ClimateCoach: A Dashboard for Open-Source Maintainers to Overview Community Dynamics

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Open-source software projects have become an integral part of our daily life, supporting virtually every software we use today. Since open-source software forms the digital infrastructure, maintaining them is of utmost importance. We present Climate Coach, a dashboard that helps open-source project maintainers monitor the health of their community in terms of team climate and inclusion. Through a literature review and an exploratory survey (N=18), we identified important signals that can reflect a project's health, and display them on a dashboard. We evaluated and refined our dashboard through two rounds of think-aloud studies (N=19). We then conducted a two-week longitudinal diary study (N=10) to test the usefulness of our dashboard. We found that displaying signals that are related to a project's inclusion help improve maintainers' management strategies.

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APPENDIX

A FIRST DASHBOARD DESIGN

Fig. 1. First iteration of design: Summarized signals; Temporal signals; Indicative signals.

Fig. 2. First iteration of design: Comparitive signals - comparison to other projects.

B THINK-ALOUD INTERVIEW PROTOCOL - CLIMATE COACH

Hello, thank you for taking the time to talk with me today!

We are doing a research study on how to design a support tool for helping maintainers monitor the climate of their project.

I and my colleagues are working on this study for <institute name>. If you have any questions about the study afterwards, desire additional information, or wish to withdraw your participation please contact me by email at <researcher email>. If you have questions pertaining to your rights as a research participant; or to report concerns to this study, please contact the Office of Research Integrity and Compliance at <institute name>. Their email is ... and their phone is ...

During the interview session, we are going to ask you some questions about your project maintenance experiences and behaviors and show you some designs to get your feedback. We will ask you to verbalize your thoughts while viewing the designs. The interview should take around 45 minutes - 1 hour.

In order to participate, you must be 18 years of age or older. Your participation is completely voluntary. All responses will be de-identified, and we will keep your answers confidential. There is no compensation for participating.

With your permission, we will also collect public data from your project and data that are brought up during the interview.

Please refrain from discussing sensitive information about yourself or third parties that would put them at risk for civil or criminal liability or damage to their financial standing, employability, or reputation.

Please do not use the real names of other individuals in order to avoid the collection of identifiable and potentially private information about a third party.

Everything will be anonymous and confidential. No one will be identified by name or any other specific characteristics.

There are no "right" or "wrong" answers, and we really appreciate your participation.

We'd like to record the audio of this interview for internal notetaking and analysis purposes. The recordings may be sent to a third-party transcription service to create a written transcript of our conversation for analysis. Only the members of our research team and the transcribers will have access to these recordings and their transcripts. Is that OK with you?

[...Get confirmation...]

We'd also like to record the video of this interview, also for internal notetaking and analysis purposes, meaning only the members of our research team will have access to these recordings. Is that OK with you?

[...Get confirmation...]

You can let us know to stop the recording during the interview if you say anything you would like removed from the record.

We may review publicly available data from GitHub or other online sites regarding your contributions. Is this OK with you?

[...Get confirmation...]

And finally can I verbally confirm that you are 18 years or older, have understood the consent information presented, and wish to continue with the study?

[...Get confirmation...]

B.1 Background about the participant

Tell me a bit about who you are and what you do.

B.2 Background about the project and their role

What is your role on Project X?

B.3 Project community

(if maintainer/owner) Are you the sole maintainer or are there others involved?

B.3.1 Tell us about the community for Project X.

Who is a part of the community?

How do you interact with them?

How do people interact with each other?

Can you give an example?

Can you show us a typical example of how you interact with the community? It can be an issue or a PR.

B.3.2 Tell us about the health of the community.
How well is the community doing?
How do you know that?

Are there any practices or activities you engage in to encourage community building?
What are they?
How did you decide to do this?

What challenges, if any, is the community facing?

Have you observed any conflict on your project?
Can you give me an example? How often do things like this happen?

How did you resolve that conflict?
Why did you resolve it like that?

Has there been any behavior you would consider toxic (inappropriate) on your project?
What was it? How did you handle it? (Why)

What about other projects?
How did you observe others handling it?

B.3.3 Project management / learning.
Do you engage in any activities to manage the community?
What are they?
How / where did you learn those? Give an example
How well are they working?

B.4 Think-aloud

<transition - explain think-aloud> Now we're going to show you some designs that include reports about your project and we want to get a sense of how you understand them. There's no right or wrong answers but we want to observe your thought process as you interact with the (design / report).

