

# Mentoring Opportunities in Computer Architecture: Analyzing the Past to Develop the Future

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## ABSTRACT

Academic mentoring programming is a powerful tool used for supporting, engaging, and retaining students in their fields of study. Researchers have long known the positive effects of academic mentoring, particularly for students from underrepresented and marginalized backgrounds. The computer architecture community currently hosts an assortment of mentoring programs geared toward women, underrepresented students, junior graduate students, and undergraduates alike.

In this work, we describe the current state of mentoring opportunities for students in computer architecture. In addition to summarizing various mentoring programs (e.g., CWWMCA, YArch, and uArch), this work details the organization and feedback from two programs (MaSA and MaSS) that the authors currently run and organize. Based on feedback from these short-term mentoring programs, along with relevant mentoring research literature, we identify opportunities for developing more productive longer-term mentoring programming for the computer architecture community. Following mentoring literature, this work makes a strong case for offering both short-term and long-term mentoring programs in the future; in particular, mentoring literature show the need for time in forming mentoring relationships for mentees to receive the multifaceted benefits of mentoring.

## KEYWORDS

Mentorship, Computer Architecture, Graduate Students, Undergraduate Students

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## 1 INTRODUCTION

Academic mentoring programming has become a common tool for helping engage and maintain students in their respective fields [18, 25–27]. While a common and easily understood concept, academic scholars still argue over the precise definition of mentorship and what activities it entails [8, 22, 24]. A generally agreed-upon (yet non-academically rigorous) definition of mentorship entails a person in a senior position taking on a supportive role of oversight and encouragement of a less experienced person.

In recent years, mentorship programs have also become an important channel to encourage and retain diverse talent in the computer architecture community. Several workshops providing mentorship opportunities for underrepresented groups in our community including women and marginalized groups [10], undergraduates [32], and junior graduate students [34] have been organized regularly. Additionally, in an effort to encourage greater interaction between senior and junior members of the community, short-term at-conference mentor-matching activities described in detail in Section 2, are becoming a standard conference feature.

The worldwide COVID-19 pandemic has increased the importance of such mentorship programs. Because in-person conferences have now become virtual, everyone's ability to meet and interact with their community has been impacted. However, the shift to virtual conferences has particularly disadvantaged newer, younger members of the community lacking the pre-existing connections to their newfound research community. Such new members would traditionally rely on in-person interactions during conferences to develop their network.

The transition to virtual conferences during the COVID-19 pandemic has been a challenge but also an opportunity. Virtual conferences have seen a much greater number of attendees and from a more diverse set of countries likely due to the ability to attend remotely and significantly lower cost of attendance.<sup>1</sup> To make the community welcoming to these new attendees—many of whom are undergraduates or new graduate students—we, the Computer Architecture Students Association, or CASA, launched a mentorship program, *Meet-a-Senior-Student*, or MaSS, at MICRO-53. The goal of MaSS is to provide opportunities for junior students (i.e., undergraduate, and 1st/2nd year masters and PhD students) to meet

<sup>1</sup>Registration costs for virtual conferences have been \$15-30 for student attendees in the past year, an order of magnitude less than in-person conferences. In-person conference student registration fees usually amounted to \$400 or more!

and interact with senior (3rd+ year) PhD students. MaSS aims to augment and is modeled after the Meet-a-Senior-Architect (MaSA) program conceived by Joel Emer and first run at ISCA 2016 [15].

Based on feedback and learnings from this first experience, we launched a second iteration of MaSS, joining forces with Joel Emer to also run MaSA at ASPLOS 2021. This iteration had more than 40% of the conference attendees who signed up as mentors or mentees in these programs, with a total of 80+ and 160+ mentees taking part in MaSS and MaSA respectively. This iteration also boasted more sophisticated matching of mentors and mentees, taking into account preference for type of mentors (academic or industry) and their research areas, and had a heavily automated matching process to ensure scalability and reproducibility in future conferences.

While we wish to advocate for continued organization of MaSS and MaSA at future computer architecture conferences (in addition to other contemporary programs targeting specific under-represented groups), our feedback from students after organizing MaSS/MaSA indicates that this is not enough. All existing mentorship programs (including MaSS and MaSA) are largely organized around conferences and are "short-term" by design: they have an engagement spanning a single meeting or at most a day for workshops. However, our preliminary feedback from mentorship activities thus far indicates that student seek longer engagements with their mentors, even after a conference. This matches results of MaSA surveys, where in 2017, for example, 80% of the respondents said they would "greatly" or "very greatly" like to have a continuing relationship with their mentor. This is primarily because short-term mentorship engagements are, by design, geared towards networking or knowledge dissemination; they are unsuited to promote a student's growth, which is an important desirable outcome of mentorship in general. To that end, we seek to highlight the next-steps to enable such a long-term mentorship program in the computer architecture community to fill a gap in current mentoring efforts.

