

User Donations in Online Social Game Streaming: the case of paid subscription in Twitch.tv

Jiajun Yu
China Agricultural University
Beijing, China
2017307070311@cau.edu.cn

Adele Lu Jia
China Agricultural University
Beijing, China
Ljia@cau.edu.cn

ABSTRACT

Online social game streaming has proliferated with the rise of communities like Twitch.tv and Youtube Gaming. Beyond entertainment, they become vibrant communities for streamers and viewers to interact and support each other, and the phenomenon of user donation is rapidly emerging in these communities. In this article, we provide a publicly available (anonymized) dataset and conduct an in-depth analysis of user donations (made through paid user subscriptions) on Twitch, a worldwide popular online social game streaming community.

Based on information of over 2.77 million subscription relationships that worth in total over 14.1 million US dollars, we reveal the scale and diversity of paid user subscriptions received and made. Among other results, we find that (i) the paid subscriptions received and made are highly skewed, (ii) majority streamers are casual streamers who only come online occasionally, while regular streamers often stream in multiple categories and receive more paid subscriptions, in total as well as per streaming hour, (iii) a considerable amount of viewers on Twitch subscribe to multiple streamers and most viewers support their streamers moderately while a small amount of devoted fans are willing to pay more and longer. Our discussions and finding shed lights on how to maintain community prosperity and provide significant reference for the system design.

CCS CONCEPTS

• **Information systems** → Multimedia information systems; Collaborative and social computing systems and tools.

KEYWORDS

User donation, paid user subscription, online game, social streaming

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1 INTRODUCTION

In recent years, the wave of online social game streaming has swept the entire society with the rise of Twitch.tv, Youtube Gaming, and Facebook-Live. Beyond entertainment, these platforms become communities for streamers and viewers to communicate, to interact, and to socialize through gaming viewing, real-time live chat messages and even user donations. In return, viewers satisfy their social desires and streamers get tangible rewards and (sometimes world-level) appreciations.

A remarkable amount of research has been conducted around online social game streaming, ranging from revealing the basic characteristics [1, 6], optimizing resource allocation in different regions [11], to qualitative analysis on the user motivation to watch live streamers [3, 8]. Different from the above analyses, in this article, we take Twitch.tv as an example and reveal the scale and the diversity of its paid user subscriptions. As far as we know, this is the first large-scale study on Twitch's revenue model.

Paid user subscriptions provide certain motivations for streamers to stream and help boosting the community prosperity. While a few related works exist, most of them are either based on small-scale dataset [7], focus merely on minority communities [9, 13] or through surveys and interviewers [4, 14]. In this article, we focus on Twitch, one of the most popular online social game streaming communities worldwide with over 140 million active users per month [12], and we analyze paid user subscription based on a large-scale dataset that we collected on Twitch. We summarize our analysis and contributions as follows:

A large-scale dataset. We provide a large-scale dataset on Twitch's paid subscription mechanism, which comprises a four-month record of over 473,185 streamers' streaming activities and interactions with viewers, including real-time live chat messages and paid user subscriptions. In total, we capture over 3.63 million streaming sessions and over 2.77 million subscription relationships that cover over 1.25 million donors, cumulative paid subscriptions reach 14.1 million US dollars. Our dataset is publicly available upon request for academic purposes.

Diversity of paid subscription. Based on the above large-scale dataset we reveal the scale and diversity of paid user subscriptions received by streamers on Twitch. We find that, similar to other popularity metrics [1, 6, 10], the amount of the paid user subscriptions received and made are highly skewed. We also find that, while the majority of streamers on Twitch are casual, a considerable number of streamers come online regularly, most of which also stream in different categories and receive more paid subscriptions, in total as well as per streaming hour. On the other hand, diversity exists in paid subscriptions made by viewers. We find that a considerable

Table 1: Basic Statistics Of The Twitch Dataset

# streamers	473,185
# streaming sessions	3,634,579
session length aggregate/mean (hour)	8,484,782.52/2.33
# live chat messages hourly max/ mean	27,946.41/19.75
# streaming languages	31
# streaming categories max / mean	15,765/4.36
# streamers who have received subscriptions	125,123
# subscribed users	1,250,208
# paid user subscriptions aggregate(USD)	14,128,187.40
# subscription relationships	2,775,760

number of viewers subscribe to multiple streamers and most viewers support their streamers moderately while a small number of devoted fans are willing to pay more and longer.