We'd like you to think aloud while looking through the designs. What we mean by that is we'd like you to tell us everything you're thinking or wondering while looking at the reports. We won't answer questions during, but you can say them aloud if they cross your mind. The most important part is that you keep talking, so if you are silent for any long period of time, we will ask you to talk. Like if I were going to think aloud while searching for the raise hand feature on Zoom I would say... (talk through example).

[Show example report, ask them to walk us through their thoughts]

[Example report]

B.5 Post think-aloud questions

What metrics do you consider important/do you want to know about/are there any we left out?
Community members' wellbeing?
Project's progress/wellbeing?

Are there any projects you think have a healthy community behind them?
What are they?
Why do you think they are healthy? (probe for examples / detail)

Are there any projects where you think the maintainers are doing a particularly good job?

What are they?
How do they relate to yours if at all?

Are there any projects you consider to be peers?
What are they?
Why do you consider them a peer?

Are there any projects you consider similar to yours?
What are they?
Why do you consider them similar?
Do you look at what they are doing? What aspects?

Are there projects you consider competitors?
What are they?
Why do you consider them competitors?
Do you look at what they are doing?
What aspects?

As a maintainer, what format would you want to receive this report in? Email, public issue, etc.

B.6 Diversity

Towards the end: how diverse is your project in terms of gender/ethnicity/*etc.*?
Do you engage in any practices or activities to encourage diversity?
What practices do you think would be helpful in improving diversity?

C DIARY STUDY PROTOCOL

C.1 Procedure Description

Total time expectation from participants: 3 hours Total cost per participant: $50 Goal number of participants: 8-10 Duration of procedure: 2 weeks

Initial Survey + Onboarding Session (30 minutes) Initial survey - 20 minutes Google form filled out independently by participant Consent information + info about the study structure Background information about the maintainer's identity, habits, and project dynamics At the end of survey, have them sign up for onboarding session time slot Onboarding session - 10 minutes Brief video call (Zoom) Explain logistics of study and weekly survey Show them the dashboard, make sure they understand basic setup Answer any questions the participant has Establish social connection with participant

Weekly usage (30 minutes each week x 2 = 1 hour total) Participants can freely use the Climate Coach dashboard as little or as much as they want during the study. Ask participants via email (sent out each Friday) to complete brief weekly surveys about how they used the dashboard that week. Survey itself should only take 15 minutes; the other 15

minutes account for potential time spent looking at the dashboard Participants should complete the survey within 48 hours of receiving it.

Exit Survey (30 minutes) Survey with questions to get feedback on dashboard and compare responses from initial survey

C.2 Initial Survey

(Section 1) Introduction

Hello, thank you for taking the time to participate in our study! We are doing a research study on a support tool designed to help maintainers monitor the climate of their project. This initial survey contains questions about your background information and your involvement in open-source development. It will also explain the logistics of the study.

My colleagues and I are conducting this study as part of the <lab name> and <lab name> research labs in the School of Computer Science at Carnegie Mellon University. If you have any questions about the study afterwards, desire additional information, or wish to withdraw your participation, please contact me by email at [email].

If you have questions pertaining to your rights as a research participant; or to report concerns about this study, please contact the Office of Research Integrity and Compliance at Carnegie Mellon University. Their email is irb-review@andrew.cmu.edu and their phone is 412-268-1901 or 412-268-5460.

(Section 2) Study Logistics Information

This study consists of 3 main parts:

Initial Survey In this survey, we will first ask some brief questions about your background. Then, we will ask you questions about your project maintenance experiences and behaviors. Lastly, we will invite you to sign up for a 10 minute time slot for an Onboarding Session over Zoom where we will explain the dashboard and setup for this study.

Weekly Usage Survey We will email you a survey to fill out once a week for the next 2 weeks. The survey should take about 15 minutes to complete. It will consist of questions pertaining to the dashboard and your project maintenance behavior. You may visit the dashboard as little or as much as you would like throughout the week. Please fill out this survey no later than 48 hours after it is received.

Exit Survey At the end of the 2 weeks, we will send an email with the Exit Survey. This survey will ask about your experience with the dashboard and for any final feedback about the dashboard. We will also ask if you have any other questions or comments about the study. Compensation: Participants will be compensated $50 (USD). If you wish, you may give this compensation to an open source project or foundation of your choice. We will notify you that the compensation has been processed at the end of the study.

C.3 Onboarding Interview (Script)

Introduction

Hello, thank you for taking the time to talk with us today! We received your response to the initial survey, and we greatly appreciate your participation in this study.

