Towards an Insightful Computer Security Seminar

Kashyap Thimmaraju\textsuperscript{1} Julian Fietkau\textsuperscript{1} Fatemeh Ganji\textsuperscript{2}
\textsuperscript{1} Security in Telecommunications, Technische Universität Berlin \textsuperscript{2} University of Florida

Abstract
In this paper we describe our experience in designing and evaluating our graduate level computer security seminar course. In particular, our seminar is designed with two goals in mind. First, to instill critical thinking by teaching graduate students how to read, review and present scientific literature. Second, to learn about the state-of-the-art in computer security and privacy research by reviewing proceedings from one of the top four security and privacy conferences including IEEE Symposium on Security and Privacy (Oakland S&P), USENIX Security, Network and Distributed System Security Symposium (NDSS) and ACM Conference on Computer and Communications Security (CCS). The course entails each student to i) choose a specific technical session from the most recent conference, ii) review and present three papers from the chosen session and iii) analyze the relationship between the chosen papers from the session. To evaluate the course, we designed a set of questions to understand the motivation and decisions behind the students’ choices as well as to evaluate and improve the quality of the course. Our key insights from the evaluation are the following: The three most popular topics of interest were Privacy, Web Security and Authentication, ii) 33\% of the students chose the sessions based on the title of papers and iii) when providing an encouraging environment, students enjoy and engage in discussions.

1 Introduction
As we undergo the digital transformation \cite{1}, education in computer security is increasingly pertinent and challenging \cite{2,3,4}. Graduate students need to be prepared for their next step, be it academia or the industry. Not only do they require a solid foundation but they also need to be aware of the state-of-the-art. Oftentimes, the latter is not included in the curriculum for various reasons: It takes time for textbooks to incorporate research from the previous months; research can be eclectic and hence may not have a text-book; or educators find it overwhelming to keep up with the vast amounts of new research and then include a subset in their teaching material. Hence, seminars (or colloquiums) are an ideal setting for students and researchers (graduate students, post-docs and professors) to actively engage with the latest published research through presentations, reading groups and discussions.

Widely adopted seminar syllabi are typically pedagogical in that, there are a static set of seminal papers in computer security and privacy that students are expected to study and review \cite{5,6}. The class meets on a weekly or biweekly basis and discusses the assigned paper. At the end of the semester students might work on a project \cite{7,8} and then submit a technical report that summarizes the seminar topics \cite{9} or the project. Such a format exposes students to a solid overview of some of the first and fundamental computer security contributions.

However, there are a few disadvantages. First, students do not get exposed to the latest research contributions and developments, which has been growing at a staggering rate: the top 4 security and privacy conference receive close to 3000 submissions a year (in total); and on average accept only around 16\% of them. Second, we believe the seminar should be a setting where students can explore areas of their interest given the broad spectrum of security research and technical sessions in a conference. Third, compared to giving a presentation, handing in a write-up can be less preferred as the students often do not receive sufficient training in academic writing. Moreover, the short timeline of a colloquium does not allow the instructors to help the student with their writing skills. On the contrary, according to our observation, students can improve their presentation skills, when giving them feedback and comments in the class. They can further improve their communication skill as making constructive criticism and suggestions constitutes an important input to the evaluation.

At our university, we have spent the last 4 (academic) years conducting the computer security seminar with students pursuing a masters degree in Computer Science. In this paper, we share our experience and feedback from designing and evaluating our computer security seminar course. In
particular, we believe our syllabus is novel and worth consideration by other educators around the world for the following reasons.

First and foremost, students not only review papers from the latest conference proceedings but also analyze the relationships between the papers in a technical session from the conference. Usually, attendees and the wider audience of a conference are not aware of the decisions behind the papers that make up a session at a conference. In our seminar, each student attempts to understand not only from a high level the connections between the papers in a seminar, but also what makes a good session, or what was the key message of the session. For example, one student reviewed 3 papers from the “Deep Learning and Adversarial ML” session at NDSS 2018 and had the following takeaways (without any modification): “Neural Networks (NNs) perform well in many tasks, e.g., static code analysis, in particular for finding vulnerabilities based on information flows analysis. However, NNs have vulnerabilities, due to model differentiation even though some protection mechanisms exist. Unfortunately, Models can’t be verified (yet). And, don’t use untrusted models for critical tasks.”

