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**Heather Miller, Institute for Software Research, CMU**





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## Open Source Numbers Everybody Should Know

*A Data-Driven Portrait of New Trends in How We Build Software, Open Source, & What Even is "Entry-Level" Now*

**Heather Miller**

@heathercmiller

Open Source Summit 2020



Carnegie Mellon University  
School of Computer Science

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classes or drivers. It's not just simple things. A touchscreen is a fairly simple driver in the end. But we are also starting to see all the drivers for AI and completely new things that basically did not exist ten years ago, just because people's expectations of what a computer does have changed. In that sense it affects me as a kernel developer, but it does not affect me another capacities.

>> Usually we close our conversations joking about our next dive trip, I think our next dive trip is going to be in Washington state in really cold water. I may or may not see you there. I may or may not see you there, but thank you so much. I enjoy chatting with you as always, and back to Jim.

>> Thank you, Dirk, and Linus. Our next speaker is Heather Miller. And she founded the center and 2016. Today she is going to share a data-driven portrait of the open source and how we build software. I'm very excited to welcome Heather Miller.

♪ ♪

>> Hello. Hello from exotic Pittsburgh, Pennsylvania. Very exciting place. Thanks for the intro, Jim. I think everyone can see my slides. Cool. As



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OH HAI

## A bit about me

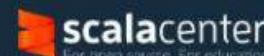
Founded the Scala Center, 2016

PhD in Computer Science, 2015

EPFL under Martin Odersky



Assistant Professor in the  
School of Computer Science  
@ CMU



For open source. For education.

### Worked a lot on Scala

- Scala Futures
- Scala's concurrency libraries
- Typeclass derivation
- Lightweight type system extensions
- Programming models for distributed programming
- Coursera MOOCs

### Joined CMU as an assistant prof in 2018

#### My research:

- bringing programming language techniques to dist. systems
- making microservice architectures more reliable
- distributed actor runtimes

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## Building a new lab at CMU

Doing stuff like making building microservice-based apps feel like you're programming in one language rather than 20. Building and formalizing language-level distributed and concurrent programming abstractions.

with some fine folks!



Assistant Professor in the  
School of Computer Science



Chris Meiklejohn  
@cmeik



Matthew Weidner



+ you?  
We're always looking for new students!

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## Just a bit more detail about some of our current projects...

### Rethinking the mathematical formulation of CRDTs

Matthew Weidner



We present a new construction:  
*semidirect product of op-based CRDTs*, which combines the operations of two CRDTs into one while handling conflicts between their concurrent operations in a uniform way. *Composability for CRDTs!*

### What if fault-injection was a sort of testing done at CI time?

Chris Meiklejohn

@cmeik



We present a novel testing methodology for distributed applications, called *Resilience Driven Development (RDD)*. With RDD, developers first specify application behavior as integration tests. Then, a novel fine-grained fault injection approach that uses exhaustive search is used to find bugs in the application.

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UM, SO WAIT

Then why are you  
talking about  
open source stuff?

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The two hardest problems in computer science are: (i) people, (ii), convincing computer scientists that the hardest problem in computer science is people, and, (iii) off by one errors.

- Jeff Bigham  
@jeffbigham

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## SCALA CENTER I'm the founding director.

And suddenly my focus is 200% what is happening in open source Scala, and how we can keep growing our ecosystem, tools, and improve developer experience for anyone.

Not only people paying into the Scala Center. But anyone with an internet connection. A good developer experience should be free.

This shift in focus was eye-opening.

I quickly observed problems with the health of some of our core projects in our own ecosystem that was cause for concern.

And what's worse, this trend is common throughout the open source community.

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## Things that are changing fast: & that more people should be aware of

How we  
build  
software

Open Source

Our idea of  
software  
engineers

What we actually  
do nowadays when  
we sit down to  
build an app.

The common  
infrastructure and tools  
that we all depend on

What SWEs should  
know, how much  
experience they  
have, and who  
they are.