The purpose of this Zoom meeting is to further explain the study and show you the dashboard that we have generated for your open source project community. This is an opportunity for us to meet you and answer any questions you may have about the dashboard or the logistics of this study.

As a reminder, we are doing a research study on a support tool for helping maintainers monitor the community health of their project.

My colleagues and I are conducting this study for the School of Computer Science at <institute name>. We would also like to remind you of additional resources available to you, which were also presented in the Consent Information section of the initial survey.

If you have any questions about the study afterwards, desire additional information, or wish to withdraw your participation, please contact me by email. If you have questions pertaining to your rights as a research participant; or to report concerns about this study, please contact the Office of Research Integrity and Compliance at Carnegie Mellon University. Interviewer email: Office of Research Integrity and Compliance at <institute name>: (email) (phone)

[share screen to show logistics slides]

Now, we will go over the logistics of the study. This study consists of 3 main parts: This Onboarding Session will take about 10 minutes. We're going to explain the logistics of the study, show you the dashboard and make sure you understand the basic setup, and answer any questions you may have. After this session, you will have two weeks to use the dashboard in your open source project workflow. We will send you a weekly usage survey at the end of each week, which should take around 15 minutes to complete, in addition to any time you spend viewing the dashboard. You may visit the dashboard on your own time as little or as much as you would like throughout the week. Each Friday morning, we will email you a survey to fill out for that week. The survey will consist of questions pertaining to your experience using the dashboard, as well as questions about your project maintenance behavior. Please fill out this survey no later than 48 hours after it is received. Last is the exit survey which should take around 30 minutes. At the end of the 2 weeks, we will send an email with the Exit Survey. This survey will ask you about your experience with the dashboard and for any final feedback about the dashboard.

Do you have any questions so far about the logistics of the study?

[... Answer any questions interviewee might have ...]

Additionally, you will be compensated $50 for your participation. If you wish, you may give this compensation to an open source project or foundation of your choice.

In the initial survey, you confirmed are 18 years or older, and consent to our use of publicly available data from GitHub for use in the dashboard. Can I verbally confirm that you have understood the consent information presented, and wish to continue with the study?

[... Get confirmation ...]

Dashboard Introduction & Questions

I will send a link to the dashboard in the chat now. Please take 5 minutes to view the dashboard and the metrics on it. If any questions occur to you during this time, please feel free to ask me out loud or in the chat.

[After 5 mins has passed]

In those 5 minutes, hopefully you had some time to look over the dashboard and its metrics. Now I am going to ask a few questions to review some sections of the dashboard. I'll put these questions in the Zoom chat for your reference.

1. According to the dashboard, how many new contributors have submitted issues in the past week? [0]

2. According to the dashboard, in the last week, what was the average number of comments on an issue before it was closed? [2]

3. According to the dashboard, what is the most common issue label in your project? [new term requested]

Further questions

Thank you for taking the time to join this call and complete the onboarding session! After this session, I will email you with the information that we covered here, including the study logistics and the link to your dashboard. Do you have any more questions about this study or the dashboard? [pause…] You may also ask questions at any time via email.

C.4 Weekly Survey Questions

Introduction

This is the survey for Week (1-2) of the 2-week study conducted by the <lab name> and <lab name> labs at the School of Computer Science at Carnegie Mellon University.

At the beginning of this study, we shared with you the link to a dashboard report for your open source project. As a reminder, you may freely visit this dashboard site as much or as little as you would like for the duration of this study.

The purpose of this survey is to learn more about your activities as an open source project maintainer in the past week. Additionally, we will ask questions about your engagement with the climate report dashboard.

Please complete this survey within 48 hours of receiving it (*i.e.*, by the following Monday). Thank you for your participation!

Section 1: Maintainer Activity

In the following questions, "your project" refers to the open source project analyzed in your dashboard report that we provided at the beginning of this study. Please answer questions with respect to this project only.

WQ1. What types of contributions has your project received in the last week? (select all that apply)

- Bug fixes
- Requests for bug fixes
- New features
- Suggestions for new features
- Documentation updates
- Other

WQ2. Which of the following best describes your level of project maintenance activity in the past week?

- Spent more time than usual on project maintenance tasks
- Spent about the usual amount of time on project maintenance tasks
- Spent less time than usual on project maintenance tasks
- Did not spend any time on project maintenance tasks

WQ3. Approximately how many hours did you spend on maintainer duties for your project in the past week?

WQ4. Approximately how many times this week have you responded to issue comments?

- None
- 1-3 times
- 4-8 times
- 10+ times

WQ5. Approximately how many times this week have you responded to pull request comments?

