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An interview with Professor June Huh

Leonardo Finzi and Nina McCambridge

Biographical sketch

June Huh is a mathematician known for his contributions to algebraic geometry and combinatorics. Born in 1983 and raised in South Korea, he earned his PhD in Mathematics at the University of Michigan, advised by Mircea Mustață. Among his many contributions, Huh is best known for his work on the theory of Lorenzian polynomials and the Dowling–Wilson conjecture for geometric lattices, which bridges a significant gap between Hodge theory and combinatorics. He has received many awards for his work, including a 2019 New Horizons in Mathematics Prize, a 2022 Fields Medal, and a 2022 MacArthur Fellowship.

Leonardo Finzi/Nina McCambridge: *What was the concept or technique that initially drew you into mathematics?*

June Huh: In mathematics, most things are very clean, cut and well-defined. It's almost like a game. Especially when you're young, it's a very well-defined task. And as you progress, the research.. becomes less and less well-defined. You have to find the right definition and then also decide which game is the interesting one to play. This kind of skill becomes increasingly important as your progress, but at least in the beginning, most of the rules are given to you. And you'll just play with it. Yeah, you don't have to worry about [anything else]. I like that aspect. I suppose this is true for many other people as well.

LF/NM: *Is that what initially interested you in combinatorics and algebraic geometry?*

JH: I learned combinatorics fairly late, so I had no idea [about] and absolutely no experience with combinatorics... when I was a beginning graduate student. I just learned combinatorics by accident because some of my friends and mentors told me about it. Yeah, I did not even know the... formal definition of a graph at that point, I've never seen statements like, if your graph is non-planer if and only if it has like, K_5 and $K_{3,3}$ trees... I did not know this stuff when I was a beginning graduate student so... [I was] sort of late coming to combinatorics.

LF/NM: *Did you learn combinatorics for algebraic geometry?*

JH: No, I mean, one thing about combinatorics is that it if you want to go into it, you don't need a lot of preparation. I already knew some algebraic geometry when I was a starting graduate student in the US and then someone told me, "...there are such and such combinatorial problems, it might be related to the type of geometry that you might be interested in." So I learned that part of the combinatorics to solve some particular problems. And then after that, I learned the adjacent combinatorics...

LF/NM: *How have the reasons for your interest in math changed since your initial interest and what's kept you doing math?*

JH: Oh, I mean, being in a wild openness is daunting at the beginning. But once you become comfortable with it, it is what makes the whole process of doing mathematics more attractive. It has an infinite potential... It gives you the feeling of sort of a discovery... roughly [like what] "real" scientists are doing... when you are testing out various definitions and... [seeing] what notions have more satisfying structural properties.

LF/NM: *Since the beginning of your career, you were proving very impressive conjectures, like the Read-Hoggar Conjecture. It seems to be pretty uncommon for a graduate student to prove such a big result. Did it feel unusual to you to prove such problems earlier on?*

JH: I mean, the story is commonly told that way, but when I was a beginning graduate student in the US, I was not really a beginning graduate student. I already had my 2 years of Master's experience in Korea before moving to the US. That's when I learned most of the algebraic geometry [I knew up until that point]. When I meet the fresh graduate students in the US, I mean, they have to now learn like basic algebra, rings, modules, fields, a little group theory, and then they have to also learn algebraic topology, and they also differential geometry, real analysis, complex analysis... There's a lot, and this is certainly– I mean, you have to go through this stage (and then some more after that) to really start encountering interesting research-level problems. I sort of did this stage before coming to US. And I was significantly older than anyone of the students in my cohort... I came to the US in 2009. I was 26 years old, at that point. I mean, it's not uncommon that there's some 26 year old PhD's at that point [making discoveries].

LF/NM: *When you came to the US from Korea, did you notice major differences between Korean and American mathematical culture?*

JH: That's hard to answer because culture in general is so different. So in particular math culture is different, but maybe it's not so specific to math... But certainly, the

US math community is much wider and more diverse, and there's simply more people in it. That makes it interesting.

