Innovation, Adoption, and the Life Cycles of Technical Skills

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Extended Abstract

An important yet understudied aspect of technological change and innovation is the development and diffusion of new technical tools and skills. For example, TensorFlow, one of the first mainstream machine learning frameworks, was released in November 2015 by Google. Since then, it has been downloaded over 100 million times, thereby making machine learning techniques widely accessible and enabling widespread knock-on innovation, worker enablement, and business value. But not all technical skills become this popular – some never make it, while others become obsolete and slowly die out.[1] Importantly, an acceleration in skill innovation can lead to faster skill, and thus worker, obsolescence. It is thus critical to understand the life cycles of skills to help employers, workers, and job seekers strategically acquire the 'right' skills.

To answer these questions, we assemble a novel dataset that combines information on the release dates, company involvement, and open-source status of technical skills with granular skill demands data from over 200 million job postings from the past decade (2010–2022). These data allow us to track demands for over 16,000 (technical and non-technical) skills by employers, regions, and occupations. 2,000 of these skills are technical, including tools and frameworks such as Fortran, Python, TensorFlow or ReactJS.

Leaning on the innovation literature, we then fit an exponential growth model to understand the doubling and half-life times of the technical skills in these data. To account for the fact, that some technical skills have existed much longer than others, we create an event study to estimate skills' growth patterns *after their release*.

Our main finding is that the diffusion speed of technical skills increased over time – in other words, after their release, newer skills reach a larger share of job postings demanding them more quickly than older skills. It has thus become harder for workers to keep their skills up to date or match the skill demands of new job postings, making a life-long learning mentality ever more important.

We also find that the adoption curves of recent technical skills are exponential – the average technical skill requires 1 year to be demanded by at least 500 job postings and has a doubling time of roughly half a year.

Finally, we identify important heterogeneity in the success of skills by open-source status and company backing. While proprietary (i.e., for-pay, not open-source) skills tend to be more successful on average, they are also more hit or miss, as their demand has significantly higher variance than that of open-source skills. The most popular skills are both open-source and

[1] See Horton & Tambe (2020) – 'Death of a Technical Skill' – for an excellent description of the labor dynamics after Apple ended support for Adobe Flash in 2010.

backed by large tech companies, such as TensorFlow (Google), Kubernetes (Google), Swift (Apple), and ReactJS (Facebook), among others. We believe that there are several factors for why the combination of open source and large company backing are so successful for skill innovation. Specifically, these firms have the skilled developers and other resources necessary for continued maintenance and improvements of these skills. Further, these skills are typically only released after sufficient internal development and maturing. Finally, large tech firms can reap significant indirect benefits of releasing free skills, including increased prestige, better worker retention, easier worker hiring due to increased skill overlap, as well as the ability to create a customer ecosystem, which includes for-pay complements.

Figure

Skill Demand Post-Release with Average in Legend.

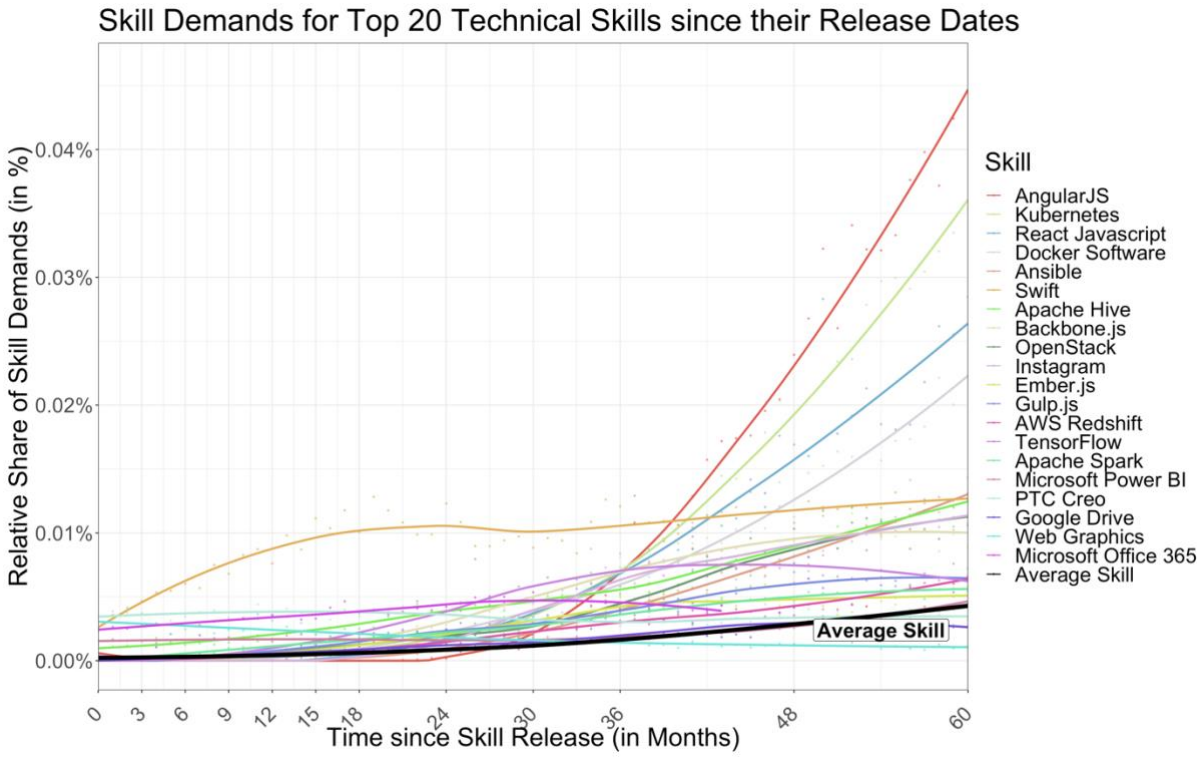

Figure 1. Monthly Skill Demands – measured as relative shares of total monthly skill demand – for the 20 most popular technical skills since their respective release dates.