This talk will cover fast-changing trends in these 3 areas

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problems in computer science are people, I agree with that spirit to come a convincing computer scientist at the hardest problem and computer science is people, and three, off by one errors. I still think this is true. And since becoming the director of this thing called the Scala Center, I went from doing stuff, distributed programming, and dealing with code and things like that, to focusing 200% on what is happening in the open source community. I been a part of it for several years holding my PhD, but it was never my responsibility to make things better until after I finished and they said, were going to do this. Our goal was not just to benefit people who are paying into the center, but it was anybody who had Internet connection. They should have a good Internet experience. When I had to go through this shift, I quickly absorbed a lot of problems in the Scala community and then I notice some of these things are problems for other communities as well. And the numbers that I am collecting are not Scala specific, there are generally open source specific, and when it comes to educational statistics, focusing on the U.S. mostly because that's where I am. That's where a lot of the large developer community is within the U.S. Some of these trends hold true, especially in Western Europe. I started collecting data on some of these fast changing trends and things that I want to bring to your attention. We will touch on three

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[NEW QUESTION](#)[SLIDES](#)**FIRST,****How people are  
getting into tech  
is changing****CAPTIONING**You are connected to event:  
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## HOW PEOPLE ARE GETTING INTO TECH IS CHANGING We all already know that hiring is difficult

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## Students graduating with CS/IT-related bachelor's degrees



\*note, this is a US-centric view!  
[https://www.ncwit.org/sites/default/files/resources/btn\\_05092019\\_web.pdf](https://www.ncwit.org/sites/default/files/resources/btn_05092019_web.pdf)

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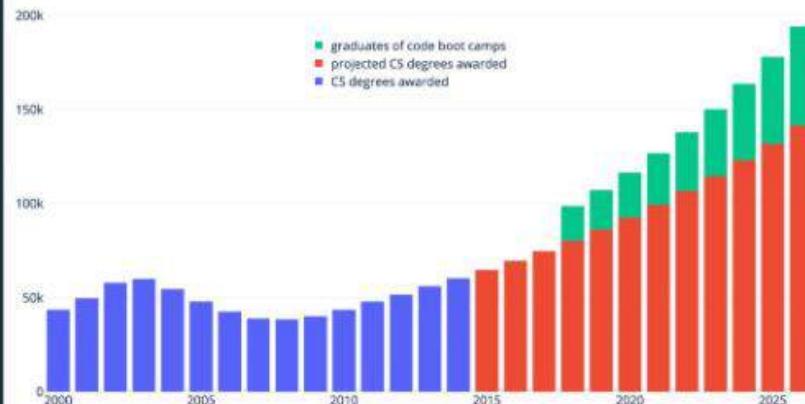
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There's still a shortage of tech workers, when you include code bootcamps too

\*note, this is a US-centric view  
[https://www.ncwit.org/sites/default/files/resources/btn\\_05092019\\_web.pdf](https://www.ncwit.org/sites/default/files/resources/btn_05092019_web.pdf)



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technical careers or software development careers, or programming is changing very quick. We all know, especially after looking at the U.S. it's hard to hire with software engineering. Obviously we're always trying to find the best developers, but there's not even enough for the jobs that we need to fill in the first place. I'm going to jump quickly to this data point here. This is actually data from two different sources that I superimposed. The blue bars are the number of bachelor degrees in technical, CS or IT related fields given by the U.S. These are statistics from the department, Bureau of educational statistics. They publish these things every couple of years. And the last numbers that I have are from the 2015 school year, and that year there was 60,000 CS or IT related degrees. And from year to year they projected about a 7.4% growth, so you could project forward in the future and see how many degrees are expected to be conferred by 2026. We are getting up to 150K. Meanwhile, the Department of Labor statistics is publishing numbers that were saying in 2017 there were over 500,000 computing jobs that were not filled. Companies were struggling to hire people and 500,000 positions. And what gets worse is that they projected this number will get higher in future years. Everybody can be like, what about tech boot camps. It doesn't mean you can't be a programmer. It's true.

