

Olympiad Training for Individual Study: Syllabus

OTIS Year V (2019-2020)

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§1 Overview

It's hard to do a really good job on anything you don't think about in the shower.

Paul Graham

§1.1 Summary

OTIS is a **guided self-study** program for math olympiads. It is not primarily meant as a tutoring program due to the large number of students.

The program consists of the following main components:

- Centrally, a sequence of **units** consisting of a couple worked examples, plus a **problem set** of approximately 9-15 olympiad problems (of which you solve some subset), most of which focus in one particular topic. Participants are given units “buffet-style”; you get access to as many units as you can complete during your time. See Section 3 for details.
- Prompt communication (via email, Facebook, Hangouts, etc.) for questions, advice, etc. See Section A.1 for a long speech on this.
- A set of ten full-length **mock olympiads** (4.5 hours and 3 problems, USAMO/IMO style) and eight brief short-answer quizzes (for computation practice). These are graded in full. See Section 4 for details about practice exams.
- Possibly online one-on-one meetings, as described in Section 1.3 and Section 5.

The program director is Evan Chen. For Year V, the other instructors are Anant Mudgal, Howard Halim, Michael Ren, Zack Chroman.

§1.2 Prerequisites

- You must be able to read and write proofs.
- Ideally, you should be reasonably confident in qualifying for your country's national olympiad¹.
- It is a good investment² to learn \LaTeX well in the summer before OTIS begins; it will pay back in spades when writing up solutions.
- You should be prepared to work very hard. OTIS is serious businessTM, and its rigor is comparable to that of MOP. A crude estimate for the total time commitment might be **roughly 8-16 hours per week**, though this varies substantially between different people and between units.
- You can do at most two full years in the Weekly or Biweekly format.³

¹This is to avoid an awkward situation in which e.g. someone fails to qualify for USA(J)MO after spending a whole year preparing for it!

²This suggestion is actually from one of my past participants.

³This is both for fairness, as well as limitations on my materials. Also, note that practice exams repeat every two years, so in a third year the practice exams would become redundant.

§1.3 Meeting formats

For Year V, there are *four* different lecture formats possible. The most common option is Correspondence, due to size constraints.

Biweekly with Evan Lectures are held **every two weeks** and are **0.7 hours** (42 minutes) each. See Section 5 for details about what happens in a meeting.

Weekly with Evan (rare) Lectures are held **every week** and are **0.7 hours** (42 minutes) each. Warning: this option is quite rare (not even offered every year).

See Section 5 for details about what happens in a meeting.

Biweekly/Weekly with other instructor You can have an instructor other than me for lectures. These instructors are usually OTIS alumni who have won USAMO or attended IMO. The advantage of this is that you can have longer or more frequent meetings by mutual agreement. Scheduling and payment for meetings would be done entirely with the instructor.

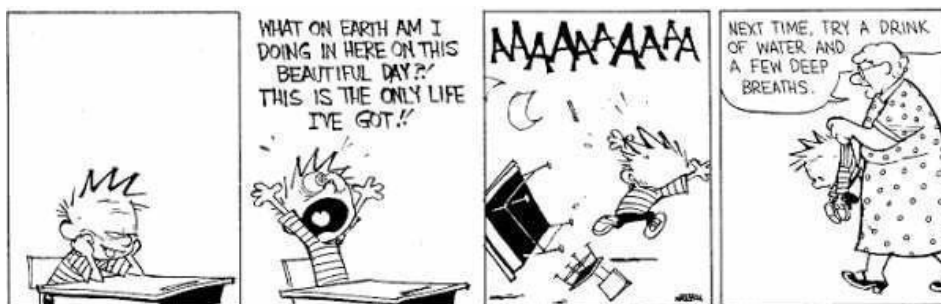
Correspondence The Correspondence format has **no lectures** at all. You submit problem sets as you complete them, and communication is done by email.

Thus you could actually pick your own pace, and you can move through as many or as few units as you have time for. This is recommended only if you are really motivated, but it has been done quite successfully before.

§1.4 Payment information

The rate is $\$80(H + 3)$ each semester where H is the number of hours of lecture.⁴ By definition, $H = 0$ for Correspondence.