- None
- 1-3 times
- 4-8 times

- 10+ times

WQ6. How would you describe the tone in discussions related to work on your open-source project?

- Multiple discussions with negative tone
- Some discussions with negative tone
- Mostly neutral tone in discussions
- Some discussions with positive tone
- Multiple discussions with positive tone

WQ7. Select any words that describe the tone in discussions related to work on your open-source project:

- Friendly
- Tense
- Professional
- Informal
- Productive
- Honest
- Hostile
- Complaining
- Supportive
- Polite
- Rude
- Welcoming

Section 2: Dashboard Engagement

WQ8. How often did you check the dashboard this past week?

- Once
- 2-3 times
- 4-5 times
- 6+ times
- I did not check the dashboard

WQ9. Are there specific parts of the dashboard that you viewed more often than others? If so, which sections?

WQ10. Did you click on any of the links to articles or external resources? (do not include links to your own GitHub page)

- Yes, I read a linked article
- Yes, I read resources about the metrics / API documentation
- Yes, I read both an article and resources about the metrics
- No, I did not click links

WQ10-2. If Yes - Why did you decide to click the link and read further?

WQ11. Which informational tips were most useful to you?

- Conversations that Need Your Attention tip
- Conversations by Label tip
- Features that Affect Project Attractiveness - Activity Level
- Features that Affect Project Attractiveness - Scaffolding

- Features that Affect Project Attractiveness - README file
- Features that Affect Project Attractiveness - Inclusive Language

WQ12. Are there any metrics that are confusing in your opinion?

WQ13. How reliable/unreliable did the metrics seem based on your experiences on GitHub this week (1 - 5; 1 - very unreliable - 5- very reliable)?

- Basic Stats
- Issue Author Stats
- Pull Request Author Stats
- New Authors
- Issue Response Time
- Pull Request Response Time
- Long-Standing Open Threads
- Issue Activity
- Pull Request Activity
- Lengthy Open Threads
- Conversation Tone Analysis
- Conversations by Label
- Comparison to Similar Repositories

WQ14. Are there any questions that you have about a specific section of the dashboard or the dashboard overall?

WQ15. Are there any other feedback or comments you have about this dashboard?

C.5 Exit Survey Questions

(Page 1)

This is the final survey for the 2-week study conducted by the <lab name> and <lab name> labs at the School of Computer Science at Carnegie Mellon University.

The purpose of this survey is to learn about your habits as an open source project maintainer and your engagement with the climate report dashboard.

The compensation for participation in this study takes the form of a $50 (USD). If you wish, you may give this compensation to an open source project or foundation of your choice. We will process the payment to you shortly after your completion of this survey. Thank you for your participation!

(Page 2) Maintainer Workflow

EQ1. To what extent are you looking for new contributors on your project? (1 - Not interested in gaining new contributors -> 5 -Very interested in gaining new contributors)

(1-strongly disagree to 5-strongly agree):

- EQ2. I feel confident in supporting the community of contributors in my project.
- EQ3. I am unsure about how to encourage a healthy project community.
- EQ4. Increasing the level of demographic diversity among contributors in my project community is important to me.
- EQ5. Increasing the level of diversity in technical expertise among contributors in my project community is important to me.

EQ6. As a maintainer, to what extent do you prioritize the following factors? (On a scale 1-5 low to high priority)

- EQ6-1. Fast response time to issues
- EQ6-2. Fast response time to PRs
- EQ6-3. Creating a welcoming environment
- EQ6-4. Attracting new contributors
- EQ6-5. Attracting a diverse group of contributors

EQ7. How often do you respond to issue comments per week?

- None
- 1-3 times
- 4-9 times
- 10+ times

EQ8. How often do you respond to PR comments per week?

- None
- 1-3 times
- 4-9 times
- 10+ times

EQ9. After viewing the dashboard this week, what goal(s) do you have for your project community? Please list at least one.

(Page 3) Contributor Community Health

EQ10. How would you describe your project's community health?

EQ11. How would you define diversity in open-source software?

EQ12. How would you define inclusion in open-source software?

(Page 4) Usefulness of the Dashboard

EQ13. Please select how much you agree with each of the following statements (1-strongly disagree to 5-strongly agree):

- EQ13-1. This dashboard made me more aware of the diversity and inclusion within my project.
- EQ13-2. This dashboard caused me to be more aware of my own behavior in regards to inclusivity in the community.
- EQ13-3. This dashboard did not have an effect on my actions as a maintainer.
- EQ13-4. This dashboard was useful to me.
- EQ13-5. This dashboard was not useful to me, but might be useful to other maintainers.
- EQ13-6. This dashboard would not be useful to most maintainers.
- EQ13-7. I looked at the dashboard mainly so I could answer the questions for the weekly surveys.