To the best of our knowledge, our analysis provides the first large-scale analysis on Twitch’s paid subscription mechanism and reveals the diversity of paid subscriptions received and made. Our analysis and discussions shed light on the subscribed user retention problem and the design of online social live-streaming communities.

2 MEASUREMENT METHODOLOGY AND THE DATASET

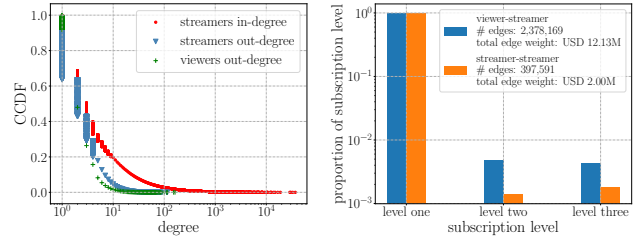
2.1 Measurement methodology

We use Twitch’s public API for collecting dynamic information on each streaming session, including the start time, the end time, the title, the language, the streaming category, as well as the number of concurrent viewers. Meanwhile, Twitch also adopts the IRC protocol to provide information on live chat messages in real time, including the time, the sender, and the content of each message, as well as the badges if the sender is a paid subscribed user.

As Twitch does not provide publicly available data on paid user subscription, in our study, we estimate the total income of the streamers and their paid subscribed users through users with badges found in live chat messages. Even though we have captured all the paid subscribed users who have left at least one message during our experiment period of four months and we conjecture that paid subscribed users without leaving any messages in four months are rare, it should be noted that the paid subscription is under-estimated in our analysis. However, as we will show later, the number of paid subscribed users and the amount of paid subscriptions accumulated by the streamers are rather remarkable.

2.2 Dataset

In our experiment, we focus on League of Legends (LoL), one of the most popular online video games on Twitch. We are currently adding more game genres in our ongoing research. Our measurement started on Mar. 8, 2021, and lasted for 119 days (4 months). We have captured all the online LoL streaming sessions in this period. Besides basic information like the start time, the duration, the streamer, and the genre, for each streaming session, we also record every five minutes the concurrent number of viewers so that we could reveal the dynamics of the channel’s popularity. Moreover, we have also captured user live chat messages in real time and for each streaming session, we record when and who has left what



(a) Degree distribution of the subscription graph (four-month). (b) Distribution of the edge weight.

Figure 1: Degree distribution and edge weight distribution of the subscription graph.

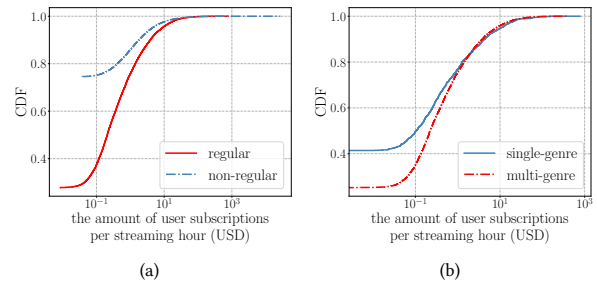


Figure 2: CDFs of the amount of paid user subscriptions received per streaming hour by regular and non-regular streamers, and by single- and multi-genre streamers, respectively.

messages, as well as the badges of the users which are later used to estimate the paid subscribed users the streamer has attracted.

As it takes at least 15 minutes to end a game in LoL, we have removed all the hit-and-run sessions with a session length shorter than 15 minutes and in total we have obtained information on 3,634,579 valid LoL sessions and 473,185 streamers who have in total attracted at least 1,250,208 paid subscribers and cumulative paid subscriptions reach \$14.1 million. For academic purposes, our dataset is publicly available upon request.

3 SUBSCRIPTION RELATIONSHIPS

In this section, we propose a subscription graph, and reveal the scale and the diversity of paid user subscription, from the perspectives of both the streamer and the subscribed user.

