From Margin to Center: Reframing the History of Women in Computing and Information Technology through Oral Histories

An Oral History Interview with Tandy Warnow

Conducted by Bethany Anderson on December 5, 2017 in Room 3235, Siebel Center,

University of Illinois at Urbana-Champaign

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Abstract: Tandy Warnow received her bachelor of science and PhD degrees in mathematics from the University of California, Berkeley in 1984 and 1991, respectively. Warnow is currently the Founder Professor and Associate Head of Computer Science at the University of Illinois at Urbana-Champaign. In this interview, Warnow describes her childhood, education, prior work at the University of Southern California and University of Texas at Austin, among other institutions, her research in computational phylogenetics and historical linguistics, as well as her professional path that led her to a career computing and as an educator.

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00:00:04
BA: Today is Tuesday, December 5, 2017, and I am Bethany Anderson from the University of Illinois Archives. I'm here today in Room 3235 in the Siebel Center with Tandy Warnow, Founder Professor and Associate Head of Computer Science, to talk with her about her background and experience as a faculty member at the University of Illinois, at the University of Texas at Austin, and the University of Pennsylvania, among other institutions, as well as to learn more about the evolution of her research and her experience working in the computer science field more broadly. This interview is part of the ACM funded project "From Margin to Center: Reframing the History of Women in Computing and Information Technology through Oral Histories. So, first of all thank you for talking with me today Professor Warnow. I wonder if you could start by talking a bit about your background and your childhood? Could you tell us where you grew up?

00:00:53
TW: First of all, thank you for doing the interview. I'm looking forward to all of this. I grew up in New York City, and in fact, I grew up in a U.N. community in Queens. So, it's like growing up in graduate student housing for a major university. That's the level of the international society we had.

00:01:13
BA: Mm-hmm. And were there any hobbies, or interests, or subjects in school that attracted your attention at this early age?

00:01:21
TW: I think I discovered mathematics in a basic way when I was in third grade, which sort of got me keen on math at that point but I always had interest in music and in being an explorer. So, one of my fantasies was to be the first person on Mars. I learned more later on in life that that was not a fun thing to think about doing, but nevertheless. Yeah.

00:01:46
BA: [overlapping] Yeah. [laugh] Could you talk about your parents? What did they do?

00:01:52
TW: My father was mostly a writer but also an inventor and he invented lots of things that were fairly useless but nevertheless, he kept inventing. So, he was a very creative person. My mother was a historian. Well, she was an archivist, like you, but worked in history of physics.

00:02:10
BA: And what sorts of things did your father invent? If you could talk a bit about that. [laugh]

00:02:18
TW: Well, let's see. He invented, the first thing that I knew he invented, was something called "stickvelopes" which was basically an envelope that was sticky on two sides and it had space in the middle, and in the middle you would put the negative from your photograph and then you would stick the photograph on the other side.

00:02:36
BA: Mm.

00:02:37
TW: And then you would stick the whole thing to a page.

00:02:39
BA: Oh wow.

00:02:40
TW: So, that way you would not separate your negative from your photograph.

00:02:43
BA: Oh, wow. That's cool.

00:02:45
TW: I don't think he ever made any money of it but I remember these stickvelopes very well.

00:02:50
BA: [laugh] So, there were a lot in your house then, in other words?

00:02:52
TW: Yeah.

00:02:54
BA: You just mentioned your mother, who was an archivist, and her name was Joan Warnow-Blewett, correct?

00:03:00
TW: Well, her name at the time was just Joan Warnow.

00:03:03
BA: Right.

00:03:03
TW: Yes, but later on she—

00:03:04
BA: She became—

00:03:05
TW: Joan Warnow-Blewett, yeah.

00:03:06
BA: And she was an archivist at the American Institute of Physics and as you mentioned, known for her work in history of physics and history of science. Did she talk much about her work at home?

00:03:21
TW: She talked about her work insofar as she would talk about the people that she met and the stories that she had heard about physicists over the, you know, many decades preceding her work.

00:03:35
BA: Mm-hmm.

00:03:36
TW: But it wasn't so much about her work so much as about the people.

00:03:40
BA: Mm-hmm. So, what sorts of stories did she tell you about these people?

00:03:46
TW: They were stories like, real stories, things that she had experienced. I think Rutherford came into her library at one point and she met him.[1] And she had some stories about Rutherford, but I can't remember if they were real or made up.

00:04:03
BA: [laugh] Yeah.

00:04:15
TW: But she also told stories about Wolfgang Pauli, the physicist, the theoretical physicist who couldn't do experiments and how he was famous for being so bad

[1] Physicist Ernest Rutherford.

at experiments that anytime you had a problem with your experiment you should somehow find a way to blame it on Wolfgang Pauli. So, there were just stories about famous people that made them real.

00:04:23
BA: [overlapping] Mm-hmm. Mm-hmm. So, were you exposed to the work of archivists at all through her stories?

00:04:33
TW: [overlapping] No, no.

00:04:34
BA: It was mostly like the stories about—

00:04:35
TW: Not as a kid. Not as a kid.

00:04:37
BA: Yeah.

00:04:37
TW: In fact, it really wasn't until, in some ways, like very soon before she died that I learned anything about her impact on the field of history of science.

00:04:50
BA: Mm-hmm.

00:04:51
TW: And how to document it. I didn't really know anything about that.

0:04:54
BA: Mm-hmm. Well, thank you for indulging my questions about this. I had to ask because as you know, I'm an archivist!

00:05:00
TW: Yes.

00:05:01
BA: So, another question about this. You know, just thinking, since we're talking about archives and your mother who was an archivist, given your work in computing which we'll talk about a bit in —later, in the conversation. What do you think is important for archivists to capture and preserve, particularly, in your area of research? What sorts of documents today would tell that story?

00:05:29
TW: So, I think increasingly people in computer science are putting a lot of their research ideas into their talks as much as they are putting them into their papers. And a lot of people's talks are on YouTube.

00:05:48
BA: Mm-hmm.

00:05:49
TW: One thing I would say is just getting people's talks. And I mean, some people are better at it than others. Some people their ideas really clearly put their high-level ideas into their talks. Other people are putting their ideas into their blogs. And some people have extremely interesting blogs whether you agree with them or don't agree with them, they really show something about where the field is going and what the controversies are.

00:06:15
BA: Mm-hmm.

00:06:16
TW: So, I think that the usual literature which is people's published journal articles don't show nearly as much of the, you know, the debates that are going on in the community as blogs and taped talks too.

00:06:33
BA: Mm-hmm. Yeah, that's really interesting.

00:06:36
TW: Of course, if you can get people's emails that would be interesting too but I think that you're not going to find their emails and people don't have correspondence in the usual way. I mean, there's so much that goes on via Skype. Or you know, whereas a lot less is going on in just written documentation.

00:06:55
BA: Mm-hmm. Yeah. Definitely. Yeah. That's interesting to hear about your thoughts about these other sorts of forums where this idea exchange is happening and it's not always in the traditional correspondence like you mentioned. So, going back to your parents though, I wanted to ask you, were there any specific professional or educational expectations that each of your parents had for you?

