Improving Donation Distribution for Crowdfunding: An Agent-Based Model

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Abstract. Donation-based crowdfunding has the potential to democratize capital raising by soliciting donations directly from the public through the Web and social media. These crowdfunding platforms, however, often function as unregulated open markets, in which there is minimal intervention to influence donation distribution across projects. In fact, research on crowdfunding hints that donation distribution in most crowdfunding platforms are suboptimal: while the overall success rates of crowdfunding projects are often low, a significant proportion of projects receive donations way over their targets. In this paper, we propose a new donation distributing system that aim to (a) distribute donations more effectively among the projects, and (b) align the allocation of donations with the preferences of donors. An agent-based model was developed to test the proposed system. Results showed that the proposed system not only increased the overall success rates of projects, but also led to more successes for projects preferred by donors. Implications to future crowdfunding platforms are discussed.

Keywords: Crowdfunding · Fundraising · Market

1 Introduction

Crowdfunding websites have received much attention recently [1], as exemplified by the growing number of projects and donations to sites such as Kickstarter, DonorsChoose.org, and GiveForward [10–13]. The appeal of crowdfunding is that everyone can raise money directly from crowdfunding websites to help accomplish his or her design projects or various purposes, bypassing traditional sources such as venture capitalists or financial institutions. In addition to raising capital, some companies have also adopted crowdfunding websites for testing purposes because activities in crowdfunding sites may predict whether potential customers and communities will embrace their new products.

An essential characteristic of crowdfunding websites is that each project aggregates capital from many people with a small donation. While different crowdfunding sites have different policies for determining success, in general, a

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project is considered successful when the donations add up to a target amount of money specified by the project creator when the project is launched. However, crowdfunding websites do not provide direct assistance to raise capital for any specific project. Rather, project creators have to actively promote their projects within a specific period of time to increase their chance of success.

Previous studies [7,9] show that the success rates of the projects on crowdfunding websites are often low. While the majority of successful projects received donation close to their target amount, a significant proportion of projects received donations way over (>200 %) their target amount [9]. In addition, many projects received donation only in the first few days after the projects were launched and slowly lost attention of potential funders and eventually failed. These observations led us to speculate that the current unassisted process of matching of the massive amount of small donations to the projects is suboptimal, in the sense that the distribution of donations can be improved such that more high quality projects can be successful. We speculate that the current "open marketplace" of crowdfunding sites is the reason why the distribution of donations to the sets of available projects is suboptimal. This is consistent with previous studies that show that social information systems that rely on user dynamics to distribute resources may often lead to higher inequality and unpredictability [6].

Similar to many social information systems, the process of crowdfunding is highly dynamic; earlier events have a large impact on later events. In addition, the behavior of potential donors is often affected by various dynamic indicators in the projects, as well as the general policies of different crowdfunding sites. For example, Wash et al. [2] showed that the return policies of the crowdfunding websites influence the efficiency of crowdfunding. Specifically, they compared platforms that adopt an "all-or-nothing" policy, i.e., the creators get nothing unless they reach a specific donation goal (e.g., Kickstarter) to those that adopt an "incremental" policy, i.e., one can get whatever is donated even if the total is below the goal (e.g., Indiegogo). They found behavior in these platforms differed substantially, as potential donors in all-or-nothing sites likely pay more attention to projects that are perceived to have a high chance of success. Beltran et al. [4] proposed a crowdfunding system to allow donors to make conditional donations, which may motivate donors to contribute more. These studies [2,7,8] support the notion that some form of intervention by crowdfunding websites, such as policies about how donations can be made, how donations are allocated, and how donors are rewarded (or acknowledged), will have significant impact on the general matching process between donations and projects.

