Teaching statement

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Since I started at ETH Zurich, I have thoroughly enjoyed and learned from teaching classes as well as from advising undergraduate, graduate, and postgraduate students. In less than 4 years, I have built a research group[1] composed of **8 PhD students and 1 postdoctoral researcher** (see Figure 1). I have also personally advised **40+ master students** doing their semester or master theses in our group, 15 of which finished their thesis with a peer-reviewed publication, and 5 of which continued as PhD student.

[1] https://nsg.ee.ethz.ch

Our **lectures** are consistently **graded positively** by ETH students. Our introductory lecture on communication networks has an average rating of 4.4+/5.0 and a **median rating of 5.0/5.0**. In 2016, I received the **Golden Owl teaching award** from ETH Zurich's student association (1 award per department per year) for "lecturers who have provided exceptional teaching".

Figure 1: A subset of my group circa November 2017 during our annual group retreat.

Ahmed (second from the right) is planned to graduate by mid-2019.

In terms of teaching philosophy, I aim at making my lectures as interactive as possible, regularly punctuating them with interactive sequences in which the students actively find the solution to a precise problem, instead of having me describe the solution directly. I also strive to make my lectures practically-relevant by continuously illustrating them with fresh, real-world examples and by organizing class-wide hands-on projects. Our flagship project involves having ~90 students build their own "mini-Internet" composed of 30+ networks, using the exact same technologies as the real one.

Status and future of lecturing and project supervision

I am currently teaching three lectures. Namely, I teach two 3rd-year bachelor lectures (since 2016): Communication Networks[2] and Discrete Event Systems[3]; together with one master-level lecture (since 2018): Advanced Topics in Communication Networks[4]. I am the sole instructor for the two networking lectures and designed them from scratch. I co-teach the Discrete Event Systems lecture with Prof. Thiele and Prof. Wattenhofer. Despite being elective, our lectures are well-attended and attract more students every year. In 2018, ∼90 students registered for Communication Networks, while 130+ registered for Discrete Event Systems.

[2] https://comm-net.ethz.ch

[3] https://disco.ethz.ch/courses/des/

[4] https://adv-net.ethz.ch

Thus far, ETH students seem to appreciate my lectures. In 2016, I received the Golden Owl of the VSETH (ETH Zurich's student association) for the Communication Networks lecture. After this success, we continued to improve the lecture content, notably by designing weekly exercise sessions and improving on our project infrastructure. To my pleasure, the scores of our 2017 teaching evaluations were even higher than in 2016 when we won the Golden Owl, with an average satisfaction rate of 4.7/5.0 and a median satisfaction rate of 5.0/5.0 (31 respondents out of 79 students). We kept a high score in 2018, with an average satisfaction rate of 4.4/5.0 and a median satisfaction rate of 5.0/5.0 (37 respondents out of 88 students).

Figure 2: With Prof. Sarah Springman (Rector of ETH Zurich) at the Golden Owl Award Ceremony.

In the fall of 2018, I started teaching Advanced Topics in Communication Networks, a master-level course on research topics in communication networks. In the first iteration of the lecture, I have focused on network programmability and network data plane programming, two timely topics. Similarly to Communication Networks, the lecture is "hands-on" with weekly practical exercices and a 7-weeks-long group project. Both the exercices and the project are based on P4[5], a new programming language which allows to specify the behavior of forwarding planes.

[5] https://p4.org

In the future, I intend to continue teaching these three lectures (modulo some adaptation of the course program) along with introducing a graduate-level seminar in which I would invite guest speakers and discuss research papers. I also intend to start offering P&S (Projects & Seminars) modules focused on Internet routing and network programmability. For this, I will directly leverage the infrastructure we put in place for the "Internet routing project" in Communication Networks (see more below). In the long run, I would like to develop a course on efficient scientific communications (written and oral), a topic which I am particularly fond of. I have already been discussing with ETH's Educational Development and Technology (LET department) about the possibility of offering such a course ETH-wide which is something that they would be interested in.

