IMO 2018, Romania - UK Student Report

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Abstract

This is the 2018 International Mathematical Olympiad student report. It aims to provide an entertaining (and possibly informative) account of the IMO and Pre-IMO camp from a student perspective. Against the advice of our deputy leader, no notes were taken during the IMO.

Sunday 1st July

We meet at UKMT's favourite airport, London Luton, at 12 noon $\pm\epsilon$ hours, with Ben the last team member to arrive despite living in London. Check-in proceeds without much drama, although Agnijo is forced to transfer some of the contents in his suitcase into his hand luggage in order to ensure the set of masses of our suitcases is bounded above by 20kg. Freddie meets us while we are queuing, and inevitably the topic of conversation amongst the team collapses into an argument over the pronunciation of 'pedal', as in 'pedal triangle'. After passing through security, where Dominic is selected for further checks - presumably due to the stamps in his passport - we eat at Pret and wait by the gate. It is here we discover that Wizz Air are facing the opposite challenge to Thameslink - while Thameslink has had to cancel dozens of trains recently due to a shortage of train drivers, Wizz Air announces that our flight has been delayed due to a shortage of planes.

The flight eventually proceeds with us exchanging problems, with Sam delighted to discover that he is sat next to me. Exchanging problems roughly translates to me providing Tom with an endless source of problems instead of doing problems myself, then asking every few minutes if Tom has made progress.

The UK delegation experiences the first part of Hungarian culture upon landing, with approximately half the plane applauding after the flight has landed. Dominic comments that this is also the case in Israel, and I comment that the fact we are on the runway does not mean we are safe, citing the Tenerife airport disaster. His face lights up, and it is here we discover his hidden enthusiasm for aviation disasters. After collecting baggage, we meet Richard from Estonia who will be joining us for the pre-IMO camp, and board taxis to travel to the hotel we will be staying at. Upon arrival we meet the Australian team, who have kindly stayed up to meet us. Room sharing is done by age, with me sharing with Ben, completely defeating the point of a 'preferred roommate' question on the paperwork we were sent prior to the IMO by UKMT. We get an early night, aware that for the next five days our mornings will begin with a four-and-a-half hour exam.

Monday 2nd July

Breakfast is surprisingly nice, with our hotel offering a selection of food wider than the traditional Hungarian processed meat slices. Following breakfast we take the first practice exam: problem 1 is an easy combinatorics, problem 2 an easy geometry that is very easy to solve with trig, and problem 3 a 'literally impossible' number theory problem that no one solves. Most of the UNKs and AUSs solve problems 1 and 2, except I discover an error in my solution to problem 1 five minutes from the end. On the bright side, it is better to make that mistake now than in the IMO, or the Ashes.

After lunch we travel into the center of Budapest, with the intention to climb a hill, then eat dinner. Freddie gives me a deceptively simple looking geometry problem that was G4 in 2011. I comment it 'looks easy' based on the number of points. Freddie informs me it is not. I draw the diagram in GeoGebra, look at in while on the metro, and solve it before arriving at our destination. Much to my surprise, Freddie is unable to concentrate on or listen to my solution in his head without access to paper or a diagram while climbing a hill and ensuring no one gets lost.

Figure 1: A typical Budapest water fountain.

We discover that Budapest's water installations are comical in their extravagance, and Ben comments that the artwork may be symbolic of Geoff's role as IMO president. We walk to dinner, and along the way learn more about the Australians. At dinner I try my best to avoid controversial topics about Australia, although this somewhat fails when the conversation turns to Harold Holt.

Tuesday 3rd July

Again, the day begins with the second training exam, and for a second day, problems 1 and 2 are found not too hard, whereas Harvey is the only UNK who solves problem 3. Following lunch, the UK team gathers to discuss what problems we will set on the following day's training paper. The third training paper involves each team setting the other team's paper, and then marking the scripts with the leaders acting as coordinators. The Australian team claims to have a shortlist of original problems that they have spent considerable time preparing. The UK team claims to have a short list, written by Sam, of a handful of geometry problems and one combinatorics problem. I had wanted to place a geometry lemma related to a problem from the 2018 Balkan Mathematical Olympiad, but this suggestion had been rejected by the rest of the team on Monday on the grounds the statement was not interesting. Following this, I propose an inequality from our winter camp with the Hungarians that has an elegant two line solution, however, since no one knows the source of the problem, this is also rejected by the rest of the team. In the end the paper we set involves a number theory functional equation from our TSTs in Tonbridge, Sam's combinatorics, and Sam's geometry. In the spirit of the World Cup, the combinatorics problem, which was originally phrased in terms of shading squares in a grid, is now presented in terms of Gareth Southgate[1] placing strikers on a grid.