On the website, you'll find a "Parent Information" handout with details on payment methods and the like (the boring stuff).



⁴The +3 term is for grading, answering questions, administration, and preparing materials. And, uh, server costs.

§2 Curriculum and Materials

§2.1 Units

The page <http://web.evanchen.cc/static/otis-samples/synopsis.html> contains a catalog of possible units (which is always changing, so may be slightly out of date).

The choice of which units to cover each year is entirely up to you. Usually, it's a bit of an overwhelming task to try and pick from such a long list; when you join, there will be a long guide giving you hints on what units to select, and I sometimes provide recommendations as well. You can (and should) also request changes at any time, see Section A.2. Starting with Year V the website has an automated system for submitting requests.

§2.2 Lecture notes (walkthroughs)

The lecture notes for every unit includes some “walkthroughs”: example problems together with a sequence of parts intended to take you step by step through the problems. Here is an example of what that might look like.

Problem (IMO 2003/6). Let p be a prime number. Prove that there exists a prime number q such that for every integer n , the number $n^p - p$ is not divisible by q .

Walkthrough. (a) Show that if $q \not\equiv 1 \pmod{p}$ then this fails. So we will restrict our attention to $q = pk + 1$.

(b) Prove that it's sufficient to have $p^k \not\equiv 1 \pmod{q}$, for the k in (a).

... and so on.

During meetings, I will probably pick one or two of the walkthroughs to work through with you. You can (and should) read through remaining walkthroughs on your own time. Full solutions to all the walkthroughs are provided in an appendix at the end of each unit.

§2.3 OTIS-WEB

OTIS has now moved onto its own dedicated website; details about this are sent to accepted participants.

The website is sort of the central hub for all materials It will be used to manage the following:

- Materials (notes and problem set) for each unit,
- Transcripts of meetings, and
- Your submissions to the problem sets.

Mock olympiads and quizzes are submitted separately, see below. (They are still listed on OTIS-WEB.)

Note that lecture notes for meetings are uploaded well in advance, and you are encouraged to skim through these beforehand. In particular, for Weekly/Biweekly participants, certain lectures may have associated **reading you will need to do before-hand**; these will be clearly indicated in the lecture notes PDF, under a section titled “Reading”.

All materials are *internal use* only.

§3 Problem sets

§3.1 Solving instructions

Each problem set has 10-15 problems, but you're not expected to solve all of them: each problem has a weight⁵ (like [5♣]) attached to it, and you are aiming to solve a certain target score or more. This will be self-explanatory once you see your first problem set.

You are expected to communicate with me throughout the week about any problems you have difficulty with (this should happen regularly!). A good rule of thumb is to **ask for hints after an hour with no progress**. When asking for hints, please describe the progress you've made so far, or approaches that you've tried and didn't work. See Section A.1 for more on that.

§3.2 Write-ups and submission

For regular problem sets, **you only need to submit outlines of solutions**, since full write-ups can be quite time-consuming. Of course, **full solutions are welcome too** if you have the time and patience. This way I can see which problems you have solved and roughly by what method, and also sanity-check that there are no obvious errors in the solution.

An "outline" is just a few sentences such that someone reading the outline could basically solve the problem from there. Here is an example of what I mean:

Problem (HMMT 2016 Guts #17): Compute the sum of all integers $1 \leq a \leq 10$ with the following property: there exist integers p and q such that p , q , $p^2 + a$ and $q^2 + a$ are all distinct prime numbers.

Solution outline: Odd a fail for parity reasons; $a \equiv 2 \pmod{3}$ fail for mod 3 reasons. This leaves $a \in \{4, 6, 10\}$, for which we can take $(p, q) = (3, 5), (5, 11), (3, 7)$, respectively. Thus $4 + 6 + 10 = 20$.

For each unit's problem set, you should submit problem sets by uploading a single PDF⁶ to OTIS-WEB. You should upload it under the "**File Uploads**" page for that unit.

One request: when submitting solutions, please **include the name/source of the problem** when known (e.g. "IMO Shortlist 2016 G2"); this makes it much easier for me to grade. You don't have to reproduce the entire statement (unless you want to).