00:07:22
TW: Nothing specific. In some ways, I don't think it mattered to—Okay, let me put it this way. I really, really liked mathematics from a very young age.

00:07:34
BA: Mm-hmm.

00:07:35
TW: And I really wanted to be a mathematician and it really frustrated me that my mother, her response to that was, "Well, you could do anything." [laugh] I didn't want her to say that. I just wanted her to say, "Yes, you should be a mathematician." So, she didn't have any particular preference for what I did with myself professionally. And it was never stated but it was very clear that I had to do something with myself professionally. In other words, if I had decided to just open a bakery and make wonderful cakes, I don't think she would have been very pleased with that. But I had to do something but she didn't really care what it was.

00:08:15
BA: Mm-hmm. Can you recall what might have been the first moment when you realized you were interested in mathematics?

00:08:26
TW: So, that I was interested in it is one thing but that I discovered that I liked doing it was another.

00:08:32
BA: Mm-hmm

00:08:33
TW: And so that second thing, there—I'm sure you're too young to have been taught this but there was at a time a way of doing square roots by hand. Did you learn this? No? Okay.

00:08:47
BA: I can't really recall. [laugh]

00:08:48
TW: Okay. So, you're too young for this but just like we would learn how to do long division we would learn how to do square roots. And so, you would write down a number and you'd partition the numerals into two pairs. And then you would just sort of do a certain kind of calculation and you could get the square root and you can do it to as much precision as you want.

00:09:06
BA: Mm-hmm.

00:09:07
TW: This is something you could do by hand, not with a calculator, just by hand. And my father, and this is—I think I was in seventh grade. My father asked me why does it work.

00:09:16
BA: Hm.

00:09:17
TW: And his question set off this just thought of like, "Why does it work?" And I said, "I'm not sure but I'm going to figure it out." And I went away and I figured out why it worked and then I turned around and took that idea and figured out how to do the same thing for cube root.

00:09:35
BA: Oh. Okay.

00:09:36
TW: So, and then I presented it to him as, "Look. I can do this cube root thing." And I was extremely pleased and very excited about this creative thing of figuring something out and making it work. And that was in, basically in junior high school. And at some point, during that, when I discovered this and I came out of my room and I said, "Mom! I figured out the cube root!" And she said, "Did you finish cleaning up your room?" And I said, "No." She said, "Finish cleaning up your room." So, in other words my mother was just not very impressed with anything I did. You know, complete confidence in me. But somehow, I couldn't impress her.

00:10:14
BA: Mm-hmm. Yeah. [laugh]

00:10:16
TW: Anyway, so that's where the math came from.

00:10:17
BA: The story of the origin of that.

00:10:19
TW: Yeah.

00:10:19
BA: Yeah, I'll ask you a question about your junior high experience in just a minute but before we finish talking about your family I did also what to ask you, do you have any siblings?

00:10:28
TW: I have a brother and a sister.

00:10:30
BA: Okay. And in doing some background research in preparation for this interview, I know you have a sister Kimmen Sjolander—hopefully I pronounced that correctly—who also pursued a career in computing and does research in a similar area. So, I wondered if you could talk a bit about your sister. And she's your twin sister, right?

00:10:50
TW: Right.

00:10:51
BA: Yeah—And how her interests and work relate to your own?

00:10:55
TW: Well, they're actually very similar. We both work on, in some sense, extremely close problems. We just take somewhat different angles for it. So, her PhD is in computer science and mine is in mathematics and she, in some sense, has become more of a biologist over the years and I have become more of a computer scientist. We both have shifted. But her focus has been on protein family identification and to some extent, protein function identification. Mine has been more on the mathematical aspects of phylogeny estimation but both of these problems relate to phylogeny estimation and multiple sequence alignment. So, there's just a lot of overlap in the things that we both think about.

00:11:42
BA: [overlapping] Mm-hmm. Mm-hmm. Is it, you know, have you had people remark that it seems to be a coincidence that you both ended up in very similar areas?

00:11:53
TW: [overlapping] Yeah. Yeah, of course! And I've often been asked, "How did this happen?" And I think later on in this discussion we'll get around to that but I think I need to talk about graduate school before I get around to explaining this one to you.

00:12:05
BA: [overlapping] Okay. Sure. Alright. So, moving on to junior high and high school. You mentioned that this was sort of a time when you, your interests in mathematics peaked. Were there any math, science, or computer classes that you took during this that particularly attracted your attention or paved the way toward pursuing a career in potentially math or computer science later on?

00:12:36
TW: Okay. There were no computer science classes. We'll just start with that. But anyway, when I was in ninth grade, I took algebra with a teacher called Mr. Bernstein and the thing you've got to know about Mr. Bernstein is, he was a rather severe character. He was not warm, he was not engaging. You would never chat him, but he was a very, very good teacher and he had a way of just expecting you to try really hard to do well.

00:13:10
BA: Mm-hmm.

00:13:11
TW: And he got—He inspired me with that expectation. And so, he was teaching algebra and I took to it. I really took to algebra. I mean, whatever, for whatever reason I took to it and I remember discovering what it was like to be really good at it and having a very friendly rivalry with the best student in the class as to, you know, trying to give each other hard problems and see whether or not we could solve them. And that was all out of his class. So, yeah, this one teacher

somehow was just this wonderful inspiration without being a warm, friendly person at all. Just from his rigor, from his expectations of achievement.

00:13:57
BA: And where did you attend junior high?

00:14:00
TW: In Queens.

00:14:01
BA: In Queens. Okay. Were there any other math or science teachers during this time that had an influence on you?

00:14:09
TW: [overlapping] No. He was really—Even though I took some good classes after that, this was the class that sort of opened things for me, and had more of an impact on my thinking about myself as a thinker; from junior high or high—everything taken together.

00:14:28
BA: Mm-hmm. So, you ended up going to the University of California, Berkeley, to pursue your undergraduate education. What made you decide to go to UC Berkeley and what did you decide to major in?

00:14:43
TW: Okay, so, how I ended up going to Berkeley. So, I had started high school at fifteen and dropped out at sixteen.[2] And then I was just sort of like you know, being a young person in New York without being in school and just having jobs.

00:15:02
BA: Mm-hmm.

[2] Correction – Warnow actually started college at fifteen and dropped out at sixteen.

00:15:03
TW: And then I got married and I had a kid and then I got divorced. And so, there I was at essentially, at nineteen years old, on my own as a single parent with a kid. And I had been to California once, at the age of eighteen. And to go from New York City and see the Bay Area, and see how beautiful it is, was just quite an extraordinary experience at eighteen. So, at nineteen I said, "Let's just go back to California." Because at some point, I would want to go back to school. I knew I wanted, at some point, to go back to school and finish my undergraduate education and I said, "We'll just go to California and make it happen there."

00:15:44
BA: Mm-hmm.