In this paper, we provide the following contributions:

- Describe our efforts at enabling mentorship opportunities via MaSS and MaSA at two computer architecture conferences over the past year.
- Analyze the preliminary feedback from one of our mentorship programs, and discuss the gaps in the current short-term mentoring efforts in our community.
- Highlight the next steps towards a community-wide long-term mentorship program in the field of computer architecture, using academic mentoring research and existing programming as a guide.

The paper is organized as follows: we first provide an overview of current mentoring programs in the computer architecture community in Section 2, then describe our experience with MaSS and MaSA over the past year in Section 3 and analyze feedback from participants in Section 4, then discuss unmet mentoring needs with existing programs in Section 5 and finally lay out the path forward for a long-term mentorship program in Section 6.

## 2 CURRENT MENTORING PROGRAMMING

Within computer architecture, there are a handful of community-wide mentoring opportunities currently available (listed in Table 1).

Shorthand	Name
CWWMCA (§2.1)	Career Workshop for Women and Minorities in Computer Architecture
YArch (§2.2)	Young Architect Workshop
uArch (§2.3)	Undergraduate Architecture Mentoring Workshop
MaSA (§2.4)	Meet-a-Senior-Architect
MaSS (§2.4)	Meet-a-Senior-Student

**Table 1: Mentoring activities in computer architecture.**

These mentoring events tend to be short-term, such as one- or half-day workshops or the duration of a conference (*i.e.*, 3-5 days).

The following mentoring-focused programs are those known to be currently active by the authors. For each program, we describe: its mission statement; its event programming structure; and finally, its running history.

### 2.1 Career Workshop for Women and Minorities in Computer Architecture

The Career Workshop for Women and Minorities in Computer Architecture, or CWWMCA, "brings together women and under-represented minorities at different levels in academia, industry, research, government and students to promote the recruitment, retention and progression of women and under-represented groups with research interests in computer architecture" [10].

Its programming structure is a mix of technical presentations and panel sessions as well as informal activities "to provide mentoring for students as they get started in their careers". The most recent workshop included a keynote speech, a student research poster session, two technical talks, a panel discussion on "handling setbacks in challenging times", and a one-hour speed-mentoring session. Keynotes and invited talks covered the "latest research trends" in computer architecture.

CWWMCA is the longest-running mentoring program in computer architecture that is known to the authors. First established in 2014 in conjunction with MICRO-48, it will be on its 7th iteration this coming MICRO-54.

### 2.2 Young Architect Workshop

The Young Architect Workshop, or YArch, is a "forum for junior graduate students studying computer architecture and related fields to present early stage or on-going work and receive constructive feedback from experts in the field as well as from their peers" [34]. Participating students in the ASPLOS 2021 iteration received mentoring in the form of two keynote talks, a panel discussion on succeeding in graduate school, and a 1-hour round-table mentoring event with established architects."

YArch was first organized in conjunction with HPCA 2019 [33]. Its organizers cited the ACM Student Research Competition as inspiration [4], along with the fact that the only two other mentoring programs, CWWMCA and MaSA, occurred (up to this point) in isolation. Thus, a student would need to attend multiple separate conferences to receive "well-rounded advice". Rather than replace the above mentoring programs, its organizers state that YArch serves to "complement" existing efforts [2].

## 2.3 Undergraduate Architecture Mentoring Workshop

The Undergraduate Architecture Mentoring Workshop, or uArch, is “designed to introduce undergraduate and Master’s students to research and career opportunities in the field of computer architecture in particular, and graduate school lifestyle and survival skills in general.” Its recent program included two technical keynote sessions on past and future research directions in computer architecture, and two panel sessions on applying to graduate school and then graduate student life.

The uArch workshop was first held in conjunction with ISCA 2019, and is a response to an issue alarming to the architecture community: the number of prospective graduate students applying to computer systems/architecture research is actually shrinking [3]. uArch hopes to help reverse this trend by exposing late-stage undergraduate students to “cutting-edge research and career opportunities” in computer architecture. The uArch workshop will once again be held at ISCA in June 2021.

## 2.4 Meet-A-Senior-Architect/Student

The Meet-a-Senior-Architect program, or MaSA, is a short-term at-conference mentoring program between more senior members of the architecture community and current students. Participation expectations are a 20-30 minute conversation between mentor and mentee sometime during the co-located conference. MaSA was conceived by Joel Emer after hearing about a program at the University of Chicago where students could sign up to meet with any professor for an informal conversation. MaSA was sponsored by SIGARCH and piloted by Joel and Partha Ranganathan at ISCA 2016 [15]. Joel continued to run MaSA at ISCA through 2020, and then (through a collaboration with CASA), MaSA was extended beyond ISCA to MICRO-53 in 2020, and ASPLOS 2021.

