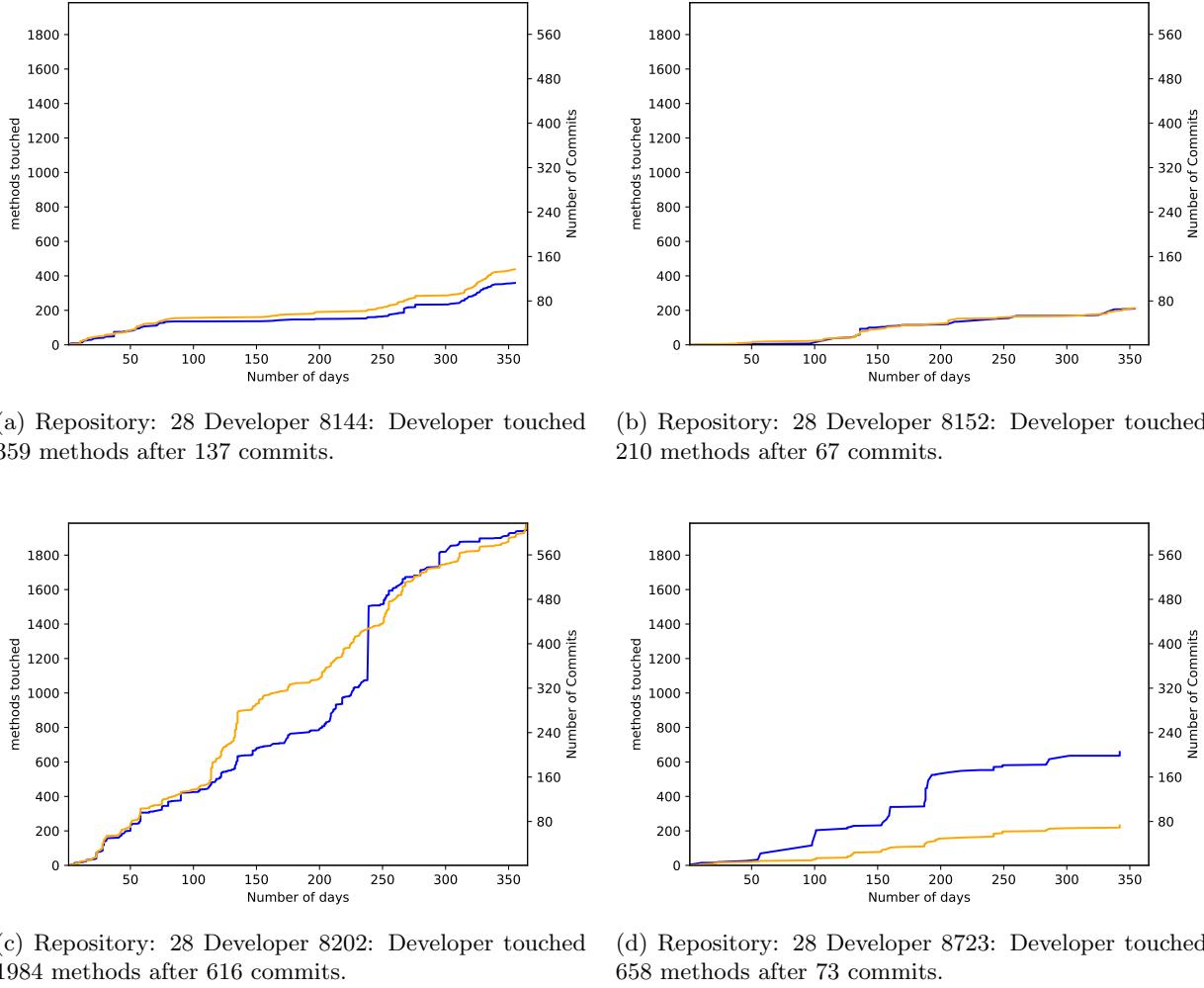
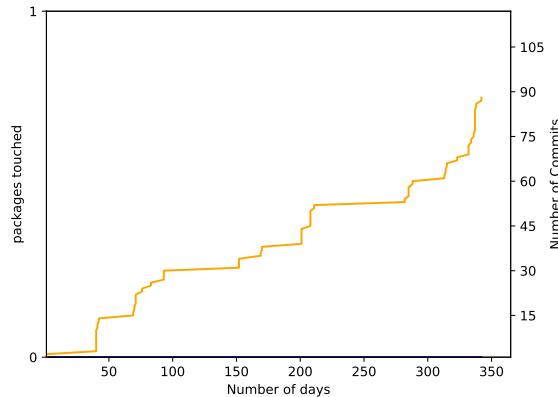


Figure 123: Number of days in the developers first year (x-axis) against methods touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

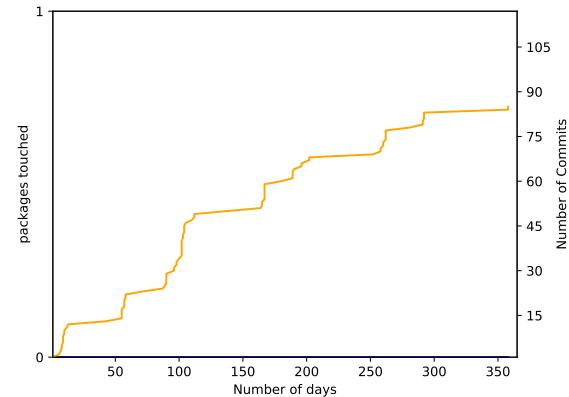
- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## 15 Repository: 33

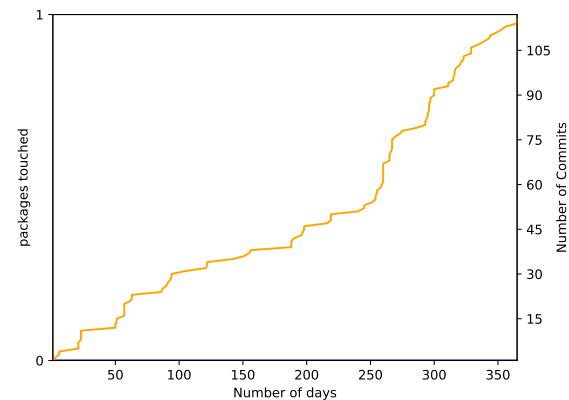
### 15.1 Developer touched - Repository 33: Developer packages knowledge



(a) Repository: 33 Developer 14183: Developer touched 0 packages after 88 commits.



(b) Repository: 33 Developer 14194: Developer touched 0 packages after 85 commits.



(c) Repository: 33 Developer 14200: Developer touched 0 packages after 116 commits.

Figure 124: Number of days in the developers first year (x-axis) against packages touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## 15.2 Developer touched - Repository 33: Developer classes knowledge

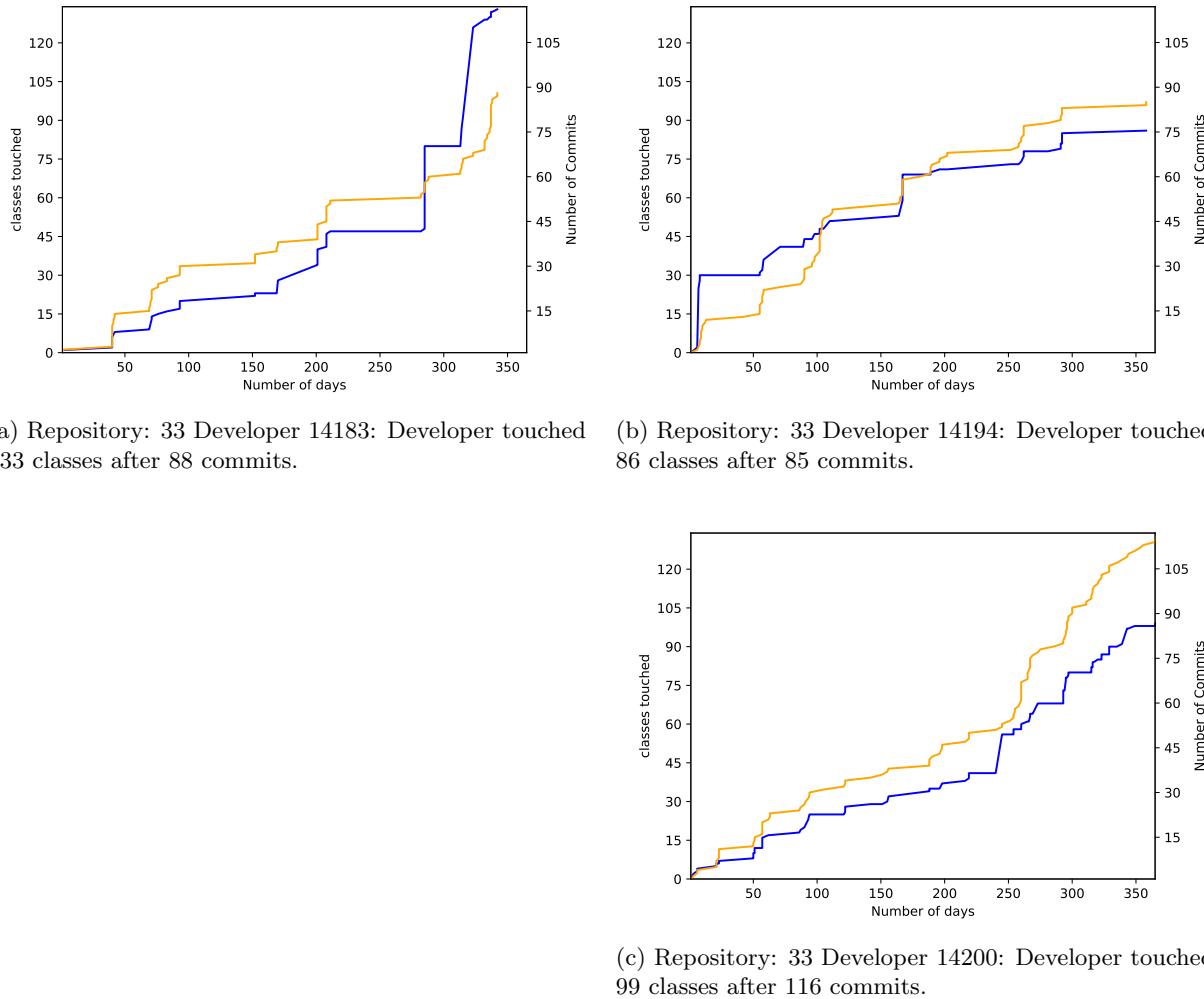


Figure 125: Number of days in the developers first year (x-axis) against classes touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

### 15.3 Developer touched - Repository 33: Developer methods knowledge

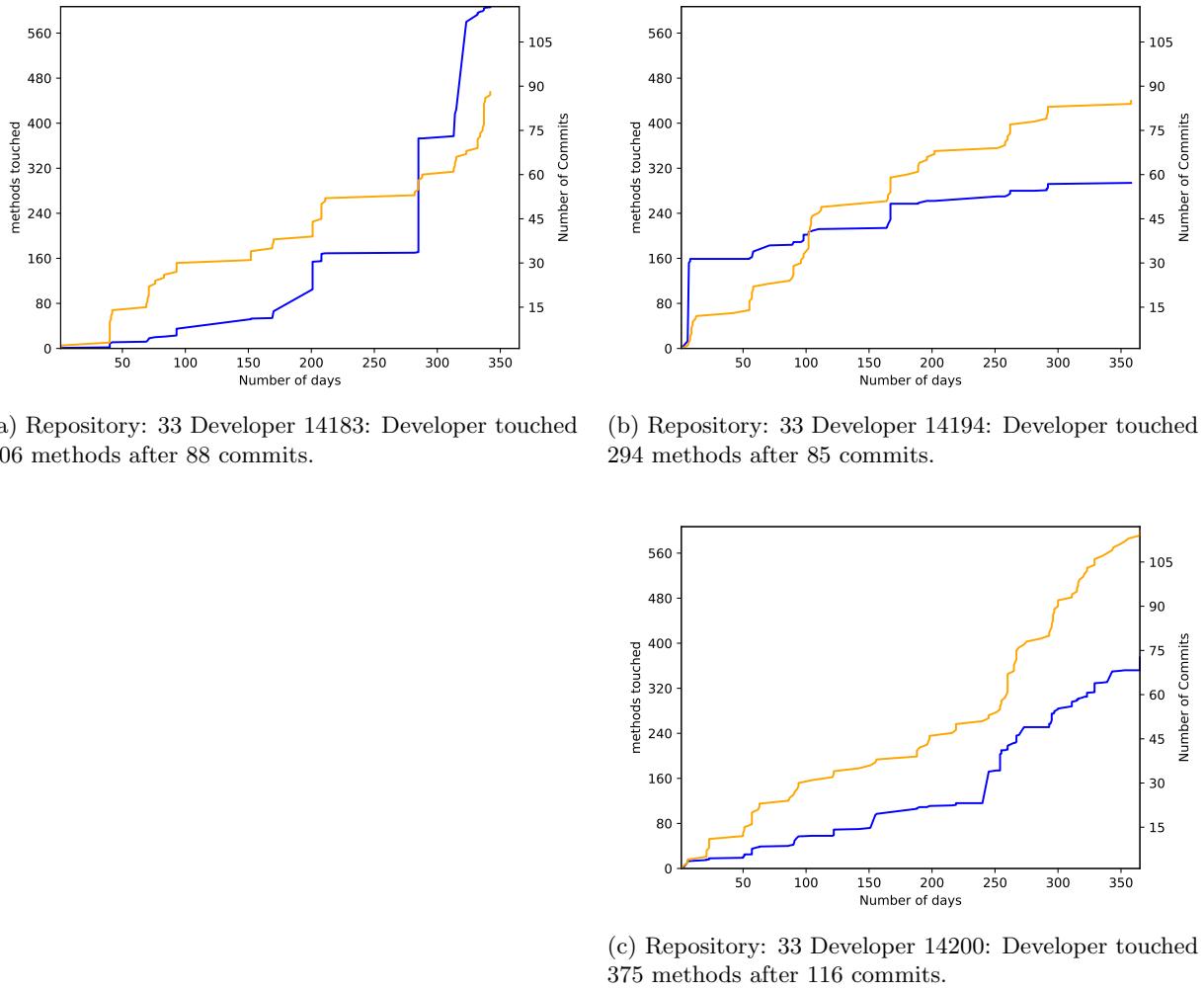
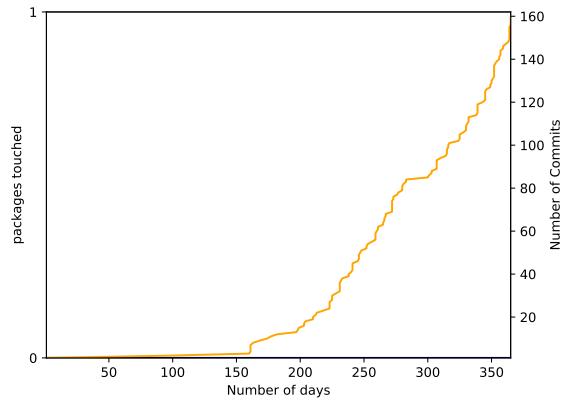


Figure 126: Number of days in the developers first year (x-axis) against methods touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

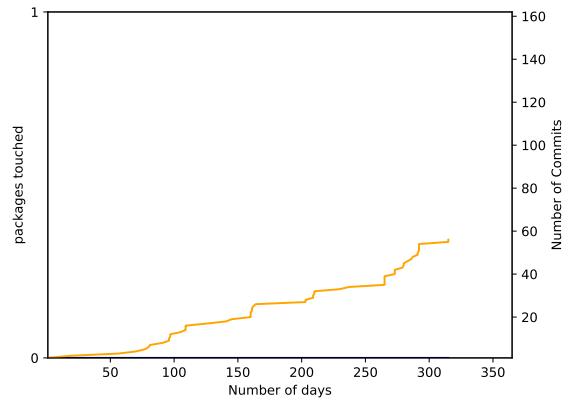
- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## **16 Repository: 36**

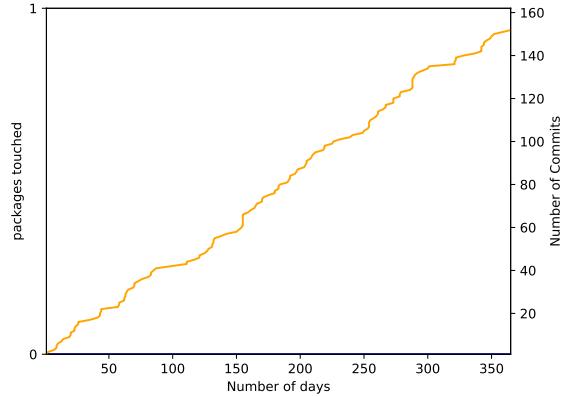
### **16.1 Developer touched - Repository 36: Developer packages knowledge**



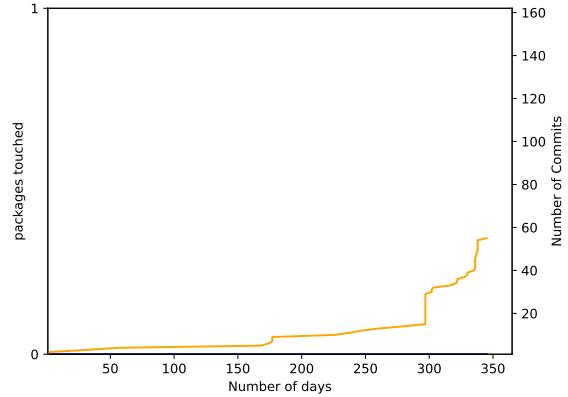
(a) Repository: 36 Developer 15361: Developer touched 0 packages after 161 commits.