00:15:45
TW: So, that's the answer about how I ended up in California. It's just I fell in love with the Bay Area. Now, why math? I just always loved math, you know. That was—I just wanted to be a mathematician. It was either that or an opera singer and it's a lot easier to do math.

00:15:58
BA: Yeah. [laugh] So, math was a very natural sort of inclination for you at this point?

00:16:02
TW: [overlapping] Yeah. Yeah.

00:16:04
BA: Yeah. So, what was it like to be a student at UC Berkeley during this period?

00:16:07
TW: So, Berkeley, it was great for me and I would say that it isn't great for everyone but it was absolutely wonderful for me. And I was interacting with people in the math department, even the way that I got into the Berkeley—See, what you have to know is that the way the University of California system was set up at the time, and it may not be any different yet—

00:16:30
BA: Mm-hmm.

00:16:31
TW: You either are admitted as a brand-new freshman or you basically come in as a junior. And at the time, I had had essentially one semester of college and that's it and so I wasn't at the point where I could come in as a junior. But I had started sitting in on a linear algebra class. Just sitting in on it, you know, like a person from off the street just sitting in on a math class and doing the homework and doing the exams. And the teacher in the class was just really, really happy to have me in his class and other people in the math department were also quite convinced that I belonged there, that they, the faculty petitioned the admissions office to make an exception for me.

00:17:15
BA: Oh, wow.

00:17:16
TW: And they did. They did make an exception. They didn't want to. But their faculty were saying, "You've got to let this person in."

00:17:23
BA: Yeah.

00:17:24
TW: So, they let me in. So, I went to Berkeley and studied math. And so, what was it like? I just used it as an incredible exploration. Like, I took languages. I took German and Italian and—Maybe that's all. German, Italian, and French. I studied music, I studied sight-singing. I read literature, I did religion. I did all sorts of different things in the humanities and of course, I did math. And , while I was doing math I was also doing the theoretical computer science classes. So, I just had a blast.

00:17:58
BA: Mm-hmm.

00:17:59
TW: I mean, it was just wonderful. On the other hand, I was also self-supported. I was not—My education was not being paid for my parents. And I was a single parent. And so, I was just basically taking off every year or two, I would have to take off and earn money to be able to go back to school. And back at that time, they did not have arrangements for single parents to take reduced loads. So, if you didn't take a whole twelve units, you had to drop out.

00:18:30
BA: Mm-hmm.

00:18:31
TW: So, the fact that I was a single parent and self-supported and all that sort of stuff was really rough. And it was not always clear to me that I was even going to finish my undergrad. But yeah, so it was great. But it was also quite a struggle because of finances.

00:18:46
BA: Yeah. So, just to back up for a minute. You talked about getting into this linear algebra class. So, did you have opportunities to take other advanced mathematics because of this? Did that sort of pave the way for you to take more like, graduate level classes or anything?

00:19:02
TW: Oh yeah. As an undergrad, I took graduate level classes but I'm just talking about what I did before I was even admitted.

00:19:07
BA: Okay.

00:19:08
TW: So, I was just—Even without being legal.

00:19:13
BA: Oh. Okay. Right.

00:19:12
TW: I was just sitting in on classes.

00:19:15
BA: Mm-hmm.

00:19:16
TW: So, that—that was the point.

00:19:17
BA: That really helped, yeah.

00:19:18
TW: Yeah.

00:19:19
BA: To get your foot in the door, in other words?

00:19:21
TW: It wasn't to get my foot in the door. It was just that I love math and I just like—They could have kicked me out. They could have said, "You're not a registered student. Leave."

00:19:27
BA: [overlapping] Right. Yeah.

00:19:29
TW: But, you know, it was just that I wanted to learn math.

00:19:31
BA: Mm-hmm. So, you graduated in 1984 with your Bachelor of Science degree in mathematics and then you enrolled in the doctoral program, also at UC Berkeley. So, what made you decide to pursue a PhD? What was the thing that made to decide to pursue graduate study?

00:19:50
TW: [overlapping] Well, if you want to be a mathematician you have to get a PhD. So, I mean that was clear. The big debate was, was I going to do math or was I going to try to do computer science? Because the kind of work that I was doing was right in the intersection of theoretical computer science and math.

00:20:06
BA: Mm-hmm.

00:20:07
TW: And basically, I could have done that work either way and at the time, I asked people you know, what I should do. Should I go for computer science or should I stay in math? And in the end, I decided to stay in math because it was easier. If I had gone for a degree in computer science, I would have actually had to have learned a lot more of the stuff I just didn't know. Like, I knew a lot of algorithms and I knew a lot of just theoretical computer science but I didn't know anything about software. I didn't know anything about hardware. And so, it was just an easy path forward to stay with math.

00:20:38
BA: So, and I don't know if this, you know is something that was more—It happened more during your graduate school years or your undergraduate years but so, you'd mentioned that you were taking these theoretical computer science courses. So, what attracted you to that? And what made you think that your, or maybe you didn't think at the time, but that your research and interest was at this intersection of computer science and math? How did that happen?

00:21:08
TW: I think the way to think about it is that about is that the kinds of math that I really liked was discrete math. And discrete math is done in both disciplines.

00:21:15
BA: Okay.

00:21:16
TW: So, it wasn't really so much—The other thing is I liked algorithms and algorithms are more often done in computer science than they are done in math. But they're really done in both. So, it was just the same work in either department.

00:21:31
BA: I see. Okay. So, what was it like to be a doctoral student at UC Berkeley? Did it—Was your experience different from being an undergrad?

00:21:41
TW: Yeah. Let's see. I was in math and the math department at Berkeley at that time was very different from the computer science department at that time and my advisor was in computer science. So, my experience in the math department was colored by how the math department dealt with its students which was almost like a zoo. You know, take in a lot of students, get them to TA for you and then get rid of almost everyone.

00:22:13
BA: Oh. Okay.

00:22:13
TW: It changed over the years.

00:22:14
BA: Yeah.

00:22:15
TW: But it was just—It was not a fun place to be a student in the math department. But on the other hand, my advisor was in computer science and increasingly, I was just essentially, just in the computer science department

because that's where my advisor was. That's where several people on my dissertation committee were; that's where I was taking classes. That's where all my friends were. And so, in some sense I lived in both communities. The math department community, and the CS department community. And so, what was it like? It was, putting aside the math department stuff, just putting aside that and just saying what was it like to be there at that time, in that research community? It was amazing.

00:22:57
BA: Mm-hmm.

00:22:58
TW: So, the context is that my PhD advisor was Gene Lawler, who is a—someone from the, basically, optimization community. And on my PhD committee was Dick Karp, and Manuel Blum, David Gale, and Dan Gusfield. Of that set of four, two of them are Turing Award winners. So, two of them were these incredibly famous theoretical computer scientists and the other two were well-known mathematicians or computer scientists also. And the community of students that I was with were incredible. Silvio Micali and Shafi Goldwasser who went on to get Turing Awards. And you might have noticed my door has pictures of these two people. Those two are Turing Award winners.