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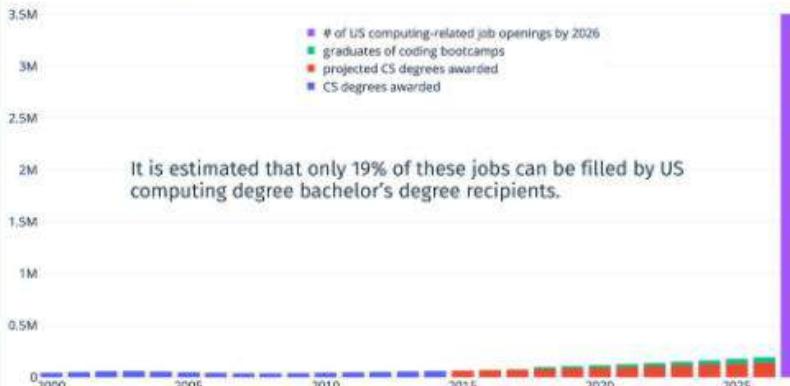
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## By 2026, there will be 3.5 million computing-related job openings\*



It is estimated that only 19% of these jobs can be filled by US computing degree bachelor's degree recipients.

\*Department of Labor Statistics, Employment Projections (Occupational Category: 15-1100) Includes new and replacement jobs and assumes current undergraduate degree (CIP 11) production levels persist.

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expected to be conferred by 2026. We are getting up to 150K. Meanwhile, the Department of Labor statistics is publishing numbers that were saying in 2017 there were over 500,000 computing jobs that were not filled. Companies were struggling to hire people and 500,000 positions. And what gets worse is that they projected this number will get higher in future years. Everybody can be like, what about tech boot camps. It doesn't mean you can't be a programmer. It's true. I'm support and tech boot camps. I'm a professor and I probably shouldn't be, but I think that's a great way to solve the shortage. Even if you add that number, they are at around, the number is not on the slide, you can look up these slides, their saved online and my schedule page. You can download them. The number is about 14% I believe, rate of increase per year. And we are starting to get good numbers with how many people are graduating from these programs. Even then we're getting up to under 200K new developers or people that could be potentially considered entry-level and 2026 let's just say. The Bureau of, Department of labor and statistics projected that by 2026 that need is going to increase to about 3.5 million. There is going to be 3.5 million openings. It's not completely fair to overlay these numbers on top of each other because especially that huge number there, the department of labor and statistics, they actually include people coming

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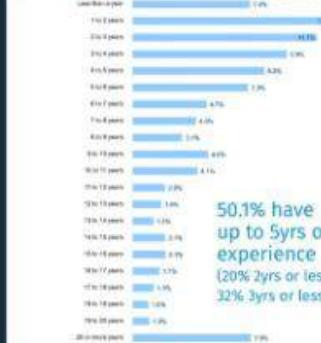
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## THE TECH WORKERS WE HAVE... A large portion of professional developers are new

### Developer Survey Results stack overflow

#### Years Coding Professionally

#### 2017



50.1% have up to 5 yrs of experience  
(20% 2yrs or less, 32% 3yrs or less)

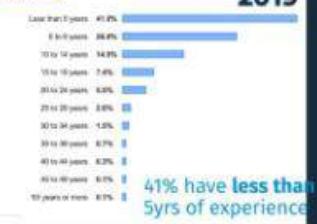
#### Years Coding Professionally

#### 2018



57.5% have up to 5 yrs of experience

#### 2019



41% have less than 5 yrs of experience

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#### TAKEAWAY:

We need to adapt, culturally, to make room for lots more newcomers

The demand for developers is just going to get more and more ridiculous.

The years of experience of practicing SWEs is dropping overall.

There's a tidal wave of newcomers entering our profession, and it's not going to slow down.

It's going to pick up speed.

## What do we do?

"New frameworks are lowering the barrier to entry," Caleb Fritske (founder of CodeTN) says; that's a far cry from the days when you had to learn the syntax of several programming languages to build useful software. "Rather than typing these seven lines of code to get a menu to pop down, you just download the framework from a code base that allows you to do that in a simpler way," he explains. "Frameworks are taking the hard work that developers prided themselves on out of the equation."