§3.3 Due dates (or lack thereof), and the unlock system

Since OTIS is largely self-paced, there is no deadline on the units. The program is run **buffet-style** where **completing existing units unlocks new ones**. Therefore, at any time you will have a choice of a few units to work on, and you can complete as much or as little as you have time for.

For students in Weekly/Biweekly format with Evan, the meetings will cover whatever units you happen to be working on when the time rolls around. A **good default pace is to complete a unit every two weeks**. This was the original stated deadline in the earlier years of OTIS (when it was really tutoring rather than self-study).

⁵The weight of the problem is actually meant to reflect how much you learn from solving the problem. This is well-correlated with difficulty just because you will take longer on harder problems, but it's not exactly the same.

⁶As I mentioned in the beginning, I suggest typesetting your problem sets in L^AT_EX. The output is very pretty, you learn how to use L^AT_EX (useful later), and you now have digital copies of all your work. After all, given how much time you're spending on my problems, don't you want to keep records of them?

For transparency, I should say now: **regular problem set submissions are NOT graded**⁷. Sorry, there are just too many.⁸ Usually, I am willing to read through the solutions to sanity-check them and point any obvious issues I can see (wrong final answer, common pitfalls, etc.). But I will probably not notice typos or more subtle errors.

Upon completing a unit, you should notify me you have done so. I usually briefly check solutions and unlock the next unit within about 48 hours of your submission.

§3.4 Mini-surveys at the end of each unit

Every unit will also have a “mini-survey” at the end worth [1♣]. I am always looking for feedback on how long the problem sets are taking, which problems are useful or not, and if you know any problems that you think could be good additions. Completing the mini-survey is very much appreciated and encouraged, even if you don’t need the [1♣].

§4 Mock olympiads and quizzes

Both the mock olympiads and the short quizzes will be **submitted via GradeScope**. (You’ll be set up for the GradeScope website after acceptance.) The exams (and solutions) themselves will be shared on OTIS-WEB. The solutions are actually available immediately, so you can read them right after taking the test, without waiting for grading.

§4.1 Exam dates

There will be 10 tests (mock olympiads) in the school year, which come in pairs. The short quizzes are short-answer practice, each with 5 much quicker short-answer problems. The dates for the practice exams are specified in Table 1. I run grading at the beginning of each calendar month for the test that just finished.

Test Name	Released	Due
Tests 1 and 2	Aug 15	Oct 1
Tests 3 and 4	Sep 15	Nov 1
Quiz A	Oct 2	Nov 1
Tests 5 and 6	Oct 15	Dec 1
Quizzes B and C	Nov 2	Dec 1
<i>Fall bonus final (optional)</i>	Dec 14	
Quizzes D, E, F	Jan 2	Feb 1
Tests 7 and 8	Jan 15	Mar 1
Quizzes G and H	Feb 2	Mar 1
Tests 9 and 10	Feb 15	Apr 1
<i>Spring bonus final (optional)</i>	Mar 14	

Table 1: Schedule for OTIS practice exams

§4.2 Strategy

Once you are registered for OTIS, you will find on the portal a handout about meta-strategies for test taking on olympiads (with respect to write-ups, problem ordering, etc).

⁷This is part of why I only ask for outlines of solutions.

⁸The practice exams are graded fully, though.

I strongly recommend reading through this before taking your first mock olympiads, since this will give you a chance to practice these strategies on many practice tests before the first one.

§4.3 Instructions for tests (mock olympiads)

Here are some instructions for submissions.

- Each test is three problems, 7 points per problem.
- There are **three levels: JMO, USAMO, and TST**. You should pick one of them to take.
- The time limit is **4.5 hours**.
- Like a real olympiad, submit complete solutions on the given answer sheets. You can download the answer sheets from OTIS-WEB.
- You are encouraged to do the problems on the olympiad that you didn't take, but please do not submit those solutions on GradeScope; leave them blank.⁹
- When submitting mock olympiads, be careful to submit the right papers to the right problems. There are five distinct questions among the tests, of which you will only submit three.
- Even if you do not think you solved any problems, submit whatever progress you made. This helps me with record-keeping so I can adjust tests in the future. In any case, if you are following my advice you should have tried every problem for some time, so it is better to avoid leaving anything blank.