Next we travel into Budapest for a choice of activities: a visit to the baths or Vajdahunyad Castle. I elect to visit the castle, on the grounds that one cannot look at a diagram on GeoGebra while in a bath, but one can while walking around a castle. Following our walk, I solve my geometry problem, and we meet for dinner outside the baths. Harvey later comments that the baths were 'very relaxing', with a massive outdoor pool where one could watch football or play chess. There is excitement in the air due to the enthusiasm among a subset of the UK team for the England match, with Harvey excited despite being Welsh. After returning from dinner, a subset of the team watch the second half in Freddie's room, and a last-minute goal by Colombia leads to a feeling of disappointment since we wanted the game to end in order to go to bed in preparation for the following day's exam.

Wednesday 4th July

This is the day where each team sits the other team's paper. I'm hoping for no functional equations, given my dislike of them and ability to lose marks on what I consider a full solution. William Hu states that the Australians intended to set a paper solely of functional equations, although luckily this turns out not to be the case. Their paper turns out to be a combinatorial geometry, a number theory functional equation, and a very hard geometry problem. The first problem takes me considerably longer than it should, and as a result I only finish writing my solution to the second problem with a few minutes to spare. No one has solved the final problem,

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[1] the England football team manager.

and the same appears true for Sam's geometry problem, although Ethan appears to have made substantial progress. At lunch the Australians comment that none of them knew who Gareth Southgate was, much to the disappointment of Sam and Ben, who had put considerable effort into a football-themed statement.

After lunch, we begin marking. I am marking problem 2 with Agnijo and Richard, and we finish marking first. The geometry and number theory has taken substantially longer to search through everyone's rough and verify calculations. Next we go into the mock coordination, with our leaders acting as coordinators. I question who we are to refer disputes to, since there is no jury. I am informed that the coordinators' word is final. Most of this proceeds without incident, however, embarrassingly we manage to miss a key error in Ethan's script, leading to his mark being reduced from 7 to 1. In my defence, Ethan manages to miss a minor error in my script for question 2, leading to my mark being reduced from 7 to 6. The marking takes most of the afternoon, and as such we only leave the hotel for dinner.
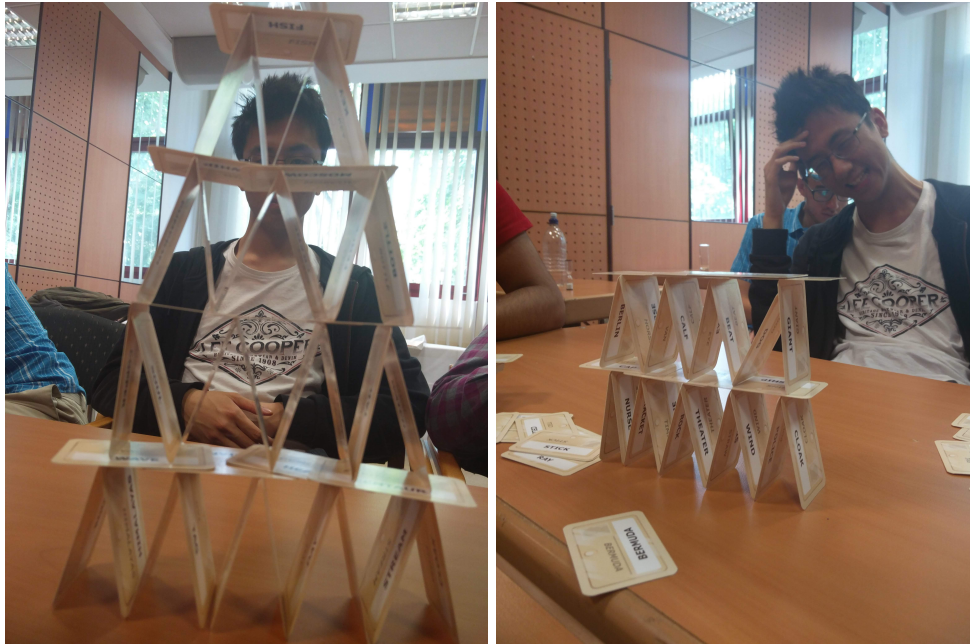
Thursday 5th July

Today is the fourth training exam, which like the others contains two fairly easy problems, and unlike the others contains an easy hard problem. The question in question was 2017 ISL A7, which is solved easily by throwing conditions into your induction hypothesis until everything works. Despite the case-heavy aspect of this problem, my solution is shorter than my solutions to the first two problems, although when Harvey's script contains lines such as 'we now consider the following four cases', both UK and Australia are unified in their view that the problem was not very nice.

Since there is heavy rain outside, and that we now have the 2017 shortlist, we remain at the hotel for the afternoon and play a board game called 'Codenames'. The game involves giving single word clues to one's team that allow them to guess words in a 5x5 grid, and some of the advice kindly provided by the other team is comical. For example, the clue 'music' and word 'rock' are apparently linked through the fact that I don't know any popular music since I have been living under a rock. Harvey and Ben eventually become bored, and begin constructing card towers.

Marking takes substantially longer than usual, which is hardly surprising when problem 2 was a combinatorics problem that needed to be written up carefully, and problem 3 required Freddie to write out my argument from scratch to understand what I meant. In the end, despite claiming something as a double induction when it was not, receive 7 on problem 3, and a '7- -??' on the front of my problem 2. This comes supplied with the note 'this would not have been an easy coordination', arguably owing to the comment on the front of my script: 'sorry, all numerators in binomial coefficients are 1 too large.' Ben claims that since a double negative is a positive, and a square is non-negative, my score is actually greater than or equal to 7.

