MIT-China Education Technology Initiative

Summer 08

June: 中国科学技术大学/合肥; July: 元智大學/台灣

A Look Ahead

Promoting CETI at USTC

A Look Back @ '05 – 西安 & 桂林

Three years ago, I participated in the CETI high school program in Xi'an (above) and Guilin (left).

In the beginning...

Three summers ago, I had the privilege of going to China as part of the MIT-CETI program and teaching at two high schools, one in Xi'an and one in Guilin. The experience was truly memorable, as I was able to meet and befriend so many Chinese students and explore so much of China that I had never seen.

Three years later, I found myself in my M.Eng. year, presented with the special opportunity to return to China as a repeat CETIzen. How could I pass it up?

Making an even bigger impact...

After having learned more through three extra years at MIT, I wanted to share that extra knowledge with others. My goal for this second CETI summer was to make an even bigger impact on my students. I hoped to encourage them to keep learning and share what I've learned over the past five years with them.

I've also had more teaching experience and wanted a chance to do a better job of making material, which may seem dry, interesting to students. Teaching is an important skill in life, and CETI is a great opportunity to hone it.

Exploring, learning, and having fun...

Besides teaching others, I also wanted to do a lot of learning for myself. Three years ago, I was able to explore not only Xi'an and Guilin, but also Shanghai and Yunnan.

This summer, I wanted to do even more exploration and learning in new places. There's so much to do around China, so many interesting people to meet, I couldn't wait to get started! ◒

First up: USTC–中国科学技术大学

Anxious to arrive...

Our first stop was at the University of Science & Technology of China (USTC) in Hefei. The school is consistently ranked among the top universities in China, particularly in science and technology fields, and so we arrived with some anxiety, especially since this would also be our first teaching stint.

On a personal level, I was even more anxious to arrive because Hefei is my hometown, the city where I spent the first seven years of my life. I was very much looking forward to returning to my 老家 and seeing what changes it had undergone.

Settling in...

We were picked up at the train station by two students and taken to the school. The administrators had arranged very comfortable on-campus accommodations for us at the university hotel.

The first evening, we were given a tour of the campus, and also met several students in their lab and chatted with them about all sorts of things. Everyone we met seemed very friendly and eager to talk to us, although some appeared to be too shy to speak up.

The next day was the Sunday before we were to begin teaching. On this day, we were shown the computer lab where we would be teaching. The facilities were very impressive, and we were welcomed by a traditional red and gold banner.

Successful 1st day...

The first day of teaching, we were met with a group of 30-40 students. Through our icebreaker activities, we learned that they were of all ages and from various departments.

The students seemed interested in the material, and several of them were actively engaged with us through asking questions during lectures. This was very encouraging because through my experience from 3 years ago, it is rare for Chinese students to gather up the courage to speak up in the classroom.

Drop-off in attendance...

As the two weeks progressed, attendance at our classes dropped so that in the later days, only 3 or 4 regulars would attend consistently. This was because we had unknowingly arranged a bad time to hold our session: the school was having their end-of-term exams during our stay. As a result, attendance was erratic, since students had to work around their exam schedules and most likely took extra time to study. I can't blame them.

The computer lab where we taught, adorned with a welcoming banner

The team with Flastar, one of our devoted students.

Eager "regulars"...

Despite all this, the few students who did come every day were a pleasure to teach. Because of the small size, we were able to have much more intimate discussions, and were able to adapt on-the-fly by discussing specific topics that interested them. We were often able to hold deeper discussions that delved into the real meat of the material.

Fun times...

Being in China, of course we had to explore

and enjoy our time there. We dined at the local eateries, ate at the school cafeteria with our students, karaoked for hours, and met with my relatives in Hefei.

We developed lasting friendships with our students despite our short stay. After classes, we would sometimes play basketball together at the school's outdoor courts. One of the students also gave each of us a very thoughtful gift: a personalized poem handwritten on a bookmark.

Suggestions for the future...