An offshoot of MaSA, Meet-a-Senior-Student (MaSS), was organized by CASA for MICRO-53. Like MaSA, it is a short-term at-conference mentoring assignment. However, the pairing assignments are between senior (3rd+ year PhD students) and junior (1st/2nd year PhD and Masters) students. The motivation for pairing junior students with those senior is that there may be topics a student may not be comfortable discussing with a senior member, but more likely comfortable sharing with a fellow student.

## 3 ORGANIZING MASS AND MASA

We briefly describe our experience with organizing Meet-A-Senior-Architect (MaSA) and Meet-A-Senior-Student (MaSS) at various computer architecture conferences, and provide analysis of some of the feedback we received. The goal of these mentorship programs is to enable better networking for students by engineering one-on-one mentoring meetings between junior and senior members. For MaSS, we match junior students with those more senior. For MaSA, it is between students and more senior researchers.

MaSA was started as a service of SIGARCH to provide opportunities for students to personally connect with faculty and industry researchers whom they do not know personally and might feel reluctant to approach directly. The genesis of MaSS in MICRO-53 was encouraged by the virtual organization of conferences starting Spring 2020 due to the COVID-19 global pandemic. The need

for more organized interactions between attendees was felt in the absence of in-person social meetings.

## 3.1 Program Structure

After the 2016 pilot version of MaSA, where only students awarded travel grants were invited to participate, the conference registration form was augmented with an offer to students to sign up to have a mentor. In 2019, 148 of 308 students who registered for the conference signed up. In 2016 and 2017, mentors were solicited individually by email by the program organizer. Starting in 2018, MaSA mentors were also solicited via conference registration. However, this did not yield a sufficient number of mentors. Anecdotally, this was due, at least in part, to the fact that registrations of several potential mentors were handled by administrative assistants. So approximately half the mentors were still obtained via individual email solicitations.

After collecting the names and emails of all the mentees and mentors interested in participating in MaSA, in the years from 2017 through 2019, the mentees were given the opportunity to provide a ranked ordering of the mentors they would most like to talk to. Since a relatively small number of mentors were highly sought after (in 2019, 4 mentors were each the first or second choices of over 20 students) the ranked order had ten choices and also as a

ISCA MaSA	Written Feedback
2017	<i>“This program was a wonderful opportunity to meet with a senior member of the architecture community who I doubt I would have had the nerve to speak to otherwise! It speaks to the value placed on maintaining the architecture community, so thank you to all of those who put their time into organizing it and participating as mentors!”</i>
2018	<i>“It is a good idea to match a first time student attendee with another student as well. It is a good start point for networking and finding friends in conferences.”</i>
2018	<i>“It would be great to have someone in my field and continue this relationship in the future. I believe this is a great opportunity for young computer architects like me to talk with senior architects and learn from their experiences. Thank you so much for organizing this!”</i>
2019	<i>“I think in the mentor selection process (the Google form), it would have been nice to see the research topic of each mentor, in addition to where they work. That would have been very helpful.”</i>
2019	<i>“Every conference of our area should provide this opportunity.”</i>
2019	<i>“This was a great program! I have benefited from this two years in a row. I have a suggestion: how about taking this mentorship experience throughout the year? Instead of meeting our chosen mentor once a year, perhaps we can set up 4 phone/video calls a year with the same mentor. It will be useful to have a continued relationship and will also help mentors see the impact of their mentorship better.”</i>

**Table 2: Select mentee feedback from three iterations of Meet-A-Senior-Architect at ISCA between 2017 and 2019.**

final matching criteria students were asked if they would prefer a mentor from academia or industry. Given this information a set of Python scripts that implemented a variant of the stable marriage problem was used to match students and mentors. Given the results of that analysis, emails to both mentors and mentees were sent to inform them of the matches. The mentees were asked to contact their mentors and coordinate a time and place to meet during the conference. Subsequently, during the conference, the mentee and the mentor meet up for roughly 30 minutes. Mentees are advised to chat about any topic they would like a senior mentor's perspective on, including their research, career growth, managing work-life balance in academia, etc., but not including soliciting job offers.

Table 2 offers a select assortment of feedback on MaSA from 2017 to 2019. It shows the general positive attitude to MaSA, along with constructive criticism that helped later evolve the program (e.g., matching by area, and expand beyond ISCA) and a prescient proposition in 2018 for a MaSS-like program. There are also initial suggestions for a long-term mentoring program, which we look further into in Section 4.2.

With the onset of the pandemic and much shorter lead times between registration and the conference, as well as the addition of the MaSS program, the procedure used had to be adapted. During the conference registration, each attendee was offered the chance to sign up for either of these programs: junior students can sign up as mentees for both MaSS and MaSA, senior PhD students as mentors for MaSS and mentees for MaSA, and faculty or industry participants are allowed to sign up as mentors for MaSA. Before the conference, the matching process for either program pairs each mentee with a mentor and communicates the contact details of the other to both the mentee and the mentor. Coordination of a (now virtual) meeting was to be initiated by the mentees as before.