00:23:45
BA: Mm. Mm-hmm.

00:23:45
TW: They were just in the same group of people. So, we had this extraordinarily strong group of graduate students in theoretical computer science, an extraordinarily strong group of faculty in theoretical computer science, and this—Other people in that group were like {unintelligible} Vijay Vazirani. Barbara Simons was in, not one of the students, but she was in our social setting. So, she was just an example of someone in my community now. Now, who is Barbara Simons and why was she so significant?

00:24:24
BA: Mm-hmm.

00:24:25
TW: She was a friend of a bunch of the faculty. They all used to like live in some big commune together and she was always dressed in black. And she was this really thoughtful interesting person. And I still see her. So, she's the ex-wife of the Simons who has the Simons Foundation and the Simons Institute. It's like there's this connection, all of these people were together. And it was a time when theoretical computer science was just bursting and having a huge growth. And these—Everyone who got their PhDs at that time from that group would just go on and immediately get a position in a top five CS department. It was an amazing experience.

00:24:59
BA: Wow. Yeah.

00:25:00
TW: So that was part of it. Just this amazingly smart bunch of people. Faculty and students. All of us extremely close and they would just go off and have these incredibly stellar careers. The other thing that was happening was, that was right around when the Human Genome Project was happening up at the Lawrence Berkeley Lab. So, LBL was doing the Human Genome Project and that was percolating into mathematics and into computer science. The Program for Mathematics and Molecular Biology got started and Sylvia Spengler, who is now at NSF, was running it. People in computer science around the world, but especially right there, were starting in this area.

00:25:44
BA: Mm.

00:25:45
TW: And my advisor was one of the very first people to get involved. So, my advisor was getting involved and Gusfield was getting involved. Dick Karp got involved a little bit later. I mean, it was just this explosion of interest coming from theoretical computer scientists moving into this area of computational biology.

00:26:04
BA: Mm-hmm.

00:26:05
TW: So, it— A very exciting time for both, for the theoretical computer science and for the beginnings of bioinformatics from computer science. Fantastic time.

00:26:17
BA: Yeah. Sounds like an incredible intellectual environment to be enmeshed within.

00:26:21
TW: Yeah, it was extraordinary, a moment in history.

00:26:23
BA: Yeah. Yeah.

00:26:24
TW: You know?

00:26:25
BA: Definitely. So, you ended up working on your dissertation, which was title, correct me if I'm wrong, "Combinational Algorithms for Constructing Phylogenetic Trees."

00:26:36
TW: It's actually "Combinatorial Algorithms."

00:26:38
BA: Oh, okay. Thank you. [laugh] I assumed I was getting something wrong. [non-interview dialogue] So, if you could talk about your work on your dissertation, why did you pick this topic? [non-interview dialogue]

00:27:00
TW: Combinatorial.

00:27:01
BA: Combinatorial. Okay. Thank you.

00:27:02
TW: Okay.

00:27:04
BA: I don't know why I'm reading that combinational, that wouldn't make sense, I guess. "Combinatorial Algorithms for Constructing Phylogenetic Trees," let the record be set straight. [laugh]

00:27:12
TW: Yes.

00:27:13
BA: Which you completed in 1991.

00:27:15
TW: Yep.

00:27:16
BA: Okay. Could you talk about your dissertation and what led you to this particular topic?

00:27:21
TW: Well, to be honest there is, happened is while I was a graduate student, my—So, my PhD advisor had just started getting involved in computational biology mostly because of problems that had to do with like string matching, which have to do with like genome assembly and genome comparison. But he also got interested in evolutionary trees and there was this extremely beautiful

math problem that didn't sound like it had anything to do with biology, which was just a graph problem called triangulating colored graphs. And so, he was connected to people like Chris Meacham who came from that community, the phylogeny community. He was a biologist but someone who had some mathematical skills and insight. And they had worked on this mathematical problem, which is equivalent to something called perfect phylogeny. So, the mathematical formulation as triangulating colored graphs was just a beautiful problem that I got turned onto because it was graph theory problem. And I loved it. So, I worked on that problem because of how pretty it was.

00:28:21
BA: Mm-hmm. Mm-hmm.

00:28:22
TW: [overlapping] Okay. The reason people do math, at least like the half of the people who do math, is because it's pretty. Okay? Not because it's useful. Just because it's pretty.

00:28:30
BA: [overlapping] [laugh] Yeah.

00:28:31
TW: And this is a really pretty problem. In fact, it was a beautiful problem and so it hooked me.

00:28:35
BA: Yeah.

00:28:36
TW: And I got involved in biology through this beautiful math problem.

00:28:39
BA: Hmm. Could you describe what it looks like in some way? I don't know if that's possible.

00:28:47
TW: [overlapping] I'm willing to tell you the problem but now that you've asked, and so now you're going to have to have a two-minute description.

00:28:51
BA: [overlapping] [laugh] Sure.

00:29:02
TW: Do you have a pen?

00:29:04
BA: I do, yes.

00:29:05
TW: Okay, what you have to imagine is, this is a graph.

00:29:07
BA: Mm-hmm. [non-interview dialogue]

00:29:12
TW: So, this a graph, it has vertices and edges.

00:29:15
BA: Mm-hmm.

00:29:16
TW: And I'm going to color the vertices, so this is going to be black and this is going to be red. Okay? R for red B for black. So, this is a graph that has two colors, okay? Now, a triangulated graph is one where there's none of these cycles. Okay? But you can have a cycle of length three but you can't have a cycle of length four. So, if I had drawn this, this is a graph that has a cycle of length four but it has something called a chord so that the largest simple cycle is of size three.

00:29:51
BA: Mm-hmm.

00:29:52
TW: There's no—This one has a cycle of size four, okay? This is called a triangulated graph, okay? Because it has these kinds of triangles. Because it has no cycles of length four or bigger. This one is not triangulated, okay? So, the question is, I give you a graph and you ask, "Can you add edges to make it triangulated?"

00:30:14
BA: Hmm.

00:30:15
TW: So, I can always add an edge to make it triangulated, right?

00:30:19
BA: Mm-hmm.

00:30:20
TW: Now it's triangulated. But I've added an edge between two black vertices.

00:30:24
BA: Okay.

00:30:25
TW: That's not allowed.

00:30:26
BA: Oh. Okay.

00:30:27
TW: Or I could have added this edge, but that's also not allowed. So, because it's a colored graph you're not allowing yourself to add edges between vertices of the same color.

00:30:37
BA: Mm-hmm.

00:30:38
TW: So, you're just asking, if I give you a graph and then ask you, "Can you add edges to triangulate it?" So, red, blue, red, blue, green. Can I add edges to triangulate this? And the answer is yes, I can just add all of those edges. Right?

00:30:56
BA: [overlapping] Okay. I see.