This was our first year of collaboration with USTC, and we hope future CETI teams will continue to visit the university. However, we recommend more careful planning beforehand to make sure that the timing of the summer program will work well with the students' schedules. Unfortunately, we were not aware that USTC students would be in the middle of their exam period when we got there. And sadly, there is little that the CETI teams can do besides being flexible with their own schedule. Therefore, it's important that the team make sure the university's administrators arrange for a convenient time for USTC students. ◒

The first day of classes began with icebreaker activities to help the students get to know us and one another

Walking through the campus on a beautiful day

CETI's Taiwan premiere @ Yuan Ze University – 元智大學

YZU's campus featured many open-air buildings. The building where we taught, above, was one of the few that were completely enclosed.

First time in Taiwan

Although Mike and I had been to China prior to this summer, it was the first time traveling to Taiwan for all three of us. In fact, the chance to go to Taiwan was one of the main draws for our team. Needless to say, we were very excited to arrive.

This was also the first time CETI went to Taiwan, and so we were anxious about the unknown, but also eager to make a good first impression and lead the way for what will hopefully become a long-term collaboration.

good hospitality

Administrators Nailing and Aminta welcomed us to Taiwan at the Taoyuan airport and drove us to our homes for the next month—an apartment complex near the university, similar to a graduate dormitory. When we opened the doors to our rooms, we were greeted by a wealth of goods supplied by the school: pillows, blankets, toiletries, and snacks. We were left wondering if there would be anything that the school hadn't thought of already. the good hospitality continued throughout our month-long stay at the university.

Highly organized administration

The amazing hospitality probably stemmed from the high level of organization. There was core team of administrators, led by Nailing and Aminta, from the university's Teaching Excellence Center that coordinated with us to plan the entire program. They oversaw everything from arranging our accommodations, to reserving classroom and laboratory space for us, to recruiting students and TAs for the program.

It was obvious to us from the coordination that the university was very serious and deeply committed to

An amazing month in Taiwan @ YZU

making this summer program a success. Ironically, we were almost taken aback by the organization. For example, the university provided 5 or 6 TAs (who were current YZU students), but we were unsure how best to utilize them to improve the classroom experience, especially since most of them were not experienced in the topics we were teaching. In future years, perhaps there should be more collaborative organization between the CETI team and YZU administration in order to maximize the effectiveness of combined resources.

Settling in...

After dropping off our luggage in our rooms, we were soon whisked off to a very nice dinner with Nailing, Aminta, and Professor Ying Li, who had initially proposed the program with Sean Gilbert.

The following day, we toured the campus and met the TAs who would be facilitating the camp. Everyone was very friendly and eager to help in whatever way they could. Unfortunately, we hadn't really considered the role of TAs, but they were very helpful as facilitators whenever we had any issues or questions, whether it be how to connect more with the students or where to get a haircut.

Three "mini" camps

YZU promoted the program as "MY Camp" — MIT-YZU Camp. Because many high school students also expressed interest, the university decided to hold two separate camps, one targeted towards high school students, and the other geared towards YZU students. The university promoted the program throughout all of Taiwan, and students from Taipei all the way to Kaohsiung signed up to join.

We were very excited when we heard this news because we would have the chance to impact such a wide range of high school students. Of course, this also meant more pressure and more work. The entire program would last 4 weeks: there would be two 1-week-long camps for high school students, and one 2-week-long camp for YZU students. Each camp would have roughly 50 students. But we were up to the challenge.

Close bonds with everyone

we really bonded with everyone over the course of our month at YZU. Of course the longer stay helped, but we really felt that everyone, from the administration to the TAs to the students, cared that we were there and truly wanted to connect with us. Likewise, we bonded closely with them.

On the first weekend we were there, the TAs learned that we wanted to try out the Modern Toilet restaurant, and so they took us there. On the last day of our first high school camp, some of the students volunteered to take us to Taipei, where we went up the Taipei 101 and got a tasted of the nightmarkets. Mid-way through the program, Nailing invited the three of us to her home for dinner with her family and some of the other administrators.