### 3.2 Participation from the Community

Following MaSA's pilot in 2016 with 32 students and 17 mentors, it grew to 183 students and 104 mentors at the last in-person ISCA conference in 2019. In its first iteration at MICRO-53, MaSS had signups from 84 junior students (undergraduate, masters and 1st/2nd year PhD) as mentees and 55 senior students (3rd+ year PhD) as mentors; this grew to 88 junior student mentees and 54 senior student mentors at ASPLOS 2021. In comparison, the more established MaSA program had more participation at ASPLOS 2021, with 168 student mentees and 87 mentors from academia and industry. This is because MaSA targets a larger pool of mentees (both senior and junior students can sign up as mentees) and also because students value a one-on-one meeting with a senior researcher or faculty member more, as such meetings are hard to engineer otherwise. Looking at MaSA and MaSS attendance at ASPLOS 2021, at least 40% of the conference attendees (at the time of freezing sign-ups) signed up to participate in either of the programs as mentors or mentees; this indicates considerable buy-in from the community about the perceived benefits of these programs.

### 3.3 Organizational Challenges and Learnings

After organizing two iterations of mentorship programs (at MICRO-53 and ASPLOS 2021), we identified three key challenges that we

subsequently attempted to address: (1) ensuring high levels of automation, (2) effectively matching interest of mentees and mentors, and (3) maintaining community engagement and awareness.

**Ensuring High Levels of Automation:** To make mentorship programs scalable and easily adoptable in future conferences, it is crucial to minimize the administrative effort in organizing them, via a high level of automation. The first iteration of MaSS in MICRO-53 matched mentors and mentees using Excel spreadsheets manually, while matching for MaSA was performed with Python scripts which accepted mentor and mentee inputs in a specific format; both processes required much manual effort, which was a pain-point especially when the process needed to be repeated. To streamline this process, the subsequent iteration of MaSS and MaSA in ASPLOS 2021 incorporated automated matching scripts in Python using *pandas* to directly process the data from the registration data-dump and written in a *jupyter notebook* for easy visualization. This ensured that the matches were finalized at the latest possible date (i.e., the weekend before the conference) to allow the maximum number of attendees to participate. The *jupyter notebooks* with the matching scripts for MaSS and MaSA are publicly available on GitHub<sup>2</sup> and the process workflow is documented in detail in a public Google Doc<sup>3</sup> to enable future conference organizers to easily organize such a program. Even further automation could be useful in the long term. For example, a web server could maintain information on mentor's and mentee's contact information, background and preferences, and perform matching and email distribution with even less manual intervention.

**Effectively Matching Interests of Mentees and Mentors:** For the best engagement between mentees and their mentors, it is critical to match mentees with mentors of their preference with whom they have overlapping interests. Recent iterations of MaSA and MaSS (including at MICRO-53) matched mentors and mentees in a random manner predominantly, while ensuring no institutional overlaps, due to the limitation of the manual matching process.

In the most recent iteration of these programs at ASPLOS 2021, a more sophisticated mentor-mentee matching process was deployed incorporating mentee preferences. All attendees were requested to indicate their research areas via check-boxes listing common research areas in the registration form. Mentees were also asked whether they would like a mentor in their research area: more than 80% indicated that they would prefer this in both MaSS and MaSA. Additionally, for MaSA, mentees were asked if they would prefer a mentor specifically from industry, from academia, or if they had no preference: 66% of mentees indicated a specific preference of an industry or an academia mentor. The automated matching scripts used greedy algorithms to provide mentors with at least one overlapping research area and from the appropriate background (industry or academia) for more than 99% of the mentees who indicated such a preference. With such intelligent matching, mentees were able to interact with mentors who were better suited to their requirements, thus leading to more fruitful interactions.

**Maintaining Community Engagement and Awareness:** One of the challenges of organizing a large and distributed mentorship

<sup>2</sup>GitHub repositories for [MaSA](#) and [MaSS](#).

<sup>3</sup>Documentation detailing the workflow can be found [here](#).

program is building awareness and sustaining engagement. For instance, in every iteration of MaSA, we faced a shortage of mentors and even after personal email solicitations for more mentors, we were sometimes unable to accommodate all students who signed up to be a part of the program. While MaSA at ASPLOS 2021 did see significant participation from industry and academia (almost 40% of senior attendees signed up as mentors and committed to mentor two students each on average), more awareness about MaSA in the community can encourage more of the senior conference attendees to volunteer as mentors. Additionally, we notice that a fraction of meetings for MaSS fail to happen if neither the mentor or mentee overcomes the inertia to send an introductory email. We attempted to address this at ASPLOS 2021 by *sending out reminder emails to mentors and mentees*, at the mid-way point during the conference, encouraging them to connect if they had not done so already: these emails were anecdotally helpful in initiating connections that may otherwise not have happened. However, more quantitative studies of community awareness and engagement (inclination to mentor, meeting success rates, subsequent interactions, etc.) are needed to address this problem in future iterations.