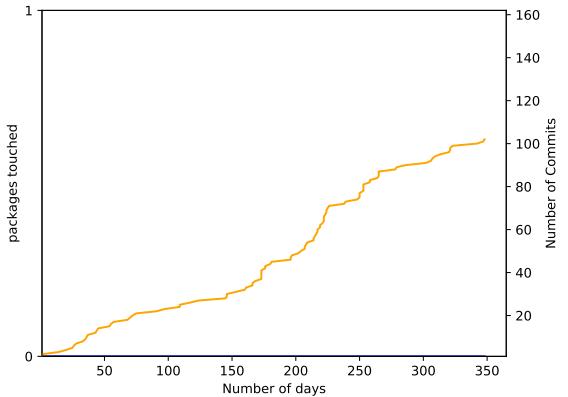
(b) Repository: 36 Developer 15385: Developer touched 0 packages after 56 commits.



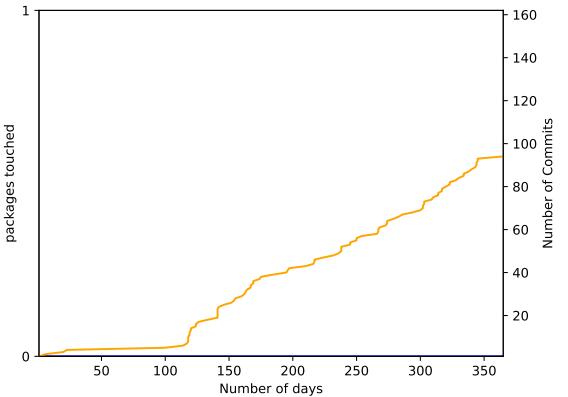
(c) Repository: 36 Developer 15411: Developer touched 0 packages after 152 commits.



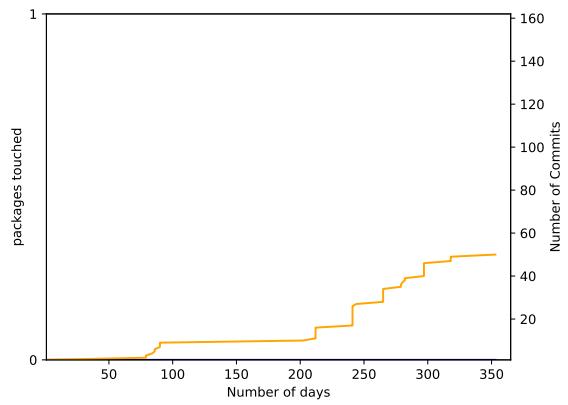
(d) Repository: 36 Developer 15442: Developer touched 0 packages after 55 commits.



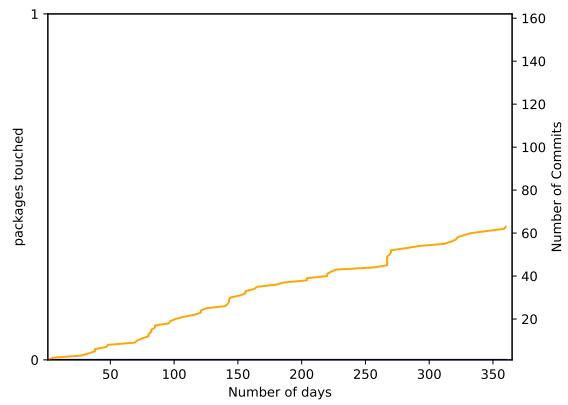
(e) Repository: 36 Developer 15462: Developer touched 0 packages after 102 commits.



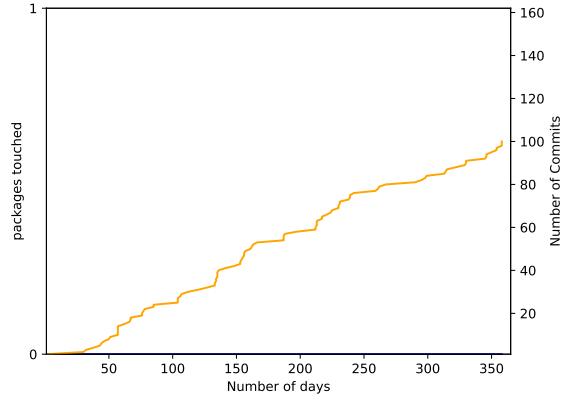
(f) Repository: 36 Developer 15476: Developer touched 0 packages after 94 commits.



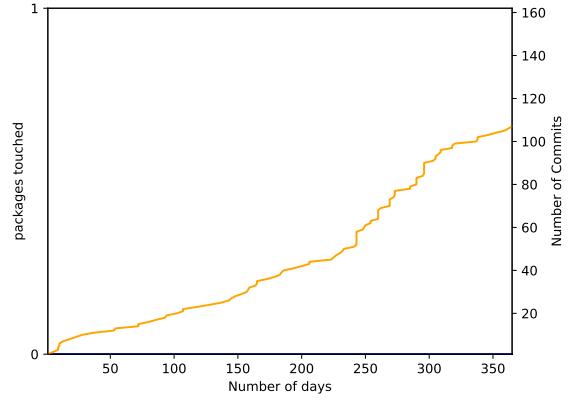
(a) Repository: 36 Developer 15502: Developer touched 0 packages after 50 commits.



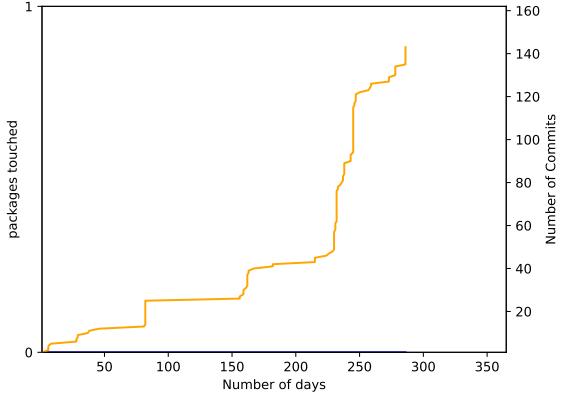
(b) Repository: 36 Developer 15530: Developer touched 0 packages after 63 commits.



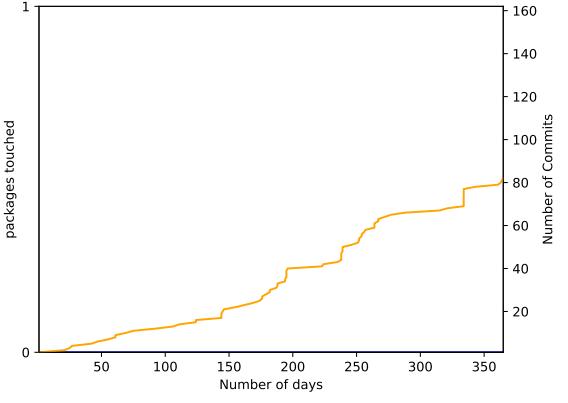
(c) Repository: 36 Developer 15541: Developer touched 0 packages after 100 commits.



(d) Repository: 36 Developer 15545: Developer touched 0 packages after 107 commits.



(e) Repository: 36 Developer 15571: Developer touched 0 packages after 143 commits.



(f) Repository: 36 Developer 15589: Developer touched 0 packages after 82 commits.

## 16.2 Developer touched - Repository 36: Developer classes knowledge

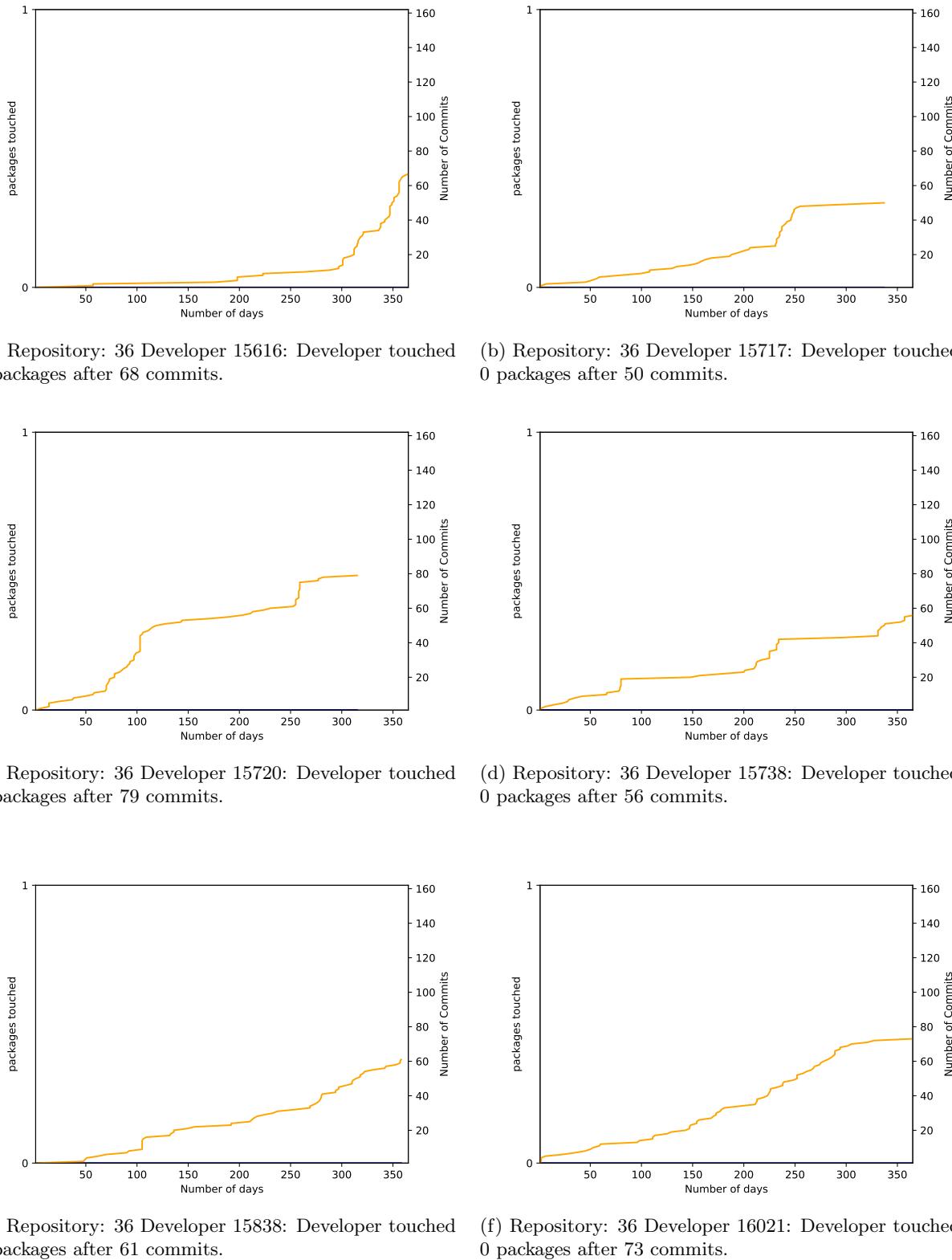
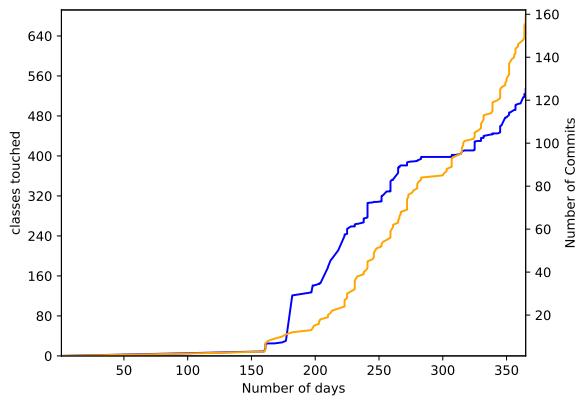
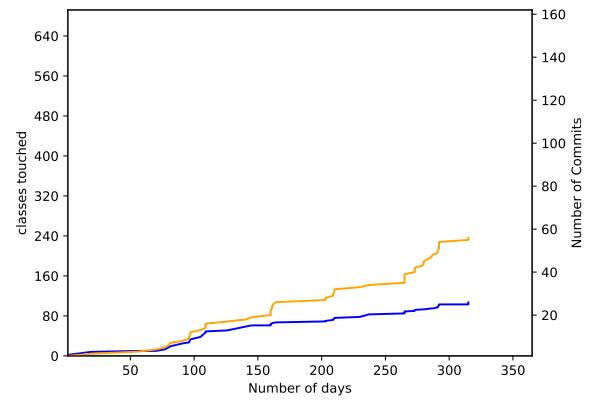


Figure 129: Number of days in the developers first year (x-axis) against packages touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

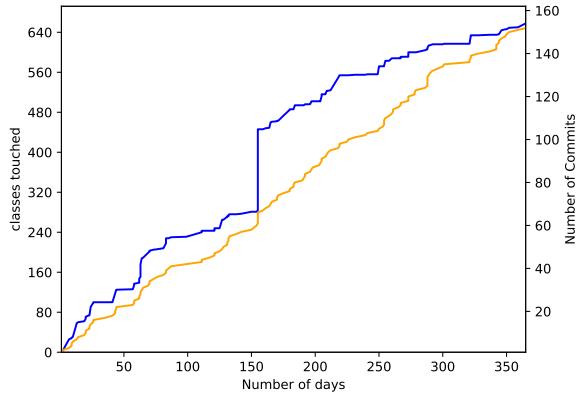
- Blue - Touched components on left y-axis<sup>162</sup>.
- Orange - Commits on right y-axis.