For dinner we travel to a Chinese, where the time between courses suggests that the food may actually have been made in China and sent to Hungary. Harvey is placed in charge of ordering and later comments that at his takeaway, the service is much faster. Unfortunately, we are forbidden from ordering the £100 soup that, according to the menu, includes exotic ingredients such as shark fin, and an equally exotic name that apparently translates to: 'an aroma so good even the Buddha jumped over a wall to eat the soup'. On the way back, some of the Australians tell us that they found 2017 A1 substantially harder than today's 2017 A7. To those who are reading this, they are wrong.

(a) Harvey with his card tower.   (b) Harvey without his card tower.

Figure 2: Harvey, with and without his card tower.

Friday 6th July

Today's training exam is different to the previous day's - today is the Mathematical Ashes, an annual competition between the Australian and UK team over burnt scripts that the UK has not lost for 10 years. The paper begins with an easy geometry, although since the problem asks to prove a line bisects an angle, I ask whether it matters if it is an internal or external angle bisector. The answer is that I must prove it is an internal bisector. Unfortunately, my diagram disagrees with the answer, prompting the question: 'what about this?', to which the reply begins 'correction (sorry) . . . '.

Following the Ashes, we travel to some escape rooms in Budapest, and upon arriving there is a brief fight to determine who will get to do the hardest room. I end up going with Agnijo, Guowen, William Steinberg and William Hu. The room certainly lives up to being the hardest, especially since one of the touchscreens did not work, making escape 'literally impossible'. With the help of the staff, we escape with around a minute to spare. Agnijo ensures this minute is not wasted after taking a minute to explain to the staff how inconvenient the broken touchscreen was.

After returning to the hotel, we discover that marking still has not finished, leading us to conjecture it must be close. This matches with discussions over lunch between the teams, and after a tense wait, we learn that the UK team has kindly decided to let the Australians win after 10 years, with a victory-in-name-only of 1 mark. We inform them that next year will be different.

The Australians have an early night, given that while our journey to Cluj involves a 7 hour coach ride leaving at 9am, the Australians are leaving at 3am to fly from Budapest to Munich, and then from Munich to Cluj. As a trivial consequence of the triangle inequality, the Australians' journey will be far longer than ours, in terms of distance.

Saturday 7th July

We leave on time, although with the absence of any real boot space in the mini-coach, it is lucky there are several spare seats at the back. It is during the journey that I discover that Sam, along with a subset of the team, has been holding a sweepstake for which team I will enter into a controversial discussion with first. Sam has gone for the USA, Tom for Syria, and Dominic decides to go for Israel. Someone suggests Wales or Scotland, although I claim they are not real countries, so do not count (where 'real' should be replaced by 'sovereign'). Dominic proposes, in an attempt to create silence, that I attempt N5 from the shortlist. Sam attempts the problem too, although it is not long until we reach the Romanian border.

At the border, Rosie suggests we have something to eat, to which Dominic decides to venture out to the cafe before making a decision of whether to eat here, or whether to continue travelling. Upon returning, he claims there are fewer seats in the cafe than people in the mini-coach, so the decision is made to continue travelling. This turns out to have been a wise move, given that the restaurant we eventually stop at has a lobster tank positioned near the entrance, and is the best meal we have had since the start of the trip. Someone remarks Ben's seafood linguine contains the entire ocean on a plate, to which I concur.

After returning to the coach, Dominic suggests I attempt the N5 properly, claiming that I was not actually doing it earlier. What follows is a fairly extensive discussion with Sam about the primes that can divide the numerator in the expression, and it appears that both of us have made approximately equal progress.

After more than the advertised 7 hours, we arrive in Cluj. A subset of the team are upbeat, largely due to England's victory over Sweden, although it is undesirable to have to say goodbye to Richard at a hotel several miles away from ours. Among other things, our journey through Cluj reveals that not only have the organisers done next to nothing in ensuring the hotels are near each other, but also judging from the posters we see, a sizeable proportion of the IMO's budget was spent on advertising.

Eventually we arrive at our hotel, which on first inspection appears reasonably nice. There is a feeling of bewilderment at the fact that each room has a dial labelled 'muzica ambientala', which does what one may expect. We learn that the US team is also staying at our hotel, as is the team from Israel, leading to accusations that Dominic has cheated in the sweepstake, given he knew which teams were staying in our hotel.

After becoming acquainted with our rooms, as well as Jeremy and Ceri, who will be staying in our hotel with us as observers, we decide to go for a short walk. Ceri is in charge of organising IMO 2019, and Jeremy will be chief invigilator. Our walk takes us to a nearby lake, prompting mockery from the rest of the team as to whether I will ask 'is this a real lake'[2]. Our guides inform us it is.