#### The New Jobs

By Marina Krakovsky  
Communications of the ACM, January 2018, Vol. 61 No. 1, Pages 21-23  
10.1145/3157077

<https://cacm.acm.org/magazines/2018/1/223883-the-new-jobs/fulltext>

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that completely going away. If this trend continues, it's obvious there is no way that coding boot camps in the U.S. bachelor programs combined can fill these openings. The Bureau says that about 19% of those jobs could probably be filled by computing degree, bachelor recipients, that's it. Clearly this means, oh, and I want to make one more point before I transitioned out of this. If you do, these are statistics from the stack overflow development survey. These are worldwide. What's interesting is that, you know, there is this concentrating over the years of people towards the top in these graphs. What they show is the number of years that people who are filling out the survey, they say their professional software developers and they say how many years they been programming. And, there is just a large number of people concentrating towards the top. Which means people have less than one year of experience, or one or two years of experience. More people less than five. The point here is there is a lot of people coming in, and I'm 30 something, I'm a professor, but any sort of software engineering, I don't assume that there are people extremely different and with a lot less experience than me coming in at a rate that they are. I think this is something that more people need to consider. It's basically we have a lot of newcomers and their arriving quickly. And so my point is that there are a lot of new developers coming in, this tidal wave of new developers entering our

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[NEW QUESTION](#)**SLIDES****TAKEAWAY:**

We need to adapt, culturally, to make room for lots more newcomers

The demand for developers is just going to get more and more ridiculous.

The years of experience of practicing SWEs is dropping overall.

There's a tidal wave of newcomers entering our profession, and it's not going to slow down.

It's going to pick up speed.

**What do we do?**

"New frameworks are lowering the barrier to entry," Caleb Fristoe (founder of CodeTN) says; that's a far cry from the days when you had to learn the syntax of several programming languages to build useful software. "Rather than typing these seven lines of code to get a menu to pop down, you just download the framework from a code base that allows you to do that in a simpler way," he explains. "Frameworks are taking the hard work that developers prided themselves on out of the equation."

**The New Jobs**

By Marina Krakovsky  
Communications of the ACM, January 2018, Vol. 61 No. 1, Pages 21-23  
10.1145/3157077

<https://cacm.acm.org/magazines/2018/1/223883-the-new-jobs/fulltext>

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SLIDES

## TAKEAWAY: Existing devs are burning out

"Unable to fill tech vacancies, employers shuffle off additional duties to current employees, which leads to burnout and has a negative impact on local business development. Over 30% of respondents surveyed by Indeed admit that this issue accelerates staff turnover."

### US Tech Talent Shortage in Numbers

March 26, 2019  
<https://www.daxx.com/blog/development-trends/software-engineer-shortage-us-2019>

"With companies unable to fill open positions, current employees are expected to fill the gaps. In many cases this results in employee turnover. Over a third of respondents we surveyed (36%) said the lack of timely hiring has caused burnout in existing employees and affected their businesses."

**Is the Tech Talent War Hurting Innovation? Hiring Managers and Tech Recruiters Respond**  
December 5, 2016  
<http://blog.indeed.com/2016/12/05/impact-of-tech-talent-shortage/>

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TAKEAWAY:

## Obviously, increased diversity would help

We know that the people who develop software are not a representative sample of society. Making more underrepresented minorities at home in tech is an obvious solution to increasing our numbers.

### But also...

Immigration = good, more tech workers

Remote workers = good, more tech workers

\*note, this is a US-centric view!

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## A QUICK ASIDE...

We need to care about diversity for more than economics alone.

