V viewpoints

Peter C. Evans and Rahul C. Basole

Economic and Business Dimensions
Revealing the API Ecosystem and Enterprise Strategy via Visual Analytics

Seeking better understanding of digital transformation.

VALUABLE INSIGHTS CAN be gained by applying visual analytic techniques to understand complex, emerging ecosystem dynamics and evolving enterprise strategies.[1,2] One such context is the application programming interface (API) ecosystem. APIs have grown dramatically in the past five years. These bits of code act as digital control points that set the terms for which data and services can be efficiently shared or "called" over the Internet.[11] There are now over 12,000 open APIs available across a wide range of market sectors, a thirtyfold increase since 2006.[a] While the ability to connect to digital resources using APIs has been a feature of computing for decades, the prominence of digital platforms, the rise of mobile computing, lower cost
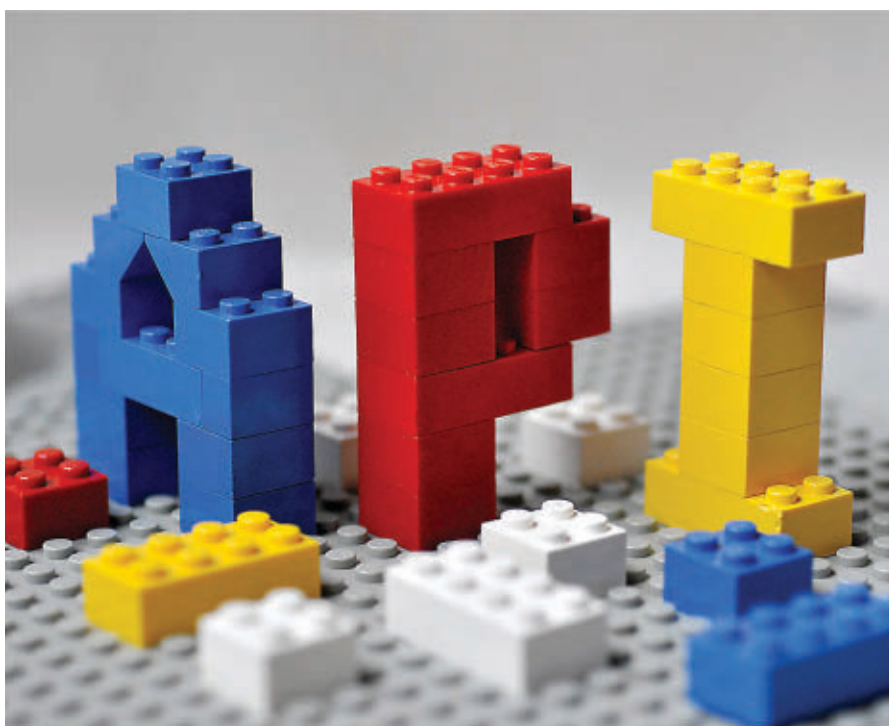

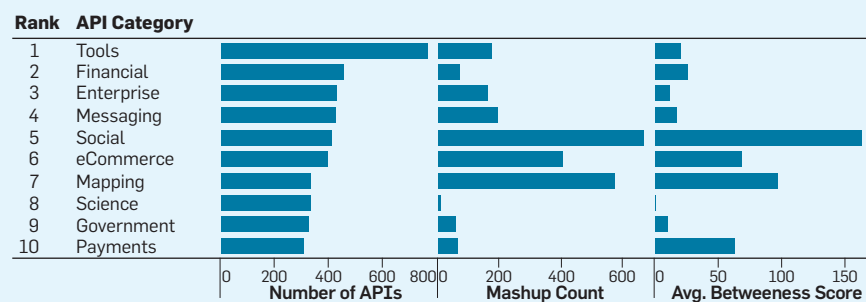a   See ProgrammableWeb, http://www.programmableweb.com/

of data storage, and just the sheer usefulness of automating how digitally encoded information can be made available and exchanged has helped to spur faster growth. Some of the most popular APIs handle a staggering number of calls. For example, Twitter, Google, Facebook, Netflix, AccuWeather, eBay, and Sabre all handle over a billion API calls per day.[4]