Eating at Modern Toilet with TAs Johnson, Candy, and Jannie

An amazing month in Taiwan @ YZU

The list of activities that we did together just goes on and on. Along with teaching the students, experiencing Taiwan with them were the two things that defined my time there.

Participation is good

I felt that teaching went better at YZU than it did at USTC. Although it was so small and intimate at USTC, I just didn't feel like we were making as big of an impact as we could be. At YZU, that all changed, as we taught about 150 students of all ages, along with a dozen TAs who also listened in during class.

Our goal was to get the students involved in class. And because we formed close bonds with them, they were more willing to participate in discussions and activities. This way, I believe they retained more of what we taught, as opposed to if they just sat and listened to us lecture.

Of course, the students were still much more shy on the whole than their American counterparts. Sometimes we would have to really nudge them to speak up in class, especially if they were unsure of their answer. Despite all this, many of them bombarded us with questions as soon as each period was over, when they could ask us in a more casual environment. We could tell that they were really analyzing what we said during lectures.

Suggestions for the future

Overall, I think the summer program at YZU was a great success, and it's a strong indication that CETI and YZU will enjoy a wonderful future. The university has voiced its desire to make this a long-term collaboration, and I whole-heartedly endorse this idea.

In future years, I think the program could benefit from better collaboration between the CETI team and the YZU administration with respect to how TAs can be best utilized. I think that if they are chosen to have experience with the material that the CETI team will be teaching, they could be a great asset and facilitator between the CETI team and the students.

I also think that the organization of the program could be changed to improve the overall benefit to the students. Instead of the 3 mini-camp structure used this summer, I think it might be better to combine them to make 1 or 2 longer camps so that the CETI team can go into more depth on the subjects they cover. One of the common feedback points given by several students was that we only gave superficial introductions to a few topics, whereas the students would have liked to delve deeper into some of them. Unfortunately, given a timeframe of only 5 days, it's difficult to go into much detail. This is why having a longer camp would allow the CETI team to get past the relatively dull introductions and get to the really interesting meat of the subjects. ◒

Studying the board with our inquisitive students

University Curriculum

MIT OpenCourseWare (OCW) Program – 2008

THE TEAM

Mike Klein – a Master's / PhD student in Computer Science from Delaware. He will lead 6.034 - Artificial Intelligence.

Jimmy Li – a Masters student in Computer Science from Virginia. He will be leading 6.001 Structure and Interpretation of Computer Programs.

Cinjon Resnick – an undergraduate in Course 18 (Mathematics). He will teach a course on psychological and mathematical games with a side focus on the Game of Life.

COURSE CURRICULA

6.001 – Structure and Interpretation of Computer Programs

6.001 is the first course in the core of departmental subjects which is required for all undergraduates in Electrical Engineering and Computer Science at MIT. This course introduces students to the principles of computation. Upon completion of 6.001, students should be able to explain and apply the basic methods from programming languages to analyze computational systems, and to generate computational solutions to abstract problems. Coding is done in the Scheme programming language.

The course covers a wide range of topics. We have selected the following topics but would be flexible about adding or replacing topics that would be more relevant or interesting to the students.

Introductory Topics
- Introduction to Computation
- Scheme Basics
- Procedures
- Recursion
- Orders of Growth

Intermediate Topics
- Data abstraction
- Higher Order Procedures
- Symbols
- Advanced Data Types

Advanced Topics
- Mutation
- Trees, Graphs, Search
- Environment Model
- Object Oriented Systems

University Curriculum

We are also planning to include two projects that would reinforce what the students learn and allow them to try their own hand at coding something interesting.

1. Baseball physics simulation: calculate the trajectory of baseballs as they are hit or thrown. This is a simpler project that will introduce the students to the Scheme language. We will also explain about the sport of baseball and its effect on American culture.
2. Prisoners' dilemma game: develop and implement strategies for winning at the Prisoners' dilemma game. We will introduce the game, along with some game theory background. We will hold a competition between the students to see who can develop the best strategy.