Sunday 8th July

Today begins with an early start, given that the Romanians have decided that multiple hours of buffer time are needed for the opening ceremony. After breakfast, which definitely feels lacking compared to breakfasts in Hungary, we meet downstairs in the lobby for the buses. As it turns

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[2]see the Balkan 2018 Student Report.

Figure 3: UNK is now England.

out, Cluj is taking the security of IMO participants extremely seriously with a police escort for the two buses from our hotel. The attention to detail, however, has not extended to ensuring that Harvey and Agnijo are recognised as contestants, given that our bus is labelled, among other countries, as being the bus for the 'England' team[3].

Eventually we arrive at the venue for the opening ceremony, which in stark contrast to the Balkan Mathematical Olympiad, has more than enough seats, and more than enough police. Of particular interest is the not-so-discreetly-armed security person at the top of the stairs behind the Syrian team. Dominic conjectures that Mossad may have placed an agent in the arena, given the presence of both an Israeli team and the son of Assad.

We are sat directly in front of the US team, who have somehow not only discovered we have lost the Ashes, but also attempted the paper and claimed the questions to be easy. Further conversation reveals almost every question on last year's shortlist was also 'easy', which is surprising given the US team scored no marks last year on problem 3. The US propose that we swap flags for the opening ceremony, however this is quickly rejected by the rest of the team. After sitting for some time, with still a significant time until the ceremony is due to start, we stand up and are promptly ambushed by the Australian team with miniature koalas. We decide to speak to some other teams, and ironically it is Tom who offends another team by asking the Swedish team about the football.

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[3]for those not aware, Harvey and Agnijo are Welsh and Scottish respectively.

When the opening ceremony does begin, it appears that the arena is doubling as the seat of the Romanian government. Officials on the stage include the Romanian president, one Romanian Deputy Prime Minister, the minister for education, the mayor of Cluj, and the benevolent dictator of the IMO, Geoff. We later learn that another Deputy Prime Minister was watching from the audience due to lack of space on the stage. Unfortunately, the consequence of so many officials is an extended period of boring speeches, although Geoff's attempt at speaking Romanian is certainly entertaining. The speeches do contain memorable lines, including but not limited to:

- "Law is the math of social sciences"

- "[When referring to IMOs following the 1959 IMO] In the 58 IMOs that followed[4]"

- And perhaps best: "Maths is the Esperanto of science"

Following the speeches, each team takes part in the flag parade, with two people in full bear suits acting as the IMO mascot dancing throughout. I assume they must have felt incredibly hot. During the parade, I was surprised to see that Taiwan walked under the IMO flag, rather than being provided with their own flag. I later heard that this was apparantly at the request of the Chinese.

The Romanians are determined to make up for the extended waiting around before the opening ceremony by ensuring we are whisked away almost immediately after the ceremony. This is slightly unfortunate, since I would have liked more time to speak to the other teams, however, we get a definitely-not-controversial photo for the UKMT yearbook by taking a UK-Syria team photo.

After we return for lunch, with no official excursion planned for the afternoon, we arrange with our guides to travel into the centre of Cluj. Our travels take us to iconic sights such as the Ethnographic Museum of Transylvania, with a spectacular display of early 20th century farming artifacts that could pass as early 15th century farming equipment. While Ben displays fondness for some of the more extravagant hats we see, the highlight is certainly the suggestion we visit an escape room after tomorrow's exam. We continue walking aimlessly around Cluj for the remainder of the afternoon, with Agnijo being mocked by the rest of the team for having a chapter on both 'Genius' and 'Mathematical Olympiads' in his latest book. We eat out in Cluj, and return for an early night in preparation for the exam tomorrow.

Monday 9th July

Our day begins early, with the coaches scheduled to leave at 7:45 despite the exam not starting until 9:30. Agnijo manages to create a minor panic by losing his folder containing pens and pencils among the organisers, even with the enormous buffer time. We arrive in the exam hall by 8:30, and spend half an hour talking to the Australians before retreating to our seats at 9:00. The next half an hour involves sitting in absolute silence until the exam begins, with the exam progressing mostly without incident, although the desks are worryingly close together.

After exiting the exam hall, the mood amongst the UK team is mixed. All of us claim solutions to problem 1, most of us claim solutions or partial solutions to problem 2, with Agnijo claiming solutions to all 3 problems. A conversation with the US team reveals they too found the paper hard.

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[4]this IMO is the 59th, and thus 58 IMOs have not followed.

In the afternoon we travel back into Cluj to visit the escape room booked yesterday. It claims to be the original escape room. We split into two groups, with my team choosing the rather dull name "UNK $\{3, 4, 5, 8\}$". The escape room is better than the one in Budapest, with the final step of connecting two live wires made more entertaining by Dominic's comment that the wires couldn't possibly be live. He likes the room so much he informs the operator that he will give a 5 star review on TripAdvisor, using his newly created account set up in response to a truly awful restaurant in Budapest.