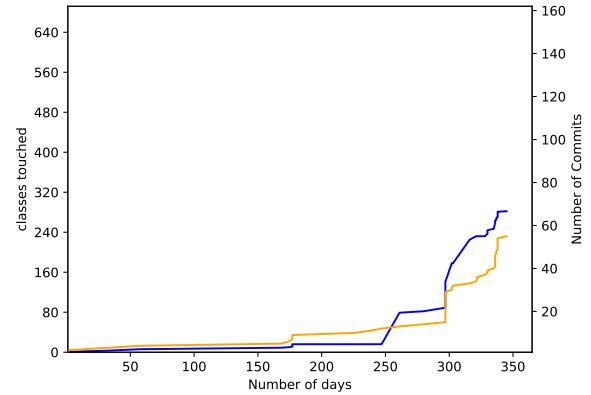
(a) Repository: 36 Developer 15361: Developer touched 540 classes after 161 commits.



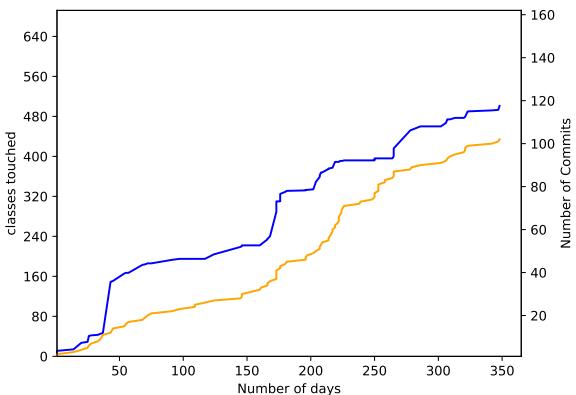
(b) Repository: 36 Developer 15385: Developer touched 107 classes after 56 commits.



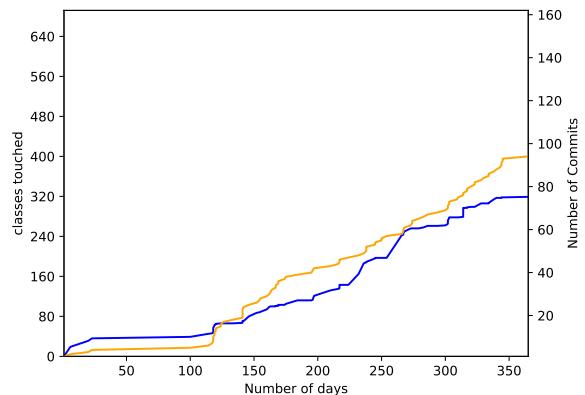
(c) Repository: 36 Developer 15411: Developer touched 659 classes after 152 commits.



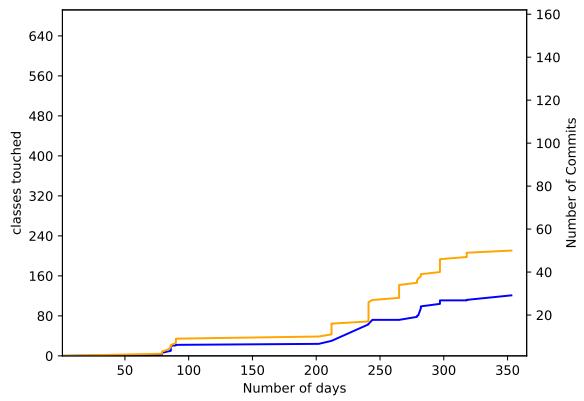
(d) Repository: 36 Developer 15442: Developer touched 282 classes after 55 commits.



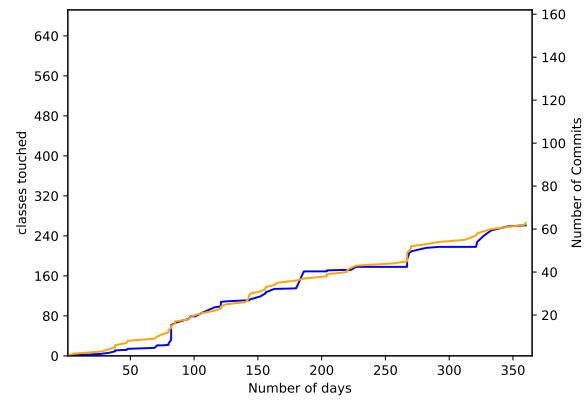
(e) Repository: 36 Developer 15462: Developer touched 501 classes after 102 commits.



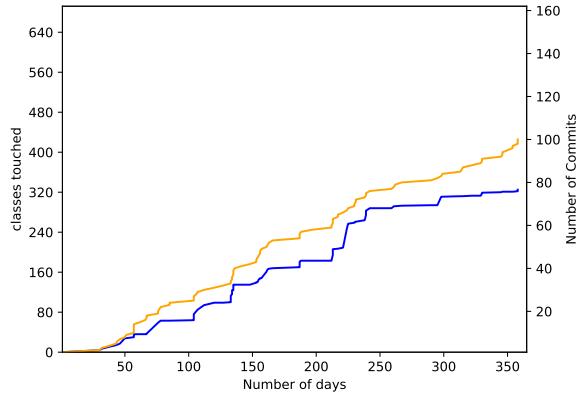
(f) Repository: 36 Developer 15476: Developer touched 319 classes after 94 commits.



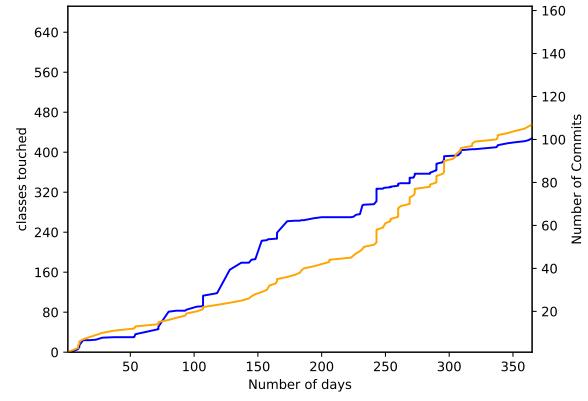
(a) Repository: 36 Developer 15502: Developer touched 121 classes after 50 commits.



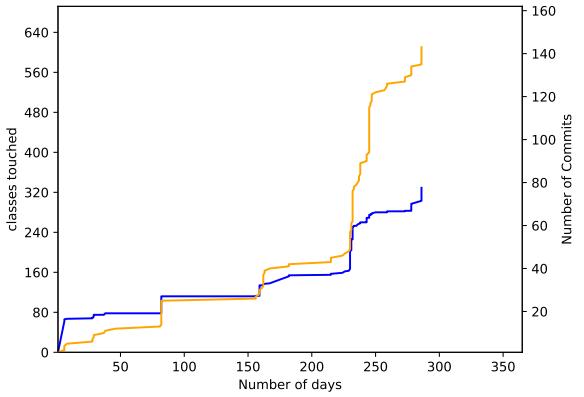
(b) Repository: 36 Developer 15530: Developer touched 261 classes after 63 commits.



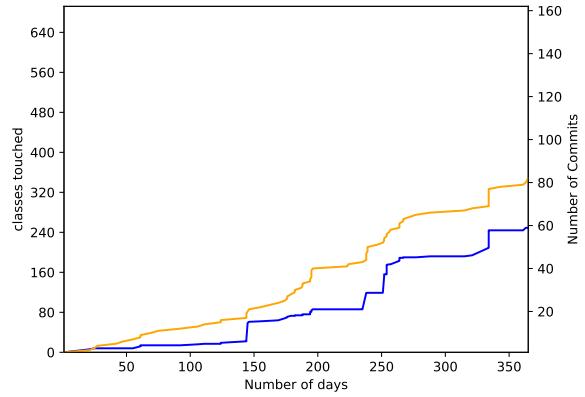
(c) Repository: 36 Developer 15541: Developer touched 325 classes after 100 commits.



(d) Repository: 36 Developer 15545: Developer touched 428 classes after 107 commits.

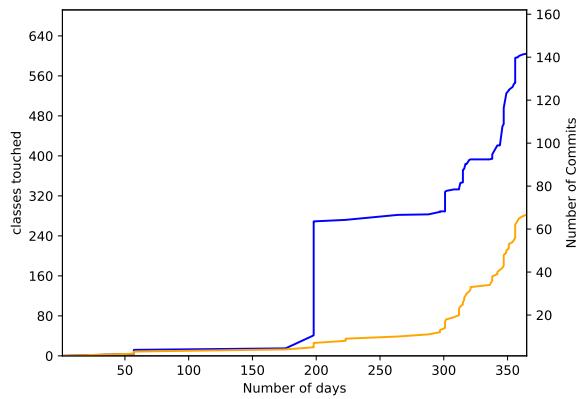


(e) Repository: 36 Developer 15571: Developer touched 329 classes after 143 commits.

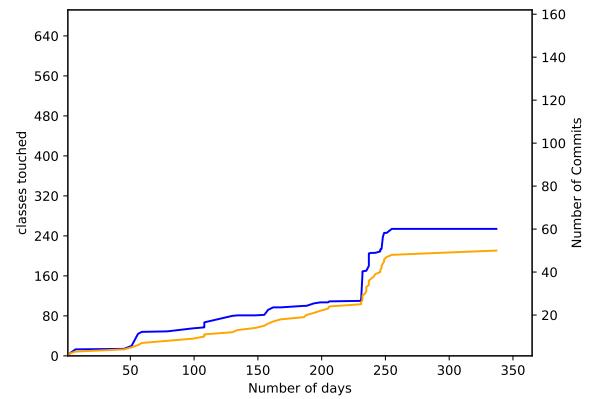


(f) Repository: 36 Developer 15589: Developer touched 249 classes after 82 commits.

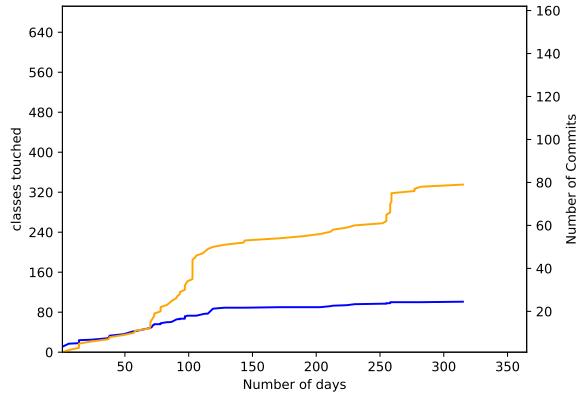
### **16.3 Developer touched - Repository 36: Developer methods knowledge**



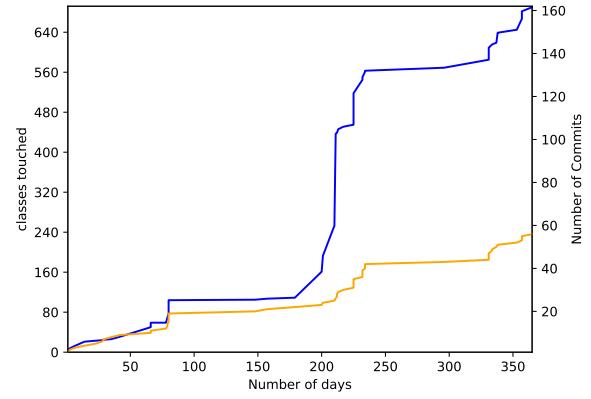
(a) Repository: 36 Developer 15616: Developer touched 607 classes after 68 commits.



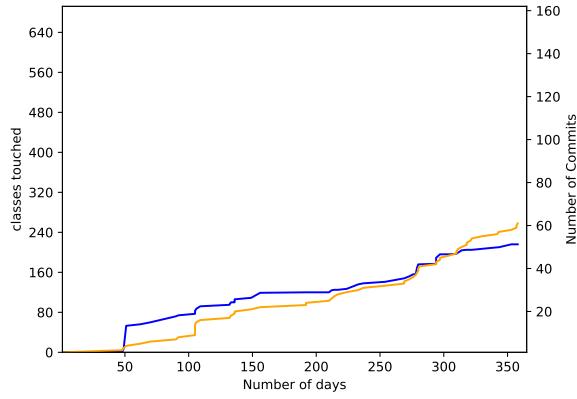
(b) Repository: 36 Developer 15717: Developer touched 254 classes after 50 commits.



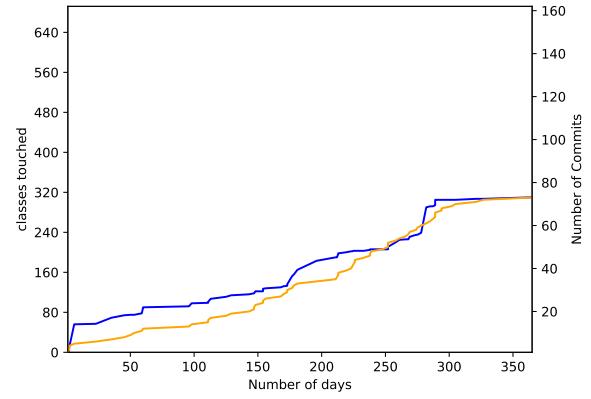
(c) Repository: 36 Developer 15720: Developer touched 101 classes after 79 commits.



(d) Repository: 36 Developer 15738: Developer touched 691 classes after 56 commits.



(e) Repository: 36 Developer 15838: Developer touched 216 classes after 61 commits.

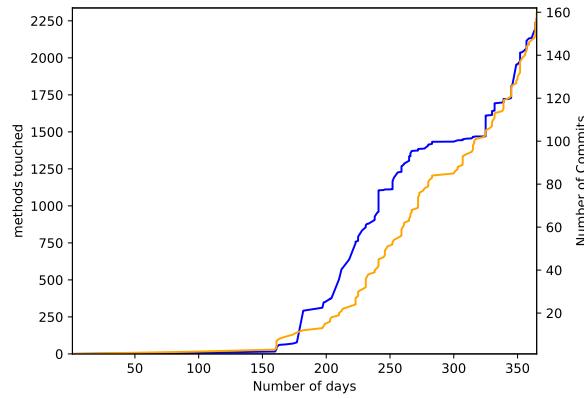


(f) Repository: 36 Developer 16021: Developer touched 310 classes after 73 commits.

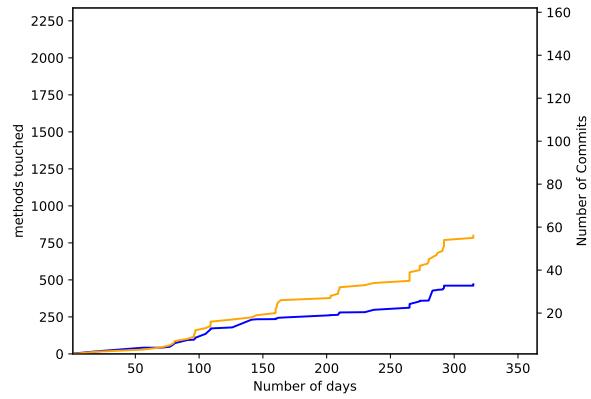
Figure 132: Number of days in the developers first year (x-axis) against classes touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

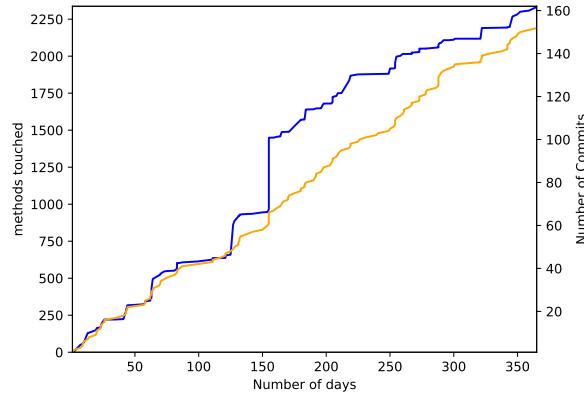
<sup>166</sup>



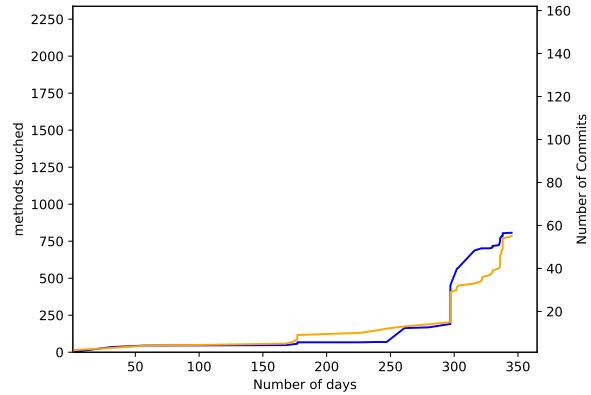
(a) Repository: 36 Developer 15361: Developer touched 2286 methods after 161 commits.