LF/NM: *One of the spectacular things you have done is incorporate Hodge theory into combinatorics and bridge a gap between combinatorics and algebraic geometry. How did those ideas of applying Hodge theory in the way that you did even come about?*

JH: I'm not even sure I came up with it. I mean, I had various collaborators throughout the years, and for example, this work I did as a beginning graduate student, on the surface of it, it doesn't explicitly involve any Hodge theory... It solves some important cases of a conjecture but those techniques couldn't cover all cases of some more general conjectures. And then I started collaborating with... Eric Katz, one of my early collaborators, and we tried to really understand what's going on in order to tackle the more general cases of the same conjecture. It was not a sudden moment of realization. Over the years, we gradually realized that what truly make things work in such and such cases, is because there is this Hodge-theoretic structure behind it. So if you want to extend this to a broader class of combinatorical objects, what you really need is to find (or if necessary construct) such a Hodge-type structure associated to this kind of combinatorial object and so on. It's a gradual realization over the years... [through] long conversation with various collaborators... It was a very slow process, but each step was a very natural progression. So yeah, no moment of enlightenment, it wasn't like that.

LF/NM: *You have a lot of different, relatively diverse results. Which of the results from which you won the Fields Medal are you most proud of?*

JH: I really like the work that I did with Petter Brändén on the construction of the theory of Lorenzian polynomials. Most of the math that I do is relatively elementary. It's not really like a fancy or very highly sophisticated mathematics, but this one in particular is the most elementary among all things... It is not an exaggeration to say that this is at the level of linear algebra plus multi-variable calculus. So if I have a very bright... math-major freshman who is very patient and who is willing to listen to me for long hours, I can really, really explain the entire theory... Which is not necessarily true for some other big theories in current mathematics. Sure, I mean, you might need many, many years if you are starting with that as a freshman, but this one, this one is very elementary, but it has some rather surprising implications. So I really like that one.

And I also like working on many different math areas. I started with algebraic geometry, I learned combinatorics, I did some algebra here and there, but I rarely had the opportunity to do some actual *analysis* analysis. So maybe the first time I used analysis to prove something not trivial? I really enjoyed the working on that project.

LF/NM: *Do you think you'll try to use more analysis in the future?*

JH: I suck at analysis, so I *hope* that I will have many more chances like that. Chances are slim, but I will keep trying!

LF/NM: *If someone were to look at your entire body of research so far, what is the thing you want them to take away, either mathematically or philosophically?*

JH: I mean, [I want them to take away] this connectedness between different kinds of mathematics. I find that very beautiful... I think it's human nature to appreciate connectedness of any kind. It's just that there is such a pure joy to find someone and talk to them and you just happen to [realize] that you're good friends of someone else. That's an enjoyable experience! Especially if the connection was completely unexpected. I don't know why. All the great meditation practitioners say that their life goal is to connect with their environment... It's in our nature.

LF/NM: *What is your favorite result of another mathematician who has built on your work?*

JH: I was just talking to Chris Eur at Carnegie-Mellon in the other room... he found some amazing structure that resembles the notion of a vector bundle in algebraic geometry, but in combinatorics. And it has very strong implications. I think it recovers almost all of the works I did in that area before his discovery with his collaborators on this notion, what is called the tautological bundle. Do you know this word, "tautological"? I think the word is used to... [signify] that this is the obvious thing that you should consider, given this data. But nobody saw, and in particular, I never imagined this obvious thing that I should have considered a long time ago... And it was built on what I did before. But it was more powerful than that. It was just pretty amazing to see that and how it works.

LF/NM: *Is it safe to say that you like the retrospectively "obvious" things because they are more fundamental to the structure of math?*

JH: Yeah, I mean, I agree in retrospect that that was the obvious thing that anyone with some intelligence should have considered. I did not see it coming. It works beautifully, it's a very nice theory.