3.1 Subscription graph

To explore deeper into our data, we propose a *subscription graph* based on the subscription relationships in our four-month observation period. In the subscription graph, either a viewer or a streamer is represented as a node, and the subscriptions made from the starting node to the end node is represented as a directed edge, with the edge weight equal to the amount of paid subscription according to subscription level. In total, there are 1,256,180 nodes (including 125,123 (9.96%) streamer nodes) and 2,775,760 edges resulting in an average node degree of 4.42 and an average edge weight of 5.09 (US

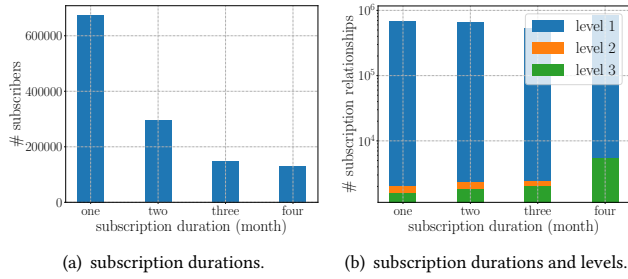


Figure 3: Diversity of subscription durations and levels.

dollars). Figure 1(a) and Figure 1(b) show the subscription graph’s degree distribution and edge weight distribution, respectively.

As shown in Figure 1(a), in general, all the degree distributions are highly skewed, particularly, 24,636 (19.69%) streamers have in-degrees larger than 10, and 364 (0.29%) streamers have in-degrees larger than 1000. Besides, 20,559 (1.64%) viewers have out-degrees larger than 10, indicating that there exist a considerable amount of viewers who have subscribed to multiple streamers. Interestingly, there also exist subscription relationships between streamers and streamers (397,591 (14.32%) edges), similar phenomenon has been found in the other game streaming platform [5]. However, as shown in Figure 1(b), streamer-streamer edges have a smaller fraction (0.03%) of higher-level subscriptions (i.e., level two or three) than viewer-streamer edges (0.09%).

3.2 Diversity of the streamers

In this section, we reveal the streamers’ behavioral differences to test their correlations with paid subscriptions received.

Regular and non-regular streamers. Our dataset captures 473,185 LoL streamers and covers a period of four months. We define the streamers who have streamed in the LoL category at least once every two weeks as *regular* streamers and the rest as *non-regular* streamers. It should be noted that the definition of regular and non-regular streamers is with respect to the LoL category. In total, we find 463,771 (98.01%) non-regular streamers, and as it turns out only 9,414 (1.99%) streamers are regular. This disparity indicates that *while Twitch is known to have attracted many professional players to stream, the majority of its LoL streamers are casual.*

It is natural that regular streamers receive more paid subscriptions as they are online more often. Interestingly, we also find that they also receive more paid subscriptions per streaming hour. As shown in figure 2(a), 4.32% of regular streamers have received over 10 USD paid subscriptions per streaming hour, whereas only 2.38% of non-regular streamers achieved so. We conjecture that *streaming regularly provides the opportunity for the streamers to make an impression on the users, some of whom eventually become paid subscribed users.*

Single- and multi-genre streamers. Focusing on regular streamers, in this section, we further analyze the behavioral differences between streamers who have streamed solely in the LoL category and streamers who have also streamed in other categories. We name the former *single-genre* streamers and the latter *multi-genre* streamers. In total, 1,492 (15.85%) regular streamers are single-genre streamers

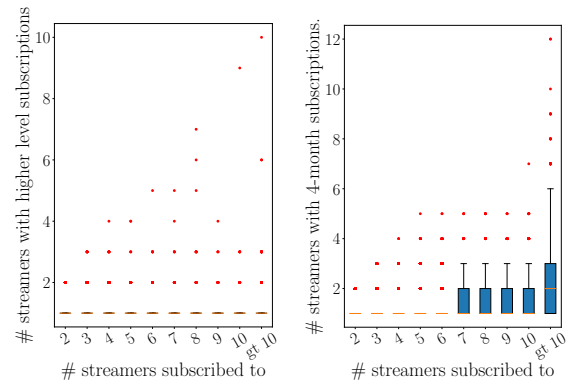


Figure 4: Box plots of the number of streamers subscribed with higher-levels and for four continuous months, respectively. Here, users are grouped based on their number of subscribed streamers.

and 7,922 (84.15%) regular streamers are multi-genre streamers, indicating that *streaming in multiple categories are common on Twitch.* In Figure 2(b), we demonstrate single-genre streamers and multi-genre streamers’ amount of paid subscription received in the LoL category. We find that 875 (58.64%) single-genre streamers are able to receive some paid subscriptions, whereas 5,925 (74.79%) of multi-genre streamers have achieved so. These results show that, even within the LoL category, multi-genre streamers in general are already able to receive more paid user subscriptions than single-genre streamers, and we believe that when considering the whole categories, they are even more popular.