Drawing such a conclusion is really helpful in quickly grasping what has been published, but also in understanding what the bigger picture of the field is. This can be valuable for researchers at different levels to find inspiration or even build on existing work. Moreover, although the conference proceedings are chosen by the instructors, the students are free to choose the session, this makes the course more meaningful to the students and instructors as everybody “learns what they are interested in”. We found that half of all the students who participated chose their session because they were eager to learn more about the specific topic. In addition to this, rather than have students write technical reports, instilling a sense of critical thinking, scientific skepticism and presentation is actually appreciated by students and being valuable. We find this to be particularly useful in computer security research with respect to threat models and evaluations.

Organization. The remainder of this paper is organized as follows. In Section 2 we elaborate on the design goals and syllabus of our seminar. Next, in Section 3 we describe the key outcomes and lessons learned from several iterations of the seminar followed by a discussion of related work in Section 4. Finally, in Section 5 we conclude this paper.

2 The Seminar

We first highlight what our goals were when we designed the seminar, and then elaborate on the details of the course syllabus, grading and schedule.

2.1 Design Goals

We designed the seminar with the following goals in mind.

1. Expose students to the state-of-the-art in computer security and privacy,
2. Expose students to a conference-like setting,
3. Promoting critical thinking and scientific skepticism,
4. Provide an encouraging environment for students and instructors to have meaningful and intellectual discussions related to security and privacy,
5. Improve students’ skills in reading, writing and criticizing scientific work as well as presenting scientific papers in a limited time, and
6. Improve students’ communication skills by valuing constructive criticism and encouraging them to give feedback to a presenter.

The first goal is specific to computer security and privacy community whereas the others are expected to empower students to become a part of a larger and more general research community.

2.2 Syllabus

Having outlined our design goals, we structured the seminar as follows. To ensure high-quality discussions and interactions in an inspiring environment, we limit the number of students to approximately 15. Next, we (instructors) choose one or two of the most recent conferences proceedings that are available online and ask the students to choose a conference session, which typically consists of 3 papers. For example, “Adversarial Machine Learning” from the proceedings of CCS 2017 [10].

After the students have chosen their conference sessions, we organize them into groups of 3 and assign each group to present one of the following papers: How to read a paper [11], Introduction [12], Methods [13], Results [14] and Discussion [15].

We have selected these articles to help the students understand the general structure of scientific papers and how to read a paper. By having them present these preparatory papers, it allows us to give the students feedback on their presentation skills, e.g., their ability to effectively communicate the key ideas and concepts, delivering high quality presentations (slides and speech), etc. We do not grade the students on these presentations as our intention in this phase is to provide a learning environment for the students to not only understand the challenges of presenting a paper, but also improve their skills for the final presentation.

The students then have the rest of the academic semester to i) review the 3 papers from the session they have already chosen, and ii) prepare a 30-45 minute presentation on them. The presentation guidelines and review form are available online [16][17]. In this phase of the seminar, the students work on their tasks; however, they can contact the instructors if they face a challenge. The student are expected to read and comprehend new concepts as well as familiarize
themselves with the related work to obtain a better understanding of the area. Moreover, to excel in presenting a scientific topic, they are encouraged to watch publicly available presentations, etc.

One month before the final presentations, we offer the students a discussion session, where they can ask us questions related to the presentation, the papers they have chosen, so on and so forth. This typically helps the class to understand the expectations. To help the students, we also share a few presentations we have deemed “good” and what is considered “not good”.

For the final technical presentation scheduled similar to a one-week course, a week towards the end of the semester, which is typically one or two weeks before the exams, is considered. According to our experience, the motivation level of the students is high during this time period, and therefore, we have chosen that. Depending on the teaching resources made available (e.g., room availability), we schedule two to five talks per day. Indeed, this is at a smaller scale compared to a conference style; however, this enables us to invest sufficient time and energy to have constructive discussions and share feedback with the class and presenters. Based on the sessions selected by the students, we schedule the talks in the most meaningful way. For example, in the summer semester of 2019, students, who chose papers from the sessions on Web Security, Web Applications, Software Security presented on the same day.