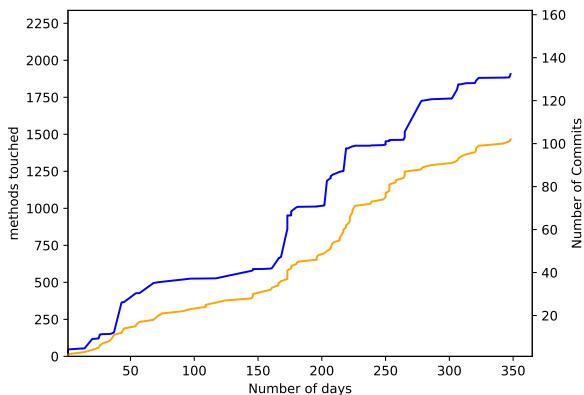
(b) Repository: 36 Developer 15385: Developer touched 470 methods after 56 commits.



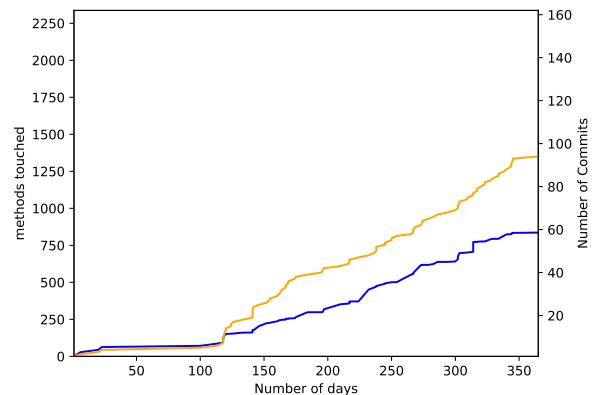
(c) Repository: 36 Developer 15411: Developer touched 2336 methods after 152 commits.



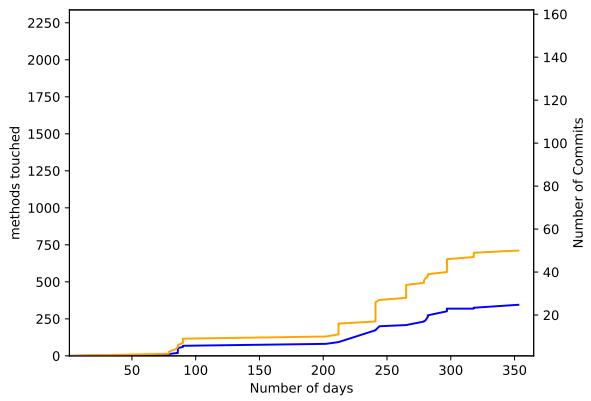
(d) Repository: 36 Developer 15442: Developer touched 807 methods after 55 commits.



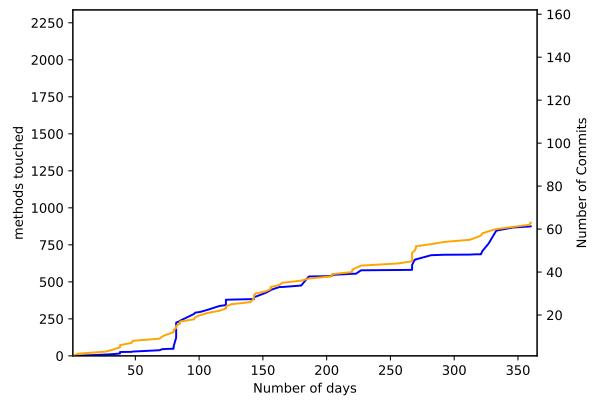
(e) Repository: 36 Developer 15462: Developer touched 1907 methods after 102 commits.



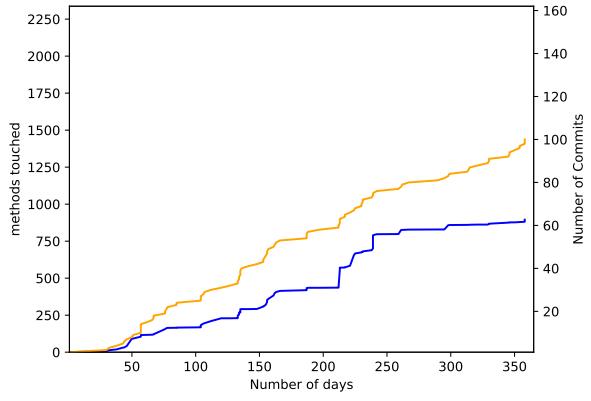
(f) Repository: 36 Developer 15476: Developer touched 836 methods after 94 commits.



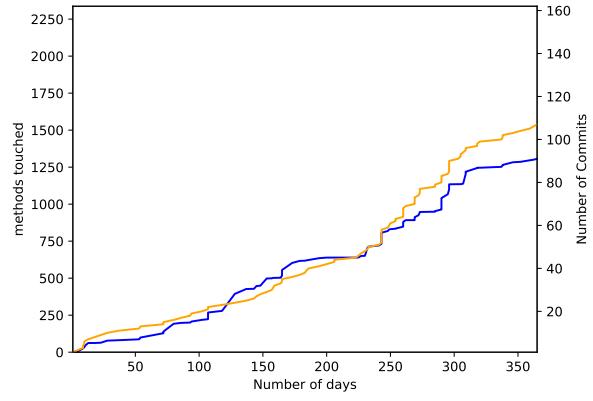
(a) Repository: 36 Developer 15502: Developer touched 345 methods after 50 commits.



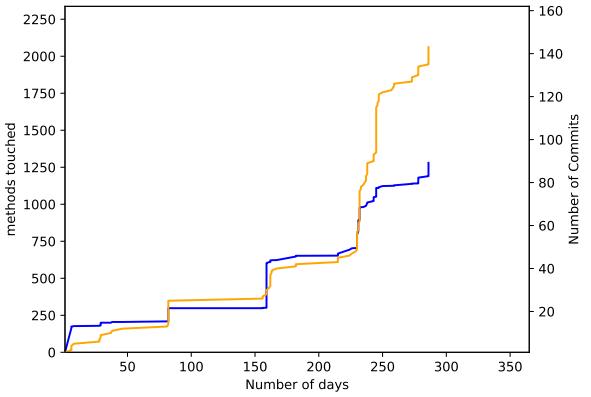
(b) Repository: 36 Developer 15530: Developer touched 875 methods after 63 commits.



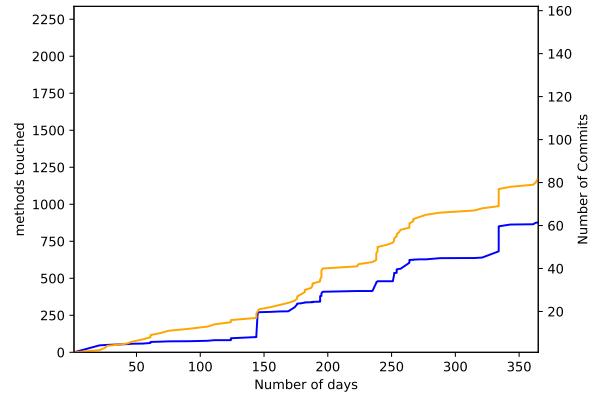
(c) Repository: 36 Developer 15541: Developer touched 895 methods after 100 commits.



(d) Repository: 36 Developer 15545: Developer touched 1306 methods after 107 commits.



(e) Repository: 36 Developer 15571: Developer touched 1280 methods after 143 commits.



(f) Repository: 36 Developer 15589: Developer touched 878 methods after 82 commits.

## **17 Repository: 37**

### **17.1 Developer touched - Repository 37: Developer packages knowledge**

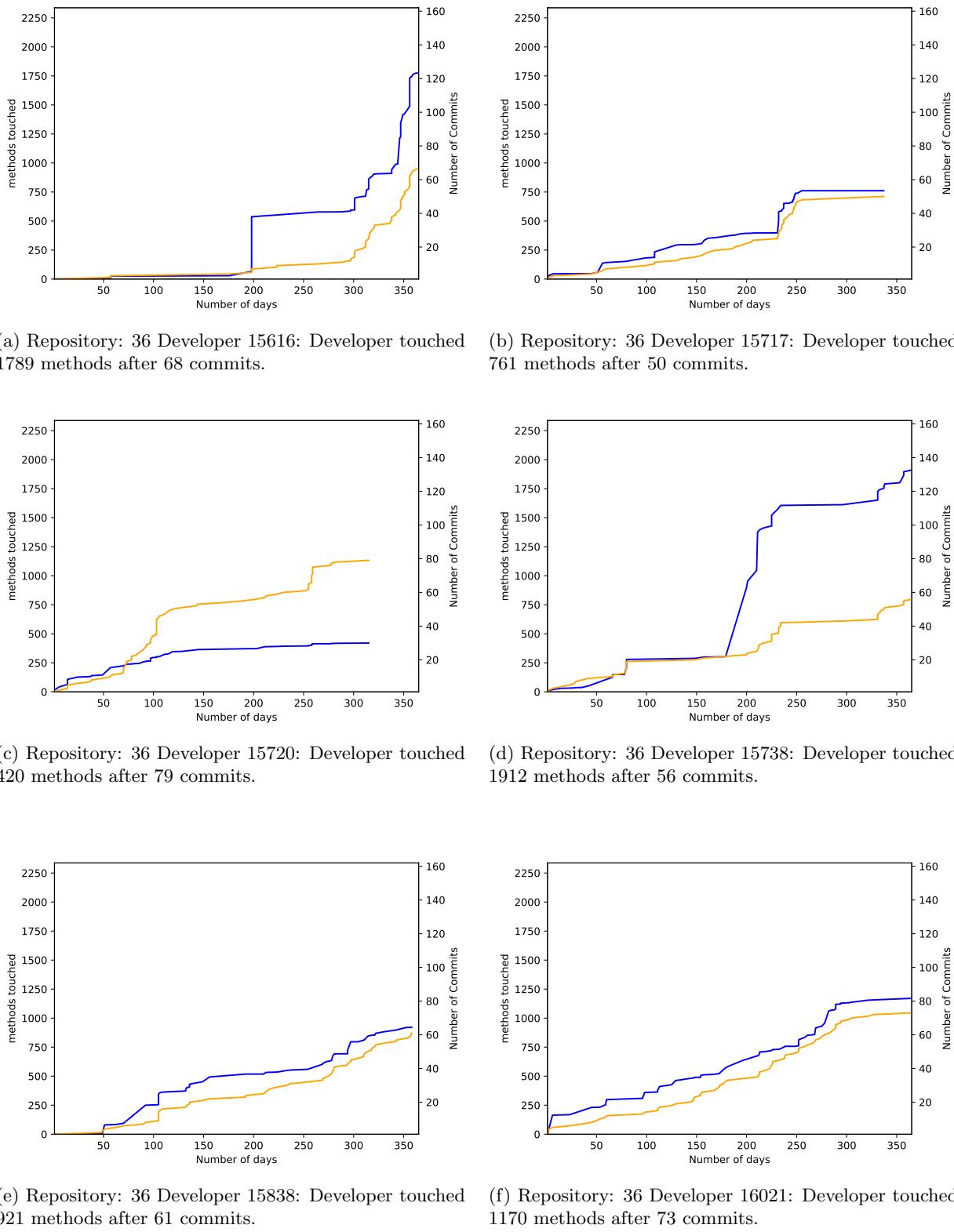
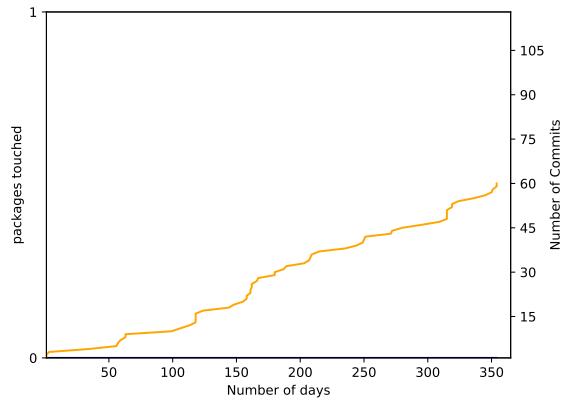
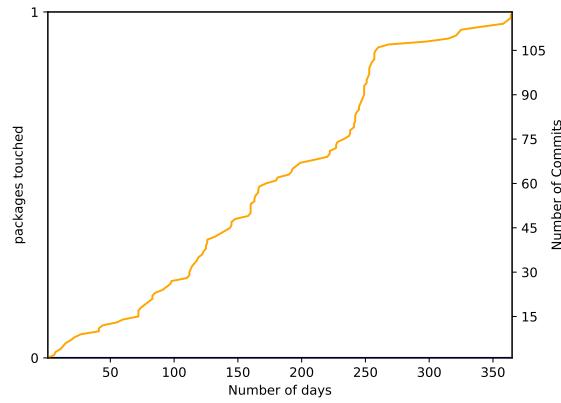


Figure 135: Number of days in the developers first year (x-axis) against methods touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

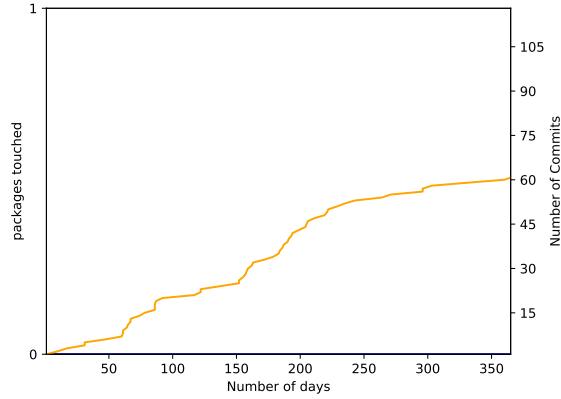
- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.



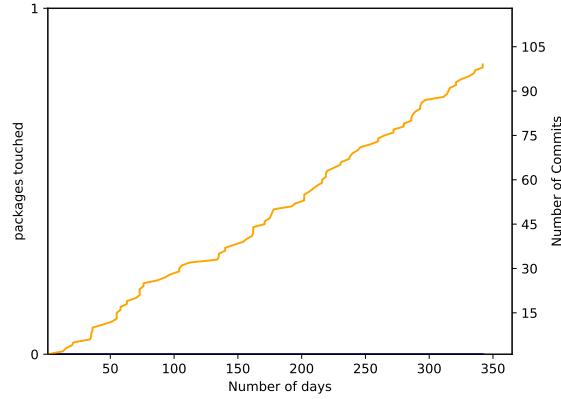
(a) Repository: 37 Developer 16180: Developer touched 0 packages after 60 commits.