00:30:58
TW: Okay. So, that's a problem and it's just called the triangulated colored graphs problem. I give you a graph, I give you colors on the vertices and I say, "Can you add edges to triangulate it? But you can't add edges between vertices of the same color." So, that's a question, yes or no? Right? That problem is a graph problem. It doesn't look like it has anything to do with biology but in fact, it's exactly the same thing as constructing evolutionary trees under some conditions.

00:31:23
BA: Mm. Hmm.

00:31:25
TW: Okay? So, that problem doesn't look like biology.

00:31:30
BA: Right.

00:31:30
TW: That's the problem that hooked me.

00:31:32
BA: Wow. Yeah.

00:31:33
TW: You can see that it has—

00:31
BA: [overlapping] That's incredible.

00:31:34
TW: You can see why it wouldn't look like biology.

00:31:35
BA: Yeah. Yeah. Definitely. That's—that's fascinating.

00:31:38
TW: Bizarre, right?

00:31:39
BA: Yeah. Yeah.

00:31:40
TW: Okay. Go on.

00:31:42
BA: Yeah, so, let's see, where was I? Just to back up a minute, you had mentioned your sister. We talked about your sister and her work which was very similar, or is very similar to your own. So, what was she doing during this time? Was she interacting with you at all as you were working on your dissertation?

00:32:05
TW: So, what happened is that she and I had both started college early and then dropped out. And I had gone back to college earlier than she had.

00:32:18
BA: Mm-hmm.

00:32:19
TW: But she went back to college after I had gone back to college. So, she went back to do her undergraduate while I was doing my graduate work.

00:32:25
BA: Mm-hmm.

00:32:26
TW: And then she, so she went to Santa Cruz, and when I was finishing my graduate work, she was basically starting her graduate work.

00:32:37
BA: [overlapping] Mm. Mm-hmm.

00:32:38
TW: So, she went and did her undergraduate and then she stayed to do her graduate work.

00:32:41
BA: [overlapping] Okay.

00:32:42
TW: And that was also at Santa Cruz. And you remember how I said that the theoretical computer science community was getting involved in computational biology?

00:32:48
BA: Yeah.

00:32:48
TW: [overlapping] And it was just like, spreading. So, my advisor was working on you know, one set of problems from a sort of algorithms and optimization viewpoint and she was working with David Haussler who had also gotten interested. So, he was just one of the people who got, you know, caught up with this desire to work on biology.

00:33:09
BA: Mm-hmm.

00:33:10
TW: And she was, so she was just caught up in this wave just like I was. So, really the reason that we both got into this area is that we were both in the same place at the same time.

00:33:21
BA: Mm.

00:33:22
TW: [overlapping] And so many of us in computer science were just getting pulled into this because our advisors were getting interested in it.

00:33:27
BA: Mm. Mm-hmm.

00:33:28
TW: So, we were all getting involved in it. And then you could say, well, granted that's biology but how come she got involved in evolution as well?

00:33:34
BA: Right.

00:33:35
TW: I mean evolution is just fun. I mean, evolutionary trees are just sort of— Everyone wants to know how life evolved. And she was more interested in proteins but because that's what her advisor was interested in. But you know, this is just a beautiful research area so it's pretty natural that we would both end up working on this.

00:33:49
BA: [overlapping] Mm-hmm. Mm-hmm. So, when you finished your dissertation, what sort of questions were you left with that you felt that you really wanted to continue exploring?

00:34:00
TW: I didn't have any. I didn't—I mean, other than I was still working on—

00:34:04
BA: Mm-hmm.

00:34:05
TW: This triangulated colored graphs problem and several different extensions of it.

00:34:08
BA: Mm-hmm.

00:34:09
TW: I had mathematical problems that I was still working on but I didn't have any specific driving direction. I wasn't even sure that I was going to continue on and do research. At one point I thought of just going into law school or something. I mean, I just really wasn't sure what was I going to do. But

fortunately, I got a really great post-doc. And that sort of gave me more—More desire to keep going.

00:34:38
BA: Mm-hmm. Mm-hmm. So, you have a post-doc at the University of Southern California, right? Where you had worked with Michael Waterman and Simon Tavaré, hopefully I said that correctly.

00:34:51
TW: [overlapping] Mm-hmm.

00:34:54
BA: Could you talk about your post-doc experience and what you worked on during that period?

00:34:56
TW: [overlapping] Yeah, so I was there for one year. And it was, again, it was another one of these interesting groups. So, I guess one of the things that I've realized is that so much of what happens is you end up in an interesting group of people. And it's the people as much as anything that influence you. So, Mike Waterman had working with him, Mike Waterman and Simon Tavaré, they had a group of people that were working with them and that group included Pavel Pevzner, who is now at UCSD, and it included Martin Vingron who is now in Berlin. And these people were working on different problems but we were all interacting together. And the main thing that I got out of that time there was the realization that what mattered in that research area was not how hard the theorem was but rather whether or not the method that was being developed was going to be relevant to any kind of application.

00:36:01
TW [cont.]: So, it was a very shocking discovery. That what mattered was not the math but the usability.

00:36:07
BA: Mm.

00:36:08
TW: Because that's not really what pure math is about. What pure math is about is, is about how beautiful it is. And not whether or not it's useful. So, it was—It was a very interesting experience to sort of discover a differ aesthetic.

00:36:21
BA: Mm-hmm. Mm-hmm. So, after USC, you went to Sandia National Labs, for a second post-doc, correct?

00:36:33
TW: Right.

00:36:34
BA: And what year was this in? Was this in 19—

00:36:35
TW: 1992 to 1993.

00:36:37
BA: 92 to 93. So, what did you work on at Sandia?

00:36:41
TW: So, it's not—So, I worked on more combinatorial optimization problems that were related to phylogeny estimation and the interesting thing there was that it was a group of people in what was called the Discrete Algorithms Group and run by this guy named Ernie Brickell. And it was, you know, in a—on an air force base working for a lab that really was largely interested in weapons research. And I wasn't doing anything related to weapons research but I was just working on whatever I wanted to. I mean, these were two years in which the first year at USC and then the second year at Sandia where I just did anything I wanted. Anything that was fun and that inspired me, I could work on. So, there was nothing that I was told to work on. I just did anything I wanted.

00:37:31
BA: Were there any fellow researchers there who you worked with on anything in particular? Anybody who had influence on you?

00:37:38
TW: [overlapping] Nope. I mean there were people that I collaborated but it was more just because they were fun for working on math puzzles.

00:37:44
BA: Right, yeah.

00:37:45
TW: You know, so that's all.

00:37:46
BA: Mm-hmm. And then in 1993 you joined the Department of Computer and Information Science at the University of Pennsylvania.

00:37:54
TW: Right.

00:37:55
BA: Where you worked until 1998? So, could you talk about your time at Penn?

00:37:59
TW: So, the best thing that happened at Penn was being introduced to Don Ringe. And Don Ringe is a linguist. R-I-N-G-E.

00:38:10
BA: Mm-hmm.