After the presentation, the students are given more time (usually, a week or two) to submit their reviews of the papers via an online form. The form can be viewed online [17]. This is, of course, further helpful for students, who would serve on the program committee of conferences or as reviewers of journals. In addition, we also request the students to complete an optional feedback form (also available online [18]), which can not only help to improve the seminar repeatedly, but also serve as useful data to be shared with our community, as the goal of this paper is.

Upon receiving all the reviews, each instructor evaluates each review independently. Once this is completed, we discuss any discrepancies in the grading of each student. In our experience, this can help us avoid introducing bias and expedite the grading process.

3 Outcomes and Lessons Learned

When we held this seminar for the first time, only 5 students completed the seminar. Due to the low turnout, the feedback we received was primarily oral. In the semesters that followed, we ensured we recorded the feedback from the students either in Likert scale or qualitative form. Roughly speaking, 50% of the students have given us their feedback (the form can viewed online [18]). Below, we describe the key takeaways and lessons learned from the past four semesters of the seminar, in which in total, 57 students have reviewed 171 papers.

Choosing the seminar. We observed that nearly all the students, who completed the seminar either were generally interested in computer security or planned to pursue computer security-related research. Only one student took the course to earn the credits (see Figure 1). Furthermore, nearly 35% of the students were at an early stage in their master studies. This emphasizes the need to provide students (early on) with an environment, where they can explore computer security-related topics and research based on their interests rather than a set of prescribed topics. We observed that less than 10% of the students planned to pursue research on security and 5% took the course as they would apply for a job in computer security industries.

Topics of interest. The three most sought-after topics from the conference sessions were Privacy, Web Security and Authentication. Software Security, Network Security, IoT and Crypto followed in equal popularity as shown in Figure 2.

We observed that the topic “Machine Learning (ML) Security,” which has been trendy in those four semester (Fall 2018-Spring 2019), was selected a few times by students who had sufficient familiarity with ML. However, three students out of four who chose the Internet of Things (IoT) sessions (from NDSS 2018 and CCS 2018), were not equipped with the technical knowledge that the papers demanded, e.g., deep understanding of software and systems security. For the most popular topics, we observed that most students were able to grasp the technical concepts, however, only a handful of students were capable of assimilating the deep technical details from the papers.

Choosing a session. Depicted in Figure 3 approximately one third of the students choose their session based on the title of papers, which highlights the importance of a title to attract readers. Nearly half of the students aimed to learn more about specific topics, hence, chose sessions accordingly. Very few students associated the session with their future, i.e., a job in the industry or pursuing research. This
points out that students attend the seminar to explore the state-of-the-art in topics that pique their interest. Note that in the conferences considered in our seminar, more than one session have been devoted to some topics. We also note that the students could choose more than one option here, therefore, the number of interested students is more than the total number of participants.

**Preparatory papers.** Students found the set of articles, given to them as introductory reading material, helpful. In fact, students, who were initially skeptical of the usefulness of those articles, found them helpful in reviewing the papers chosen by them.

**Student takeaways.** From the feedback we collected, there were three main benefits for the students. The first was being positively surprised by the diversity, complexity and difficulty of computer security. Second, they learned how to critically read, review and present scientific literature. Third, it helped improve their presentation and critical thinking skills in English (as many students are not native English speakers).

**Paper summaries.** The final review paper handed in by students include a summary of each paper in the session chosen by them. This paper has offered us (instructors) an overview of the latest methods, systems and problems addressed. Furthermore, we believe it enables us to analyze trends across conferences within an academic year as well as across years. We are currently working on a collation of the summaries from the papers reviewed in our seminar, which covers sessions from conferences in 2018 and 2019.

**Reviewing a paper.** In the first semester, when we held this seminar, the final review paper summarized three papers in the session chosen by each student. We then realized that this could not align well with our design goals. Hence, we switched to a format where the students (critically) review the papers in their session. This was well received not only by the students, but also by us for various reasons. First, it promotes critical thinking about scientific papers. Besides, for the student, reviewing a paper can further add a sense of engagement in the community. Second, the review papers could become concise and to the point. Third, it gives the students a sense of the real world paper submission experience. Finally, by asking the students to describe the relationship between the papers in the session, they can better grasp the notion of interdisciplinary research studies coming together under the umbrella of “a conference session.”