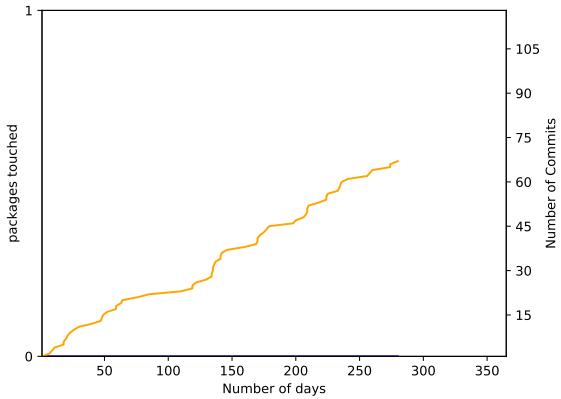
(b) Repository: 37 Developer 16199: Developer touched 0 packages after 117 commits.



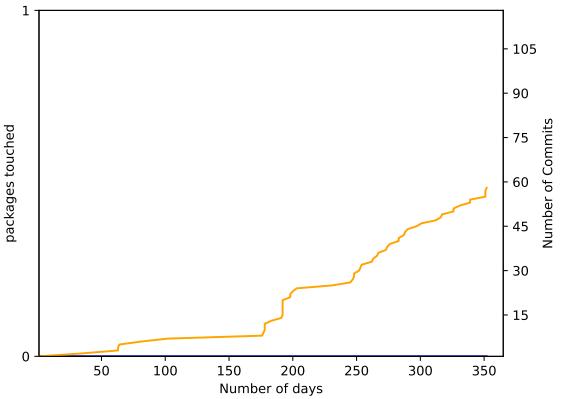
(c) Repository: 37 Developer 16202: Developer touched 0 packages after 61 commits.



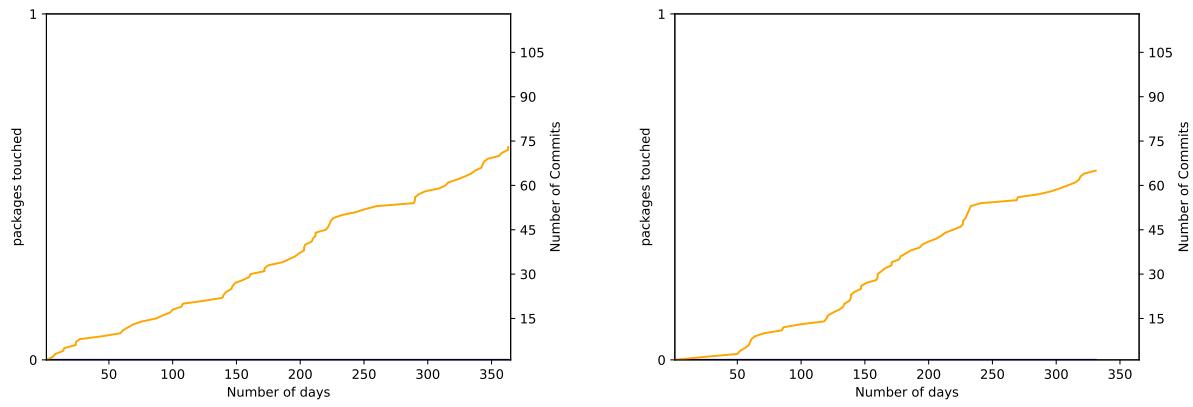
(d) Repository: 37 Developer 16227: Developer touched 0 packages after 99 commits.



(e) Repository: 37 Developer 16237: Developer touched 0 packages after 67 commits.



(f) Repository: 37 Developer 16301: Developer touched 0 packages after 58 commits.

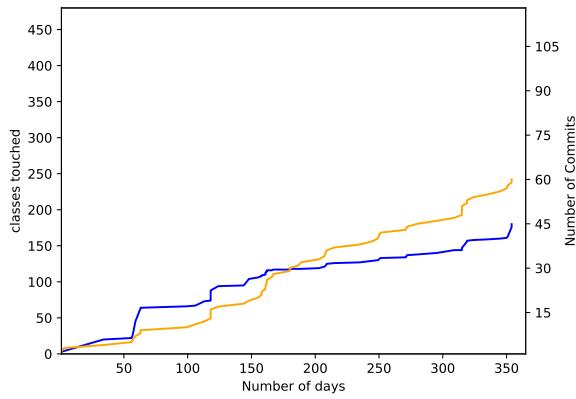


(a) Repository: 37 Developer 16372: Developer touched 0 packages after 73 commits.  
(b) Repository: 37 Developer 16686: Developer touched 0 packages after 65 commits.

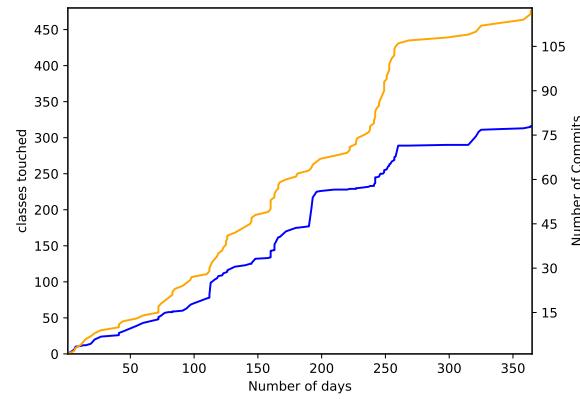
Figure 137: Number of days in the developers first year (x-axis) against packages touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

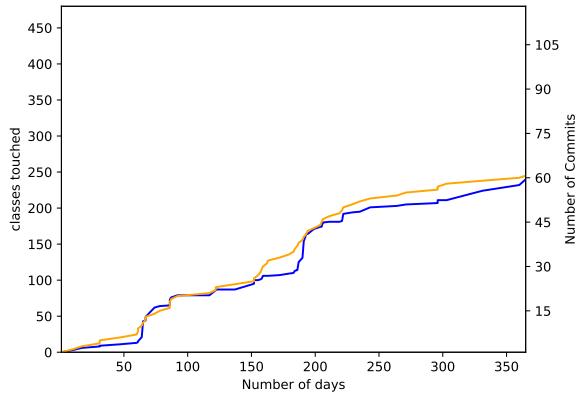
## 17.2 Developer touched - Repository 37: Developer classes knowledge



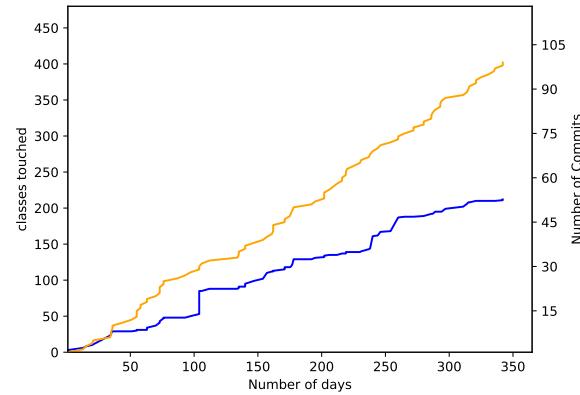
(a) Repository: 37 Developer 16180: Developer touched 180 classes after 60 commits.



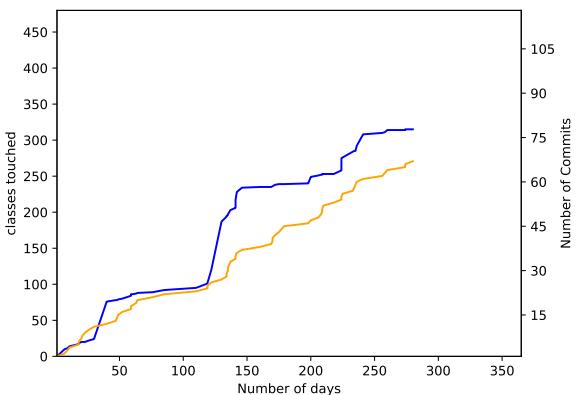
(b) Repository: 37 Developer 16199: Developer touched 316 classes after 117 commits.



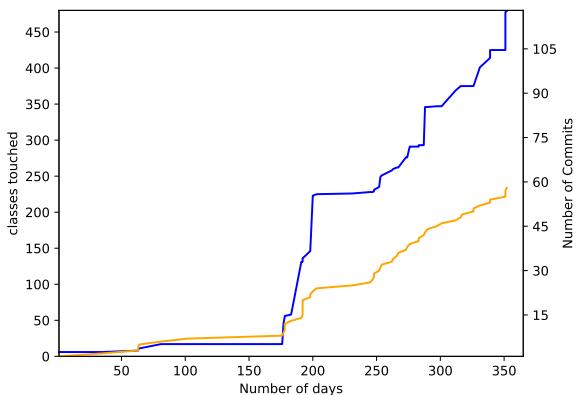
(c) Repository: 37 Developer 16202: Developer touched 243 classes after 61 commits.



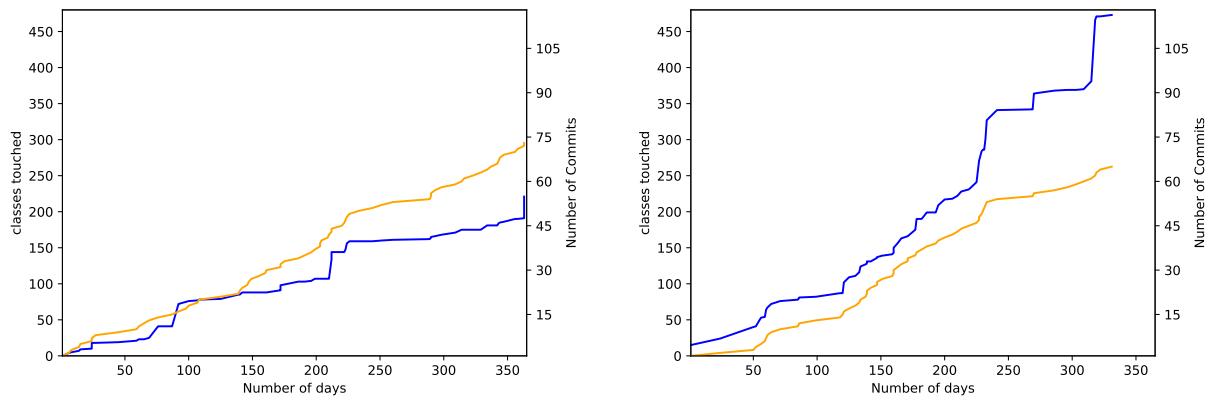
(d) Repository: 37 Developer 16227: Developer touched 212 classes after 99 commits.



(e) Repository: 37 Developer 16237: Developer touched 315 classes after 67 commits.



(f) Repository: 37 Developer 16301: Developer touched 479 classes after 58 commits.

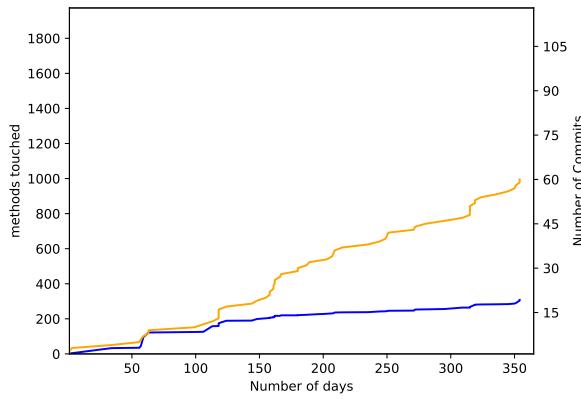


(a) Repository: 37 Developer 163372: Developer touched 221 classes after 73 commits.  
(b) Repository: 37 Developer 166686: Developer touched 473 classes after 65 commits.

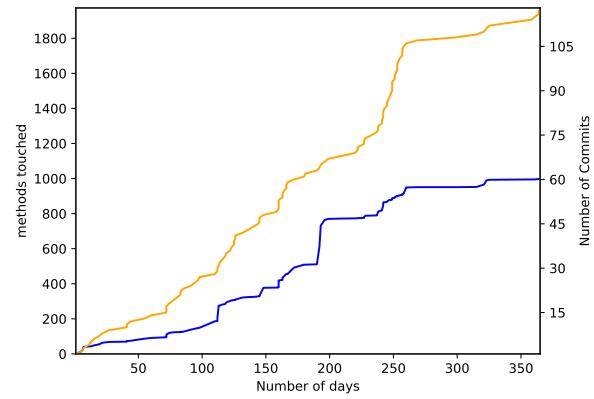
Figure 139: Number of days in the developers first year (x-axis) against classes touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

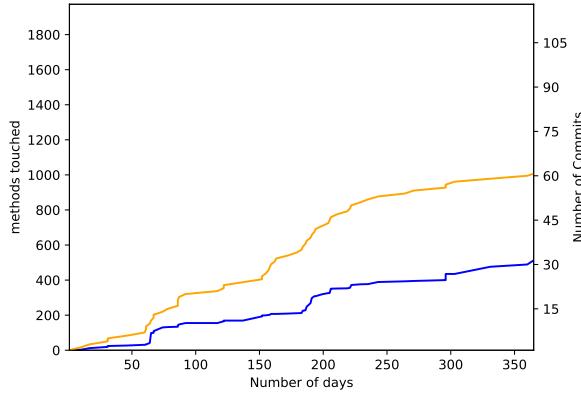
### **17.3 Developer touched - Repository 37: Developer methods knowledge**



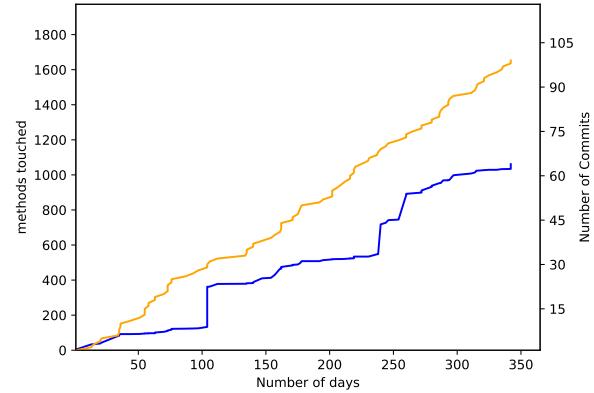
(a) Repository: 37 Developer 16180: Developer touched 308 methods after 60 commits.



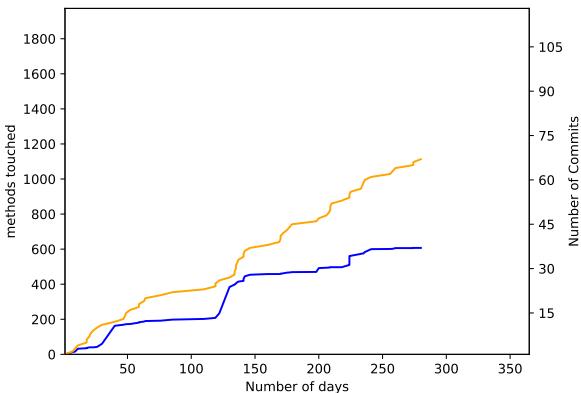
(b) Repository: 37 Developer 16199: Developer touched 998 methods after 117 commits.