Firms are finding APIs to be beneficial in a variety of ways. The initial provider can use an API as a way to create new revenue streams, by offering access to already existing digital information through a range of different business models (including subscription, license, freemium, or pay-as-you-go). For example, Thomson Reuters, which has an extensive 45 million over-the-counter exchange-traded instruments globally, is building out a set of APIs to make it easier for other companies to access this data.[3] APIs also make it possible for third parties to build entirely new digital applications and services by creating "mashups" that integrate existing APIs. More than 6,000 such mashups have been created in recent years.

While open APIs promise to create value, boost productivity, and offer strategic advantages for firms that embrace their use, they are not deployed evenly across firms or industry sectors. What sectors have attracted the most APIs? And what firms are situated at the core of the API ecosystem and which remain at the periphery?

To better understand the broader structure of the API ecosystem, we leveraged a comprehensive curated dataset of over 11,000 APIs and 6,000 mashups, across 329 sectors. We converted the API data into a mashup network, where nodes represent APIs and edges represent if two APIs have been used jointly in a mashup. Edges are scaled proportional to the total number of mashups: the thicker the line, the more mashups were created using the corresponding two APIs. We then computed important network properties, including various centrality measures, to understand the position, prominence, and influence of APIs in the network. Finally, we visualized this network using a cluster-emphasizing force-directed layout algorithm (OpenORD),[7] identified and colored communities within this graph using a modularity-based

Figure 1. Open APIs by top 10 sectors.

Rank	API Category	Number of APIs	Mashup Count	Avg. Betweeness Score
1	Tools			
2	Financial			
3	Enterprise			
4	Messaging			
5	Social			
6	eCommerce			
7	Mapping			
8	Science			
9	Government			
10	Payments			

Source: Authors calculations with data from ProgrammableWeb, 2015

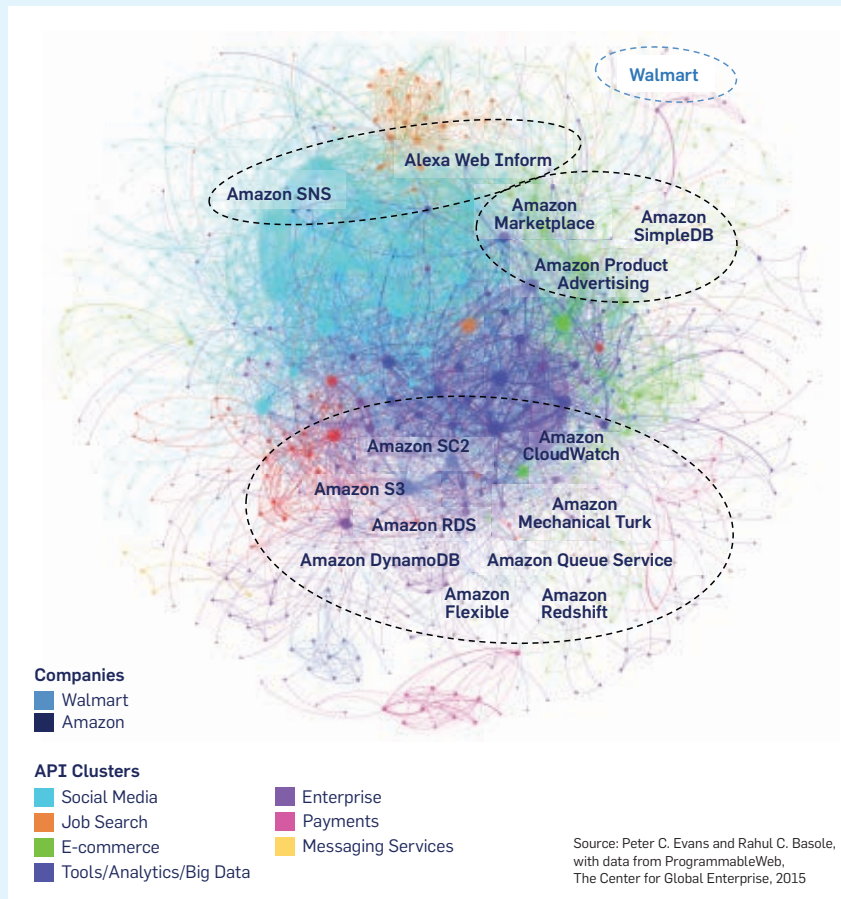approach,[9] and sized nodes according to their influence.[6]