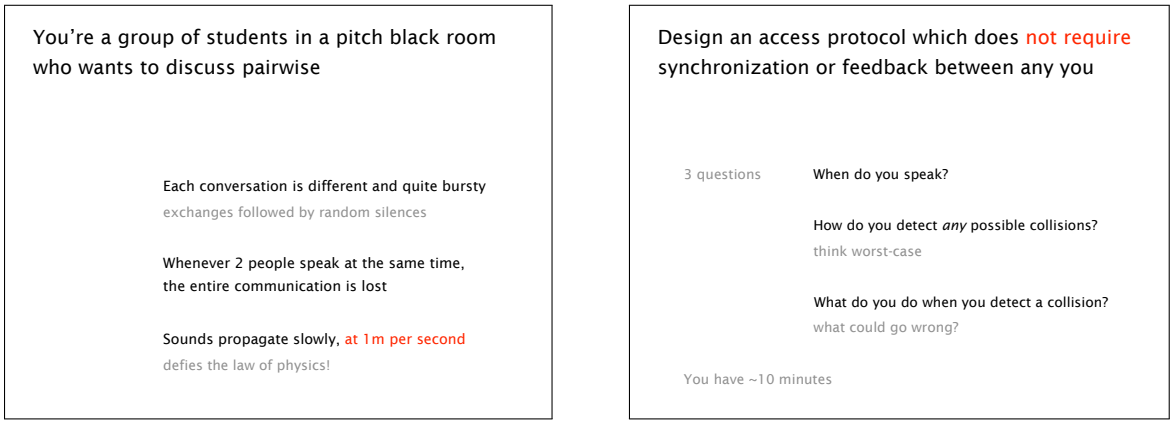

Figure 3: An example of an interactive sequence performed during the "Communication Networks" lecture in which I ask the students to design a shared media access protocol.

Within 10 minutes, students usually manage to find all the main principles underlying well-known protocols such as Carrier-Sense Multiple Access with Collision Detection (CSMA/CD).

Lecturing style and philosophy

I highly enjoy *and* learn from teaching classes. I find the activity extremely rewarding, if not the most rewarding of the job. I also enjoy learning about and experimenting with new teaching methods. I followed multiple workshops on the topic including the "Teaching at ETH: Committed and skilled" workshop.

In terms of style, I aim to make my lectures interactive, engaging, and hands-on. To do so, I regularly punctuate my lectures by:

1. describing real-world examples (e.g., how does Google's infrastructure work) and recent Internet-related news (e.g., explaining the underpinnings of large-scale attacks).
2. performing live demonstrations in which I show the students how to probe some aspects of the Internet directly from their laptop. I vividly remember this "eye-opening" feeling when, as a student, my professor (and future advisor) did the same kind of demonstrations. Emulating this feeling with my students is particularly invigorating.
3. asking students to actively solve problems in the lecture through "interactive sequences". For those, I leverage the fact that a lot of the fundamental principles (e.g., routing, reliable transport, economic incentives) behind the Internet are quite intuitive, enabling students to discover them by themselves. I illustrate one example of such an interactive sequence (inspired by Prof. Scott Shenker) in Figure 3. In this sequence, I ask the students to design a shared media access protocol. On average, it takes students less than 10 minutes to design a protocol with the same key ingredients as the real one (here, CSMA/CD).