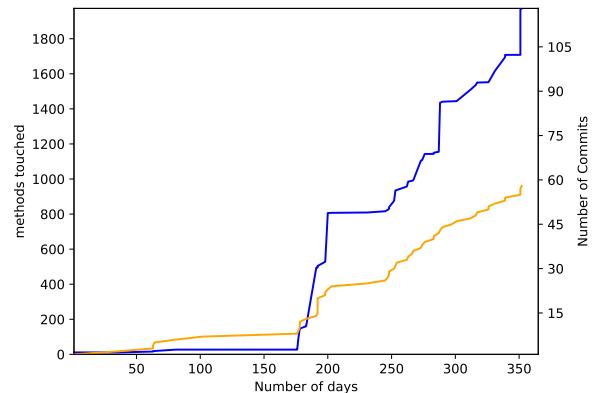
(c) Repository: 37 Developer 16202: Developer touched 522 methods after 61 commits.



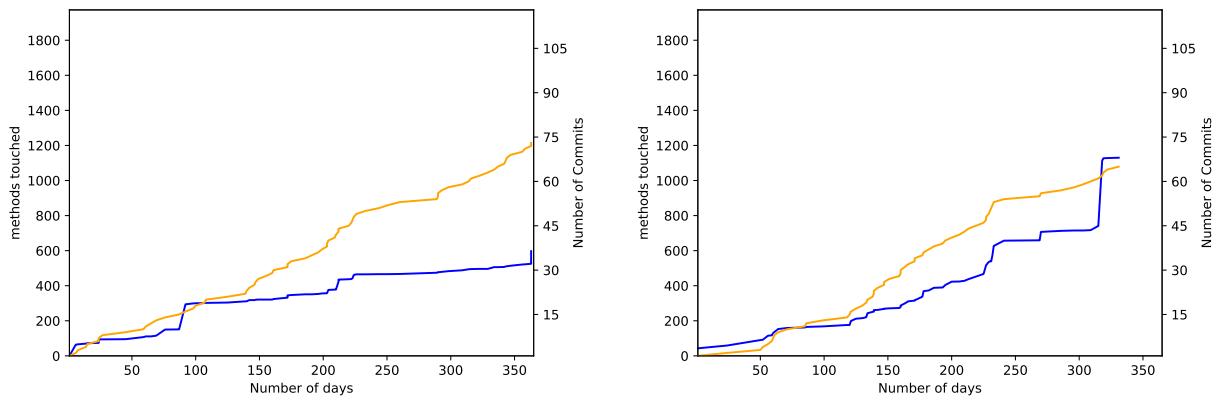
(d) Repository: 37 Developer 16227: Developer touched 1061 methods after 99 commits.



(e) Repository: 37 Developer 16237: Developer touched 607 methods after 67 commits.



(f) Repository: 37 Developer 16301: Developer touched 1972 methods after 58 commits.



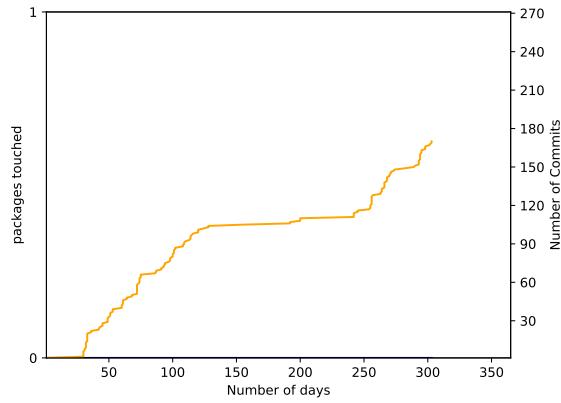
(a) Repository: 37 Developer 16372: Developer touched 597 methods after 73 commits.  
(b) Repository: 37 Developer 16686: Developer touched 1130 methods after 65 commits.

Figure 141: Number of days in the developers first year (x-axis) against methods touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

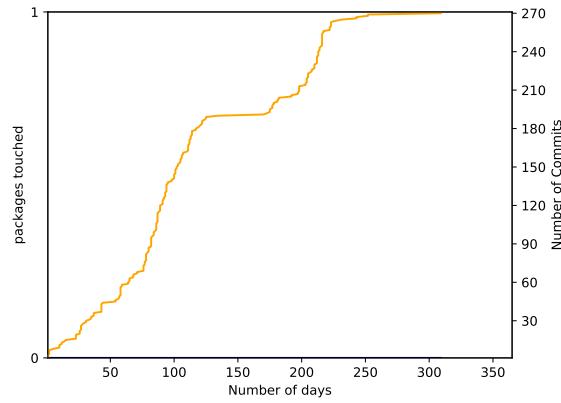
- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## **18 Repository: 39**

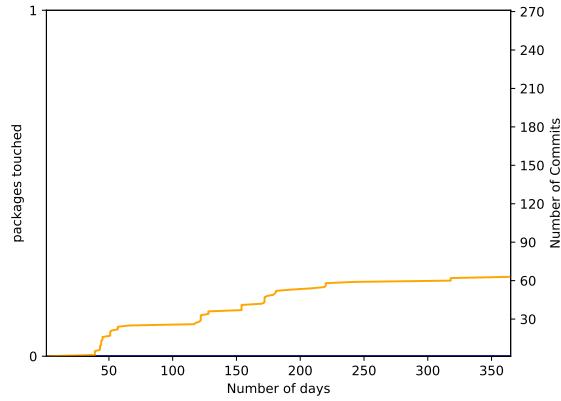
### **18.1 Developer touched - Repository 39: Developer packages knowledge**



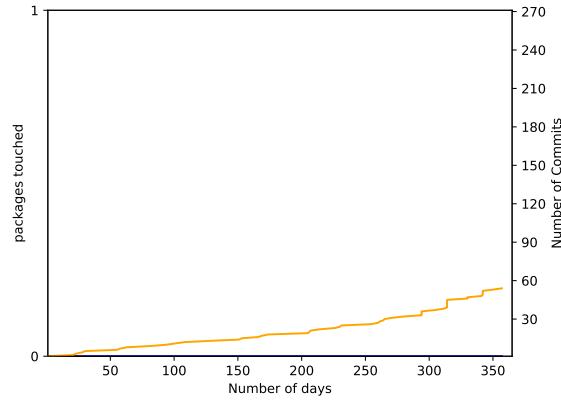
(a) Repository: 39 Developer 17820: Developer touched 0 packages after 170 commits.



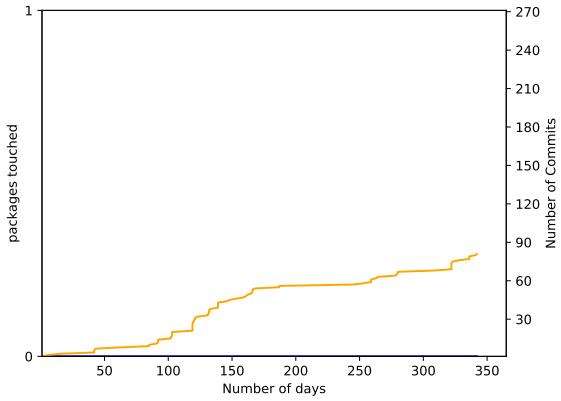
(b) Repository: 39 Developer 17821: Developer touched 0 packages after 270 commits.



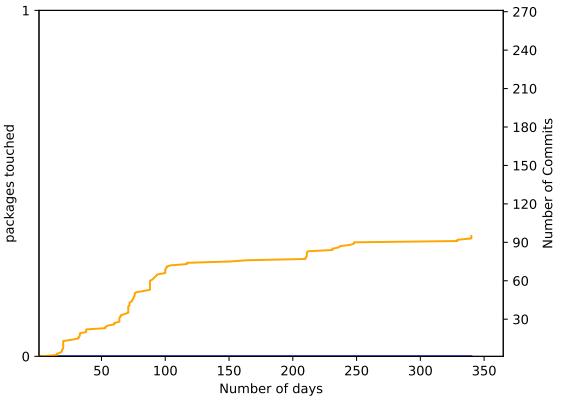
(c) Repository: 39 Developer 17835: Developer touched 0 packages after 63 commits.



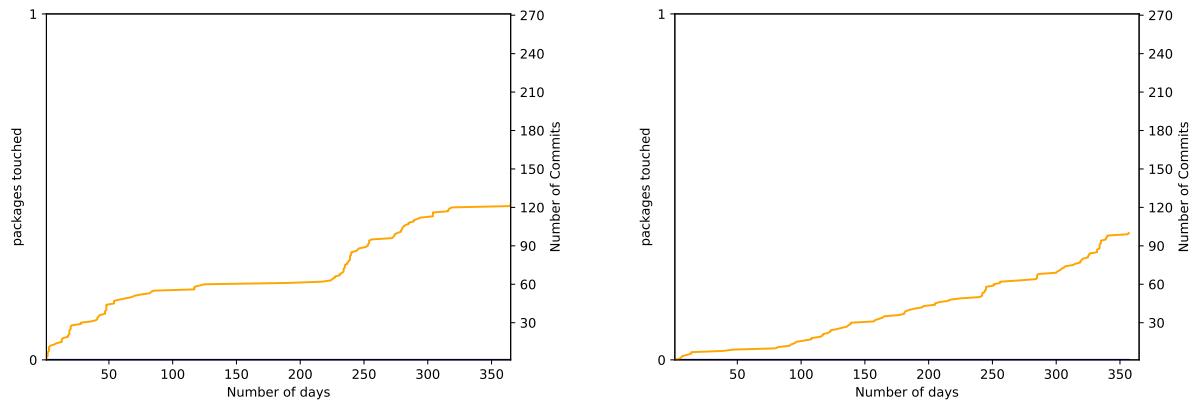
(d) Repository: 39 Developer 17844: Developer touched 0 packages after 54 commits.



(e) Repository: 39 Developer 17853: Developer touched 0 packages after 81 commits.



(f) Repository: 39 Developer 17856: Developer touched 0 packages after 95 commits.

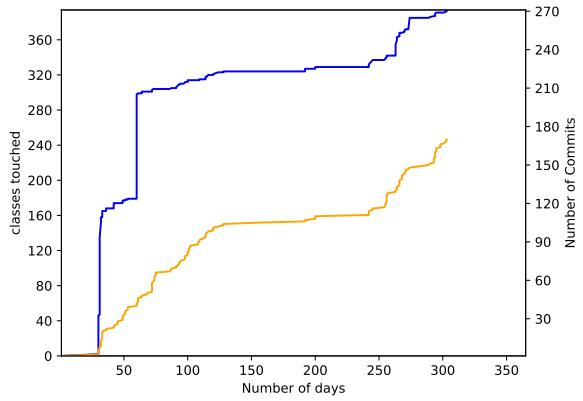


(a) Repository: 39 Developer 17861: Developer touched 0 packages after 123 commits.  
(b) Repository: 39 Developer 18371: Developer touched 0 packages after 100 commits.

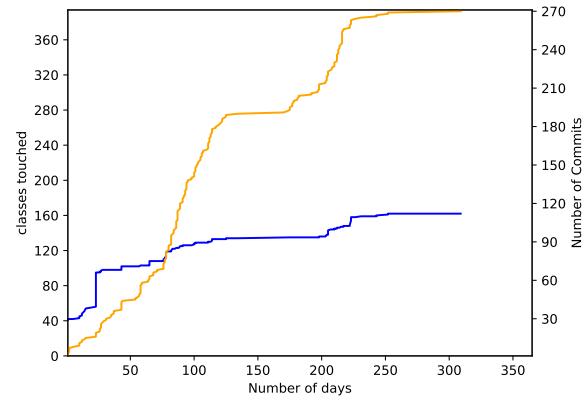
Figure 143: Number of days in the developers first year (x-axis) against packages touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

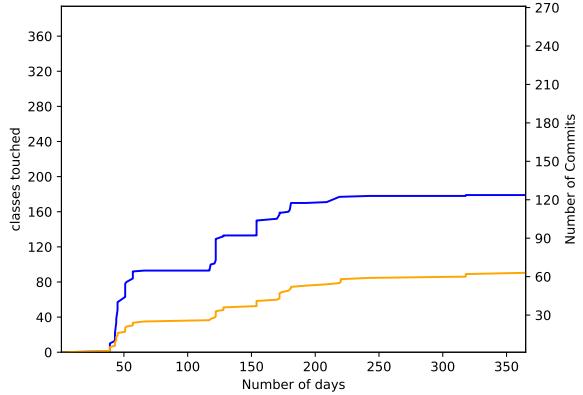
## 18.2 Developer touched - Repository 39: Developer classes knowledge



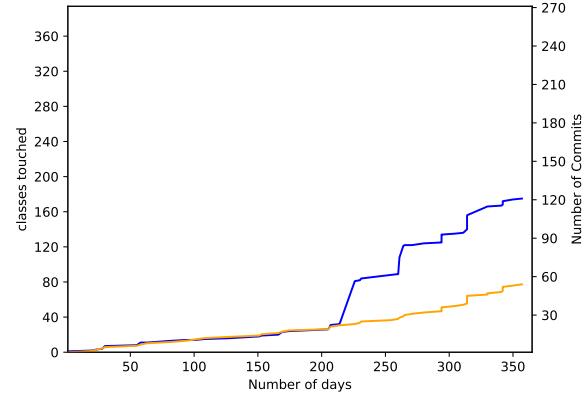
(a) Repository: 39 Developer 17820: Developer touched 393 classes after 170 commits.



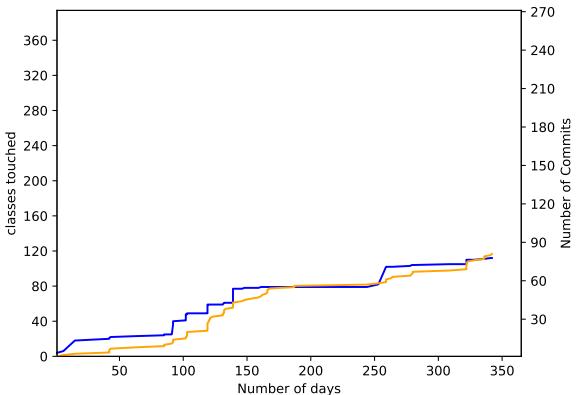
(b) Repository: 39 Developer 17821: Developer touched 162 classes after 270 commits.



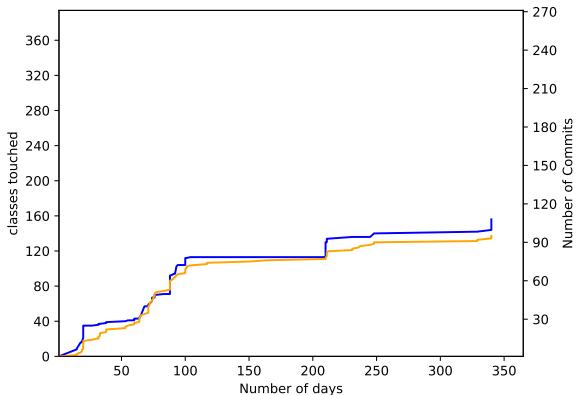
(c) Repository: 39 Developer 17835: Developer touched 179 classes after 63 commits.



(d) Repository: 39 Developer 17844: Developer touched 175 classes after 54 commits.



(e) Repository: 39 Developer 17853: Developer touched 112 classes after 81 commits.



(f) Repository: 39 Developer 17856: Developer touched 156 classes after 95 commits.