The network analysis reveals interesting sectoral differences. The highest concentrations of APIs are primarily found in software tools, finance, enterprise, messaging, social networking, and e-commerce (see Figure 1), ranging between 400 to over 750 per sector. Mapping, science, government, and payments are also prominent sectors, each containing between 300 to 400 open APIs. But a large number of open APIs does not mean there will necessarily be a large number of API mashups. The most active areas for building new mashups use social, e-commerce, and mapping APIs. For example, to date there are 671 mashups built on social media APIs, and another 576 built on top of mapping APIs. Surprisingly, while there are more than 450 open finance APIs available, there are only 70 mashups that leverage these interfaces. Relatively low ratios of new mash-up generation are also found in health and payments. Comparing the average betweenness centrality scores of APIs in each category, a measure of relative network prominence, the most central sectors to the API network include social, images, search, and mapping sectors. This is followed by e-commerce, cloud computing, video, and payments.

Although it does not yet rise into the top 10 ranking of API sectors (by count), our analysis reveals transportation-related APIs are growing rapidly. These APIs offer a variety of functionality. For example, PlugShare's API enables owners of Teslas and other electric cars to locate charging stations and to a community of other electric vehicle users. The PlugShare Station

API responds to over a million queries a month to locate and input recharging facilities and is now moving with other providers to build a common payment system through the Open Charge Point Protocol (OCPP). A growing number of local governments have moved to offer APIs to improve the information around public transportation, such as the Swiss Public Transport, Toronto Transit Commission, and the BART metro system in San Francisco. As the trend toward smart cities and connected vehicles grows, transportation-focused open APIs are only likely to grow. The Ford Motor Company and General Motors have established API programs that allow third-party software developers to build apps that will enable vehicles to include a wide range of "connected car" features ranging from voice recognition to advanced vehicle diagnostics.[8] Moreover, startups like MetroTech Net are building APIs that publish highly accurate and dynamic data on traffic patterns retrieved and analyzed from traffic cameras and other sensor data. Given its size and the value of improvements in information flows, the transportation segment appears destined to move from the periphery to the core of the API economy.

Our visualization also provides insight into variation in API strategies used by firms. Our visual analytic analysis revealed that only few traditional firms are active in the open API economy. For example, few if any major companies appear in the core component whether they are from banking, insurance, pharmaceuticals, food, transportation, or energy. Instead, we see the API economy is dominated by relatively recently established digital companies. Most central to this emerging eco-

Figure 2. API economy visualized: Amazon.com versus Walmart.

Companies
- Walmart
- Amazon

API Clusters
- Social Media
- Job Search
- E-commerce
- Tools/Analytics/Big Data
- Enterprise
- Payments
- Messaging Services

Source: Peter C. Evans and Rahul C. Basole, with data from ProgrammableWeb, The Center for Global Enterprise, 2015

system are companies that have built businesses around areas such as social, mapping, search, online payment, image sharing, video, and messaging. This includes digital platform companies like Google, Microsoft, Facebook, Amazon, eBay, Yahoo, Salesforce, and Twilio, as well as lesser-known companies like Quova, Anedot, and Zapier.