00:38:11
TW: Who worked on the evolution of languages, and specifically Indo-European languages. And the thing that happened there and the reason it was so significant for me is that I had already done some research that I thought might be relevant to reconstructing trees on some kind of data and we were introduced by a collab—by a fellow colleague of mine with the idea that maybe we would find something that we could work on together. But when we started talking, he started describing the linguistic data and how languages evolve according to what they understand and it made me realize that it—What I thought we were going to do was not what we were going to do but opened up a collaboration that led to something like fifteen papers—

00:38:53
BA: Mm-hmm.

00:38:54
TW: Over the next few years. And several grants. And it was just an incredibly wonderful time and the main point is that my research went from being mathematics that was problem solving, combinatorial mathematics that had no data—To being completely data driven. So, working on linguistic data and modelling the data and trying to understand how languages evolve by modelling the data, developing methods under those models was an [stammers] incredible experience and transformed the way I think about research. And it's all because of working with him.

00:39:34
BA: Mm-hmm. So, you—There was an article published in the New York Times in 1996 about this research.

00:39:40
TW: Right.

00:39:41
BA: If I'm correct. And it was on the Indo-European language groups. So, could you talk about that specific work that you did on the Indo—

00:39:53
TW: Indo- European.

00:39:54
BA: Yes.

00:39:54
TW: Yes, so, exactly. So, when I first met Don his basic statement was, "Look. We've got this data, we have a certain understanding about how they evolve. We have certain methods we can use but it only goes so far and what we did together, what Don and I did together, is formulate models of language evolution that allowed us to extract much more information from the same data. So, without changing the data, just developing better tools to analyze the data we were able to resolve the Indo-European history to a much greater extent.

00:40:26
BA: [overlapping] Mm-hmm.

00:40:28
TW: So, there are big controversies in the field, there still are, but they were especially big controversies back then, that our analyses largely put to rest many of them. And one of the things that was really remarkable about Don Ringe is that when we started working together, he was pretty sure that that evolutionary history of Indo-European would have certain features but after we did the method development and did the analysis of the data, it didn't turn out that way.

00:40:53
BA: [overlapping] Mm-hmm. Hmm.

00:40:55
TW: And so, he changed his opinion. And it showed me what it was like to be someone who was so rigorous and true that you would adjust your assumptions because you learned something new. Not everyone will do that.

00:41:10
BA: Mm-hmm.

00:41:12
TW: It was incredible to work with him.

00:41:14
BA: Mm-hmm. And how long did you work on that specific project with him?

00:41:19
TW: Well, it's the same project and we worked together. I don't—We didn't really even ever completely stop. And at some point, we'll start again.

00:41:26
BA: Yeah. [laugh]

00:41:27
TW: So—

00:41:27
BA: So, it's ongoing in other words.

00:41:28
TW: [overlapping] Yeah.

00:41:30
BA: Were there any other colleagues who you worked with at Penn?

00:41:32
TW: So, the other person who had a really big influence on me at Penn was a post-doc that I hired, Ken Rice, who came from Harvard where he had done a post-doc with Michael Donoghue and then he became my post-doc. And he—

The thing that I got from working with Ken Rice is that he taught me how to use simulations to explore methods.

00:41:54
BA: Mm-hmm.

00:41:55
TW: And that was, okay, there's two types of data now. There's quote unquote real data and then simulated data and both types of data complement what you understand from a purely mathematical perspective. And so that was the really big experience I had was working with Ken Rice.

00:42:11
BA: Mm-hmm. So, did that change the nature of your research from then?

00:42:15
TW: Yes, absolutely.

00:42:17
BA: Yeah.

00:42:17
TW: Because the insights I got into methods from simulations was just as important as the insights I got from working with real data and both of them really, really flesh out what it means to do mathematics.

00:42:35
BA: So, moving on to UT-Austin. In 1999, you moved to the University of Texas at Austin's Department of Computer Science where you were for fifteen years, correct? So, how did your research evolve during this time?

00:42:51
TW: Well, it became more project driven. I think—I guess that would be the answer. That when I got there, shortly after I arrived there, the head of

Integrative Biology got in touch with me and said, "You know, I wrote an NSF proposal and it didn't get funded because they said I needed someone who did method development. Would you like to work with me?" And so, we got together and he told me about the problem he was working on, and that was Bob Jansen. And that let to developing again, methods and models for looking at genome scale evolution, and that research together led to some multi-institutional projects that involved people at the University of New Mexico and other places. So, increasingly I got involved in more data-driven research.

00:43:35
TW [cont.]: Getting data where the methods to analyze the data were inadequate, developing models for evolution and then methods based upon those models. And it was, you know, so basically, the theme is someone who's got data and the methods don't — They're not adequate and you need new mathematics and then you need methods based upon the mathematics and then you develop new understanding about the biology by this kind of cycle. It's—that was sort of what happened increasingly at Texas. I also got with Randy Linder, who was working on what's called reticulate evolution and that was again the same kind of data that need new methods. They need new models; they need new mathematics. And that led to these multi-institutional collaborations with people who would each bring in their own expertise.

00:44:21
BA: Mm-hmm. During this time did you still work on the historical linguistics research as well?

00:44:27
TW: [overlapping] I still working on historical linguistics with Don Ringe, yes. And with a student that I had at Penn, sorry, at Texas and then with a probabilist/statistician at Berkeley, who is Steve Evans. So, again, this multi-university,…

00:44:43
BA: Mm-hmm. Yeah.

00:44:44
TW: …multidisciplinary approaches.

00:44:46
BA: Sure. Yeah. So, at UT you were a member of several programs, including the Institute for Cellular and Molecular Biology and Computational and Applied Mathematics. So, how did your exposure to these different units or programs affect your perspective on computer science as well, since you just talked about these large-scale projects that you became involved in?

00:45:09
TW: So, I don't think that these things really affected the way that I think about computer science so much as, as my work was becoming more and more collaborative and more involved with data—

00:48:22
BA: Mm-hmm.

00:45:23
TW: My interactions with people from different departments were becoming richer and more connected. The one thing that was certainly going on at Texas that was extremely valuable finally was the fact that it had a big supercomputer. So, the TACC supercomputer was extremely helpful to me there.

00:45:41
BA: Mm-hmm. Could you talk about Project CIPRES?

00:45:45
TW: The CIPRES Project.

00:45:46
BA: Yes.

00:45:47
TW: So, the CIPRES Project was one, was a, something like almost twelve-million-dollar thing from NSF but we—This was something which was spearheaded by basically me and Bernard Moret from the University of New Mexico with some of our colleagues to try to build a computational infrastructure so that people could do really large-scale phylogeny. So, that would mean new mathematics, new algorithms, new database technology, supercomputers. All this kind of stuff. And we brought together people who worked on these problems from different disciplines and different perspectives and the leading people in this area, like Wayne Maddison and Mark Holder and Dave Swofford and some of these people are biologists who did software development. And they were actually more skilled at software development and algorithm development than most computer scientists. It was really quite an amazing experience. The first time we wrote the grant for NSF to get this, a proposal to NSF, we didn't get the money. The second time we did it we got the money. But the point is that this team that came together transformed this field.