In this work, we develop and test one such intervention in crowdfunding. The goal is to understand the how the proposed intervention may impact the complex dynamics behind crowdfunding, to the extent that it could assist donors to make their donations more effective by enlarging the benefit to more crowdfunding projects. Specifically, the proposed intervention is inspired by an existing theory and algorithm in economic research [5], which was originally used to optimally allocate students to high schools that they preferred. Through this system, students can list the schools they want to attend in order, and the algorithm will

iteratively match the students who have been rejected in the last round until most of the students match a school. Inspired by this algorithm [5], we apply a modified version of this algorithm to crowdfunding websites. First, we preliminarily extract a feature of this algorithm, matching students' preferred ranking with schools, to investigate their usefulness for crowdfunding websites. Then, we construct an agent-based model to simulate the algorithm's effect in various crowdfunding environments and analyze how well it can help match donors to projects.

Research Goals. Our goal is to explore the possibility of applying the new method of donation to crowdfunding websites. The previous method that only allows each donor to choose a single project to donate at a time. In other word, a donor has to decide how much money he/she want to donate to each project. Nevertheless, the capital of each individual is limited. When donors are interested in multiple corwdfunding projects, it is hard to find a good way distributing the limited capital into multiple projects to effectively support those projects. Therefore, our method allows donors to select multiple projects a time and decide the total amount of donation. Our system will help the donors spread out their donation among their chosen projects based on dynamics of the ongoing crowdfunding activities. Moreover, our method can reallocate donations when the prior funded project fails to achieve the donation goal in the end or has acquired sufficient funding. As previous studies mentioned that donors would like to see their donations utilized effectively.

This work proposes a new way to help donors spread out their donations. Specifically, our first research goal is (1) to use an agent-based model to explore the impact of our new method on the success rate of crowdfunding projects, (2) to investigate if the success rate of crowdfunding projects will be influenced when donors provide a list of ranked preferred projects. and (3) to test the number of projects that donors choose each time may affect the success rate of crowdfunding projects. We propose a new model and present the results of a simulation using an agent-based model.

2 Model Description

On current crowdfunding platforms, donors are allowed to choose a single project to donate to at a time and decide how much money they want to give to each project. In our system, donors have the option to select multiple projects they want to contribute to. They can specify how much money they want to donate in total and also rank their selected projects based on their preferences. Our system will automatically allocate their donations to the projects based on their preferences and thus better utilize the monetary resources. We propose to apply the new method of donation to crowdfunding websites, changing the one (donor)-to-one (project) model to one (donor)-to-multiple (projects) model. The money could be better utilized by our one-to-multiple model because each donation would have chance to be reallocated to other projects if the prior project fails

to achieve the donation goal in the end, or it has already acquired sufficient funding. The aim of this algorithm is to find the best intervention to maximize the number of projects reaching their funding goals and enhance the effectiveness of each donation.

2.1 Agents (Donors)

Methods of Donation. Using the agent-based simulation model, we aim to answer the following questions: Will the success rates of crowdfunding websites increase when donors can select multiple crowdfunding projects to donate? If so, how impact does the selection improve the success rates? If donors are allowed to select and rank multiple projects to donate, how will the selection and ranking influence the success rates of projects and the overall efficiency of the crowdfunding system? To answer these questions, we developed and compared four types of crowdfunding platforms using different donation methods, and used agent-based model to simulate behavior in these platforms:

1. **Single selection (SS):** This method already exists in current crowdfunding websites donors only choose one project ($n = 1$) at a time and decide how much to donate. This method provides a baseline measurement of existing crowdfunding platforms.
2. **Multiple selection without ranking (MS-NR):** Donors select up to n projects and decide how much money they would like to donate in total.
3. **Multiple selection with ranking (MS-R):** Donors can select up to n projects and decide the total donation amount, but they are required to rank all of their selected projects according to their preference. Our system allocates their money to the higher ranked projects first.
4. **Multiple selection with mixed ranking (MS-M):** This method combines the second and the third approaches. After choosing up to n projects, the donors places their selected projects into different ranking levels according to their preferences, and each ranking level contains multiple projects that are equally preferred by the donor. This is the most general way to structure their preference toward the selected projects.

