

Magnet or Sticky? A Stack Overflow Tag-by-Tag Typology

1st Kotori Hieda

Information Science and Electrical Engineering, Kyushu University

name of organization (of Aff.)

Fukuoka, Japan

hieda@f.ait.kyushu-u.ac.jp

2nd Yu Mingzhe

Information Science and Electrical Engineering, Kyushu University

name of organization (of Aff.)

Fukuoka, Japan

yumingzhe@f.ait.kyushu-u.ac.jp

3rd Yasutaka Kamei

Faculty of Information Science and Electrical Engineering, Kyushu University

name of organization (of Aff.)

Fukuoka, Japan

kamei@ait.kyushu-u.ac.jp

Abstract—Stack Overflow (SO) is one of the most popular question and answer sites for software developers. SO stores posts assigned with tags that correspond to the keywords of each question. If a developer asks question related to Python and inputs “Python” tag on the post, the developers interested in Python can participate in the post easily. Since 2008, SO has become one of the most trusted online communities. In this study, we explore developers’ interest by analyzing how they use tags. We classify tags into four: (1) attractive, (2) fluctuating, (3) stagnant, and (4) terminal based on magnet values and sticky values. We analyze data of table “Posts” of approximately 42 million posts in SO and table “Users” of approximately 9 million rows of user information. Results reveal that some historical events in IT are retrieved, which include launching of new tools and terminating of services with the transition of magnet value and sticky value.

Index Terms—magnet, sticky, tag, user migration, OSS census

I. INTRODUCTION

The Pew Research Center (PRC) [1] is the U.S. fact finder that provides information on social problems and demographic trends that shape the United States and the world. *Magnet states* are defined as states where a high percentage of the population migrated from the outside, whereas sticky states have a high proportion of those living in the same state since birth. Nevada is a *magnet states* because 86% of the population migrated from other states. It is possible to find the movement of American citizens by studying this demographic trend.

For software developers, understanding other developers’ interests are important as the popularity of developers have advantages. Many developers like to work with convenient and

easy-to-use tools. To develop a project efficiently, developers must focus on long-term-projects.

In this study, we focus on new and existing topics of Stack Overflow (SO). Inspired by previous studies [2], we apply Magnet and Sticky metrics to the topics collected in SO. The magnet metric is the number of new developers attracted to a topic and Sticky metric is the number of existing developers who stay with the topic. We examined the values of tags “magnets” and tags “sticky” by classifying them to the tags *programming language, framework, and environment*. We also compared the news and history of software companies and web services. If changes in their characteristics are discovered, we examine factors responsible for the changes based on their magnet values and sticky values.

We address the following two research questions:

(RQ1) What are the values of magnet and sticky in SO?

In many cases, the sticky value is higher than the magnet value. In addition, the magnet value rate decreases more than that of the sticky value.

(RQ2) How do magnet and sticky values change over time?

When the status of tags moves to quadrant, we find that interesting events happen in the related tags.

II. DEFINITION OF MAGNET AND STICKY

This section describes how we measure the appeal and adhesion of users on different topics. Following the Pew Research Center (PRC) definition, we use the Magnet and Sticky metrics to illustrate the migratory trends of the U.S. citizens. The PRC defines magnet states as states where a large proportion of adults are from other states. From the

Topic	User	2017	2018	Magnet2017	Magnet2018	Sticky2018
1	A	●	●	3/3	1/2	2/3
	B	●	●			
	C	●				
	D					
	E		●			
2	A			2/3	2/2	1/2
	B	●	●			
	C	●	●			
	D		●			
	E		●			

Fig. 1. Example of Magnet and Sticky values definition

magnet metric, the proportion of adults residing in the magnet states were not born in the state. PRC defines the sticky state as the state where a large proportion of adults born there continue to live in the state. Thus, the sticky metric for the state is the proportion of adult residents born in the state. These definitions are good for a population study where a single adult can only occupy one state at a time. However, the definition is inapplicable to the topics discussed by the SO users as users can ask or answer questions on several topics at the same time. Therefore, we expand new definitions for SO topics.

Magnet and Sticky in SO

SO contents are questions and answers to the questions and comments [3] called Posts in the SOTorrent [4] database. Each question has one or more tags that separate the question into different topics. Posts on a question have their creator (for the question content, one is the questioner, and for the answer, one is the respondent), a participant of the topics, and the question. We also define the asking or answering questions activity on some topic as a discussion topic. For example, a classical question in SO has three tags like Java, Apache, and Linux asked by a user A and answered by a user B and C. Thus, C are participants of Java, Apache, and Linux-topics.