00:46:51
BA: Mm-hmm.

00:42:52
TW: Because as a result of this project, something like 60 people from theoretical computer science moved into this area and it really transformed the field. So, it was a fantastic historical time.

00:47:05
BA: Mm-hmm. And just for the listeners, CIPRES stands for Cyber Infrastructure for Phylogenetic Research, correct?

00:47:11
TW: Yep.

00:47:12
BA: So, what was your role in this project specifically?

00:47:15
TW: So, the—I was one of the people who basically got it to happen but I was also the second director. The first director was Bernard Moret and when he went to Switzerland, I came, took over as the second director.

00:47:30
BA: Mm-hmm. Okay.

00:47:31
TW: And I was the head of the algorithms research throughout.

00:47:34
BA: Throughout, and sorry if you already said, but is this project still ongoing? So, it did end?

00:47:41
TW: {overlapping] No, it's over. But there's something called the CIPRES gateway.

00:47:44
BA: Okay.

00:47:45
TW: Which is the continuation of the effort.

00:47:47
BA: Ah. I see.

00:47:48
TW: So, people when they know about CIPRES, they know about it now as the Gateway.

00:47:50
BA: Mm-hmm.

00:47:51
TW: But that's the—That was the continuation of the CIPRES Project.

00:47:55
BA: Okay. So, I want to get to your time here at the University of Illinois. In 2014 you left UT-Austin and you came to the University of Illinois as Founder Professor in Bioengineering and Computer Science. How does the academic environment here at Illinois compare to UT-Austin or Penn, how would you say?

00:48:17
TW: It's very similar to Texas.

00:48:20
BA: Mm-hmm.

00:48:20
TW: In many ways, it's very similar to Texas.

00:48:25
BA: In what ways?

00:48:26
TW: Well, it's a relatively big department in a state school with a fantastic supercomputer. [laugh] And a strong computer science department.

00:48:36
BA: [overlapping] Mm-hmm.

00:48:37
TW: That's—Those are the ways in which similar. I think that one of the ways in

which it's different is, at least for me, it's even more collaborative than it was. The computer scientists are more collaborative with each other and then they're more collaborative with me. So, there's more opportunities for me here than I had at Texas in terms of collaboration with computer scientists. I had lots of collaborations with biologists there. I have more collaborations with computer scientists here.

00:49:00
BA: Mm-hmm. Are there also more opportunities for advancement in terms of administration here?

00:49:07
TW: I don't know yet. [laugh] I—you know, you don't know what the opportunities are unless you ask for them and I haven't asked for them. So, I don't have an answer for that one.

00:49:18
BA: Okay.

00:49:19
TW: I guess we'll find out, we'll find out since there is so much turnover here we will see who gets advanced into those positions.

00:49:27
BA: Alright. So, here at Illinois are there any colleagues or friends or administrators who have been particularly influential to you in your work?

00:49:37
TW: So, I would say that Bill Gropp who's the head of NCSA. He's actually part of the reason I came, because when they were recruiting me, he told me how, what kind of support I could expect in terms of computational infrastructure, and that was extremely helpful. And right now, he and I are on a grant together.

00:49:56
BA: Mm-hmm.

00:49:57
TW: Another person who is very helpful here is Chandra Chekuri who is another algorithms person and we have a grant together. And then another person here is Becky Stumpf and Becky Stumpf is an anthropology professor.

00:50:06
BA: Mm.

00:50:07
TW: And we actually collaborate. So, we've co-supervised a post doc and we're co-supervising, in a sense, we're working with one of my grad students, is working with her as well. Two of my grad students are working with her. So, I have a collaborator in anthropology doing microbiome research.

00:50:24
BA: Mm. Okay. I also want to talk about your engagement with professional organizations and ask if—what capacity you've involved in associations like ACM, or others? If you could talk about that.

00:50:39
TW: So, I'm a member of the ACM and recently elected fellow of the ACM. And I'm chairing their Paris Kanellakis Theory and Practice Award.

00:50:47
BA: Mm-hmm.

00:50:48
TW: I really like the ACM and I'm very glad to be supporting it. I've been involved and I'm also a fellow of the International Society for Computational Biology. I'm not doing anything specific for them but on the other hand, in the past I was on the board of directors.

00:51:04
BA: Mm-hmm.

00:51:05
TW: So, that's the answer for those two. You wanted, probably wanted, to know a little bit more about what it's like to chair that awards committee?

00:51:14
BA: Yes.

00:51:15
TW: So, this is a super interesting thing because this awards committee is for theoretical computer science that an impact on some application area. That's very near and dear to my heart but last year when I was on the committee, the people who were being nominated were so phenomenal that it made me realize, "Okay. They're really doing great stuff, you know? I'm not going to get this award. They're the ones who are getting it and they deserve it."

00:51:36
BA: Mm-hmm.

00:51:37
TW: They're amazingly strong people doing beautiful work that has a big impact.

00:51:41
BA: Mm-hmm. And how long have you been in that capacity? As the chair of the committee?

00:51:44
TW: [overlapping] Well, I think this is my second year.

00:51:46
BA: Your second year, okay.

00:51:47
TW: But now I'm chairing it.

00:51:49
BA: Mm-hmm.

00:51:50
TW: And I'll do it one more year after this.

00:51:51
BA: Okay. Alright, so now I want to talk about teaching and pedagogy. So, what are your favorite aspects of teaching?

00:51:59
TW: I love having graduate students.

00:52:01
BA: Mm-hmm.

00:52:01
TW: I just, I mean, it's an incredibly intimate relationship and the connection is like, forever. So, I really love having PhD students, specifically. That's the, my favorite part about teaching.

00:52:15
BA: Does your approach to teaching undergrads differ from your approach to teaching graduate students?

00:52:21
TW: In the class it differs but not a lot. I try to do the same things in classroom teaching just with somewhat reduced expectations but not entirely reduced.

00:52:22
BA: Mm-hmm.

00:52:33
TW: Obviously everyone needs to learn stuff but they also need to like do something that's independent. It's the difference between classroom teaching and non-classroom teaching. So, with research students whether they're grad students or undergrads, it's an intimate relationship. In classroom stuff, it's not as intimate.

00:52:51
BA: Mm-hmm. Mm-hmm. So, what is your approach to research mentorship for graduate students?

00:52:57
TW: I try to help them get to the point where they'll be successful, in, as independent researchers. And that means I have very, very high standards for them. Both in terms of their research but their presentations, what they write, how they interact with people. So, it's constantly pushing them to attain a very, very high level and to have extremely high standards for themselves, and perfectionism.

00:53:30
BA: Have you encountered any challenges in teaching that you'd like to talk about? [laugh]

00:53:26
TW: Teaching in classes or teaching in—What kind of teaching are you asking about?

00:53:28
BA: Just in general. Teaching undergrads or graduate students.