EQ14. Did you add/modify any features to your project based on the content in the dashboard (example: README)?

- Yes
- No
- Other

If yes, which features were added/modified?

EQ15. How likely are you to continue to use this dashboard after the study?

- Unlikely

- Somewhat unlikely
- Neither likely nor unlikely
- Somewhat likely
- Likely

EQ16. As a maintainer, how would you prefer to receive this website report?

- Social media (*i.e.*, Twitter, Reddit, *etc.*)
- Podcast or blog for developers
- Email
- Other

EQ17. Any other feedback regarding the dashboard?

D INFORMATION OF INTERVIEW PARTICIPANTS

Table 1. Characteristics of Email Interviewees' Projects

Participant ID	Number of Contributors	1+ Women/Non-binary?
R0P1	298	N
R0P2	7	N
R0P3	21	Y
R0P4	21	Y
R0P5	202	Y
R0P6	50	N
R0P7	34	N
R0P8	6	N
R0P9	4	Y
R0P10	8	N
R0P11	5,000+	Y
R0P12	47	N
R0P13	1,181	Y
R0P14	3	Y
R0P15	1,237	N
R0P16	231	Y
R0P17	27	N
R0P18	96	N

Table 2. Characteristics of Think-aloud Interviewees' Projects

Participant ID	Number of Stars	Project Size	1+ Women/Non-binary?
R1P1	11	13	N
R1P2	67	28	Y
R1P3	5.7K	42	N
R1P4	20.6K	100+	Y
R1P5	468	27	N
R1P6	1.5K	39	N
R1P7	468	27	N
R1P8	176	37	N
R1P9	65	24	N
R1P10	810	17	N
R2P1	544	18	N
R2P2	73.9K	100+	Y
R2P3	708	100+	N
R2P4	131	27	Y
R2P5	158	8	N
R2P6	2.1K	100+	N
R2P7	126	28	Y
R2P8	8.3K	98	N
R2P9	2.1K	100+	N

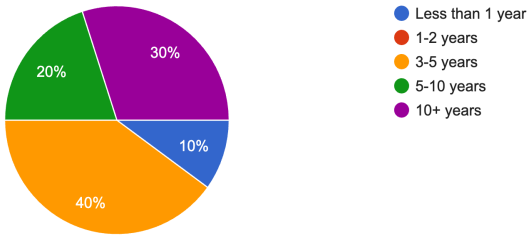

Fig. 3. Years of Experience in Open-Source Contribution

Table 3. Characteristics and Basic Status of Diary Study Participants' Projects

Participant ID	Number of Stars	Total Number of Contributors	Avg Issues Closed	Avg PRs Closed	1+ Women/Non-binary?
R3P1	2.5K	31	4	8	N
R3P2	4.5K	47	32	14	N
R3P3	146	27	2.5	8	Y
R3P4	8.1K	100+	26	118.5	Y
R3P5	1.3K	19	0	2.5	N
R3P7	6.3K	26	2.5	0	N
R3P9	2.1K	93	0	19	Y
R3P11	8.1K	100+	25	103	Y
R3P12	18.7K	100+	5.5	15	N
R3P14	23	7	0	0	Y

E TIPS IN THE DASHBOARD

Table 4. Tips we provided in our dashboard

Dashboard signal	Tip
`Conversations that Need Your Attention`	Researchers have found that excessive review delays, nitpicking, and long wait for review are predictors of negative experiences in the code review process. Blocking a change request can cause unnecessary interpersonal conflict and negative feelings among contributors [1].
`New authors`	New contributors may need some additional support from the project community. In order for an open source project to be sustainable, it's important to not only attract new contributors, but also retain them.
`PR comments`	If a pull request is coming from an external contributor, try to comment on the PR before closing it. This can be helpful for the author and acknowledges their contribution.
`Conversation tone analysis`	If you do not already have one, consider creating a code of conduct for your community to promote respectful, productive discussions! Here is a template to get you started: https://www.contributor-covenant.org
`Conversations by labels`	Consider adding issue labels that explicitly highlight starter tasks for new contributors. Labels like "newcomer friendly", "good first issue", and "help wanted" can help attract and retain new contributors [2]. These labels will appear in GitHub repository search results.

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