§4.4 Instructions for quizzes (short answer)

These are intended to give you bit of short-answer practice during the school year, to help prepare you for AIME, HMMT, PUMaC, MP4G, et cetera. (Indeed, you can expect most of the problems to come from there.)

- Each quiz is **45 minutes long**, and features **5 short answer problems**. Think of it like $\frac{1}{3}$ of an AIME, except probably harder and faster.
- Use the answer sheet provided on OTIS-WEB. You will only submit short answers for grading. (Thus your score will be one of $\{0, 1, \dots, 5\}$.)

§4.5 Bonus final olympiads

You can request a final at the date in Table 1 if you have completed most of the previous OTIS exams due before then. So, it serves as sort of an end-of-semester present, which is why it comes out around Christmas in the fall semester! The final problems are supposed to be especially nice (or at least I think so, seeing as I save them all year). I hand-design these for each individual.

The bonus finals are totally optional. You can do these as a mock exam if you really want to, or you can also just work on the problems for fun.

⁹It seems that the GradeScope now lets you omit submissions for problems; this was not true before.

§5 Meetings

This section describes meetings for those in the Weekly or Biweekly formats with Evan. If you have a different instructor, you can expect something similar to what's below, but the exact details might be slightly different. Correspondence students may skip this section altogether; it doesn't apply.

§5.1 Logistics and scheduling

By default we will use **Zoom** for meetings. **All meetings are one-on-one.** The course webpage will contain a link that opens the Zoom classroom. You will need to install the Zoom client yourself before then.

As described already, participants (except Correspondence) meet every one or two weeks. Meetings with Evan are **0.7 hours** long, but can be longer with other instructors. The exact time of day is usually coordinated close to the start of each semester.¹⁰

§5.2 What happens in a meeting?

Examples of things we can do in a meeting on the n th unit (all flexible):

- Present solutions to problems from the previous $(n - 1)$ st unit.
- Work together through the examples/walkthroughs for the n th unit.
- Work together through any practice problems from the n th unit (for example, things you've tried and are stuck on).
- Questions about reading or lecture notes (or anything else).

§5.3 Transcripts

Typically, I will have a \LaTeX document (in real time¹¹) which serves as a sort of "black board" for the class. So problem statements, partial progress, etc. will all appear there, live, during the meeting.

To the right is an example of part of a transcript from last year (which is also posted in full on my website for download).¹²

The advantage of this setup is that we get a full transcript of the class that you can review on your own time; not too much of a need to try and take your own notes, or deal with video transcripts and the like. I usually upload these immediately after your class (if not, I probably made a mistake, so please send me a reminder).

You can review the transcripts at any time later; the transcripts will be under the link "File Uploads" for each unit.

IMO 2014 Problem 6

Example (IMO 2014/6)

Prove that for all sufficiently large n , in any set of n lines in general position it is possible to colour at least \sqrt{n} lines blue in such a way that none of its finite regions has a completely blue boundary.

Strategy

Color lines blue until stuck.

Proof this strategy works.

Look at a maximal configuration. Claim that in here, at least \sqrt{n} lines are blue.

So suppose there k blue lines and $n - k$ red lines. Then there are $\binom{k}{2}$ intersections of two blue lines. Moreover every red line is part of an almost-blue polygon. So can associate every red line to a blue intersection.

By "geometry", at most two red lines per blue vertex. Thus

$$\binom{k}{2} \geq \frac{1}{2}(n - k) \implies k \geq \sqrt{n}.$$

Putnam example

¹⁰Fair warning: There are a lot of you, so I re-schedule classes often. I apologize in advance.

¹¹This means a lot of me typing furiously and getting angry at \LaTeX compilation errors. I always forget the `fragile` option when using Asymptote in Beamer.

¹²Yes, I really type \LaTeX that fast.

§6 Miscellaneous

§6.1 Surveys and feedback

Throughout the year, I send three large OTIS surveys by email.