To aid the students in these processes, we shared several resources with them, e.g., reviews we received from conference submissions, how to review a paper [11]. Benchmarking crimes [19], Security Experiments [20], etc.

**Benefits to instructors.** After instructing this seminar for four semester, we have obtained several benefits. First, the presentations and paper summaries have given us a holistic view of the state-of-the-art from the top security conferences. Second, we have been able to find excellent students to assist us in our research that has resulted in theses and publications. Third, the discussions and talks have led to new ideas through the critical analysis of papers that appear in the proceeding of top-tier conferences. Finally, we have also improved our own teaching style.

**Students’ feedback.** Overall, the majority of the feedback from our students was positive. One of their comments on the seminar schedule was to hold weekly meetings instead of the block style. Regarding improvement, we were requested to give student more time to present details provided in the paper. One the one hand, it shows how interested they are in the topics offered in the seminars. Whereas, one the other hand, it reflects the fact that other lectures should be developed to cover the details of the new approaches published recently. This becomes more evident as covering such details does not fall within the scope of our seminar, as summarized under our design goals, see [21]. Here we quote some of the positive and negative feedback we received from the students (without any modification).

“Definitely keep the format of reading 3 (or at least mul-
multiple} papers, since this gives us some room to discuss the topics in a broader context than simply presenting the contents of a single paper. I also really enjoyed that we had the possibility and were encouraged to give our own opinions and criticism, during the presentations as well as afterwards in the discussion. I think I learned a lot more than in previous seminars where I only had to repeat the contents of a paper without having to do a lot of thinking myself.”

“Good job! Especially the discussion and feedback after each presentation were a good idea. I also like the format: Papers from RECENT TOP conferences (not some unknown texts which have almost the same age as me) are presented and reviewed. This is especially helpful, for the move from master studies to doing research as PhD student.”

“Usually, I just read the useful parts of the paper to help me write the paper, but this time, I read the whole articles and let me fully understand the way of solving the problem. On the other hand, the topics are also interesting, I have learned a lot of new ideas.”

“Maybe add a few notes on what exactly is expected in the review form. How much text is required or how detailed the explanations are supposed to be. Maybe be clear about the attendance up front.”

4 Related Work

We have surveyed computer security seminars offered at other universities and observe that various seminar instructors do indeed have students review papers from conference proceedings [5, 6, 7, 21, 22]. Furthermore, similar to our setting, some instructors even provide their students with helpful resources and tips on how to read, review, write and present scientific work [9, 25]. Oftentimes, the papers that students are suggested to read are selected by the instructor/professor [7, 25, 26], which mainly include seminal papers and project work [8]. In one instance [27], we found the seminar involves students presenting chapters from Ross Anderson’s textbook [28]. Our syllabus rather focuses on various technical sessions from at least one or two recent conferences.

5 Conclusion

In this paper, we described the design goals and structure of our computer security seminar. We also discussed the key outcomes and lessons learned after instructing this seminar for 2 academic years. In particular, we believe that our seminar syllabus offers students an encouraging environment to explore and learn the latest approaches and contributions in computer security and privacy community. Furthermore, the review process established by us, especially, the emphasis placed on the relationships between papers in a conference session, instills a sense of confidence in students and promotes critical thinking. In particular, constructive criticism is necessary and valuable for students to improve their skills, essential for their future studies, research and jobs.

6 Acknowledgments

We express our sincere thanks to Jean-Pierre Seifert who encouraged and supported us in designing this seminar. We also thank our colleagues at the Chair for Security in Telecommunications, Technische Universität Berlin for their feedback and criticism when we designed and evaluated the seminar. A special thanks to all the students who participated in the seminar as well as for sharing their feedback with us.