#### 4 ANALYSIS OF FEEDBACK FROM MASS

This section details the feedback received from the first MaSS program held in conjunction with MICRO-53. The feedback highlights how mentors and mentees perceived the program, strategies to improve success rates in connecting mentors and mentees, and interest in accompanying short-term mentoring programs with a longer-term mentoring program. We first describe the survey used to gather the feedback and the participants who provided the responses. Next, we highlight how useful mentor and mentees found MaSS. Finally, we detail the feedback from MaSS participants.

##### 4.1 Survey Statistics

The anonymous [survey](#) was designed using Google Forms and administered to all 55 mentors and 84 mentees participating in MaSS. A total of 11 mentors and 19 mentees volunteered to participate in the survey. Of the 11 mentors, 4 mentors were matched with a single mentee; 7 were matched with two mentees each.

##### 4.2 Feedback from Survey

Figure 1 illustrates how survey participants felt about the overall usefulness of the MaSS program. We find about 73% of mentors and 90% of mentees found the interactions either *useful* or *very useful*. The strong feedback highlights the need for facilitating interactions among junior and senior students across the research community. Furthermore, all mentors and mentees indicated they would participate in future iterations of MaSS.

The feedback from mentees is shown in Figure 2. Similarly, Figure 3 and Figure 4 show the feedback from mentors with one and two mentees respectively. The feedback highlights three key aspects: (1) did the mentor and mentee meet?; (2) who reached out first to initiate the interaction?; and, (3) would they participate in a long-term mentorship program?

**Feedback on successfully connecting:** Figure 2a shows approximately 90% of mentees successfully met with their mentors; 10% were unable to meet. To maximize the success of mentorship

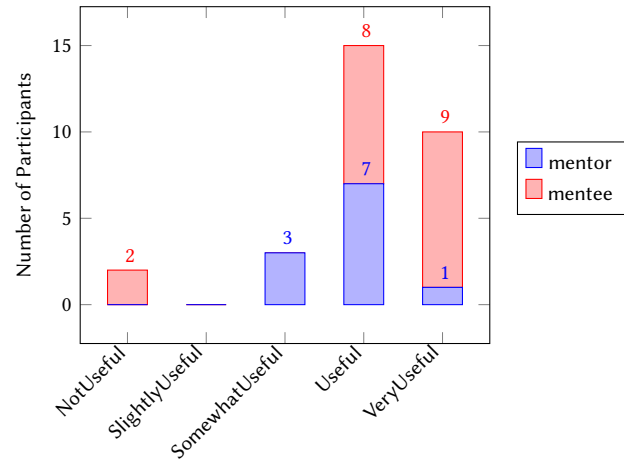


Figure 1: Usefulness feedback from MaSS participants.

programs, it is crucial to ensure everyone’s time and commitments are honored and reduce the number of mentees who did not meet their corresponding mentors. To understand potential opportunities, we look at the breakdown of mentors that had one versus two mentees. In particular, from the mentors participating in the survey, Figure 3a shows all mentors with a single mentee connected and met with their mentees. While all responding mentors with two mentees met with their first mentee (Figure 4a), only 14% of them met with their second mentee (Figure 4b). Though the sample size of mentors is small (20% of all student mentors in MaSS), the significant distinction between mentors connecting with their first and second mentees is an important gap to close. One way of closing this gap is by increasing the number of mentors via community engagement and awareness (Section 3.3), as well as facilitating conversations between mentors and mentees.

**Feedback on initiating conversation:** A crucial first step of mentors and mentees meeting one another is for them to initiate conversation. Here we describe feedback we received on whether mentors or mentees initiated conversation via e-mail. Overall, Figure 3b and Figure 2b show that roughly 75% of mentees contacted their specified mentors. This is a direct result of MaSS being setup to encourage mentees to reach out to their mentors—bridging gaps between junior and senior students in the community. Similarly, for mentors with two mentees, about 70% of interactions with the first match were initiated by the mentee; however, of the *second* mentees, Figure 4b shows the fraction of mentees initiating conversations to drop precipitously. To mitigate such cases, in subsequent iterations of MaSS at ASPLOS 2021, the organizers actively reached out to mentors and mentees to remind them to connect (Section 3.3).

**Feedback on long-term mentorship:** While MaSS is focused on providing short-term, one-time mentorship opportunities, the survey gauged students’ interest in longer term mentorship programs. For instance, Figure 2c, Figure 3c, and Figure 4d illustrate that over 84% of mentors and mentees want opportunities for long term mentorship among junior and senior students in the computer architecture community. This is an area the Computer Architecture Student Association (CASA) continues to explore (See Section 6).