The parameter n is the maximum number of projects each donor can select, and it is adjustable in our simulation. By setting n equal to 1, all the methods are equivalent to the first baseline method. When n is greater than 1, the donors can select 1 to n projects.

2.2 Donation Distribution

The algorithm for donation distribution in our system uses the following rules when allocating money:

1. When a new donation is made, our system will allocate funds to the selected projects based on the sequence of the donors preference. The system will

allocate a donation to the highest ranked project first, but will not donate any more than is needed to reach the projects funding goal. If there is money left after donating to the first project, our system will put the rest of money towards the donors next preference sequentially until there is no money left. If multiple projects are equally preferred by the donor (when using MS-NR and MS-M methods), the algorithm will donate to the projects that will end sooner first, followed by the projects that need less money to reach their funding goal. If all of the selected projects have met their goal, the remaining money will be allocated to the highest ranked project. This rule is demonstrated in Figure X. When t = 1, the donation is assigned to project A first and then project B based on their deadline and how much they need. When t = 2, the money is assigned to project C because the highest ranked project (project A) already succeeds.

2. When a project expires and fails to achieve its goal, the donations it received will be reallocated to other projects based on the donors ranking. Along with the first rule, this ensures that the money will only be allocated to a lower ranked project when the higher ranked project has either been fully funded or has expired and failed. This rule is demonstrated in Figure X when t = 3, where project B is expired and thus its donation is reallocated to project C based on the preference.
3. When a donation is assigned to a project that is already fully funded, our system will try to move the same amount of money from the previous donations of the project to other projects if the reallocation satisfies donors preferences. Therefore, more projects will benefit from the reallocated money, while the successful project still receive more or equal funding. This rule is demonstrated in Figure X when t = 3, where $50 is assigned to project C which already succeeds. To help more project, $50 from the second donation is moved from project C to project D by our algorithm.
4. After each donation is made and allocated to one or more projects, it might be reallocated because of the above rules. We set a fixed time period (currently set to 30 days) during which each donation could be reallocated to other projects; otherwise, the donor would never know which final projects their money is allocated to. When distributing donations, our system will only consider the money that can be reallocated.

Figure 1 shows an example of our donation algorithm and process.

3 Experimental Setup

The agent-based simulation model was implemented in Python. We crawled Kickstarter and DonorsChoose.org collecting information from the years 2014 and 2015 about donation goals project status, and the amount of donation for each donor. These data provide help our simulation with realistic scenarios for crowdfunding websites.

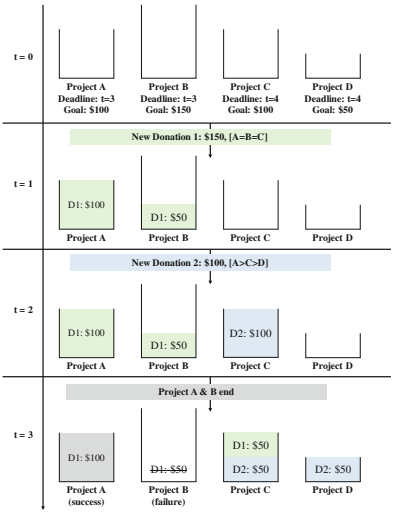

Fig. 1. An example of our donation algorithm. At the beginning of the simulation ($t = 0$), there are four projects with different donation goals and deadlines. When $t = 1$, a new donation is made with Project A, B, and C at the same ranking level; thus, the donation allocation follows the first rule. When $t = 3$, Project B fails, its donation is reallocated to Project C by rule 2, and because Project C is fully funded, our system assigns part of the donation D2 from Project C to Project D by rule 3 (Color figure online).

3.1 Donation Setting

The information released from the several crowdfunding platforms revealed that the average amount donated by an individual donor is between 50 to 100 USD. After analyzing the data from Kickstarter, we observed that the distribution of donation was closed to a logarithmic normal distribution. Consequently, our model adopted this distribution to randomly produce the amount of donation for each donor. In addition, based on the real data from crowdfunding websites, this model will randomly generate 210000 donors a month, and their preferred projects will be randomly selected from the live projects at the time the donor entered. Each donor randomly chooses 1 to n projects with a ranking that is also randomly generated from all possible combinations.