6.034 – Artificial Intelligence

6.034 is a mid-level course usually taken by sophomores and juniors in Computer Science. The course teaches its students how to use the traditional tools that computers have used to solve hard problems, including search, constraint satisfaction, and learning algorithms. The course's real goal, however, is to explore how these tools reflect our own human intelligence.

Though 6.034 usually involves both programming and advanced math (calculus, linear algebra), you really don't need either to understand its core ideas. I intend to target a general audience -- anyone who can handle arithmetic and algebra should be able to participate fully.

Since our time is short, I've chosen to focus on learning algorithms. This area of AI is diverse and quite fun for hands-on projects. Time willing, I'd like to cover a range of projects, starting simple and made-up, and moving on to real-world problems:

- How can a computer guess the gender of a student by height or shoe size?
- How can a computer tell apart a banana, an apple, a lychee, and a grape?
- How can a computer learn which celebrities we think are good looking -- and can it tell us why?
- How does Pandora.com figure out what music I like?

We could use many approaches to solve these problems. I'd like to cover these:

- Nearest neighbors: the basic classifier
- Identification trees: uncover the simplest explanation for why two things are different
- Neural networks: mimic our own brains' learning
- Support-vector machines: use fancy math to turn a hard-looking problem into an easy-looking one
- Boosting: many bad learners working together can make a good learner

University Curriculum

Again, while the internal workings of these algorithms may involve complicated math, the intuition for each of these is much more accessible. I'll focus on the intuition.

Along the way, I'll contrast artificial intelligence with human intelligence. We'll try to answer questions like:

- What does it mean to be intelligent?
- Where does intelligence live in the human body? The brain? Parts of the brain? The brain and more?
- If we want a computer to be intelligent, should we mimic humans? If so, on what level?
- Computers need lots of data to learn. Can we make a program that learns from only a few examples like people do?

Psychological and Mathematical Games

I plan to devote most of the course to a mix of psychological games and mathematical games, with 3-5 days at the end geared towards examining the Game of Life. It will be quite interactive and the students will learn while having fun playing these games in order to glean information about them.

The study of games is a very rich subject that can become complex very quickly. In order to keep this at an appropriate level, we're going to stick to games that are fairly simple to explain but contain rich underlying behavior.

Examples of such mathematical games are:

- Nim games such as Pearls Before Swine (which closely resembles the Chinese game Jianshizi) or Northcott's game
- Combinatorics games such as Chomp (both two-dimensional and three-dimensional)

Mathematical games in general have interesting deterministic solutions that are usually exceptionally elegant.

Examples of such psychological games are:

- Caro's three-card poker game
- Dollar Auction Game
- Pirate gold game

Psychological games encourage interesting thoughts on the connection between the math involved as well as the rational step to make.

Considering time constraints, I plan to analyze at least those games listed, but am open to suggestions for others that greatly interest the students. And if time permitting, I'll have an ample supply of others.

University Curriculum

I'd like to leave 3-5 days to analyze the Game of Life, a famous cellular automata invented by John Conway in 1970. This model is very complex, but incredibly simple on the outset. There is too much to cover on this subject in such a short span, but we will go over the motivation for the rules put forth, as well as examine a few patterns already well understood. Then, depending on the technology available, we can either discuss some of the more interesting questions such as Garden of Eden patterns and Infinite Patterns or we could have the students try to design their own unique designs.

Communication

Good communication skills are useful in every aspect of our lives, from everyday conversation to writing technical papers and giving presentations. We will introduce some tips and heuristics for improving the students' communication skills.

Topics we will cover include:

- How to speak in front of an audience
- How to frame your talk/paper correctly for the target audience
- How to keep your audience/reader's attention
- How to make your talk/paper memorable
- How to write a resume/cover letter/statement of objectives
- How to make a good impression at interviews

Culture

We are very interested in the lives of the students and the culture they live in, so we're sure they are also interested in the lives of Americans and American culture. We will share some of the topics we think will be interesting.