**Suggestions for driving MaSS and CASA initiatives:** In addition to the aforementioned feedback, mentors and mentees were

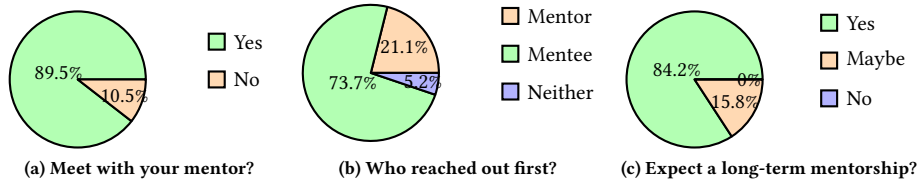


Figure 2: The survey administered to all mentees.

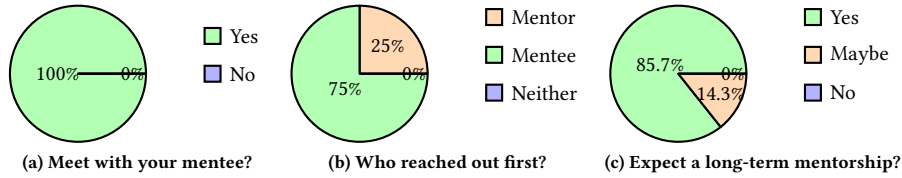


Figure 3: The survey administered to MaSS mentors who were assigned one mentee.

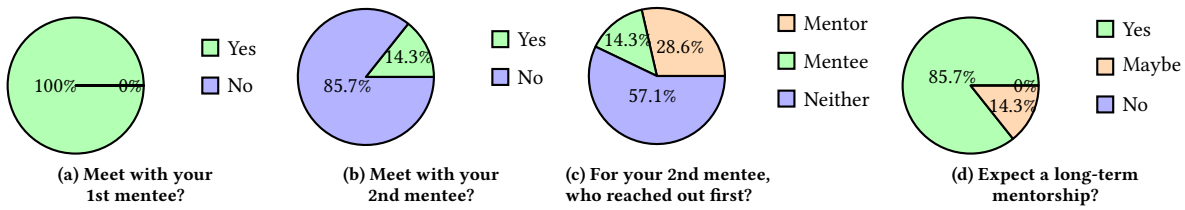


Figure 4: The survey administered to MaSS mentors who were assigned two mentees.

Suggestion	MICRO-53 MaSS Written Feedback
#1	"I can't remember what the registration as a mentor was like, so excuse me if this was already done. I think it might be useful for the mentors to broadly select their fields (e.g. security, GPUs, microarch, etc.) and then the mentees could select which field they'd like to match with."
#2	"Please ask mentees to schedule at least 30 minute long slots. Any shorter, and the conversation is not productive."
#3	"MASS was an amazing initiative and I will continue to participate in it in future conferences as much as possible. Another addition (not modification) to MASS can be Meet a Group of Students - where 4 students are paired and they get to have a group chat, this essentially provides an opportunity to network with more people at once (it may or may not be based on mutual interests as architecture itself is the mutual interest)."

Table 3: Select mentee feedback from Meet-A-Senior-Student at MICRO-53.

able to provide open and anonymous feedback on MaSS, which we summarize here. Common feedback includes mentors and mentees preferring to connect with students in similar or adjacent research areas of interest. (Sample feedback appears in both Tables 2, 2019-1 for MaSA and 3, #1 for MaSS.) Acting on this feedback, the matching process for the subsequent iteration of MaSS and MaSA at ASPLOS

2021 provided research-area-based matching for mentees with such a preference. Furthermore, students expressed interest in group activities (Table 3, #3) and networking opportunities where 3 to 5 students are grouped together. While MaSS focuses on one-on-one mentorship opportunities, following the interest in group interactions, CASA has organized a regular series of virtual social hours called [ArchChat Social Hours](#).

## 5 IDENTIFYING UNMET MENTORING NEEDS BY STUDYING MENTORSHIP LITERATURE

Our experience with MaSS and MaSA indicates that students find our current mentoring programs beneficial, and we advocate for these to be continued. At the same time, we seek to identify what mentoring needs may yet be unmet. To that end, we discuss prior academic literature on mentorship, describe the support an ideal mentoring relationship can provide, and highlight the aspects which are not yet covered by existing mentorship programming.

### 5.1 Definition of Mentoring in Literature

While the concept of mentorship is intuitive to understand, a consistent technical definition eludes researchers and academics [8, 17, 22, 24]. In a literature review spanning 25 years of mentoring research, Crisp and Cruz identify over 50 differing definitions of mentoring, and cited an even greater variety of characteristics [8].

If we consider the etymology of the word “mentor”<sup>4</sup> as a guide, then we can deduce mentoring as an act between two people where the more experienced, usually older, person counsels and offers advice to the less experienced, usually younger, party. And although the definition of mentoring may eternally be in doubt, its value as an educational strategy is not. Mentoring programs have become a “national priority” and been implemented in the thousands from the local to the national level [17, 25], and found to be beneficial in a variety of settings including business [23, 24], academics [5, 8, 19, 22], and personal development [13].