LF/NM: *You talk a lot about how you've collaborated with other people on your results, not just in research but in teaching and advising. Do you see yourself as a mentor figure? Do you enjoy teaching other people and supervising theses? Or do you just like doing the math and everything else is peripheral?*

JH: So I was a post-doc for many, many years, and I was, and I still am, a relative "newbie" to the faculty at Princeton University. I have graduated one PhD student so far… I didn't do any advising to this person other than just asking questions that I am interested in knowing the answer. And it worked out great. Let's see that works again for the next year!

This person is Matt Larson, and by now in any measure, I think, he's probably a stronger mathematician than me and it was just amazing to see how fast one can mature in 4 years or 5. That was amazing. I would be very happy to see something like that again and again, if possible. Maybe I was just lucky or something like that.

LF/NM: *How much do you enjoy the process of math? Do you enjoy the working through it or the presenting of the final result?*

JH: So, I mean, the honest answer would be neither. The most fun part is to start the project because then you have so many ideas, so many big expectations and hopes: "Oh all would be amazing if this works out, I have this to try this to try this to try!" And then it requires actual work to carry some of those ideas out. It's still fun, but you really need to work to carry out that part. And then, okay, maybe you work really hard with your friends and you did it and then the worst part is now you have to write it. And that's very painful. And it's a very, very slow process because writing in mathematics, especially if you intend to write well, is a very tedious process and you have to be very, very careful and you have to revise many, many times and so on. So I would rank, the first part first, second part second, and third part third. But every part is necessary.

LF/NM: *Yesterday during your talk*[1]*, you made a very interesting comment. You had mentioned that there is this open conjecture and you challenged the audience by saying if they can use artificial intelligence to solve this problem, that would be pretty amazing. Recently, more open problems like some of the Erdős problems are being solved using AI. How do you hope AI is used in mathematics going forward?*

JH: Maybe I wasn't so explicit yesterday… but that particular problem… we don't really know how difficult it would be, but my guess is that it's not a difficult problem. But it's very different than all these Erdős problems… It's not like solving, "Here is a statement, and is this statement true, and if it's true, how would you prove it?" It's not of that form. The question is, well to use technical language, how would you characterize the mixed volumes of 4 convex bodies in the plane?… The part of the problem is to guess the answer and then maybe after guessing it, try to prove that

[1]This talk was given at the Joint CMU-Pitt Mathematical Sciences Colloquium.

your guess is correct. Whether AI can do the first part, I'm sure they are now pretty capable in doing the second part. So I'm interested in seeing examples where they can do the first part. And this is a relatively easy open problem, I think. Many things like this will be a good test case. Usually, what distinguishes the really, really good mathematicians from the regularly-good mathematicians is how well you can do the first part... That's where the so-called "intuition" is used. It's not about logic processing.

LF/NM: *At some point in your life you wanted to be a journalist. Do you ever try to apply the journalistic spirit to math by trying to write things in an accessible or exposition-heavy way?*

JH: I wasn't particularly interested in being a journalist, that was a compromise. I really enjoyed writing and then I quickly discovered that its nearly impossible to make a living by being something like a poet... So what kind of jobs can you do as writer? [Journalist is] one of the options. I ended up like doing what I like, so I write a lot! And certainly having the ability to write well, it's very, very important in mathematics. So I think I have not wasted my experience.

LF/NM: *Who's your favorite poet?*

JH: I recently I really enjoyed reading this Irish person, his name is David Whyte. He's an interesting writer. He has this book titled *Consolations*. It's supposed to be this book of points, but it's really this dictionary of everyday words... He picks out 40 or 50 easy, everyday words, words that you first learn as a very, very young child. The words are the title of the poems, but it really doesn't look like a poem, and if you go there, there's a description of that word. It's very interesting, it's very interesting, so there's... extremely easy words, maybe like 'friend' or 'love' or 'return' or things like this. And then he has an explanation of that word, usually about 2 to 3 pages. It's very, very interesting and some of them very, very beautiful.

In April 2026, Huh delivered the 2026 Pittsburgh Mathematical Horizons Lecture at the University of Pittsburgh.

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