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allows you to do that and a simpler way. Frameworks are taking the hardware's that developers used to pride themselves on out of the equation. They take away here is that it's easier to teach people that are beginners because we have these frameworks that can do things and fewer lines of code, fewer, like cognitive cycles if you will. This is helping. Another issue that I would be remiss not to bring up is that we have an issue with existing developers burning out. What is happening in the face of this problem where companies can't fill all the positions that they have, employers are trying to shuffle additional duties on the employees they currently have. There's a lot of work with burning out. If you ask people in the world of hiring and tech positions, people at Indeed.com who have done a survey on this, they say this accelerates staff turnover. More responsibilities are being on people. Something worthwhile to hold onto here. I'm going to make a quick point and plug some research on diversity. Obviously increased diversity would help and immigration, that would be great. And making it easier to do remote work, these are ways to start to fill this need where it may be we are having trouble filling it come obviously. I would like to mention, I'm going to just mention some research that I would encourage you if you are interested in any of this to have a quick look at

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**PAPER:** Gender and tenure diversity in GitHub teams.

## Increased diversity = increased productivity

Research from one of my colleagues:

There is evidence that software teams that are more diverse are more productive.

Holding other confounds fixed, teams that are more diverse with respect to gender and/or tenure/experience tend to write code faster than teams that are less diverse.

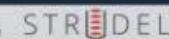
Aside: Why should you care about gender diversity?

Productivity boosts



\*Gender and tenure diversity in GitHub teams. Vasilescu, B., Posnett, D., Ray, B., Brand, M.G.J., van den, Seniebrink, A., Devanbu, P., and Feikov, V. CHI 2015.

Carnegie Mellon University  
School of Computer Science

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## PAPER: The Impact of Social Capital on Sustained Participation in Open Source How do we stop people from disengaging?

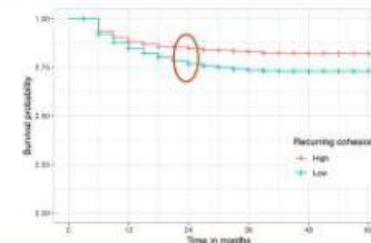
People on informationally diverse teams engage longer:

Being part of teams with more diverse information ~  
more prolonged engagement, esp. for women

Information diversity should  
reduce the risk of demographic-based echo chambers.



More social capital ~ more prolonged engagement



Take away: Invest in building social capital  
& Foster informationally diverse teams

Going Farther Together: The Impact of Social Capital on Sustained Participation in Open Source, Olu, H.S., Nolte, A., Brown, A., Serebrenik, A., and Vasilescu, B. ICSE 2018

Carnegie Mellon University  
School of Computer Science

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**TAKEAWAY:**

**SCIENCE ACTUALLY SAYS THAT DIVERSITY +  
PEOPLE MENTORING EACH OTHER MAKES  
YOU BUILD BETTER SOFTWARE. LIKE REALLY.**

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There's a lot of work with burning out. If you ask people in the world of hiring and tech positions, people at indeed.com who have done a survey on this, they say this accelerates staff turnover. More responsibilities are being on people. Something worthwhile to hold onto here. I'm going to make a quick point and plug some research on diversity. Obviously increased diversity would help and immigration, that would be great. And making it easier to do remote work, these are ways to start to fill this need where it may be we are having trouble filling it come obviously. I would like to mention, I'm going to just mention some research that I would encourage you if you are interested in any of this to have a quick look at when you have time. Basically there is research that says and this is from a colleague of mine at CMU. If you look at the productivity of software engineering teams, teams over a long period of time. If you hold other compounds fixed, teams that are more diverse with gender and 10-year experience, they tend to write code faster than teams that are less diverse. You know, what that means, actually, this is another point I will show you. You should look at this. There is another paper about how particularly women lose engagement faster and this idea of having, you know, mixed diversity in terms of gender and experience, it tends to lead to people building software, better software faster. And ultimately this has basically they are being diversity, people being sensitive to one

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## OPEN SOURCE SURVEYS: 2015 & 2016 Black Duck "Future of Open Source" Survey

**Black Duck**  
*(now Synopsys)*  
runs an annual survey asking companies about their open source use.

They survey >1,000 companies about their open source usage.

<https://www.blackducksoftware.com/2016/future-of-open-source>



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## OPEN SOURCE SURVEYS: 2015 & 2016 Black Duck "Future of Open Source" Survey Why did companies suddenly decide to shift building atop OSS?