3.2 Project Setting

The variety of projects on crowdfunding platforms is diverse. According to different fundraising purposes, the donation goals and the duration of the crowdfunding projects are various. On Kickstarter, the donation goals for technology and design projects are usually higher than for other kinds of projects. Moreover, Kickstarter restricts the duration of fundraising campaigns to two months. In contrast, the projects on DonorsChoose.org are related to education. Their

donation goals are often under 1500 USD, and project duration can be more than two months.

Therefore, the characteristics of every crowdfunding website are highly different, and we can only use some of them in this study. In our model, we randomly generated a donation goal between 100 USD to 10000 USD and a duration of 7 to 60 days for each project. Also, our model randomly created 3250 projects a month, which is similar to the real situation on crowdfunding websites.

In order to examine the influence of donation methods on the success rate of crowdfunding projects, we ran multiple simulations with different methods and controlled the maximum number of projects ($n = 1$ *to* $n = 10$) each donor could choose. The results of success rates reported in this paper are averaged from 30 simulation months (around 97500 projects) for each data point.

4 Results and Discussion

Fig. 2 shows that when each donor can only choose one project to donate, the success rate is approximately 54 %, which is 8 % – 10 % higher than on Kickstarter. A possible explanation for this difference is that the projects selected by the donors in our simulation model were randomly generated, but donors on real crowdfunding websites are usually affected by various dynamic indicators of the projects resulting in an uneven distribution of donations across projects, resulting a lower success rate.

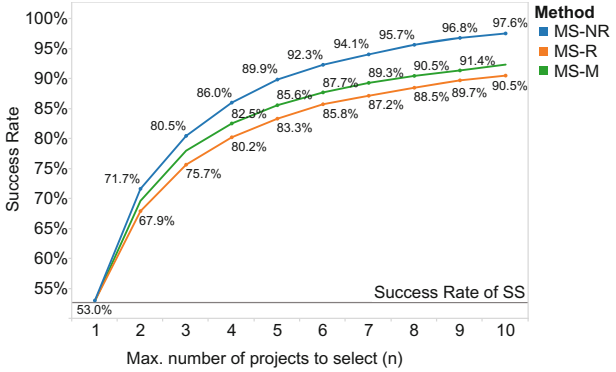

Fig. 2. This figure shows the results of our simulations. Success rate versus maximum number of projects (n). The x-axis is the maximum number of projects ($n = 1$ to 10) that each donor can choose at a time in the simulation, and the y-axis is the success rate across all crowdfunding projects. Color shows details about different methods. The data points are labeled with average success rate (Color figure online).

The success rates of the donation methods (MS-NR, MS-R, and MS-M) are all apparently greater than the baseline (SS) method. This finding answers our first research question, and suggesting that the new donation methods may distribute the donations more effectively, which could benefit more crowdfunding projects.

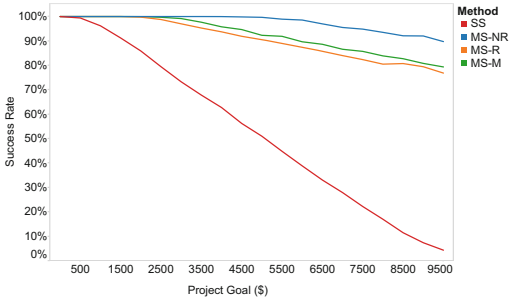

Fig. 3. The trend of success rate with respect to goal (dollars). Color shows details about methods. ($n = 10$)

Figure 2 also answers our third research question, showing that the success rate of our donation methods increases to n. That is, if donors choose more projects, their donations will have more flexibility to invest to other projects when the prior funded projects were failed. According to Fig. 2, as the maximum number of projects (n) a donor can choose increases above 5, the success rate will gradually saturate. This finding may be of interest for future research that explores how to optimize the efficiency of crowdfunding websites and fundraising strategies.