Magnet. Magnet topics attract a large proportion of new users; thus, we calculate the magnetism of a topic as the proportion of users who ask or answer questions during the time period under new registered users in a specific year.

Sticky. In sticky topics, a large proportion of the users keep participating in the discussion in the time period. Thus, we calculate the stickiness of a topic as the proportion of the users who discuss the topic in the time period.

Example (Calculating magnet and sticky values). To calculate magnet and sticky values of topics that belong to a major category, we use a total of six questions (α , β , γ) and five users (A, B, C, D, E); The registration date of user A, B, C was in 2017, and the registration date of user D, E was in 2018 [2] as shown in Figure 1.

Filled black circles in Figure 1 represents user activities (e.g., creating questions, answering questions, and adding comments to the questions) in a topic in a certain year. For example, while User A has activities in the Topic 1 in the year 2017 and 2018, but he/she has no activities in the Topic 2.

To calculate the magnet metric, we observe three new users who registered their accounts in 2017 (A, B, C), and all of them discuss topic 1, whereas two of them (B, C) participate

Question	Tag1	Tag2	Topic1	Topic2
α	python	python-3.x	python	
β	python-2.7	numpy	python	numpy
γ	c++17	boost-asio	c++	boost

Fig. 2. Example of the merge of tags belonging to analogous subjects

in the discussion topic 2. In this case, the Magnet value of topic 1 in 2017 is 3/3, topic 2 is 2/3.

To calculate the sticky metric on topic 1, three users participated in the discussion in 2017 (A, B, and C). Only two of them participated in the discussion in 2018 (A, B). Hence, the sticky value of project 1 is 2/3. In topic 2, two users participated in the discussion in 2017 (B and C); however, only one of them participated in the discussion in 2018 (C). Though new users D, F participated in the discussion in 2018, we still calculate the value of sticky as 1/2.

Example (Merging similar subjects into one topic). We merge subjects (i.e., tags) that belong to analogous subjects into one topic. For example, we consider that different version numbers (e.g., tag “Python-2.7” and tag “Python-3.6”) are one of the common examples of analogous tags.

We also need to merge derivatives of the same technology on different platforms, merge derivatives of special tools in a certain tool family, or a combination of technology with a commonly used library, etc. For example, the tag “react-tjs,” “react-router,” “reactjs-flux,” “create-react-app” should be merged into one topic “react.” We can get this information from the “Related Tag” column of the “Tag Info of SO.”

Figure 2 shows that question has tag “python” and “python-3.x,” question β has tag “python-2.7.” According to our merge rule, they all belong to topic “python.” The question γ has tag “c++17,” showing that it belongs to topic “c++.” Therefore, question β also belongs to topic “numpy” and question γ also belongs to topic “boost.”

III. DATASET

We analyze the SO dataset (SOTorrent) provided by Sebastian Baltes et al. [5]. SOTorrent is an open dataset based on the official SO data dump and provides access to the version history of SO content at the level of whole posts and individual text or code blocks.

The dataset consists of 20 different tables stored in data on official SO data dump and data extracted from the original official SO data dump.

However, we only analyze the data from table *Posts* of approximately 42 million posts from SO and table *Users* of approximately 9 million rows of user information from July 2008 to September 2018. We focus on users, tags, and time of questions. Moreover, we consider users who ask or answer questions in SO. Those who comment or like/dislike questions or answers are excluded from the statistics.

IV. STUDY RESULTS

In this section, we provide answers to these questions:

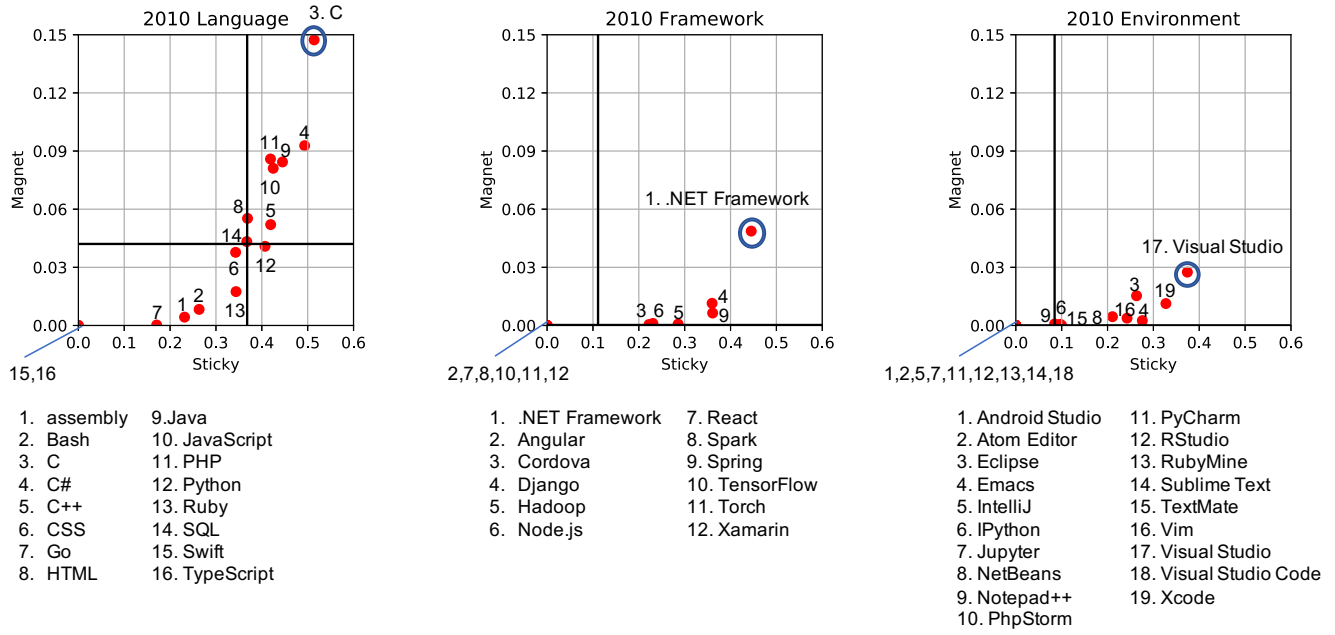


Fig. 3. Distribution of Magnet and Sticky values in Programming Language, Framework and Environment

TABLE I
AVERAGE QUADRANT TRANSITION RATE

Language					
	Attractive	Fluctuating	Stagnant	Terminal	*
Attractive	81.3	10.6	5.0	3.1	0.0
Fluctuating	12.5	87.5	0.0	0.0	0.0
Stagnant	7.3	0.0	86.5	6.3	0.0
Terminal	3.1	0.0	5.0	91.9	0.0
*	0.0	0.0	25.0	50.0	25.0

Framework					
	Attractive	Fluctuating	Stagnant	Terminal	*
Attractive	92.9	7.1	0.0	0.0	0.0
Fluctuating	20.0	50.0	0.0	30.0	0.0
Stagnant	30.0	0.0	20.0	50.0	0.0
Terminal	0.0	0.0	33.3	66.7	0.0
*	0.0	0.0	9.2	14.6	76.3

Environment					
	Attractive	Fluctuating	Stagnant	Terminal	*
Attractive	83.1	9.3	3.6	4.1	0.0
Fluctuating	24.8	60.5	0.0	14.8	0.0
Stagnant	9.2	4.2	69.6	17.1	0.0
Terminal	1.8	0.0	8.1	90.1	0.0
*	2.5	8.3	12.5	13.3	63.3

A. (RQ1) What are the values of magnet and sticky in SO?

Approach. We calculated magnet and sticky values as defined in Section II. We plot the magnet value on the vertical axis and the sticky value on the horizontal axis. We classify the plotted points into four quadrants.

Attractive: Tags with a high magnet and sticky value. By understanding the tags, we can discover the interests of developers.

Fluctuating: Tags with a higher magnet and lower sticky value. This tag attracts people, but it is short-term. Excellent developers will be disinterested.

Stagnant: Tags with a lower magnet and higher sticky value. These tags are difficult to attract new users, but it can maintain existing users.

Terminal: Tags with the lower magnet and lower sticky value. This tag can neither attract new developers nor keep them interested.

The median of the magnet and sticky values for each year is used for the quadrant threshold because the median is unaffected by outliers. From the sticky value definition in Section II, the sticky value depends on the number of tag users in a year and the following year. To answer RQ1, we got 9 years' worth of sticky values based on the information on the number of tag users from 2009 to 2018. The sticky value must depend on the number of new tag users, but, if the number of new tag users in a year is too low, the sticky value will be too small. To remove noise, we fix thresholds for each topic when the magnet and sticky value is less than the threshold value, it is set to 0.

We did not analyze all the tags at once, but divided them into three categories for analysis. The selected categories and their contents are:

- programming languages (assembly, Bash, C, C #, C ++, CSS, Go, HTML, Java, JavaScript, PHP, Python, Ruby, SQL, Swift, TypeScript)
- frameworks (.NET Framework, Angular, Cordova,

Django, Hadoop, Node.js, React, Spark, Spring, TensorFlow, Torch, Xamarin)

- environment (Android Studio, Atom Editor, Eclipse, Emacs, IntelliJ, IPython, Jupyter, NetBeans, Notepad++, PhpStorm, PyCharm, RStudio, RubyMine, Sublime Text, TextMate, Vim, Visual Studio, Visual Studio Code, Xcode)

We chose these tags based on SO's survey of over 100,000 developers in 2018¹. We focused on tags used by more than 5% of developers who answered the questionnaire.