2016

### Top 3 reasons to use OSS:

- #1 quality of solutions
- #2 competitive features & technical capabilities
- #3 ability to customize & fix

2015

### OSS vs proprietary:

- 66% of companies consider OSS options before proprietary alternatives

OPEN SOURCE BECAME THE DEFAULT CHOICE

<https://www.blackducksoftware.com/2016-future-of-open-source>

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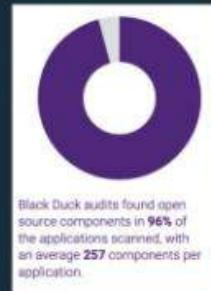
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## OPEN SOURCE SURVEYS: Synopsys 2018 Survey (was Black Duck) Everything is OSS now

Scanned/analyzed (anonymized) data of over **1,100** commercial code bases.



**96% USED OSS IN 2018!**

- Open source components in 96% of applications scanned!
- Average of 257 open source components per application!

In 2017, 36% of code base was open source components. In 2018, that number is 57%.



The average percentage of codebase that was open source was 57% vs. 36% last year. Many applications now contain more open source than proprietary code.

**MANY APPS ARE NOW MORE OPEN SOURCE CODE THAN PROPRIETARY**

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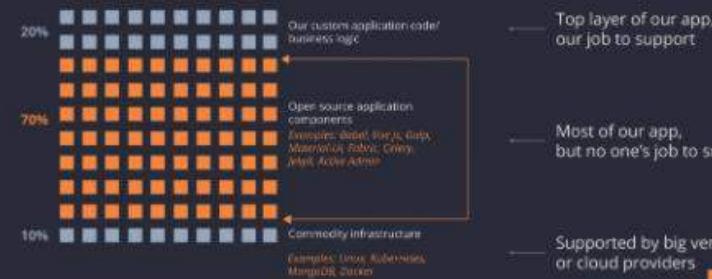
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## OPEN SOURCE SURVEYS: 2018 Tidelift Professional Open Source Survey Software now is mostly made out of OSS components

Most applications are built on top of a foundation of 70% or more open source code



TIDELIFT

[https://cdn2.hubspot.net/hubfs/4008838/introduction\\_to\\_Managed\\_Open\\_Source.pdf](https://cdn2.hubspot.net/hubfs/4008838/introduction_to_Managed_Open_Source.pdf)

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## TAKE A MINUTE TO INTERNALIZE THAT.

### Synopsis:

in 2017: 36% of code bases are open source components.  
in 2018: 57% of code bases are open source components.

### Tidelift:

in 2018: 70% of code bases are open source components,  
only 20% is custom application/business logic.



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## Software now constructed from OSS puzzle pieces



Mike Krieger  
Instagram co-founder

Blog article:  
Advice on picking tech for your startup

“ Borrow instead of building whenever possible ”

“ There are hundreds of fantastic open-source projects that have been built through the hard experience of creating and scaling companies; especially around infrastructure and monitoring...that can save you time and let you focus on actually building out your product. ”

<https://opbeat.com/blog/posts/picking-tech-for-your-startup/>



Nadia Eghbal Twitter  
Series 1 event = majority  
Jan 25 - 4 min 19 sec

### Open source was worth at least \$143M of Instagram's \$1B acquisition

Every tech company built after 2000 has benefitted from open source infrastructure—that is, free, public code that anybody can use to build software.

It's saved companies countless dollars, developer hours, and headaches to be able to use someone else's code to get up and running instead of having to build everything from scratch.

I decided to take a stab at calculating how much that infrastructure is actually worth to a company.

Instagram is a great example to look at, not just because of its acquisition price, but how quickly it was able to scale and exit.

