NSF AI INSTITUTE FOR ADVANCES IN OPTIMIZATION (AI4OPT)

A GUIDE TO THE SETH BONDER CAMP IN COMPUTATIONAL AND DATA SCIENCE FOR ENGINEERING

Organizer Version

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1 Introduction

The Seth Bonder Camp (SBC) in Computational and Data Science for Engineering is intended for high school students interested in engineering who do not have exposure to computer science and/or data science in their middle and high schools. The educational module of the SBC is composed of three levels that are organized in order of increasing difficulty. Level 1 introduces students to computing using *Snap!* as a visual programming language, level 2 introduces students to data science using *Python* as a programming language, and level 3 introduces students to Deep Learning and Reinforcement Learning using *Keras* as an Application Programming Interface (API). The camp is structured to enable a flipped classroom approach. Lectures are recorded in advance and are made available to the students online using a Learning Management System (LMS). Currently, SBC materials are available on Canvas through Georgia Tech. Any partner institute interested in running the camp should get in touch with AI4OPT management to get access to the materials. The camp materials are developed to enable both *in-person* and *all-virtual* delivery.

This guide offers general tips for starting and running a level-1 SBC at with a focus on *planning* and *organization*. It draws from past experiences; the camp has been successfully offered multiple times both in-person and virtually at Georgia Tech and the University of Michigan. When applicable, this guide needs be complemented with other institution-specific requirements for running high-school camps which is beyond the scope of this document.

2 Prior to the Camp

A standard level-1 camp is designed to cover one week worth of activities typically running from 9am to 5pm for five consecutive days during the summer. Planning for the camp starts two months prior to the camp start date. In what follows, we discuss main organizational elements that needs to planned ahead of time to ensure a smooth experience for both students and organizers.

2.1 Student Recruitment

The SBC is intended for students interested in engineering who do not have exposure to computer science and/or data science in their middle and high schools. In past years, this has resulted in a truly diverse set of participants weighted heavily towards minorities, women, and students with learning disabilities. The camp can be offered using a targeted-enrollment strategy, an open-enrollment strategy, or a hybrid strategy that mixes both.

Targeted enrollment: This strategy enables giving access to computational and data science education to those who do not have access to it through their schooling program, which is the primary goal of this camp. It requires reaching out to minority-serving schools to recruit students. This type of enrollment is typically accompanied with waived/discounted registration fees.

Open enrollment: This strategy allows expanding the camp's reach to cover any middle- or high-school students interested in learning more about data science. This typically requires advertising the camp online or through outreach activities. Some departments/schools have units that are responsible for outreach and summer camps activities. You may want to check their requirements for camp announcement and promotion, and they may be able to help you in this. For example, in the case of Georgia Tech, it is required to coordinate with the Center for Education Integrating Science, Mathematics, and Computing (CEISMC) as they are responsible for direct student enrollment, registration fee payment, and parent communication.

Hybrid enrollment: If your camp capacity allows, you may be interested in having both targeted and open enrollment . In this setting, you will have students from minority serving schools and students who opted to join the camp to explore their interests. This enrollment strategy requires more careful planning for in-class activities, to make sure that all students get the attention and help they need.

2.2 Teaching Support

Teaching Assistants (TAs) are required to help students during the camp and guide them through the materials and practical sessions as needed. These TAs are typically undergraduate students who are comfortable with computer and data science concepts. The number of required TAs depends on the number of students expected to enroll in the camp. Based on past experiences, maintaining a ratio of 1 TA for every 7-8 students works well. These TAs need to be hired at least one month in advance as they are expected to go through the camp materials themselves to make sure they are familiar with the concept to be at a good position to assist students. Once recruited, they need to be added to the corresponding Canvas course where the materials can be accessed online. A *teacher* version of the guidebook is available upon request to help new TAs get onboard and navigate camp materials.

2.3 IT Support

Setting up the course online: Course materials are organized in modules and are expected to be made available for both students and instructors. Contact the AI4OPT management team to get access to a copy of the course materials using Canvas. The team will give you a cloned version of a past camp, updated, and clear of past entries, grades, and submissions.

Creating student accounts: Students enrolled in the camp need accounts (username and passwords) to be able to access course materials. Depending on your school operations, this step may be done internally by your IT department team, or it can be done by a unit at the university level. For example, in the case of Georgia Tech, CEISMC is responsible for creating students accounts and providing it to camp organizers before the camp. When creating the account, make sure that students are also granted access to the Wi-Fi system (e.g. eduroam). This will help avoid connection issues during the camp itself.