Results: Figure 3 shows a quadrant plot of the magnet and sticky values of the 2010 programming language, framework, and environmental tag², revealing that the magnet value is lower than the sticky value. The results are similar to the findings of the PRC. For example, the U.S. citizens are likely to live in the same house than to change houses; it is easier for developers to continue developing the same content.

Summary: Tags with high magnet value are easy to use even for beginners. A tag familiar to C has a high magnet value and sticky value, and it is more attractive.

B. (RQ2) How do magnet and sticky values change over time?

Approach: From 2010 to 2018, we calculated the probability of the tags moves quadrants from one year to the following year. For example, there were six Attractive tags in 2010. Of the six Attractive tags in 2010, five were Attractive the following year. Therefore, the transition probability from Attractive to Attractive for 2010 - 2011 is 5/6 or 83.3%.

Quantitative results: Table I shows that the proportion of the vertical axis is in the quadrant for 2010 - 2018, the horizontal axis is the year old. From the table, the ratio of tags is almost the highest for those that do not move the quadrants from the previous year to the following year in any programming language, framework, and environment. Since the tags have hardly changed from any quadrant to 2, once the tags have become popular to a certain extent, the users of the tags have not significantly reduced. This shows that once tags have become less popular, it may continue to be unpopular.

Manual analysis: Table II shows the transition of each tag quadrant in the framework, revealing how the tags move in the quadrant. From this, you can see that Visual Studio [6] and Xcode [7] have been attractive for a long time. Visual Studio is an integrated development environment for Windows and Xcode is an integrated development environment for Apple. Since these are the first IDEs that beginners will touch in their respective environments, it is likely that new users will be asked questions by SO. In addition, we can see that Jupyter [8], PyCharm [9] and RStudio [10] have gained popularity as opposed to the decrease in popularity of Sublime Text [11] and IPython [12]. We think the reason is that the popularity of Python has increased in recent years and that Jupyter has made IPython available in multiple languages.

Summary: Since there are many beginners asking questions on SO, IDE tags for beginners tend to be attractive. Also, with the emergence of easier-to-use tools, the popularity of what were once attractive decrease, and the popularity of new, easy-to-use tools increase.

V. CONCLUSIONS

Critical development of a programming language, a program framework, or an operating system depends on their ability to keep the community alive and attract more people to participate in discussions. SO, the world's largest program Q&A platform, has enough questions and answers on a topic to solve users' problems. This study applied the magnet and sticky population concepts to explore topics in SO. The results show that the numbers of participating topics are exploding with the development of computer technology. Even the most popular themes that did not attract people's attention 10 years ago now attract a large number of participants. Under respective major categories, the most popular topics are still very popular after 10 years, and only a small number of languages or frameworks can become one of the most popular topics. This research provides a reference for enterprises to choose their main technology stack. It can also be used as a reference for computer science students to learn new technologies. The study (1) can predict the trend of computer technology in the next few years and (2) can identify easier technologies to access the questions and answers.

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¹<https://insights.stackoverflow.com/survey/2018>

²We choose the year 2010 because it is the first year for which yearly data of sticky value can be obtained.

TABLE II
QUADRANT TRANSITION OF FRAMEWORK 2010 - 2018

[illegible]

Framework	Name	2010	2011	2012	2013	2014	2015	2016	2017	2018
.NET Framework		A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	Fluctuating	A ttractive
	Angular	*	*	*	*	*	S tagnant	A ttractive	A ttractive	A ttractive
	Cordova	A ttractive	A ttractive	A ttractive	Fluctuating	Fluctuating	Fluctuating	Fluctuating	T erminal	T erminal
	Django	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive
	Hadoop	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	Fluctuating	T erminal	T erminal	T erminal
	Node.js	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive
	React	*	*	*	*	*	*	*	*	T erminal
	Spark	*	*	*	*	*	*	*	*	T erminal
	Spring	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive	A ttractive
	TensorFlow	*	*	*	*	*	*	S tagnant	A ttractive	A ttractive
	xamarin	*	*	*	*	*	S tagnant	T erminal	T erminal	T erminal
	Xamarin	*	*	T erminal	S tagnant	S tagnant	T erminal	T erminal	S tagnant	T erminal

[illegible]