- The first (longest) survey¹³ is sent around the third unit or so.
- The second survey will be sent around the end of the fall semester.
- The third (shortest) survey will be sent at the end of the year.

You need not worry about these until you see them, but when you do, I really appreciate your feedback. Of course if you have comments at other times of the year, I am more than happy to take those as well.¹⁴

The mini-surveys at the end of each problem set are also quite valuable to me.

§6.2 Dates

We follow the MIT academic calendar.

Fall Early September to early-mid December.

Spring Mid-late January to mid-April (just before USAMO).

In Weekly and Biweekly, lectures last about **twelve weeks** per semester (barring unexpected conflicts, snow days, apocalypse, etc.). Since one can work through materials outside these dates (e.g. during the long winter break), progressing through **six to eight units per semester** is a good baseline.

Lectures with Evan do not take place during the winter (mid-December to mid-January), but the rest of the program will still be functional over the break.

Starting from Year VI, it is possible to submit late applications for OTIS Correspondence mid-way through the year. This is not recommended and is intended for cases where a student missed the application deadline; for example, the deadline for some practice exams may have elapsed (although you will still be able to access the previous exams, they will not be graded).

§6.3 Office hours (Q/A and live solving)

At some points during the year, I will also hold **open office hours** on Zoom, in which any participants (even those in Correspondence) are welcome to drop by and ask questions, chat, etc. These are **completely optional**, but **free**.

Some information about how this works.

- For the first 10-20 minutes (as people are coming in), I'll take any questions that people have (privately or publicly).

¹³The nice thing about having a start-of-year survey (rather than an end-of-year survey like the rest of the world) is that your feedback will actually be used right away this year, rather than just helping future instances of OTIS.

¹⁴In particular, if you run into a problem you think would fit well on one of my units, please send it to me! (Or if you run into a nice problem in general.) Many of the problems you see in OTIS were forwarded to me by participants and friends.

- Once people are settled in, I'll put up a few problems that are on my to-do list, and people vote on which ones we want to work on. We'll then solve (or at least try to solve) the problems as a group, in what is usually a hectic and hilarious mass collaboration. I only pick problems that I have not done before, so you can get a genuine experience.

This usually takes a couple hours and we get through 1-3 problems.

For problems that get solved, I'll usually post our solution within the next couple days on AoPS, too.

- The office hours are held at irregular (but pre-announced) times to accommodate everyone's schedules and time zones.
- The course webpage will contain a link that opens the Zoom classroom. You will need to install the Zoom client yourself before then.

§6.4 Facebook group

We have a Facebook group for each year, for comedic value.

§6.5 T-shirts

Assuming sufficient demand, participants can order T-shirts around December or January of each year.

§7 Your to-do checklist

Here is a checklist of what's expected of you, to help keep track of the many parts.

- After acceptance:
 - Register for an account on OTIS-WEB and GradeScope
 - Agree on a schedule for the school year
 - Read the handout on test-taking strategy (before first practice olympiad)
- Before each unit:
 - Do any reading specified in the notes for that unit
- During each unit:
 - Meet with me/instructor at scheduled times
 - Work through the walkthroughs
 - Solve the problem set for that unit
 - Keep me updated on your progress on the problems (see Section [A.1](#))
 - Submit outlines of solutions to OTIS-WEB (under “file uploads”)
 - Optionally, drop by office hours
- Before the deadlines in Table [1](#), submit:
 - Practice olympiads (usually two per month)
 - Quizzes (in selected months)
 - Request a bonus final (optional)
- Throughout the year:
 - Respond to surveys
 - Send me good problems

§A Some advice and words of encouragement

§A.1 Talk to me, I don't bite

I want to really stress the importance of keeping in contact with me, and in particular the importance of asking for pointers when stuck.¹⁵ The problem sets are meant to help you learn through practice, rather than for me to measure anything (skill, time spent, or whatever). A problem will usually teach you a lot more in the first one or two hours than in the six hours after that. So it's much better to ask for feedback on your approaches once you've hit a barrier, rather than being stuck for hours on problem 5 and then not reading problems 6-10.