Granting Canvas, computer, and Wi-Fi access: Once students' accounts are created, they

need to be given access to Canvas, a computer, and Wi-Fi. First, enroll students using the account information into the course you created on Canvas. You can skip this step and ask students to self-enroll at the beginning of the camp. You will just need to provide them with a self-enrollment link; in the case of Canvas, you can get this link by going to the course page, clicking on the "Settings" tab on the left panel, and copying the URL at the bottom of the Settings page, you will see the following message: *This course has enabled open enrolment. Students can self-enrol in the course once you share with them this URL: https://gatech.instructure.com/enroll/{courseID}*

You can copy this link and give it to student to self enroll. It is important to note that while self-enrollment is possible, it is recommended that students are enrolled manually by camp admins prior to the camp start time. This is a way to ensure that all accounts are working as expected without any issue. If any issue is faced when enrolling students manually (e.g. expired password), contact the entity that provided you with the account information to fix it (e.g. reset the password). This entity is CEISMC in the case of Georgia Tech.

2.4 Space/Lab Reservation

A lab space needs to be reserved to accommodate the expected number of students. This could be a lab space with computers installed already, or a regular classroom with enough power outlets for charging laptops. It is recommended to reserve a room well in advance to make sure that the same desired space is available for the whole camp duration. Besides the lab space where camp educational activities are expected to take place, it is desirable to reserve a separate space for lunch times and conducting mini activities that is near the lab space; this helps in reducing the time needed for reconfiguring the space for different activities.

2.5 Miscellaneous

There are other requirements that needs to be planned ahead of time. A summary is given in what follows.

Meal planning. Make sure to collect information regarding any student dietary restriction ahead of time if lunch is provided as part of the camp. In the case of Georgia Tech, these info are collected during student registration by CEISMC, and CEISMC coordinates with GT dining to make sure everything is taken care off; make sure to communicate with CEISMIC as well in case TAs were promised lunch, to send them the right count and requirement in time.

Extracurricular activities planning. Some activities require special type of supervision. For instance, if students are taken to the Campus Recreational Center (CRC), e.g. to play basketball, they need to be accompanied with first aid certified mentors and a specific mentor-to-student ratio needs to be maintained for student safety. Make sure to check your institution requirements when planning such activities to avoid any unexpected delay during the day of activity. In the case of Georgia Tech, contact CRC to book courts and coordinate with CEISMC to arrange for supervision requirements.

Headsets. Depending on the space setup, you may want to make sure that students have access to personal headsets as they watch videos at their own pace. You can either provide each student with one or ask them prior to the camp to bring their own.

3 During the Camp

The camp educational program is meant to be flexible so that each student can learn at their own pace. During sessions, students are expected to work on labs individually or in teams, and seek TAs help when needed. In the following, we discuss a few things that needs to be coordinated at the student and TAs levels to ensure that students are getting a personalized

experience while staying engaged with the group as a whole.

3.1 Class Organization

A camp cohort typically consists of around 50 students. To make it more manageable and to ensure that students get a personalized experience, it is good to organize the class into working groups where each group is assigned to a TA for the whole camp duration. Based on past experiences, maintaining a ratio of 1 TA for every 7-8 students works well.

3.2 Surveys

Multiple surveys need to be administered at the beginning of the camp, at the end of the camp, and during the camp. The goal of these surveys is to help better understand student background, preparation, and attitute towards data science to improve the current camp and future camps. Contact AI4OPT management team to get latest links to surveys. Other surveys may be required by your corresponding institution. For example, CEISMC at Georgia Tech administers additional surveys of their own.

3.3 Mini Activities

A portion of the camp is designed to include extracurricular activities that are not necessarily related to computational and/or data science topics. Such activities are designed to allow students to network and get to know one another, disconnect and recharge to increase their focus and engagement during lab sessions, learn more about wider data science topics, and/or get introduced to college life, expectations, and potential exciting fields of studies. Example mini activities that were used in previous camps is given in the Appendix.

3.4 Assignment Grading

The educational program of the camp is composed of two primary components: (1) lecture-type videos that introduce students to technical topics and, (2) hands-on assignments that

give students opportunities to practice and apply what they have learned. TAs need to grade assignments ideally as soon as they are submitted, or latest within one day of their submission to give students timely feedback. The goal is not just to have students practice and submit as many assignments as they can during the camp duration, but rather to allow them to explore and get confident about their learning. From past experience, it is good to have dedicated TAs just for grading. In the past, we assigned grading to graduate students who work offline. They provide students personalized feedback on their submissions via Canvas. Graders sometimes go into the classroom and discuss key aspects of solutions and common mistakes as needed.