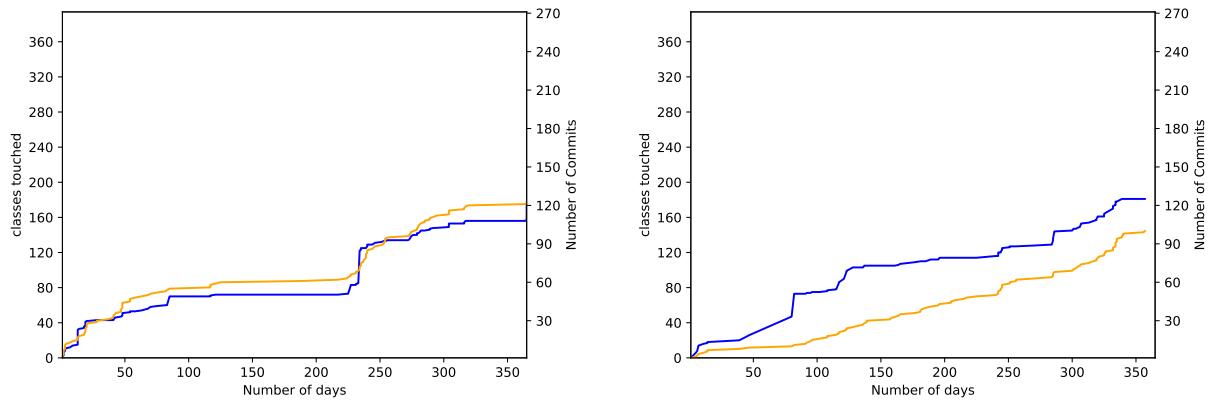
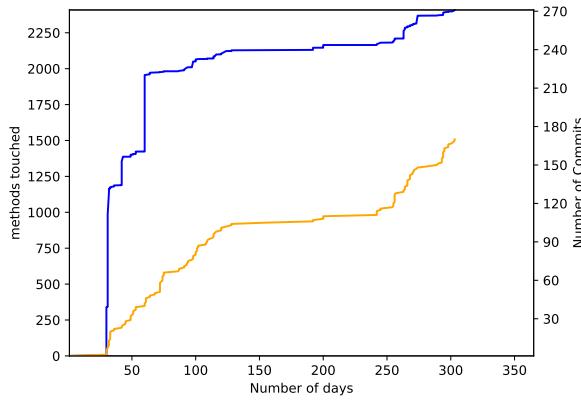


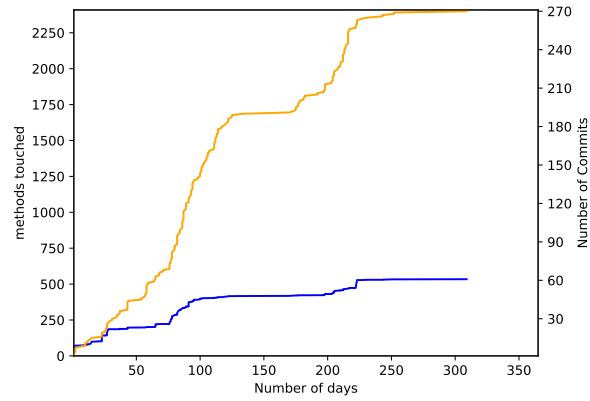
Figure 145: Number of days in the developers first year (x-axis) against classes touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

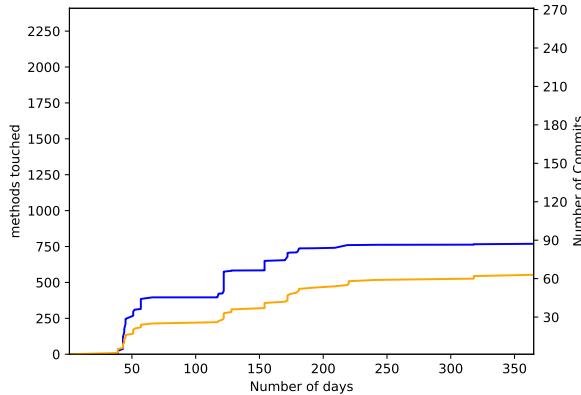
### **18.3 Developer touched - Repository 39: Developer methods knowledge**



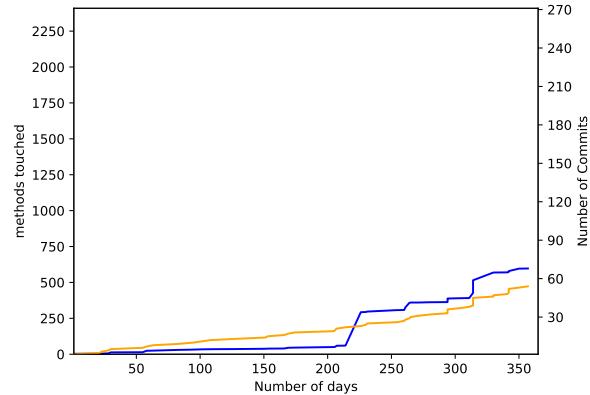
(a) Repository: 39 Developer 17820: Developer touched 2408 methods after 170 commits.



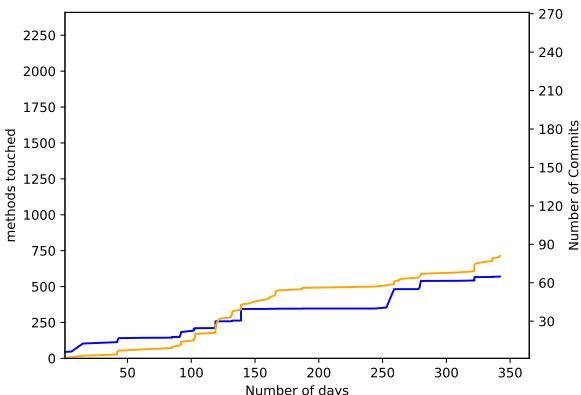
(b) Repository: 39 Developer 17821: Developer touched 534 methods after 270 commits.



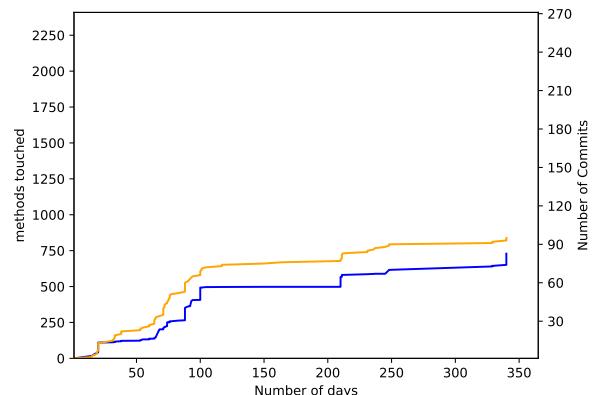
(c) Repository: 39 Developer 17835: Developer touched 769 methods after 63 commits.



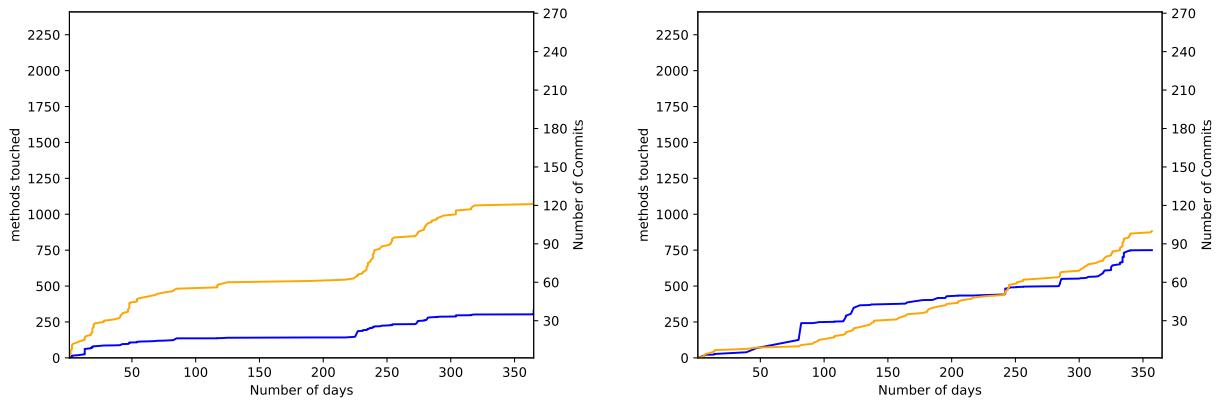
(d) Repository: 39 Developer 17844: Developer touched 597 methods after 54 commits.



(e) Repository: 39 Developer 17853: Developer touched 570 methods after 81 commits.



(f) Repository: 39 Developer 17856: Developer touched 729 methods after 95 commits.



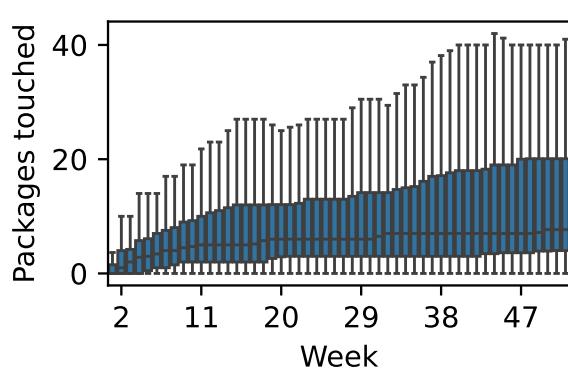
(a) Repository: 39 Developer 17861: Developer touched 331 methods after 123 commits.  
(b) Repository: 39 Developer 18371: Developer touched 750 methods after 100 commits.

Figure 147: Number of days in the developers first year (x-axis) against methods touched by sustained later joiner developers (y-axis). Sustained later joiner developers joining the project after six months and contributed at least 50 commits over a period of 250 days or more.

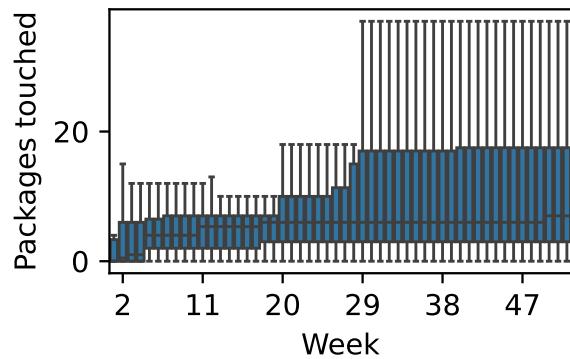
- Blue - Touched components on left y-axis.
- Orange - Commits on right y-axis.

## 18.4 Box plot developer - 14 For packages touched for each period

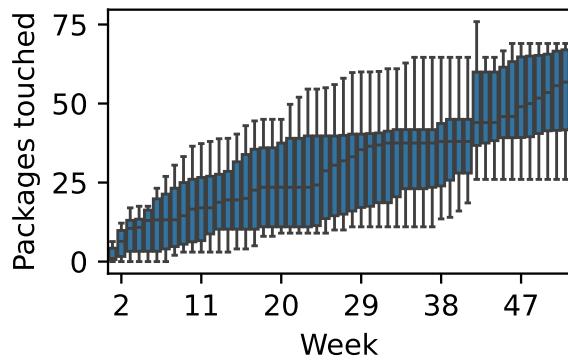
A box plot of packages touched on average each period the number of commits to components touched.



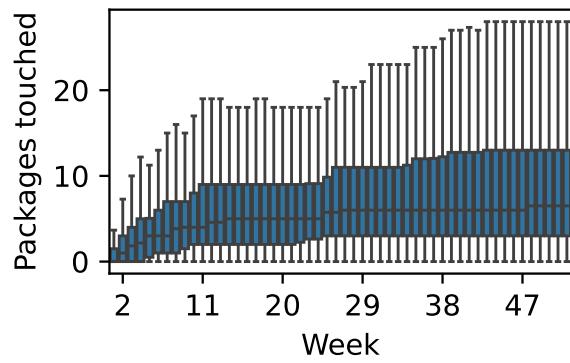
(a) All developers (244) showing packages touched



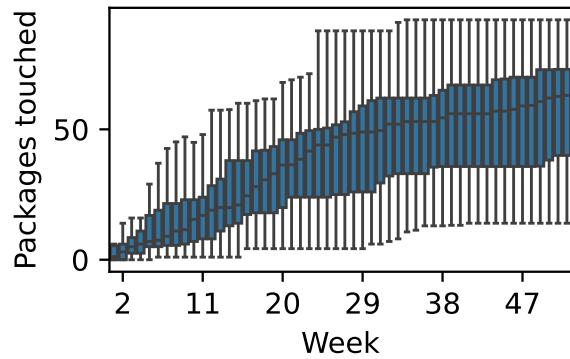
(b) Transient founder developers (13) showing packages touched



(c) Sustained founder developers (6) showing packages touched

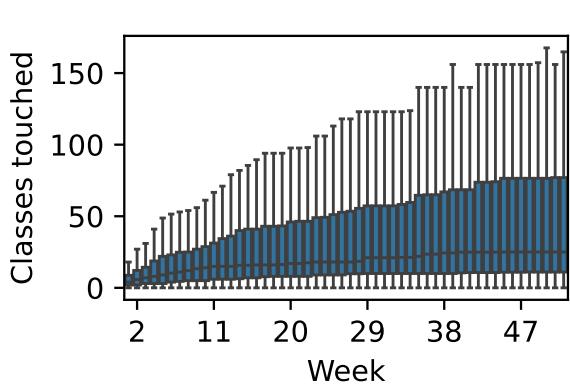


(d) Transient later joiner developers (204) showing packages touched

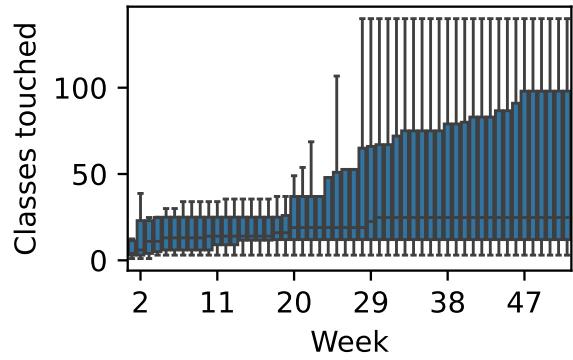


(e) Sustained later joiner developers (21) showing packages touched

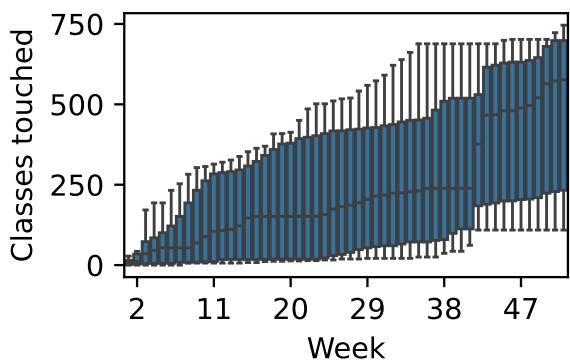
Figure 148: A box plot of total packages touched on mean each month, with quartile shading.