On any unit, a rough estimate is that you will need help on at least 1/3 of the problems, in the sense that you're unlikely to solve the problem no matter how much time you spend. (The actual constant varies a lot by person and unit.) That means that in expectation you should be writing to me 3+ times per unit. This is a lot!¹⁶ Put more concisely, **the problem sets should feel interactive**. This only works if you reach out to me.

Some pointers on asking questions:

- *Do it.* Really. I want to hear from you.
- You can contact me through Facebook messenger, email, or Google Hangouts. I recommend the first two since I'll see those on my phone¹⁷, but I'll eventually notice and respond to Google Hangouts as well.
- *Timing:* I try to respond to OTIS messages as soon as I see them, since I consider this to be one of the most important parts of my job. However I tend to sleep early (sometimes as early as 10PM ET), so if you message me late at night I will probably not get it until next morning. But if you message me during daylight hours, you might typically expect a response within about 6 hours. If I don't respond to something within 24 hours, please remind me.
- It's more convenient for me if you refer to problems by source e.g. "USAMO 2010/6" (instead of "problem 10", say). I have a lot of the contest years memorized by now.
- Describing what you've tried so far (even things that didn't work) is helpful, so I can give more refined suggestions.
- Don't be afraid to ask for further directions if the first answer I give isn't sufficient!

That +3 term in the semester payment is there for a reason. Make use of it!

§A.2 Flexibility of units

I want to stress that the curriculum is malleable. You can and should **request changes or additions to your chosen units, at any time, for any reason**. Starting with Year V the website has an automated system for submitting requests.

¹⁵Here's another long digression: people often call this "asking for hints", but I don't like this phrasing and try to avoid it when possible. The reason is that hints are seen as things that you only take if you can't do something yourself. This is only true during the "big game" when you're being scored. Training is not like that: long delays in feedback actually make learning slower.

¹⁶If you find you're consistently able to solve nearly all the problems, consider asking me to make your curriculum more difficult.

¹⁷Hooray for technology in education?

There are many, many, valid reasons to do so. If I *really* think that something is a bad idea, then I will warn you in advance, but in general this is supposed to be a one-on-one learning experience and so I want to really give you a lot of ownership.

Here is a list of examples of good reasons (by no means exhaustive) that you should request changes to curriculum:

- (a) I made a mistake¹⁸ and accidentally gave you a unit that you’ve already done¹⁹, or didn’t give you a unit that you specifically requested.
- (b) Your preferences have changed since last June, and now you want to work on less geometry and more combinatorics.
- (c) A little bird told you that the Anti-Problems unit is *hilarious*.
- (d) You cleared that Euclidean Algorithm unit in three days, and want another unit to work on for the other eleven days. This applies even if you are weekly or biweekly.
- (e) More generally, if you work through units faster than one every two weeks, you should add some more.²⁰ As an extreme example, Grant Yu holds the program record with *51 units* completed in one year.²¹
- (f) That Z-level Analysis or Extreme Graph unit just isn’t clicking. You want to downgrade the difficulty, or skip it altogether.
- (g) You find a D-level of a unit too easy and want to do the Z-level one instead.
- (h) You saw Evan nuke a problem with homography, and are now curious.
- (i) You’ve realize you’ve seen most of the problems on the Linear Algebra unit already so you’d rather work on something else.

In short: this is an **all-you-can-eat buffet** with 100% satisfaction guarantee™. The “one unit per two weeks” is meant as a baseline and shouldn’t be taken too seriously.

§A.3 Hints on scanning files

If you have a iPhone/Android/whatever, there are quite a few apps that will let you take pictures with your phone, and then automatically apply the correct linear transformation to get a scan of the page. For many of you this will be more convenient.

The one I use is called “Tiny Scanner” on iPhone (free if you put up with a few annoyances). Others have used “Cam Scanner” as well.

§A.4 OTIS documents are on Dropbox

Almost all OTIS content (e.g. handouts) is actually hosted on Dropbox, so whenever I make changes to documents on my computer, they are updated online in real-time. Thus **problems and documents change (or disappear) frequently for this reason**. If you don’t like this behavior, save local copies of the documents as you get them, and check for updates time to time.