4 After the Camp

4.1 Student Certificates

Upon the camp completion, students are provided with certificates that show their achievement level. Student can either complete the camp at the core, intermediate, or advanced level depending on the progress they have made during the camp, i.e., the number and grade of the assignments they submitted. Contact AI4OPT management team to get a copy of certificate template. Here is a summary of certificate level given students accomplished based on past experiences.

- **Attendance:** student attempted to submit 1 or more assignments.
- **Core:** student submitted up to Lab 6, with no missing assignments, and scored 50% or above in all of them.
- **Intermediate:** student submitted up to Lab 13, with no missing assignments, and scored 50% or above in all of them.
- **Advanced:** student completed up to Lab 13, plus completed 2 of Labs 14 - 17, and scored 50% or above in all of them.

Once the certificates are generated, they can be emailed to students or sent to them via Canvas.

4.2 AI4OPT Reporting

It is important to close the loop by evaluating camp performance from different angles. This includes assessing student attitude towards computational and data science prior to and after the camp, and student performance given various demographics and background factors. Multiple sources of data can be used in this analysis including surveys, registration data, and student grades and achievement levels. A summary of these analysis is required for AI4OPT reporting. Contact AI4OPT management team for further guidance.

4.3 Mentoring Program Preparation

The camp provides a great opportunity to identify students with potential and/or interest in furthering their learning. Maintain a list of these students along with their contacts to invite them later to participate in the mentoring program. The program is currently being designed and more details will be made available soon.

5 In-Person Delivery Checklist

- ☐ **Prior to** the Camp
  - ☐ Set camp dates and camp capacity.
  - ☐ Decide on a student enrollment strategy and plan accordingly.
  - ☐ Reserve lab space and other required spaces for lunch and extracurricular activities.
  - ☐ Recruit Teaching Assistants (TAs).
  - ☐ Set up an on-boarding meeting with TAs to discuss expectations.
  - ☐ Share the SBC Guidebook for Teachers with TAs.
  - ☐ Contact IT to set up laptops if space reserved does not include desktop computers.
  - ☐ Contact IT to set up user accounts for computer, Wi-Fi, and Canvas accesses.
  - ☐ Contact AI4OPT management to create Canvas course with all required materials.
  - ☐ Enroll TAs and students in the Canvas course.
  - ☐ Do necessary arrangement for food taking into account students allergies.
  - ☐ Schedule campus tour early on if part of the extracurricular activities.
  - ☐ Schedule CRC activities and make sure you have enough students chaperones.
  - ☐ Communicate to parents camp's schedule and drop-off and pick-up locations.
- ☐ **During** the Camp
  - ☐ Assign TAs to working groups.
  - ☐ Schedule end-of-day debriefing sessions with TAs.
  - ☐ Make sure assignment grades are posted in time.
  - ☐ Make sure students and TAs are engaged, and are having fun too!
- ☐ **After** the Camp
  - ☐ Generate certificate for students depending on their accomplishment level.
  - ☐ Send certificates of completion by email or via Canvas messaging.
  - ☐ Send a summary to AI4OPT using survey results and students performance.

6 All-Virtual Delivery Checklist

- ☐ **Prior to** the Camp
  - ☐ Set camp dates and camp capacity.
  - ☐ Decide on a student enrollment strategy and plan accordingly.
  - ☐ Set up a virtual meeting environment, for example, using Teams.
  - ☐ Recruit Teaching Assistants (TAs).
  - ☐ Set up an on-boarding meeting with TAs to discuss expectations.
  - ☐ Share the SBC Guidebook for Teachers with TAs.
  - ☐ Contact IT to set up student's Canvas accounts.
  - ☐ Contact AI4OPT management to create Canvas course with all required materials.
  - ☐ Enroll TAs and students in the Canvas course.
  - ☐ Set up any virtual games or activities.
  - ☐ Communicate to parents camp's schedule.
- ☐ **During** the Camp
  - ☐ Assign TAs to working groups and create breakout sessions.
  - ☐ Schedule end-of-day debriefing sessions with TAs.
  - ☐ Make sure assignment grades are posted in time.
  - ☐ Make sure students and TAs are engaged, and are having fun too!
- ☐ **After** the Camp
  - ☐ Generate certificate for students depending on their accomplishment level.
  - ☐ Send certificates of completion by email or via Canvas messaging.
  - ☐ Send a summary to AI4OPT using survey results and students performance.