## 5.2 Benefits of Mentoring in Academia

In the realm of graduate studies, research has shown that actively having a mentor during graduate school is a dependable predictor of whether a student will continue in a research-focused direction after their graduate studies [11, 12]. Better yet, studies show that being mentored is positively correlated with presenting work at conferences, publishing articles and book chapters, and even securing postgraduate funding [9]. Additionally, undergraduates exposed to mentoring programs tend to later become mentors themselves, continuing a positive cycle of support [5, 20].

Mentoring relationships are especially crucial for underrepresented and marginalized student populations, and has been identified as an “essential strategy” in assisting students of color overcome the challenges of higher education [7]. Black graduate students who identified having a mentoring relationship in graduate school, for example, had increased scholarly submission rates, accepted publications, and conference participation [20]. In another study on the outcomes of mentorship in underrepresented students, those mentored for at least a year earned higher resulting GPAs, completed more credit hours per semester, and were less likely to leave their chosen academic programs [6]. Given that underrepresented and marginalized students are already nearly four times more likely to leave higher education before graduating [16], any strategy which helps reduce such attrition is a welcome inclusion.

## 5.3 Types of Support Mentoring Can Provide

In her seminal work on mentoring [23], Kathy Kram identifies two forms of support mentors may give to mentees: instrumental support and psychosocial support.

*Instrumental support* includes concrete activities done by a mentor to help the mentee build knowledge [30]. An example in our community could be a mentor introducing the mentee to a new simulator or toolchain or recommending specific articles to read on a given research topic. The benefit of such support is obvious as it expands mentees’ knowledge and competence in their field.

*Psychosocial support*, on the other hand, involves a mentor’s personal encouragement, counseling, and emotional support for their mentee [19]. Such support helps mentees develop their sense of competence (i.e., self-efficacy) and feeling of belonging within their chosen field or profession [14]. This support is found to be particularly important to women and other underrepresented or

marginalized student populations [7, 9]. Understandably, such psychosocial support is more likely to require more time to develop in a mentoring relationship, compared to instrumental support which is easier to establish from the start [20].

*Networking support*, is a third form of support that a mentor can provide, as identified in later research. Such support involves advocating for a mentee such as introducing them to one’s network of academic connections for the purpose of expanding the mentee’s own network and academic opportunities [9, 21].

All these forms of mentoring support may not be provided in a single mentoring relationship and a mentee may naturally identify multiple mentors, with each providing a different type of support.

## 5.4 Need for Long-Term Mentoring Programs

There may be an implicit assumption that an academic research advisor is, by virtue of her/his position, their advisees’ mentor. Scholars stress this may not necessarily be the case [28, 29, 31]. It is possible that an advisor-advisee relationship can fail to manifest psychosocial support while still being academically successful [28, 29]. In fact, researchers highlight that only when an advisor-advisee relationship “evolves into a more connected, active, and reciprocal relationship and when the advisor begins to offer a range of both career-enhancing and emotional or psychosocial functions, the advising relationship becomes a mentorship” [20].

In the event a student is unable to build such a mentoring relationship (in particular one covering all the facets of mentorship) with their advisor, the student may look elsewhere to identify such mentors. Community-level mentoring programs such as MaSS and MaSA, for example, serve as an avenue for a student to develop such mentoring connections. However, Kram [23] warns that time-delineated mentoring programming may result in insufficient time for mentoring relationships to develop into one with both instrumental *and* psychosocial support. This is a drawback of both MaSS and MaSA, and most other mentoring programs currently active in our community, as they are primarily co-located with conferences and short-term by design. Thus, there is a need for a longer-term mentoring program in our community, where students can develop deeper, more meaningful mentoring relationships.

## 6 TOWARDS LONG-TERM MENTORING

Given the mentor and mentee feedback from MaSA and MaSS, and mentoring literature presented in this work, we propose the creation of a long-term mentoring program in computer architecture. First, we describe the proposed structure of the program: the process for matching mentors to mentees, the expected program obligations, and a general timeline. Then, we outline challenges that may need to be addressed. Finally, we describe some guiding examples for the way forward, highlighting similar efforts in other communities.

### 6.1 Long-Term Programming Structure

**Mentor/Mentee Selection:** As shown in Section 3, mentees were more satisfied with their matches when they were matched with mentors of a similar research area or preferred background (industry or academia). Because of the long-term aspect of this program, we propose allowing both mentees and mentors the freedom to “pick each other” from a pre-calculated shortlist of candidates who

<sup>4</sup>In the Odyssey, Mentor is described as an old friend of Odysseus. With Odysseus heading to war, he charges Mentor with counseling his son, Telemachus and caring for his household.

might be good matches for each other. Matches will be based on not just research area and background, but also communication format preferences, and other factors such as gender or location.