- American universities, particularly MIT
- Lives of American students
- American music
- American sports
- American movies

DAILY SCHEDULE

We propose the following as a daily schedule for our 2-week program. Each day consists of 2 lectures on 2 of our 3 main topics. These lectures will mostly introduce new concepts. The Recitation/Lab will serve as a reinforcement of the previous day's lectures. Here, the students will be able to work individually or in small teams on hands-on projects in order to get a practical understanding of the topics that were taught.

University Curriculum

In addition to the formal lectures, we will also include blocks of time dedicated to cultural exchange between us and the students. These cultural components will be a good break for us and the students to talk about less technical subjects and have some fun.

10:10 - 11:00	Lecture 1
11:00 - 11:30	Interactive Culture Exchange
11:30 - 11:40	Break
11:40 - 12:30	Lecture 2
12:30 - 2:10	Lunch
2:10 - 3:00	Recitation/Lab
3:00 - 3:10	Break
3:10 - 4:00	Interactive Culture Exchange
4:00 - 5:00	Flexible Outdoor games Sports

REQUIRED RESOURCES

In order to teach these courses successfully, we would ideally require the following resources:

- A lecture hall with projector and chalkboards
- A computer lab where students could work individually (or in small teams) on projects
- Installation of Scheme on computers for 6.001
- Connection to the Internet

High School Curriculum

MIT-YZU Summer High School Program – 2008

The Team

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Course Curricula

Artificial Intelligence

Monday - What is AI?

Why should we study Artificial Intelligence, and what does Artificial Intelligence really mean?

We'll talk about what some famous people think about AI, and also about what some not-famous people think about AI. Some people think AI has two separate parts: 1) *science*, studying how our human minds work with computer programs, and 2) *engineering*, solving difficult problems quickly. I'll show you how *representation* unites those two ways of looking at the field.

A puzzle for you to think about: a farmer has some grain, a chicken, and a fox. The chicken wants to eat the grain, and the fox wants to eat the chicken. But when the farmer is with them, he prevents the chicken and fox from eating anything. The farmer wants to cross a river in a small boat with only room for him and just one of the other three. How does he get all of his things safely across?

If you figure out the answer: good! We humans are smart, and can usually solve this problem pretty quickly. If you ask us how we find the answer, we'd probably just say "reasoning" or "I thought about it for a while." But how can we make a computer program to solve this problem? How would the computer program "think about it"?

High School Curriculum

Tuesday – Searching

Google Maps can give me directions between almost any two places I can think of. I can write only a few Chinese characters, but I can use a computer program to help me write many more. How do these programs work?

Even though these problems sound very different, both Google's map program and my Chinese program use the same technique to solve their problem: *search*. One way to represent these problems is this: I am at a *start* state, and I want to get to a *goal* state, by somehow going through some middle state.

For maps, the states are actual, physical locations on the planet! To get to the goal, we just walk or drive from one location to the next.

For typing Chinese characters, the locations are letters, characters, or a mix of both: I start at "dagai", which then turns into "大gai", and then "大概".

In class, we'll see some dumb ways and some smart ways to search through these states.

Think about this: how does the computer know to type "大概" instead of "大蓋"?

Wednesday - Game Search

Deep Blue is a famous chess program because it beat the world champion chess player Gary Kasparov in 1997. Since then, chess programs have become even better, and regularly beat the world's best human players.

We'll see how programs like Deep Blue can play chess, 象棋 or 圍棋. Surprisingly, while computers are very good at chess and 象棋, they are terrible at 圍棋! By the end of this class, you will know why!

Think about this: when you play chess, 象棋 or 圍棋, how many moves do you think ahead into the future? How do you decide if a particular board configuration is good or bad for you?

Thursday - Constraint Propagation

There is a famous proof in mathematics that any map can be colored with just 4 colors. That is, if you want to color a map of the world so that neighboring countries have different colors (so you can tell them apart), you only need red, blue, green, and yellow paint. But knowing that we *can* color the map does not tell us *how* to color that map. Today we'll talk about a method computer programs can use to solve problems like this.