Furthermore, as shown in Fig. 2, the success rates of MS-NR were 3 % – 6 % higher than those of the other two donation strategies (MS-R and MS-RM), which answers our second research question. This is likely because when donors select projects without ranking, their donations are free to move around among those projects. On the other hand, if there is a ranking difference, the donations can only be moved to lower ranked projects when higher ranked projects are failed or fully funded. As a result, with MSNR, there are less constraints when distributing donations, while MSR is the most strict method.

Figure 3 presents the relationship between the success rate and project goals when using different donation methods. The success rate of the SS method decreases linearly when project goals is increase. Although the success rates of our methods (MS-M, MS-NR, and MS-R) also decrease with project goals, the success rates decrease much slower and remain at least 75 % when the project goals reach 10000 USD. This figure implies that our methods do not take away money from the high-goal projects to make low-goal projects succeed, but to rather distribute donations more effectively so that projects with any goal amount all have increased success rates.

Figure 4 shows the relationship between success rate and project duration when using different donation methods. The success rate of the SS method increases linearly with respect to project duration because longer projects have more time to receive donations. Our methods have better success and a more rapid increases with project duration. When the duration of a project is longer than about 22 days, the project success rate will approach 100 % in our system. This may indicate that our method can help crowdfunding projects reach their donation goals more quickly.

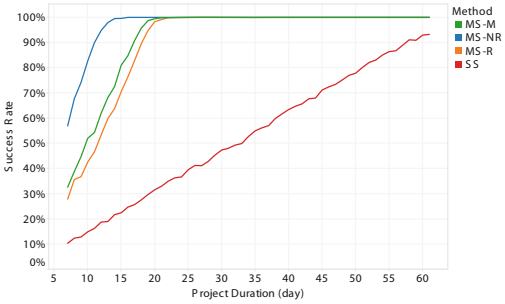

Fig. 4. Success rate versus project duration (day) when $n = 10$ (Color figure online).

In summary, our findings suggest that our system can help crowdfunding websites distribute donations more effectively by enlarging the benefit to more crowdfunding projects.

5 Limitation

Previous studies [2,3] performed an experiment in a lab setting to evaluate the performance and efficiency of their strategies for crowdfunding platforms. However, their experiment designing was far from the real crowdfunding platforms' experience. Therefore, this work constructs an agent-based model to simulate our algorithm in crowdfunding environments, that draws on data from real crowdfunding websites. However, the characteristics of the projects and the donation behavior on different crowdfunding platforms are divergent and difficult to simulate. This is the major limitation of this work, and future work will focus on improving the simulation model of crowdfunding platforms. Specifically, the goals and duration of crowdfunding projects were generated by uniform distributions further research should improve this model to reflect the real situation on each crowdfunding platform. Also, the donor's behavior in the real world will be affected by the quality, status, and other aspects of the projects, and thus would be different from uniform random selection of projects as simulated in our model. Although these limitations are present in our simulation, the comparison of the four methods was done with the same simulation settings. The trends reported in this study would therefore be comparable when adopting more realistic settings.

Besides, in order to deploy our methods to increase the efficiency of crowdfunding websites, it would be good to conduct a large-scale user study to understand the impact of the method on actual donors. How many projects would a real user select? How would they structure their preferences? Will the reallocating feature affect their motivation to donate?

6 Conclusion

Crowdfunding platforms have fundamentally changed the way we fundraise, and there are still lots of avenues to be explored in future research to improve the

efficiency of crowdfunding websites. In current platforms, donations may usually be distributed to a small proportion of projects with high exposure and promotion on crowdfunding websites, which may cause an uneven distribution of donations. Therefore, we focus on how to help donors match the projects they may be interested in and how to help donors assign their capital to the projects they prefer. This work proposed the new methods inspired by the algorithm in economic research, and our method significantly increases the success rates of projects on crowdfunding websites in our simulation. We hope this work provides some new perspectives that will help improve fundraising on crowdfunding websites.

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