The retail sector provides a fascinating example of these stark differences.[5] Consider the position of Amazon.com and Walmart in the core API ecosystem (see Figure 2). Amazon.com has had an explicit policy of creating open APIs. The results of our visual analysis support that. Amazon has over 33 open APIs, which have been combined with many other APIs to create more than 300 mashups. Walmart, by contrast, has only one API that has yielded only one mashup. Considering the centrality scores of Amazon's APIs compared to that of Walmart, it is not surprising to observe that Amazon sits near the core of the API economy whereas Walmart is more peripheral.

This is not to say that traditionally brick-and-mortar retailers do not actively use API tools and services to support a range of approaches aimed at optimizing and personalizing device and screen experiences. In fact, they do. Macy's, for instance, has tapped Twitter's Audience Platform to reach more customers and boost sales. However, the number of open APIs that Macy's itself has established is very small. Among this small number, only one other mashup has been established. Amazon, by contrast, has a large and growing number of open APIs. This is particularly true in the e-commerce space where there are now 140 mashups built on Amazon APIs. Amazon is also clearly branching out beyond e-commerce into areas such as cloud, enterprise tools, mapping, messaging, networking, and payments. These areas are generally considered fundamental information infrastructure services for the emerging Internet of Things industry. As a result, it may be important to consider whether it will

be necessary to reclassify Amazon's industry peer group in time.

The growth of the API economy, however, is not without its risks. For several years a battle has been waged over whether APIs can be copyrighted or are they exempt and more appropriately subject to the doctrine of "fair use." A key attractiveness of APIs is the ability to copy and repeat the best bits.[10] Another concern is that an API provider can abruptly change pricing terms or even turn off an API that has become critical input into services that others have created. The degree to which these risks represent speed bumps or something more serious remains to be seen. Meanwhile, investment in APIs is taking place across a wide range of sectors and companies discover new ways APIs can drive productivity, reduce costs, and enhance flexibility of their operations and services. As API networks grow richer and more complex, visual analytic techniques will provide a valuable tool for discovering, tracking, and sensemaking of the evolution of API ecosystems and what it means for different industries and specific enterprise strategies. Ⓒ

References
1. Basole, R.C. Visual business ecosystem intelligence: Lessons from the field. *IEEE Computer Graphics and Applications 5* (May 2014), 26–34.
2. Basole, R.C. et al. Understanding business ecosystem dynamics: A data-driven approach. *ACM Transactions on Management Information Systems (TMIS) 6*, 2 (June 2015), 6.
3. Curtis, J. Thomson Reuters opens sources data APIs for developers. *ITPRO* (July 1, 2015); http://bit.ly/1MRWuys
4. DuVander, A. Which APIs are handling billions of requests per day. *ProgrammableWeb* (May 23, 2015).
5. Evans, P.C. and Basole, R.C. Decoding the API Economy with Visual Analytics; http://bit.ly/1Us6bWU
6. Freeman, L.C. A set of measures of centrality based on betweenness. *Sociometry 40*, 1 (Jan. 1977), 35–41.
7. Martin, S. et al. OpenOrd: An open-source toolbox for large graph layout. In *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series 7868*, 5 (Jan. 2011), 4.
8. Newcomb, D. Ford, GM open their dashboards to outside developers. *Wired* (Jan. 8, 2013).
9. Newman, M.E. Modularity and community structure in networks. In *Proceedings of the National Academy of Sciences 103*, 23 (2006), 8577–8582.
10. Samuelson, P. *Oracle v. Google*: Are APIs copyrightable? *Commun. ACM 55*, 11 (Nov. 2012).
11. Tilson, D., Lyytinen, K., and Sørensen, C. Research commentary-digital infrastructures: The missing IS research agenda. *Information Systems Research 21*, 4 (2010), 748–759.

Peter C. Evans (pevans@thecge.net) is Vice President, The Center for Global Enterprise.

Rahul C. Basole (basole@gatech.edu) is Associate Professor, School of Interactive Computing and Director, Tennenbaum Institute at Georgia Institute of Technology, Atlanta, GA.