Not much of interest happens after the escape room, with the team in perhaps a worse mood than previous nights due to the morning's exam. At dinner, one awkward moment involves me commenting while discussing potential medal boundaries with Dominic that 'it would be embarrassing not to get a bronze'. It took several seconds for the penny to drop and me to realise that he did not win a medal in his first year, as was indicative by the sudden look of horror on my face upon remembering this fact.

Tuesday 10th July

The early start is similar to the previous day's, although one team decides, once in the exam hall, to protest at the excessive wait by lying on the floor. Other teams follow suit, and it is not long until the arena has become divided into 2 disjoint sets by the line of contestants. What happens next, however, is not something I feel able to comment on impartially as a UNK, so here is the Australians' account of the event:

"Determined to prove that the UK continues to be a hub of innovation and bright ideas, UNKs Tom and Harvey took the IMO flag and started parading it around the perimeter of the exam room. A spontaneous procession followed, with each team taking their own flag and holding it high while marching around the room. Some of the invigilators stood around and looked confused; others took out their phones and recorded the parade, and others still joined in the fun. Eventually, the flags were returned to their holders and the contestants were seated ready for the second exam."[5].

The exam proceeds smoothly, with the exception of me using my 'HELP' red card to ask the invigilators to pick up a pen I have dropped, and my subtle vandalism of the 'MATH QUESTION' card to 'MATHS QUESTION'. When we meet outside the exam hall, most of the team appear to have solved the first 2 problems, and Agnijo claims solutions to all 3. The mood is slightly more positive than the previous day, although Harvey is slightly disappointed at the likely possibility of winning another silver medal. Ben comments that his solution to problem 5 was different to ours, with him claiming that after one gets over the 3-venn diagram required to define 7 sequences, his solution is both natural and simple. Once back on the bus there is some surprise after learning that problem 3 was C4 on the shortlist, despite its difficulty.

Dominic is separated from us after lunch in order to mark our scripts and then fight for marks in the annual battle known as coordination. In his absence, Cezara, our guide, has planned an excursion to the Cluj Court of Appeal, given that she is the daughter of one of the judges. The rest of the team pretend to put me on trial for breaking the UK's many year streak of not asking questions to the IMO jury. My questions to the jury apparently were found quite entertaining by the Jury, and will be omitted here in order to avoid embarrassment.

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[5]The Australians' account of the IMO can be found at `https://ausimo.wordpress.com/`

Next on our agenda is to go for a ride in the pedalos on the nearby lake, although enthusiasm wanes at a rate roughly proportional to the steadily increasing level of rain. Luckily, half the team appear to permanently carry umbrellas, which provide refuge until we find a local tea room to sit down in. Dominic and Ceri join us, and claim that their initial opinion of our scripts is fairly positive. Tom asks about his problem 5, although I am slightly concerned by the fact that Dominic's solution to problem 5 involves claiming the main part of the problem as 'obvious', and then proceeding to do a lot of unnecessary hand-waving before finishing the problem.

Since Dominic is busy marking scripts and thus decides to return to the leaders' hotel to continue in his endeavour, there is no one left to raise concerns about our nutrition, thus we eat at the hotel.

Wednesday 11th July

For Agnijo, Sam and Harvey, there will never be a need to sit another olympiad paper as a competitor. One may assume that the organisers would have allowed us competitors to avoid an early start following the exams, but alas this is not the case. Like every morning in Romania, the day begins with an early start and us boarding the coach around 30 minutes before it leaves.

Today's excursion is to Alba Iulia, a city in Romania containing a medieval citadel and according to the Internet, a 2 hour drive from Cluj. Unfortunately, this does not include the 1 hour stop our coach convoy takes 10 minutes from the hotel outside an industrial estate. Apparently, there was a problem with our police escort due to a missing coach. Jeremy and Rosie consider abandoning the sinking ship and walking back to the hotel, yet just before we abandon hope, the coach sets off again. Little do we know that it will still be more than 2 hours on Romanian roads before we arrive.

Upon arrival, to the surprise of no one, we are informed that being behind schedule, we only have 2 minutes in the cathedral. Our tour continues at a similar pace, with the Americans bringing the finer aspects of their culture to Romania by chanting 'U-S-A!' inside a church. It is during our tour that we learn our marks for problem 5 and 1, and learn that Tom received 3 for problem 6. My mark is not yet decided for problem 6, but will probably be 0. None of this is surprising apart from Tom's 3 on problem 6. We later learn that this was because he showed that an inversion in X gives the same problem. Why this is worth 3 marks is beyond us, and presumably stating 'rotate the diagram by 360 degrees and enlarge with scale factor 1' would also earn 3 marks, given that this gives the same problem. Dominic also adds we will be eating out tonight since he has now acknowledged the importance of a nutritional diet.

Eventually we return to the coaches and are driven to a large building where there is a buffet of cold meat in breadcrumbs, which is about as appealing as it sounds. We sit with the US team, or at least the two members of the US team who went on the excursion. Enquiries regarding the location of the other 4 members are met with the dark response "they're dead". The remainder of the coach journey is comprised mostly of my failed attempts to connect to the wifi of the coach in front, although I am delighted to hear from Tom that I have secured a mark on problem 6.