**Communication Frequency:** We wish to give participants the flexibility of choosing their primary communication format, be it video conferencing, phone calls, or email. However, we wish to be strict on the time requirements of the program, as both mentors and mentees are equally occupied with their primary obligations. Our goal is to set an expectation that a mentor and mentee should meet for approximately 30 minutes per month over the course of a year, with the flexibility to choose when this time is scheduled each month. While six cumulative hours over the course of a year may seem small, a previous mentoring study showed that just a little over 120 minutes, or two hours, of mentor time over the course of a year-long mentoring program led to better academic performance (increased GPA and credit hours) in its student mentees [6]. In order to limit the time burden on the mentor, we will ensure that mentors are assigned no more than two mentees at any given time.

**Mentoring Formats:** In order to facilitate productive mentoring sessions and establish clear expectations, initial conversations between the mentor and mentee should revolve around defining the specific goals for the mentorship and/or for the mentee's development. We expect that these goals will differ from mentee to mentee. Offering each mentor-mentee pair the ability to define custom goals will ensure that each mentee has the ability to receive the specific advice that they would like to seek out. Subsequent conversations can potentially revolve around these goals, or about changing the goals over time as the needs of the mentee change.

## 6.2 Challenges in Programming

Based on our experiences with MaSA and MaSS, and with the different programming and organization required for long-term mentoring as opposed to short-term mentoring, we have identified three challenges that we expect to have to tackle as we begin organizing our long-term mentoring program:

**Finding Enough Mentors.** As we discuss in Section 3, there remains a struggle to find enough mentors to pair up with mentees. We believe this will only be magnified for a long-term mentoring program, given (1) the longer commitment that the program demands and (2) the various other service obligations that are stretching many potential mentors very thin. To help expand the mentor pool and distribute the workload, we will need to grow awareness of our long-term mentoring program (along with the strong desire for such a program from the student community, as shown in Section 4). Part of this awareness effort will rely on faculty who are already supportive of these mentoring efforts to spread the word to colleagues about mentorship opportunities and the value that long-term mentoring provides to the community.

**Identifying and Catering to Mentee Needs.** The needs and desires of mentees under a long-term mentoring program can be very diverse, and can span a range of technical and personal topics. We would like our program to provide support for all of these topics that are relevant to the community, but this requires careful planning during the mentor-mentee pairing process. We expect that we will need to expand the infrastructure that we currently have for MaSA/MaSS pairing to help us support this pairing. In

particular, given the broader scope of topics, we will need to develop quantitative surveys that we send to both mentors and mentees, both to gauge the qualifications and desires of mentors to provide advice on various topics, and to identify the specific topics that each mentee would like mentorship on.

**Ensuring Continued Engagement** One advantage of MaSA and MaSS is that by being coupled with conferences, there are well-defined windows of time when mentoring sessions can take place. With a long-term mentoring program, no such window of time exists, requiring a different and more proactive approach to ensuring that mentorship meetings take place. Given the flexibility that we want to offer in the program structure (see Section 6.1), we do not want to set up fixed time windows for mentorship meetings. Instead, we will look at a system of generating regular reminders to be sent to program participants to check in with their mentor/mentee. To ensure that pairings are not neglected (either intentionally or unintentionally), we will also use periodic feedback forms to identify if any mentors or mentees need to be contacted and/or swapped.

## 6.3 Way Forward for Program Ramp-Up

To ensure the long-term success of the program, we will borrow lessons from a similar existing program and take a pilot-based approach. For example, the programming languages (PL) community hosts SIGPLAN-M, a long-term mentoring program established in August 2020 [1]. As of April 2021, SIGPLAN-M has matched over 180 mentors and 300 mentees (as tweeted by SIGPLAN-M chair, Talia Ringer). The mentee pool consists of not just students, but also junior faculty (who are mentored by senior faculty).

We believe we can adopt a program model similar to the PL mentoring program in our community. To avoid scaling issues and learn how our program should be modified for the architecture community, we intend to launch a small-scale pilot program with a select group of mentors and mentees. Throughout the pilot, we intend to collect periodic feedback from participants to iterate on the program structure prior to a community-wide launch.

## 7 CONCLUSION

Academic mentoring is a common and successful tool for engaging, supporting, and encouraging students during their studies. The computer architecture research community hosts several well-received short-term mentoring programs catered to a range of student populations. In this paper, we describe these known programs at length, and detail the beginnings of, and organization of two such programs: the Meet-a-Senior-Architect (MaSA) and Meet-a-Senior-Student (MaSS) mentoring programs.

While these programs have been quite successful based on the feedback we presented, we also observe that they are short-term by design, and thus may not generate strong academic mentoring relationships. We discuss prevalent literature on mentoring which suggests that academic mentorships require longer time frames to develop [19, 28], much longer than these programs allow for. To that end, we promote the creation of a long-term mentoring program for the computer architecture community. Using mentoring literature and existing programming as guides, we lay out a path forward for such a long-term mentoring program and look forward to seeing such programming successfully take root in the community.



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