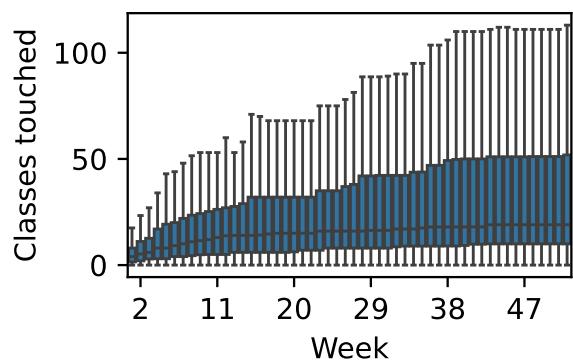
(a) All developers (244) showing classes touched



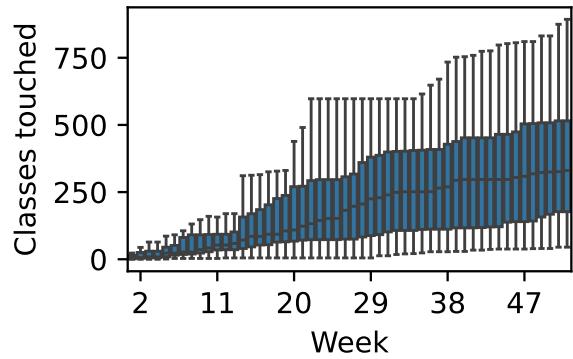
(b) Transient founder developers (13) showing classes touched



(c) Sustained founder developers (6) showing classes touched

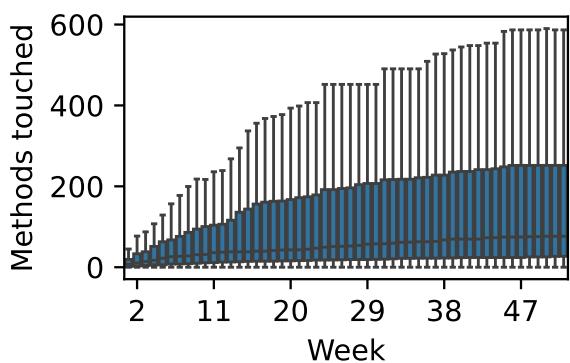


(d) Transient later joiner developers (204) showing classes touched

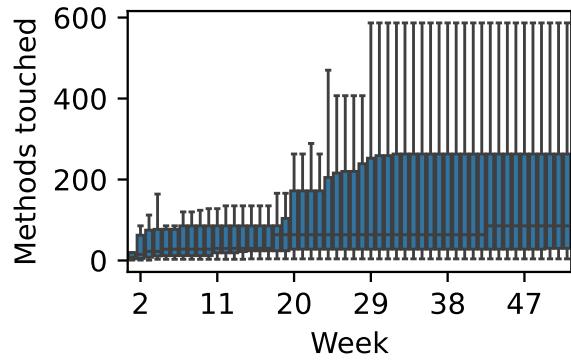


(e) Sustained later joiner developers (21) showing classes touched

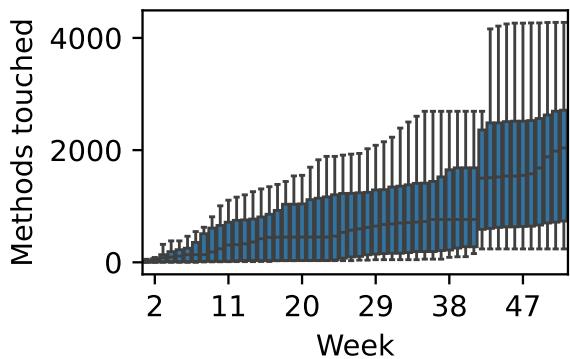
Figure 149: A box plot of total classes touched on mean each month, with quartile shading.



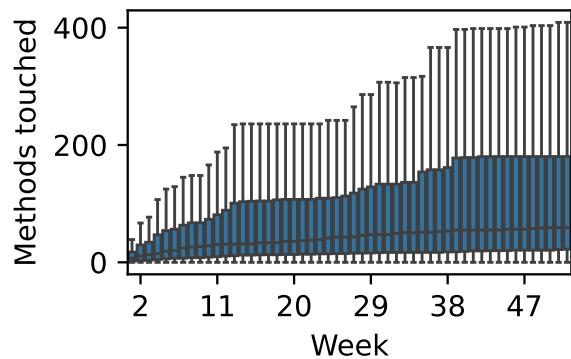
(a) All developers (244) showing methods touched



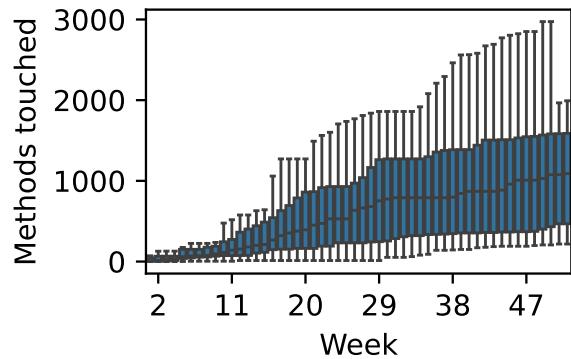
(b) Transient founder developers (13) showing methods touched



(c) Sustained founder developers (6) showing methods touched



(d) Transient later joiner developers (204) showing methods touched

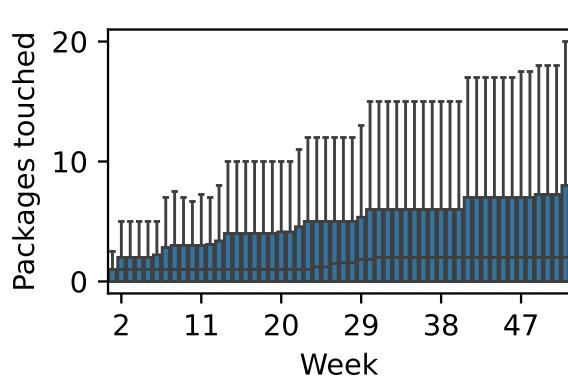


(e) Sustained later joiner developers (21) showing methods touched

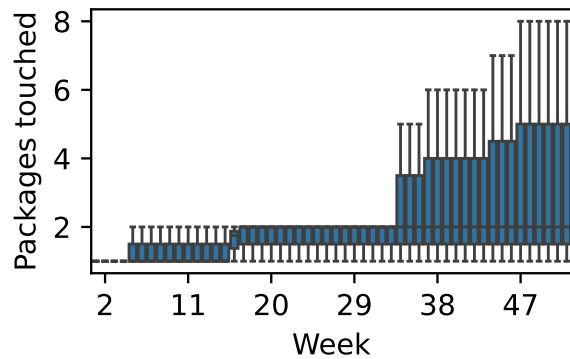
Figure 150: A box plot of total methods touched on mean each month, with quartile shading.

## 18.5 Box plot developer - 21 For packages touched for each period

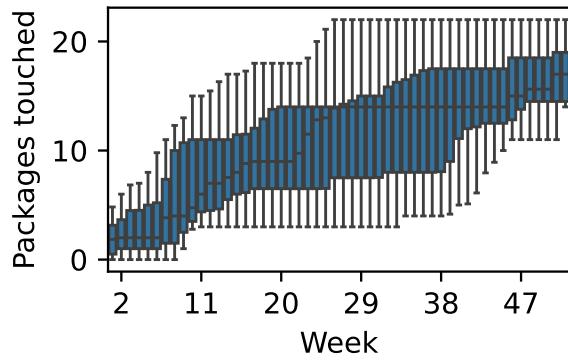
A box plot of packages touched on average each period the number of commits to components touched.



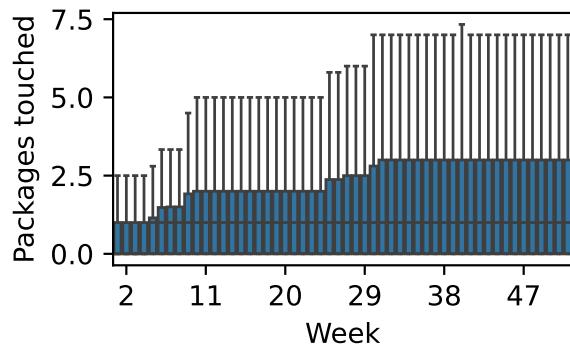
(a) All developers (300) showing packages touched



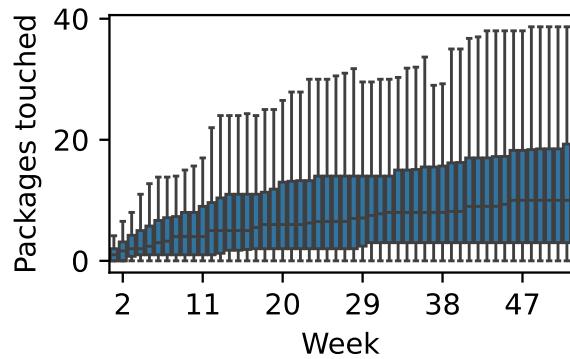
(b) Transient founder developers (3) showing packages touched



(c) Sustained founder developers (7) showing packages touched

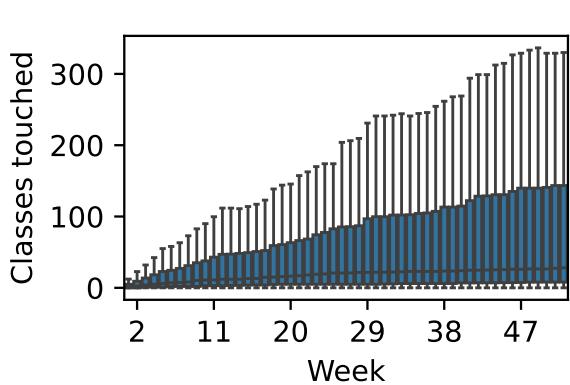


(d) Transient later joiner developers (206) showing packages touched

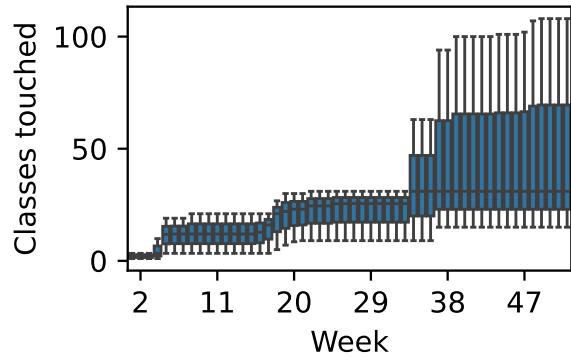


(e) Sustained later joiner developers (84) showing packages touched

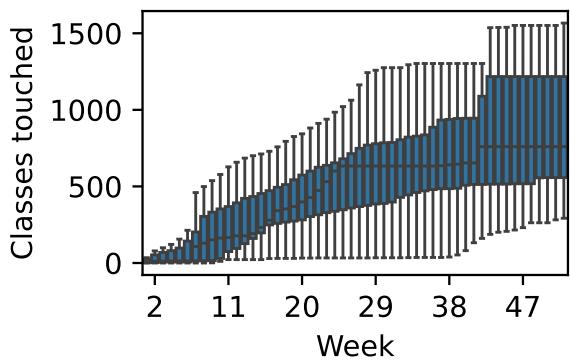
Figure 151: A box plot of total packages touched on mean each month, with quartile shading.



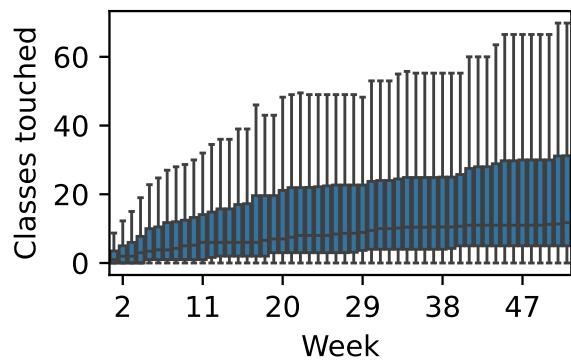
(a) All developers (300) showing classes touched



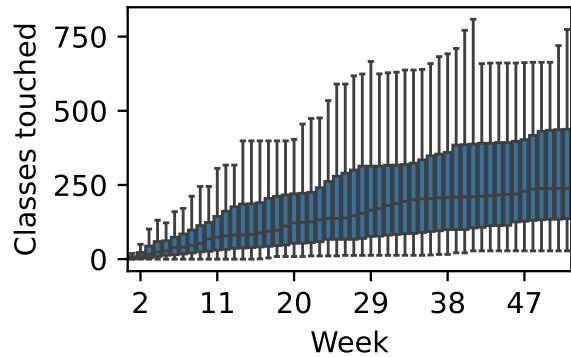
(b) Transient founder developers (3) showing classes touched



(c) Sustained founder developers (7) showing classes touched

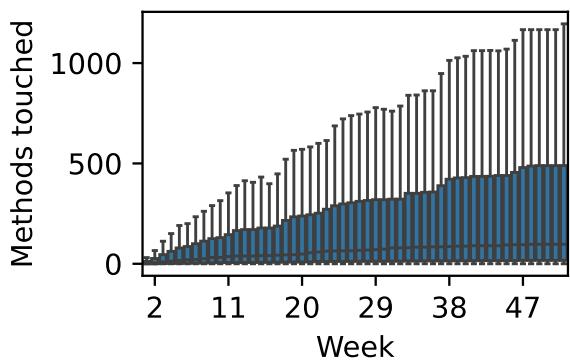


(d) Transient later joiner developers (206) showing classes touched

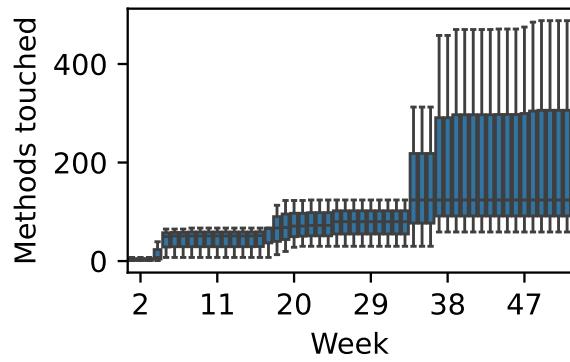


(e) Sustained later joiner developers (84) showing classes touched

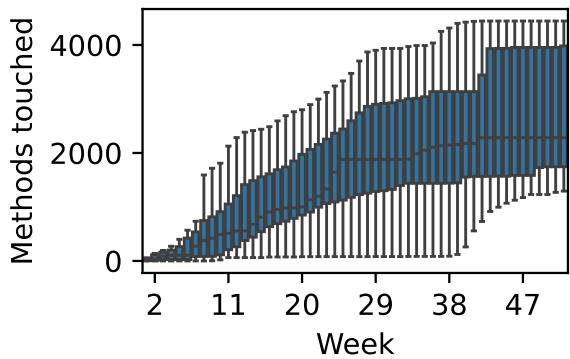
Figure 152: A box plot of total classes touched on mean each month, with quartile shading.



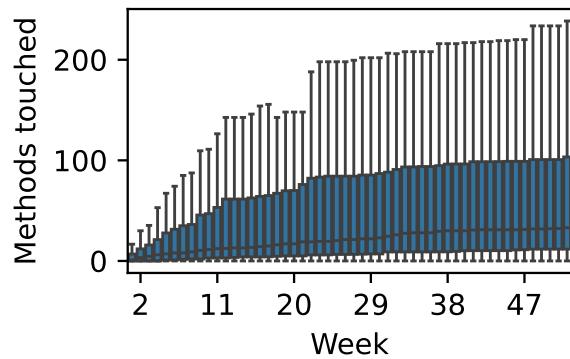
(a) All developers (300) showing methods touched



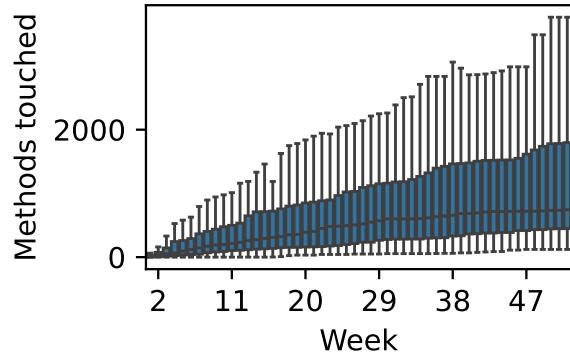
(b) Transient founder developers (3) showing methods touched



(c) Sustained founder developers (7) showing methods touched



(d) Transient later joiner developers (206) showing methods touched



(e) Sustained later joiner developers (84) showing methods touched

Figure 153: A box plot of total methods touched on mean each month, with quartile shading.