<https://medium.com/@nayafia/open-source-was-worth-at-least-143m-of-instagram-s-1b-acquisition-808bb85e4681#.d6gzzr9nk>

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usage and the main reason they claimed that was because it was lower cost and there was no vendor locked in. By 2018, this is now scanning dependencies of commercial code bases, open source components were found. Over 1100, open source components were found in 96% of applications that were scanned. There was an average of 257 open source components. 96% were using open source and 2018. The average number of open source components was a whopping 257. And 2017 the percentage of these company code bases that were considered open source components was 36%, by 2018 that number had increased to 57%. It's shocking change. There is a company called tidal lift that many of you have heard of, they observed similar things and that is open source applications are 70%, I'm sorry, most applications that they are scanning and analyzing which are closed source or end user, 70% are open-source components. 20% is business logic and 10% is infrastructure. Basically 20% of what you are engineers at your companies are writing, you're only writing 20% of the application which is amazing. We are writing not all of it by ourselves anymore. Finally it works. Take a second to internalize that. In 2018 36% were open-source. In 2018 57%. Still a majority, it's amazing. I'm going to jump over this point, but I love these quotes if you're interested. The cofounder of Instagram argued for overbuilding

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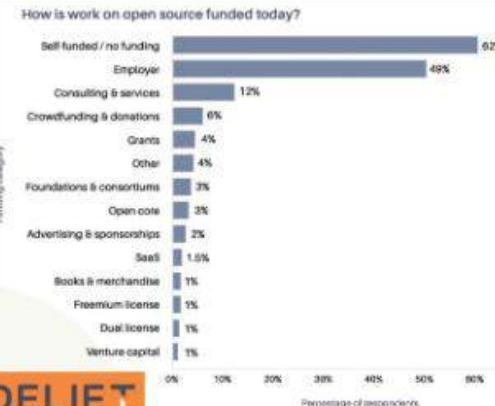
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## OPEN SOURCE SURVEYS: 2018 Tidelift Professional Open Source Survey Yet, most have to self-support their OSS work



# 62%

of respondents said that they are required to financially support their open source work with their own funds, or that they receive no external funding at all.

Over 1,200 respondents

**TIDELIFT**<https://tidelift.com/about/2018-tidelift-professional-open-source-survey-results>

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SLIDES

**HYPOTHETICAL WORST CASE**

**OpenSSL**  Cryptography and SSL/TLS Toolkit

In 2014,  
**66% of all web servers were using OpenSSL**

Meanwhile, OpenSSL was maintained by only a few volunteers

“ Steve Marquess, noticed that one contributor, Stephen Henson, was working full time on OpenSSL. Curious, Marquess asked him what he did for income, and was shocked to learn that Henson made one-fifth of Marquess's salary.

“ Marquess had always considered himself to be a strong programmer, but his skills paled in comparison to Henson's. ... Henson had been working on OpenSSL since 1998.

<https://fordfoundcontent.blob.core.windows.net/media/2976/roads-and-bridges-the-unseen-labor-behind-our-digital-infrastructure.pdf>

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## Empirical Analysis of Programming Language Adoption Looked at lots of data.

- 10 years of repository meta data, tracking up to 590,000 open source projects
- Survey data of developers over multiple surveys, ranging from 1,000 to 13,000 respondents

### BIG QUESTION:

**Which factors most influence developer decision-making for language selection?**

### Empirical Analysis of Programming Language Adoption

Lev A. Meyersnick  
UC Berkeley  
levm@eecs.berkeley.edu

Ariel Rabkin  
Princeton University  
arielr@cs.princeton.edu

and developers in determining when and whether to let new or rare, experimental languages. To do this, the language adoption study quantitatively studies the use of languages. This paper addresses that gap. We present a combination of user research and software repository mining to investigate the factors that influence developer language choice.

Since there is no standard about the programming language adoption process, we focus on broad characteristics:

What statistical properties describe language popularity? We begin (Section 2) with an empirical analysis of language use across 590,000 open source projects. Such a massive dataset reveals what languages have the most users and how. Our analysis includes the overall distribution of projects and developer experience.

We find that language popularity follows a power law, which means that one language is concentrated in a small number of users, but many unpopular languages still find a user base. The popular languages in our study serve a variety of application domains while less popular ones tend to avoid the mainstream. Even in niche domains, popular languages will more typically win.

Which factors most influence developer decision-making for language adoption? Section 3 examines the subjective motivation of developers when picking languages for specific projects. Knowing when motivates developers to pick a language helps designers and advocates address those needs.