7 Appendix

7.1 Mini Activities

Find your match. This is an example ice-breaker activity which could be done on day 1 of the camp. Each student is given a slip and told to find their matching pair (e.g. Disney duos). Once they find their matching pair, each pair should:

- Introduce themselves
- Discuss where they are from/what high school they go to
- Why they came to the camp
- From there, they can casually chat about things

This is a good way for students to initially get to know each other. Best done outside/in a large area as students will be moving around a lot to find their pairs.

Sorting. Have the students go outside and then introduce to them a very important and well-known topic utilized in Computer Science: *Sorting!* Now, let's apply sorting on a real level. We will have students sort themselves by whatever we tell them to. And how they sort themselves increase in levels of difficulty. Here are some examples of both easy and hard sorting guidelines:

- Alphabetically by first name
- In order by birth date (with/without year)
- Alphabetically by your 2nd grade teacher's last name spelled backwards
- Alphabetically by the name of the street that you live on spelled backwards
- Etc.

Be sure to tell the students to sort themselves as fast as they can and time them. For each sort, once the students are done sorting, the TA with the timer says the amount

of time it took students to sort themselves. After each sort, TAs will also go through the students to make sure everyone is sorted correctly. Have the TAs record the number of errors in sorting and after every student has been checked, the TAs will also tell the students the number sorting errors they had. The goal is to minimize both sorting time and error occurrences.

For the very last sorting, we will have students sort by last name using bubble sort. Before doing this, be sure to explain to kids the notion of bubble sort. TAs will watch over the students as bubble sort is being done. After two passes, call stop and tell the kids to observe that obviously it is taking a very long time to sort and we aren't even close to being done yet. This is where we end the activity, by telling the kids how in Computer Science, there are different types of sorting algorithms with different efficiencies and speed. It is important that we develop sorting algorithms to handle our data efficiently and quickly.

Trivia. A set of trivia questions for students to answer. Students will form teams of 4-6 and write down their answers to questions presented in trivia on a piece of paper. There are 40 questions it total divided into 4 sections, 10 questions each. These sections are: (1) your institution facts/traditions (e.g. Georgia Tech's traditions), (2) Data Science, (3) General Trivia, and (4) Marvels' Avengers. After each section, the TAs will go over the answers to the questions of that section. A correct answer gives you a point. For questions where you must give a number as an answer, being within the ballpark of the correct answer gives you half a point. No cellphones or laptops allowed. If students go on cellphones or laptops there are penalty point deductions. The team with the most points after the 40 questions wins.

Campus tour. Take students in a campus tour to show them the main (and cool) aspects of your school. The following is an example plan for a tour of Georgia Tech campus. Give a tour of Georgia Tech campus, just like how tour guides would give. Here is the

recommended route to go along:

1. ISYE complex
2. Exhibition hall/café/student store area,
3. Student center/Einstein statue,
4. CoC/Klaus
5. CULC/library (check if roof area is open)
6. Tech Tower
7. Freshman dorms on east campus
8. Up freshman hill
9. Towards Tech Green/Campanile
10. Back to ISYE complex

Be sure that the tour guide is very energetic, fun, and entertaining. Preferably an official GT tour guide; they need to be booked in advance. Talk about each of these locations that you stop by. And while walking, you can talk about your college experiences in social and academic settings. Be sure kids bring water bottles with them, as it could get hot on this tour.

Shark Tank. Students form teams of around 6 people, give or take. This makes up a company of people who will create the next big idea. They come up with an innovative idea in about 45 minutes. Afterwards, each team (company) presents/pitches the idea to the sharks (the TAs). For each team, after they pitch an idea, they give a certain amount of money they would like from the sharks and a certain amount of ownership they would be willing to give to the sharks (e.g. We would like $5,000,000 from you, and in return you get 5% ownership of the company). After TAs hear all of the presentations, they will debate among themselves to see which company they would like to invest in most. That company is the winner.

Outside Group Discussion - College/Career Choice. This is a more casual mini activity, where people go outside and talk with the TAs for about 45 minutes. Discussions could be centered on the following:

- How to prepare for college in high school as from the experiences of TAs
- High school experiences from both students and TAs
- College experiences of TAs and their suggestions on how to get the best college experience
- Career and academic aspirations of both TAs and students
- Etc.

This mini activity can be done multiple times throughout the camp.

Data Science Song Contest. Have students form a group and write lyrics to a song relating to data science played to the tune of a well-known song by any artist. Essentially, they're creating a parody of a song centered around data science. It doesn't have to be serious, in fact, it's better if the song is more towards the funny/goofy side. They have 45 minutes to do this. The song itself doesn't have to be long. It can be a verse, and then a chorus. Afterwards, each group sings in front to the panel of judges (the TAs). After each group gets to perform, the TAs decide which one was the best.