References

[1] Nebojsa Nakicenovic et al. The digital revolution and sustainable development: Opportunities and challenges.
[2] Matt Bishop. Teaching computer security. In SEC, pages 65–74. Citeseer, 1993.
[3] NSF announces $78.2 million to support frontiers of cybersecurity, privacy research. https://nsf.gov/news/news_summ.jsp?cntn_id=296933 Accessed: 23-03-2020.
[4] Alan Sherman, Melissa Dark, Agnes Chan, Rylan Chong, Thomas Morris, Linda Oliva, John Springer, Bhavani Thuraisingham, Christopher Vatcher, Rakesh Verma, et al. IN-SuRE: collaborating centers of academic excellence engage students in cybersecurity research. IEEE Security & Privacy, 15(4):72–78, 2017.
[5] Seminar in computer systems (236827). http://www.cs.technion.ac.il/~dan/course/scs/2016/ Accessed: 04-03-2020.
[6] CS 261: Security in computer systems. http://inst.eecs.berkeley.edu/~cs261/fa18/ Accessed: 05-03-2020.
[7] Topics in computer and network security. https://cs356.stanford.edu/ Accessed: 05-03-2020.
[8] CS 261N: Internet/network security. https://www.icir.org/vern/cs261n/ Accessed: 05-03-2020.
[9] Seminar: Selected topics in IT security. https://net.cs.uni-bonn.de/de/wg/itssec/lehre/ws-201718/selected-topics-in-it-security/ Accessed: 05-03-2020.
[10] CCS 2017 - session 3a: Adversarial machine learning. https://acmccs.github.io/session-A3/ Accessed: 23-03-2020.
[11] Srinivasan Keshav. How to read a paper. ACM Computer Communication Review (CCR), 37(3):83–84, 2007.
[12] Thomas M Annesley. “it was a cold and rainy night”: Set the scene with a good introduction. Clinical chemistry, 56(5):708–713, 2010.
[13] Thomas M Annesley. Who, what, when, where, how, and why: the ingredients in the recipe for a successful methods section. Clinical chemistry, 56(6):897–901, 2010.
[14] Thomas M Annesley. Show your cards: the results section and the poker game. *Clinical chemistry*, 56(7):1066–1070, 2010.

[15] Thomas M Annesley. The discussion section: your closing argument. *Clinical chemistry*, 56(11):1671–1674, 2010.

[16] Computer security seminar introduction slides. [https://bit.ly/38uOBi0](https://bit.ly/38uOBi0) Accessed: 06-03-2020.

[17] Computer security seminar review form. [https://forms.gle/VakhXBCA4BD96H9Q](https://forms.gle/VakhXBCA4BD96H9Q) Accessed: 06-03-2020.

[18] Computer security seminar feedback form. [https://forms.gle/XsWmxALVHNYBpWmS](https://forms.gle/XsWmxALVHNYBpWmS) Accessed: 06-03-2020.

[19] Erik van der Kouwe, Dennis Andriesse, Herbert Bos, Cristiano Giuffrida, and Gernot Heiser. Benchmarking crimes: an emerging threat in systems security. *arXiv preprint arXiv:1801.02381*, 2018.

[20] Sean Peisert and Matt Bishop. How to design computer security experiments. In *Fifth World Conference on Information Security Education*, pages 141–148. Springer, 2007.

[21] Hot topics in computer security. [https://www.uni-goettingen.de/de/seminar-hot-topics-in-computer-security/422078.html](https://www.uni-goettingen.de/de/seminar-hot-topics-in-computer-security/422078.html) Accessed: 05-03-2020.

[22] Formal methods for security. [https://cms.cispa.saarland/fmssem_1920/](https://cms.cispa.saarland/fmssem_1920/) Accessed: 05-03-2020.

[23] Joint advances in web security. [https://cms.cispa.saarland/jaws1920/](https://cms.cispa.saarland/jaws1920/) Accessed: 05-03-2020.

[24] CS 294-163: Decentralized security: Theory and systems. [http://inst.eecs.berkeley.edu/~cs294-163/fa19/](http://inst.eecs.berkeley.edu/~cs294-163/fa19/) Accessed: 05-03-2020.

[25] CS 7936 — computer security & privacy seminar. [https://my.eng.utah.edu/~cs7936/](https://my.eng.utah.edu/~cs7936/) Accessed: 04-03-2020.

[26] CSC 790 security seminar. [http://csweb.cs.wfu.edu/~fulp/CSC790/csc790.html](http://csweb.cs.wfu.edu/~fulp/CSC790/csc790.html) Accessed: 04-03-2020.

[27] Computer security seminar (203.3365). [http://www.cs.haifa.ac.il/~orr/CompSecSeminar/](http://www.cs.haifa.ac.il/~orr/CompSecSeminar/) Accessed: 04-03-2020.

[28] Ross Anderson. *Security engineering*. John Wiley & Sons, 2008.