Through multiple surveys, we see that developers value open-source libraries as the dominant factor in choosing programming languages. Other factors are tied to intrinsic language properties.

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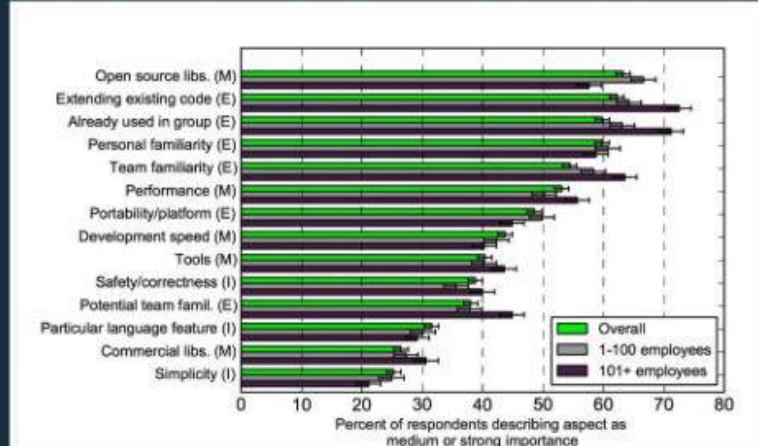
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## EMPIRICAL ANALYSIS OF PROGRAMMING LANGUAGE ADOPTION

### Importance of different factors when picking a language:



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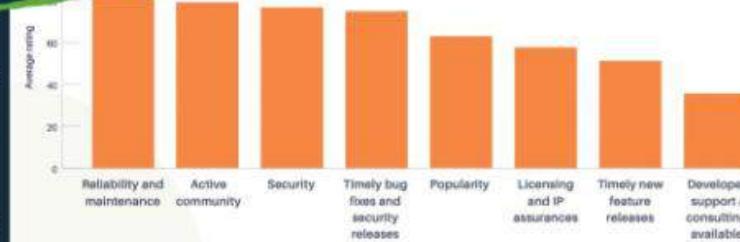
OPEN SOURCE SURVEYS: 2018 Tidelift Professional Open Source Survey

## Professional users want an active community!

What do respondents value most in evaluating open source libraries?

Respondents rated an active community as being over 20% more important than the popularity of a project.

TIDELIFT



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## What does this all mean?

### TAKEAWAY:

Community & Ecosystem are among the most important factors to an open source project's success.

To stay alive, there should be a relentless focus on growing the community and ecosystem! And that is hard work.

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## Things that are changing fast: & that more people should be aware of

### We saw 3 areas...

How we build software

What we actually do nowadays when we sit down to build an app.

**TAKEAWAY:**  
We largely glue together open source components, now (we didn't do this as much, not even like 3 years ago.)

Open Source

**TAKEAWAY:**  
There remain sustainability issues in OSS that we should be more cognizant of.

Our idea of software engineers

What SWEs should know, how much experience they have, and who they are.

**TAKEAWAY:**  
Most developers are extreme newcomers. We need to adapt to this.

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particular programming language, open-source libraries, existing code, and there was familiarity. These are all factors and not to the language. What was more important was the open-source libraries and communities spirit and TIDELIFT, neat thing is over the text, but they found the same thing ultimately what they found was that professional users, people want to adopt open-source libraries, and active community. The most important thing was that software is reliable and well maintained, it has an active community is supporting and using it, and that maintainers provide timely fixes, the resources to do that. I gave you too many things and you're probably all dying. The main point here is that there is research that points to the fact that community ecosystem are among the most important factors to an open source project, and open-source project success. That's it. I want to provide a couple of sentences of summary and then I will let you all escape. Basically the takeaways from this talk or that the way that we build software is becoming, is different than it was when Linus decided that Linux was a good idea. People are reusing, building frameworks way more than the ever work. The whole idea of developers priding themselves on efficient ways to implement something, now we tell a newcomer, rabbit off a shelf and reuse that thing. That was how, that's how it's going. We know that there are sustainability issues and open-source, things like Linux foundation are hopefully helping it. And then

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