High School Curriculum

Just as searching is not only for finding a path on a map, constraint propagation is not only for coloring maps. We can use it on any problem with lots of choices where making one choice limits our future choices: a program to help you choose which classes to take (and when to take them) in college; a program to help you build a customized computer online; a program that schedules airplanes and pilots to particular flights.

Do you play Sudoku (數獨)? How do you keep track of all the possible values in each square? When do you decide it is safe to decide on a number? Do you have any tricks to play faster?

Friday - Learning

We humans can learn patterns and new ideas very quickly. Jimmy, Cinjon, and I have traveled together for about a month, and are now all very good at guessing what type of food each other will like to eat. How have I learned to predict whether Jimmy will like a new food?

We humans learn by making smart guesses. Our reasoning is often something like this: "If two things are similar in *this* way, they're probably similar in other ways too." Today I'll show you a few different ways a computer program can use this type of reasoning.

Some of these programs can even tell us what is important and what is not: the program might tell us that "spicy" is an important factor in deciding whether Jimmy likes some food, but that "eaten with a spoon" is not. And for me, it might say nothing is an important factor, because I like eating everything!

Since this is the last day, think about this: by now I have shown you many smart programs and the clever tricks they use to solve problems. Are these programs intelligent? Have you ever seen a program that is as smart as us? We have smart programs and clever tricks, but what is missing?

High School Curriculum

Topics in Computer Science

Monday

Many problems in all kinds of fields can be modeled as graphs and then solved using techniques in graph theory. For example, the problem of finding the shortest path from one location to another in a city is an obvious candidate for using graph theory. I will motivate the idea by first explaining one part of the Google search engine, and then introduce the key definitions and apply them to other examples.

Tuesday

Given a graph, one important problem that is often encountered is to match up pairs of nodes. Usually, there are additional requirements that limit the possible matches or that dictate the criteria for finding the best match. For example, a worker needs to be matched to a task, but each worker may have a particular that he/she prefers or is best at. An optimal match would have to take these factors into account. I will introduce this topic and provide example applications.

Wednesday

We are often interested in finding the best of something: the best TV for the price, the shortest path from one place to another, the product mix that will give the most profit for a company. Techniques in optimization provide formal methods of finding these optimal solutions. I will introduce linear programming and explain how modeling problems as linear programs allow them to be solved for an optimal solution. There are countless interesting practical applications of this technique, and I will show a few. I will also demonstrate how these linear programs can be solved easily using Microsoft Excel.

Thursday

Many interesting problems in computer science are difficult or time-consuming to solve. The field of algorithms deals with understanding these problems and finding solutions that are efficient. One technique for making otherwise incredibly time-consuming problems much quicker to solve is dynamic programming. Many important problems fall into the class of problems that can be tackled using dynamic programming. I will explain the criteria for determining whether dynamic programming can be applied to a problem and take the students through several examples.

Friday

On the last day, I will show examples of past projects that I've done for a Software Engineering Lab at MIT. These projects required the application of many computer science skills that I've learned. Hopefully the students will enjoy these demonstrations and be motivated to learn more about computer science!

High School Curriculum

Mathematical Games

Introduction:

Games. What are they? How can we evaluate them?

Monday

1. Rational participants

   Game = Sea Dogs

   We're going to play an interactive game to learn more about rationality and yield a surprising result

Tuesday

2. Models and minimax

   Game = Poker, simplified

   Today, we'll play a basic version of poker and try to understand the intricacies behind it.

Wednesday

3. Thinking about probability

   Game = Hall's Game

   Probability sometimes leads to surprising results. Today's class will examine a popular game that has such a characteristic.

Thursday

4. Defining Games

   Game = Hackenbush

   Now that we've learned simple concepts, let's take a gander at the theory behind it all. What is a game worth?

Friday

5. Impartial Games

   Game = Various impartial games.

   More specific than yesterday, let's tackle (and play) [all] impartial games.

High School Curriculum

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