Also plan accordingly if you plan on being in China, since without a VPN you cannot access Dropbox content.

¹⁸Seriously, happens all the time.

¹⁹There are some units that have multiple versions so that you can do them more than once, though.

²⁰I’ll probably notice this, too, so you may not even have to say anything.

²¹If you do this, I might have a hard time finding units for you the next year.

§B Mission statement (not meant to be read)

I want to have an official mission statement here, but it's more for completeness and my own reference. You do not need to read it unless you really really want to.

OTIS is built with **four goals**. These are the metrics which I use to measure my “success” each year, and guide all my design decisions. For each goal, I give a brief description and my plans to achieve it.

- *Systematic hard work.* First and foremost, I want students to learn work ethic. The focus is squarely placed on problem sets, with lectures minimal or nonexistent. You will do a large number of problems: there is no way around this.

The program's structure is set in a fairly explicit way, with individual units and concrete deliverables. Thus students work in a systematic and organized fashion. I like to think that the careful planning and design of OTIS (and even the sheer amount of material) helps set a good example as well.

- *Learning how to learn.* OTIS is my attempted answer to “how should people learn?”, in the context of math olympiads. Yes, you have to spend a lot of time, but there's more to it than that.²² How do you know you really understand something? What should you be thinking about after you've done each problem? How do you prioritize approaches? Why are philosophy and intuition so important? And so on.

During OTIS, these ideas are addressed indirectly through examples and explicitly through discussion. I don't claim my answers are the best or only ones. But I hope it's one helpful viewpoint. My intention is that seeing olympiad math from the OTIS perspective gives insight into these nuances.

- *Enjoyable and worthwhile experience.* In the short-term, I want OTIS to be fun. In the long-term, I want students to be able say, “*hey, I really enjoyed OTIS and learned a lot from it, and I'm glad that I joined*”, even if they didn't do as well on USAMO as they hoped. I think this kind of maturity and appreciation is important later on in life (for example in trying new things without excessive fear of failure).

This is where the human face of OTIS comes in. Part of it is in design: point-based problem sets, picking fun problems, keeping a human voice in writing.

The other part is just being available. During the school year, I see a lot of students who are left to float around and fend for themselves. My hope is that I can be a good mentor for students: being there to answer questions, giving guidance and encouragement, just being enthusiastic, etc. It's hard to learn math in a vacuum; I hope to fix that.

- *Olympiad math itself:* after completing OTIS, students should have learned a lot of olympiad math. Hopefully, the mechanism for this is self-explanatory!

Optimizing all four metrics simultaneously is hard enough. And so, to take a page from Ravi Vakil: **there are no other goals**.²³

²²To quote Palmer Mebane: “It's always discouraging to see people say that they're planning to do every problem in PSS or every IMO SL, because it sounds like they're more intent on being able to say they've done that than actually doing the problems as thoroughly as they should.”

²³I follow Unix philosophy: “write programs that do one thing and do it well”.

§C Math conventions

Here are some conventions and notation that OTIS will use. (For example, they may appear on OTIS practice exams with no further clarification.)

- We let $\mathbb{N} = \mathbb{Z}_{>0} = \{1, 2, \dots\}$ denotes the set of *positive* integers (i.e. 0 is not a natural number). We use $\mathbb{Z}_{\geq 0}$ for nonnegative integers.
- The functions $\lfloor \bullet \rfloor$ and $\lceil \bullet \rceil$ are the floor and ceiling functions.
- The graph-theory terms “graph”, “vertex”, “edge”, “degree”, “directed graph”, “tournament” will be used freely. Graphs are *simple* graphs unless otherwise specified.
- The function \log actually denotes the *natural* logarithm (not the base-10 logarithm).
- We say 0 divides itself, but not any other integer.
- Some problems may refer to chess pieces (e.g. bishops on a chessboard), and a few problems may refer to entire chess games (really!). We take <http://www-math.bgsu.edu/~zirbel/chess/BasicChessRules.pdf> as the agreed-upon rules for the games of chess for such problems.
- Empty sums are equal to 0 and empty products are equal to 1.