Arriving back not at our hotel, but instead outside the location for the IMO lecture, we are bundled in without any say as to whether we want to attend. The first speaker informs us how useful maths is in the real world, and how beneficial studying maths at university is. Given that students attending the IMO typically intend to study classics or history, this talk definitely was

not a waste of our time. The next speaker is Ciprian Manolescu, the only person to secure three perfect scores at the IMO. He talks about knot theory, which is infinitely more interesting than the first speech. Unfortunately for him, most of the audience appear more interested in checking phones for updates to their results. The final speaker talks about maths of some sort or another, of which I quickly lost interest in the moment the Navier-Stokes equations were displayed. This is not to say the decline in interest is entirely due to lots of complicated symbols with little actual content to the talk, but instead that at this point we are receiving texts about how little time we have to reach the restaurant booked for dinner. As soon as the talk ends, we are first to leave, with us left to the mercy of Ben's precise directions: 'if you see a fountain you've gone too far'.

Despite the directions, we arrive at dinner on time, and are congratulated by Geoff and the rest of the UK delegation. Everyone is happy with our performance, not least since by reading last year's reports, one could reasonably have expected us to not make the top 30. Over dinner we hear of the highlights of coordination, with Dominic describing his method of securing 3 for Tom on problem 6 as: "I sensed their [the coordinators'] vulnerability, and pounced. Like a jaguar."

We aim to return fairly early to watch the England-Croatia game, although missing the England goal due to waiting for a taxi, some members of the team arrive back to the hotel slightly disappointed. We watch the match in the lobby since several Croatians are already gathered there. Ben removes the Union Jack from the flags in the lobby, and proudly displays it throughout the match, at least until Croatia score. He stops displaying it at all when Croatia score again. While some of the team are upset that England lost, happiness is conserved within the UK team since I am delighted at the prospect of not being forced to watch the world cup final, and being able to text those back at home with more interest in football that 'I guess it's staggering home, and got lost on the way'.

Thursday 12th July

To the surprise of no one, the organisers continue their crusade of early mornings, having clearly ignored the fact that few contestants were in bed before midnight. Luckily today's coach journey is significantly shorter, and does not involve a stop at an industrial estate. The excursion is to Salina Turda, an old salt mine near the town of Turda. Upon arrival, the forecast of rain naturally leads to thoughts of the Thai cave rescue. The caves themselves are awe-inspiring, and the sheer size of them is amazing. The many gaps in the wooden walkways above large drops appear to frighten some members of the team, leading to other members of the team seeking to point out the largest gaps to those members.

Perhaps most amazing is what is located at the bottom of the salt mine. A Ferris wheel, mini-golf and table-tennis courts are not what one would initially expect, and contrary to popular expectations, do enhance the quality of a visit to a salt mine. We spend about an hour in the mine, and spend time simultaneously challenging our stomach and mind by playing Mao[6] on a roundabout.

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[6]Mao is a popular card game often played at UKMT camps, despite Dominic's attempts to ban it.

Figure 4: A typical Romanian salt mine.

Returning to the coach, the main drama amongst the UNKs is not speculation of the medal boundaries or the upcoming jury meeting, but instead the leaked photos on AoPS detailing the almost-complete marks from coordination. To the surprise of everyone on the bus, the partial results point towards the UK ranking 11th or 12th, a result that no one expected.

We have lunch, and deputy leaders present leave us in order to attend the final jury meeting, and it is shortly after we arrive back at the hotel that medal boundaries are announced and scores are uploaded to the website. The mood among us is largely inversely correlated with age, except Agnijo for obvious reasons. I win a silver medal in the same way I won a silver medal at the Balkans, made the BMO2 leaderboard, and won a BMO1 Gold: by being on the boundary. Both myself and Tom are very happy to have won silver medals, especially given our quite lucky and extremely lucky partial marks on problem 6 respectively, and the fact that speculation over the boundaries can end is a huge relief.

In order to celebrate, Cezara has arranged for a UNK excursion to the local sports centre, in order to play table tennis. The plan fails when we discover that not all the team have brought the appropriate footwear, leading to an impromptu game of basketball. This is near to a total disaster, with us learning that not only are mathematicians typically poor at basketball, but also that after about 20 minutes, we are bored of the game. After sitting down at the nearby cafe, we learn of the location of tonight's restaurant, where we will eat with the Australian team. Upon arrival at the restaurant, the Australians are already there, and all too keen to play their game: 'the man in the moon'. Ben describes it as "puerile", and it appears to involve passing

a cup round the table making statements about 'the man in the moon' which are either true or false, as judged by the Australians. I am unable to figure it out, not least due to my lack of interest, and conjecture the validity of a statement is solely based on the nationality of the person making the statement.

Friday 13th July

Finally we have a day which does not officially involve an early start. The key word in this sentence is 'officially'. The team have volunteered to help in a demonstration by Rosie at the leaders' hotel of the 'Diamond Maths Challenge', the international version of the Team Maths Challenge. Luckily, leaving at 8:30 is delightfully late compared to previous days.