3.3 Diversity of the paid users

Overall diversity. We first reveal the overall diversity of paid subscriptions made by the users from three perspectives, namely the amount, the duration, and the level of the subscriptions. We have already shown in figure 1(a) that the viewers subscribe to different number of streamers. Considering the subscription amount, we find that 917,367(73.38%) users have in total paid less than 10 US dollars, whereas 3,456 (0.28%) users have contributed over 100 US dollars.

Meanwhile, subscription durations are also different. As shown in Figure 3(a), over half of the subscribed users are *hit-and-runners*, i.e., they have only subscribed for one month and did not continue their subscriptions afterwards. In the meantime, we still observe that a considerable amount of users are devoted, i.e., 131,937 (10.55%) users have always subscribed in our observation period of four months.

When further differentiating subscriptions of different durations, as shown in Figure 3(b), we find that, interestingly, higher level subscriptions (i.e., level two and three) take a higher proportion in longer-term subscriptions. This result indicates that *higher level paid subscriptions, i.e., stronger subscription relationships, also tend to last longer.*

Multiple interests and favorite streamers. Besides the overall diversity as shown above, for individual users, we also find that while they support multiple streamers at the same time, their support varies for different streamers. Among the 275,576 (22.04%) multi-interest users, 12,652 users have subscribed at higher levels (i.e., level two or three) and 97,792 users have subscribed continuously for four months, for at least one streamer among whom they subscribe to. Focusing on these *users with preference*, we examine how individual users support streamers differently.

As shown in Figure 4(a), no matter how many streamers users subscribe to, except for a few outliers, most users with preference only subscribe to one streamer at higher levels. On the other hand, as shown in Figure 4(b), 25% users with preference who have subscribed to over 6 streamers would subscribe for four continuous months to more than one streamer, i.e., they have more than one favorite streamer. These results indicate that *it is more common for users to subscribe longer than to subscribe at higher levels to their favorite streamers.*

4 RELATED WORK

We summarize related work within each research topic our work covers as follows:

Online social game streaming. With the development of online social streaming communities, a number of researches have been carried out in recent years. Focus on online social game streaming, Pires and Simon [10] presented a measurement analysis on traffic in Twitch and YouTube Live. Jia et al. [6] analyzed basic characteristics of gamecast sharing sites including Twitch.tv and WoTrepays. Deng et al. [1] found that Twitch's streaming is significantly influenced by game tournaments and revealed a complex and rich ecosystem. Wang et al. [13] presented a large scale analysis of user interactions in an online game streaming community in China.

User donations and paid subscriptions. It's a rather less explored line of research in online social game streaming. Gros et al. [2] conducted a quantitative analysis based on an online questionnaire, which was completed by 603 Twitch users, and analyzed the different popular streamers' interaction with users including the live chat message and paid subscription. Lu et al. [8] presented the results of an online survey of 527 live streaming users, and focused on the motivations and experiences of viewers, as well as the effect of user donation and fan group interaction in engaging users. Our previous work [9] revealed the dynamics of user donations based on an online game streaming community in China. However, most of the above related previous works are based on small-scale dataset [2] or focus merely on minority platforms [9, 13]. In contrast, we focus on Twitch, which is one of the most popular online social game streaming communities worldwide, and we conduct a large scale analysis that covers four-month information of the activities and paid subscriptions of 473,185 streamers and 1,250,208 subscribers.

5 CONCLUSION AND FUTURE WORK

In this work, we have conducted an in-depth analysis about paid subscriptions made through paid subscriptions on Twitch, a worldwide popular online social game streaming platform. Based on over 2.77 million subscription relationships that worth in total over 14.1

million US dollars, we reveal the scale and diversity of paid user subscriptions, and analyze the behavioral differences of streamers and their correlations with paid subscriptions received.

Among all the results, we find that (i) the amount of the paid user subscriptions received and made are highly skewed, and the majority of streamers on Twitch are casual streamers who only come online occasionally, while a considerable amount of streamers come online regularly, and most of which also stream in different categories and receive more paid subscriptions, in total and per streaming hour, (ii) a considerable amount of viewers on Twitch subscribe to multiple streamers, most of which support their streamers moderately while a small amount of devoted fans are willing to pay more and longer. For our future work, we plan to investigate different categories and combine theories from different fields to better understand the motivations and causations behind paid subscriptions.

ACKNOWLEDGMENTS

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