I am confident that students not only appreciate these interactions but that it also leads to a deeper understanding of the material—one that will last longer through time. This is actually recognized by the students themselves as attested by some of their comments taken verbatim from my teaching evaluations:

"I would keep unchanged the little games during the lecture, that is definitely something that I would remember forever"

"Keeping the students involved in the lecture helps a lot for active participation"

"Few lectures offer the opportunity to apply the knowledge from the lecture directly"

Besides interactivity and engagement, my goal is to provide students with hands-on experiences using various network technologies. To do so, we designed a set of practical projects that are performed in groups during the lectures. Our "flagship" assignment consists in a class-wide project in which **students build their own mini-Internet** composed of ∼30 networks. Our setting faithfully reproduces real network conditions enabling students to really understand "how the Internet works". More specifically, each group of students is responsible for managing its own network composed of ∼10 routers that they first setup in isolation. We then connect all these networks together (see Figure 5) during an evening "hackathon". Figure 4 depicts a scene from this year's hackathon. This event is usually the occasion for them to realize the problems faced by operators in practice, e.g. the fact that all networks need to work in unison for the Internet to work at all.

Similarly to the lectures, the feedback we received from our students on the projects is very positive. Another token of appreciation is that **our assignments are now used in other universities**, such as in Columbia University in the lecture of Prof. Ethan Katz-Bassett.

In the future, I intend to continue investing in making my lectures even more interactive and hands-on. Among others, I plan on developing a P&S course on Internet routing (building upon our "mini-Internet" project). In the long run, I am also thinking about developing a project together with Swisscom which would allow students to take control of how Swisscom routes their own traffic.

Figure 4: 2018 Internet Hackathon

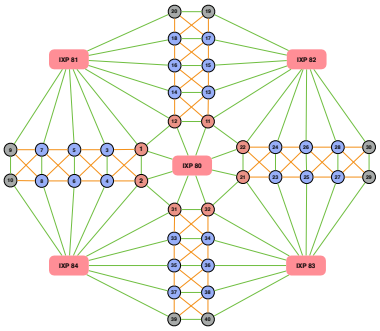

Figure 5: Our mini Internet topology. Each node represents one network of 10 routers managed by 3 students.

Supervision of semester and master student projects

In the last 4 years, my group has supervised over **32 master projects and 32 semester projects**. I was personally involved in 40 of them.

My advising philosophy is that mentoring should be personalized to account for the diversity in students' interests and backgrounds. As much as possible, I try to meet each student interested in doing a thesis in our group to discuss about possible topics. These meetings often lead to fruitful brainstorming sessions. I think that tailoring the topic to the student is both engaging and highly motivating for them. Once the topic is chosen, I usually pair each master student with one PhD student with whom he/she will meet weekly throughout the semester. Besides guaranteeing close supervision, doing so also enables my PhD students to acquire advising expertise. I personally aim to make myself available every other week to meet with each master student and the advising PhD student.

Thus far, the feedback we received from our master students has always been positive. In addition, 15 students managed to publish the results of their thesis in a peer-reviewed venue. Finally, 5 master students continued as PhD student in my research group (Alexander, Edgar, Roland, Rüdiger, Tobias).

Supervision of doctoral students

I am currently advising **8 graduate students** as part of my research group (Figure 1). I solely advise 7 of them and co-advise Rüdiger with Prof. Martin Vechev (an ETH professor and expert in the area of programming languages). My first PhD student, Ahmed El-Hassany, is expected to graduate by mid-2019. In addition to my group, I also closely collaborate with many other graduate students, both at ETH and internationally.

As an advisor, my aim is to develop my students' research taste and technical capabilities, foster their creativity, and avoid them wasting time on irrelevant or uninteresting problems. As networking is a deeply multi-disciplinary area, I always encourage my students to acquire expertise in other subjects along with building strong mathematical foundations. Similarly, I encourage them to gain real-world experience through industrial internships and broaden their research network by interning in top universities. Thus far, my students have performed industrial internships at Google (Tobias Bühler, Maria Apostolaki), Microsoft Research (Maria Apostolaki), Facebook (Ahmed El-Hassany); and research internships at University College London (Thomas Holterbach), and MIT CSAIL (Maria Apostolaki). Finally, I also encourage my students to disseminate their research ideas as much as possible by giving talks in both academic and in industrial contexts. As an illustration, my students are directly in touch with multiple network operators and companies (both nationally and internationally).