Driving up to the leaders' hotel, there are clear differences to our own. For example, the students' hotels do not have swimming pools, large driveways or 5 stars above the buildings. Harvey is wearing Po-Shen Loh's lanyard after finding it the previous night in our hotel, a move bound to confuse some of the leaders. The demonstration involves us students running the Crossnumber and shuttle rounds of the TMC with the leaders. This is made exponentially more fun by the leaders who, upon being faced with having to do arithmetic, take out their calculators.

After returning to our hotel, we bump into Po-Shen Loh, who likes Po-Shen Yau so much he insists on a photo before reclaiming his lanyard. I wait in the lobby for around an hour, and eventually it is time to leave for the closing ceremony.

The closing ceremony is in a different venue to the opening ceremony, and while slightly smaller, lacks air conditioning. Combined with our blazers, it is not long before we feel extremely hot. We are armed with thousands of UKMT, IMO, and IMO 2019 stickers to hand out, and given the multiple-hour wait, inevitably we resolve to attack as many teams as possible with our stickers. The Australian team in particular deserve to feel our wrath, given they ambushed us at the opening ceremony with miniature koalas. In addition to this, I finally find a chance to ask Evan Chen if anyone proofread his geometry book for mathematical errors, partially in response to finding dozens of errors myself in it. The answer is no. Irrespective of this, Evan Chen's book is excellent. If you want to improve at olympiad geometry, ~~ask Dominic for a copy~~ buy a copy.

Like the opening ceremony, the closing ceremony involves speeches by half the Romanian government, although thankfully they are slightly shorter than at the opening ceremony. Geoff's short speech ends entertainingly with the statement: 'And this is my entry for the shortest official speech competition'. After the speeches medals are awarded, with the organisers opting to display names on the screen behind rather than enter the political minefield of pronouncing names from across the world. Strangely, while most contestants are awarded medals in groups of about k with k around 10, given that the number of silver and gold medals was not congruent to 0 mod k, I end up in a group of 2 due to my surname being at the wrong end of the alphabet. The ceremony finishes with a bizarre laser light show and the use of confetti cannons.

In the brief period between the ceremony and boarding the buses, we take part in a photo with the US team, and Harvey has a photo taken of him and Hafez al-Assad, complete with Assad wearing a UKMT sticker. It is only afterwards that Harvey realises he is wearing Po-Shen's lanyard, having somehow reacquired it.

On the bus back to the hotel, I search the medal for any mathematical errors, but cannot find any except the clear contradictory definitions of A, and additionally the odd fact that one sponsor's name is on the medal.
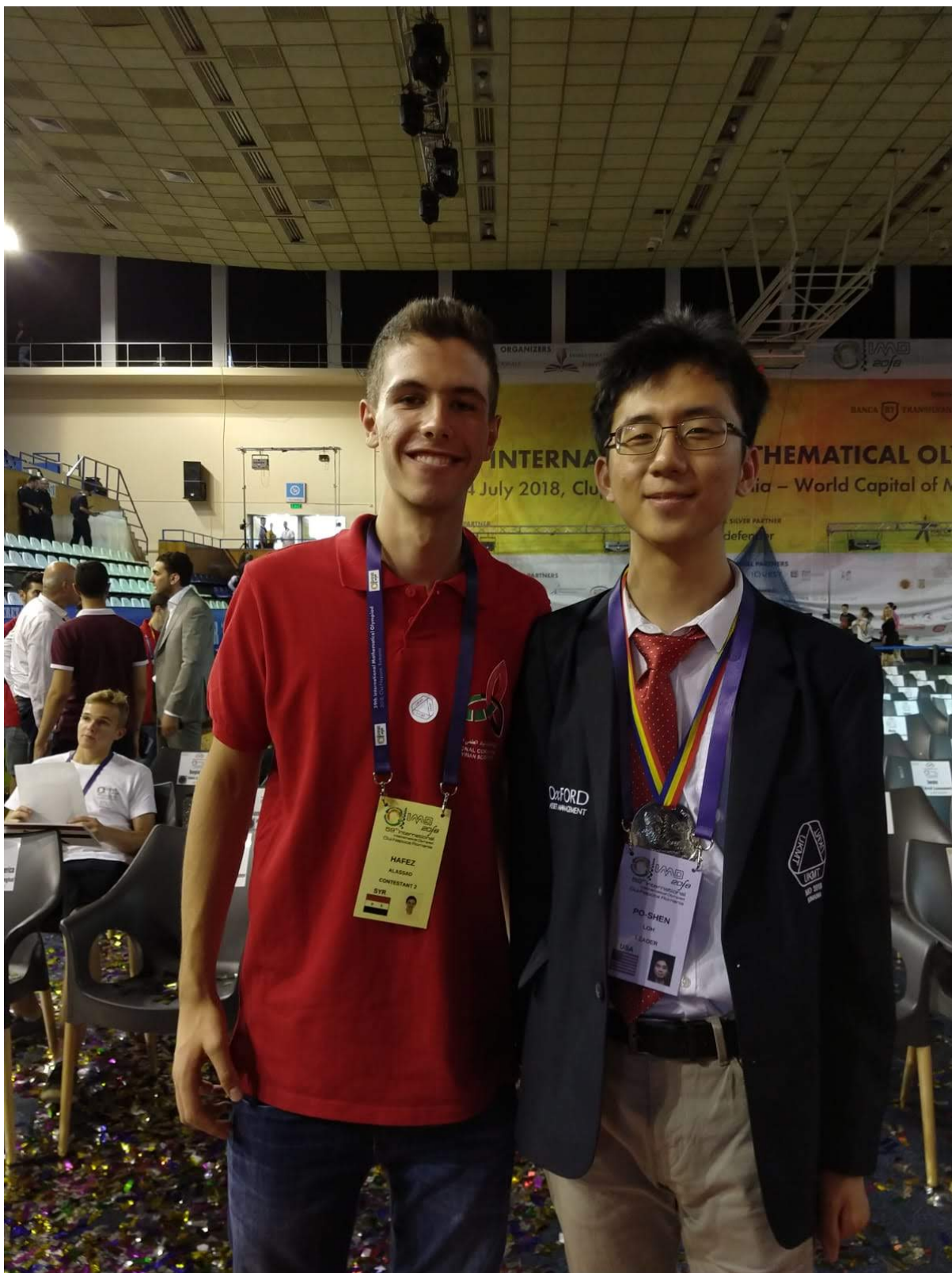
Figure 5: Po-Shen Yau with a member of the Syrian team.

Figure 6: Is ω in A or not?

For the final event of the 2018 IMO, we attend the farewell banquet at the leaders' hotel. We sit with the Australians, and to the disappointment of me and many others, the sushi runs out before we can find any. After the meal, I, along with Harvey, are forced to vacate the room due to the stupidly loud music being played. In the corridor, we discover that Agnijo has his own fan club following his perfect score.

We decide to move outside where it is slightly quieter, and despite the Australians' attempts to force us to dance, the rest of the evening proceeds with us saying goodbye to all the teams we have met.

For the first time in 9 years, the IMO is in Europe, and UKMT appear determined to emulate the jet lag of an exotic destination by booking a 6:00 flight from Cluj. Ceri, Jeremy and Ben all leave early to have an early night, however, for the rest of the team. . .

Saturday 14th July

. . .arriving back to the hotel at 0:30 on Saturday leaves little time for sleep. We spend the time playing board games, and luckily just before we leave I receive an email from Guowen containing the Australian's shortlist. I hope this will be sufficient to keep me awake on the flight, although unfortunately it is not. The coach to the airport involves innovative baggage solutions (i.e. a trailer), and luckily is far shorter than the journey to Cluj from Budapest.

Arriving almost 3 hours before our flight, the journey through the airport is made slightly less painful with a double espresso. We meet Po-Shen at the gate, who now being in possession of his lanyard, presents Harvey with it as a parting gift. Dominic leaves us to return to Israel, and comments via text that his queue has 2 dimensions. We board our flight, and being seated in the middle seat, am delighted to observe an empty row one ahead on my right. As soon as

boarding finishes, I stand to move to the empty row, and at the same time, the person in the row in front stands too. What follows is a brief tense moment, leading to me securing the empty row for the UNK team, a result clearly appreciated by Geoff who moves later given the presence of a loud young child next to him.

After a few hours, we land at Luton, leave the plane, pass through immigration and with that, the 59th IMO is over.

Acknowledgements

A vast amount of work goes into ensuring that the IMO runs smoothly, and that the UK is able to send a team. I do not know all the people involved at UKMT, and I am sure much goes on behind the scenes that I am unaware of. Moreover, I am extremely grateful for the work everyone involved puts in to create such an enjoyable and memorable event. With this in mind, here are some of the people who deserve to be thanked:

- The organisers, for ensuring the papers were sat, the opening and closing ceremonies ran smoothly, and providing us with great accommodation.

- The sponsors of the IMO, without whom the IMO would not have been possible.

- Oxford Asset Management, whose generous funding allows for the UK's exceptional training programme.

- All the volunteers at UKMT camps throughout the year, for always providing us with interesting maths and that we can keep improving.

- Dominic, who not only organised some of the best excursions and was pivotal in securing crucial marks, but also has helped us improve throughout the year through organising camps, setting exams and replying to all our emails over the past several months.

- Freddie, for reading through our scripts during the pre-IMO camp, and also being a great source of medium geometry problems.

- Rosie, for looking after all of us over the two weeks and ensuring we all returned to the UK.

- Jeremy and Ceri, for working to ensure that next year's IMO will actually happen.

- Geoff, who continues to lead both the IMO Board and UK team to even greater heights.

- Cezara and Alexandru, our excellent guides who not only planned our fantastic excursion to the Cluj Court of Appeal, but also were always there throughout the week.

- The Australian team, for giving us something to aim for next year.

- And finally, the UK team: Agnijo, Sam, Tom, Ben and Harvey, for resisting the urge to push me off a cliff, of which there were many opportunities.