00:53:32
TW: [overlapping] Classroom teaching is always challenging. I mean, teaching is

always challenging no matter what. What makes classroom teaching challenging is that, especially in a large class, you can't personalize things enough. And a lot of people that you, I mean, if they would come to your office hours, you could personalize it. But they—Too many students just don't go to office hours.

00:53:51
BA: Mm-hmm.

00:53:51
TW: The challenging thing with classroom teaching is you want to give them stuff and if they don't come, they can't get it.

00:53:56
BA: Right.

00:53:57
TW: The challenging thing with one on one stuff is that not everyone, I mean, the most important thing is building the relationship and it doesn't always work.

00:54:06
BA: Mm-hmm.

00:54:07
TW: When it works, it, then you can take people who have weaknesses and you can really help surmount them but if they don't build that relationship—

00:54:14
BA: Mm-hmm.

00:54:15
TW: Or if you don't build that relationship, whatever. Then it just doesn't work. That's the frustrating thing with the mentorship.

00:54:19
BA: [overlapping] Mm. Mm-hmm. Yeah. So, you recently published with Cambridge University Press, *Computational Phylogenetics: An Introduction to Designing Methods for Phylogeny Estimations*. And so, this is a textbook that you recently published and worked on. What inspired you to write this textbook?

00:54:41
TW: I was teaching a graduate class and I kept, and there were no good textbooks for this, and so I just kept adding to my notes. And eventually I thought, "Okay. At this point, I should just turn it into a book."

00:54:52
BA: Mm-hmm.

00:54:53
TW: And that's why I wrote it. Ten years. But it eventually got written.

00:54:56
BA: Oh wow. [laugh] So, could you talk about the cover design for this textbook? It depicts a Monterey Cypress Tree?

00:55:08
TW: Right. So, the question is why? Well, you remember we talked about the CIPRES Project?

00:55:11
BA: Yes.

00:55:12
TW: The logo for the CIPRES Project is that specific tree.

00:55:16
BA: Mm-hmm.

00:55:17
TW: So, that's why. It's just honoring the project.

00:55:19
BA: Mm-hmm. So, you mentioned that this took ten years for you to work on this textbook and you wanted to write something that wasn't there. That had not been written yet. Was there anything else that you were—Oh wow.

00:55:37
TW: Photo of the same tree I just took on a trip to Monterey.

00:55:39
BA: Oh wow. It's a beautiful photo.

00:55:43
TW: Yeah. Okay. So, you were asking?

00:55:45
BA: So, it took you ten years to write this textbook and you were essentially writing something that had not been written yet. So, there was definitely a need for this in the classroom and otherwise. Was there anything else that you were trying to accomplish in writing this textbook that perhaps relates to or does not relate to your larger approach to teaching or pedagogy?

00:56:10
TW: It's really a combination of a scholarly book, of putting together a place where all these, you know, innovative ideas would be available for future algorithm developers and also an attempt to make something accessible about the theoretical foundations of phylogeny to people who don't have mathematical training. So, trying to make it actually understandable why these things work, why they don't work to biologists. And I've always had biologists in my classes, so trying to communicate very abstract concepts.

00:56:41
BA: [overlapping] Mm-hmm.

00:56:42
TW: So that they would understand the tools that they were working with, and understand the conditions under which they worked and the conditions under which you no longer had such guarantees.

00:56:50
BA: Mm-hmm. Mm-hmm. Could you describe your writing process for this book?

00:56:59
TW: A lot of anxiety, right? [laugh] You don't want to say anything false so you're constantly looking to see is there anything wrong.

00:57:54
BA: [laugh] Yeah.

00:57:05
TW: Yeah.

00:57:07
BA: Was there anything that you ended up taking out of the book?

00:57:10
TW: I had a whole section on historical linguistics and I decided that I just didn't have time to include it. So, I took it all out. I had material about reticulate phylogenies that I took out. I had material about genome rearrangements that I took out. So, in the end I just took out stuff because there wasn't going to be time to do justice. But those may end up in later books. Who knows?

00:57:36
BA: Mm-hmm. Were there any particular influences or did anybody influence you in writing this textbook?

00:57:44
TW: Only in the sense that, so one thing that's interesting is one of my former post docs had written a very nice textbook on phylogenetic networks. And so, I had been looking at other people's books to see if there were ideas or presentations that would be very useful for me. And his book on phylogenetic networks was so beautifully written that I used some of his presentations and I used some of his images and he's credited. So, he's Daniel Huson.

00:58:15
BA: Mm-hmm. Mm-hmm.

00:58:16
TW: Yeah.

00:58:17
BA: What are the takeaways that you hope students will have from the textbook?

00:58:22
TW: That you can't approach this research purely mathematically. You have got to look at data.

00:58:28
BA: Mm.

00:58:29
TW: At the same time, if you don't have the mathematical foundations, you don't have the intuition you need to understand things. So, it's really this work needs data-driven understanding and mathematical foundations. So, that's, I guess the take-home is you need both.

00:58:43
BA: Mm-hmm.

00:58:44
TW: And the other take-home is that what happens on small data sets is not what happens on big data sets and so you need new methods.

00:58:50
BA: Hmm. Mm-hmm.

00:58:51
TW: Those are the two take-homes.

00:58:53
BA: So, if you were to describe your research process, what would that look like?

00:58:59
TW: So, it's basically, I'm a puzzle solver in a sense. I'm a detective, right? And you're trying to solve a problem and the problem is not going to yield from just one perspective and so you keep looking at it from multiple perspectives going back and forth and back and forth. So, it's sort of alternating between looking at something from a purely mathematical standpoint to doing simulations to looking at biological data to developing methods to looking at results and it's just a cycle between these different perspectives in order to get new methods that work well. So, it's cyclical alternating viewpoints.

00:59:32
TW: Mm-hmm. What would a typical day look like for you?

00:59:36
TW: Typical day is just busy with email.

00:59:38
BA: [laugh] It takes over, doesn't it, yeah?

00:59:44
TW: I get time to myself in the morning. I get up around five o'clock in the morning.

00:59:45
BA: [overlapping] Mm-hmm.

00:59:46
TW: And I have coffee and that's when I do work and have some, a chance to think about things. And then after that I'm just busy.

00:59:53
BA: Mm-hmm. Yeah.

00:59:54
TW: I think everyone has that life; it's only a question of what time they wake up.

00:59:58
BA: Yes, definitely. Are there any specific events in your career thus far that you consider to be the most rewarding?

01:00:07
TW: The work with, well two things. The work with Don Ringe was just one of the highlights of my life. Some of the grad, some of the PhD students I've had, just really love them to pieces. The collaborations, whether it's with a graduate student or with someone else, I mean, it's the collaborative, it's doing with someone that you can't do by yourself. And that makes it so wonderful. And not everyone feels that way. Some people really prefer to work by themselves but I just love a good collaboration. It's a big deal for me.

01:00:47
BA: Mm-hmm. So, what challenges have there been in your career?

01:00:52
TW: Well, so you might remember I said something about the shock I had when I went to USC?

01:00:57
BA: Mm-hmm.

01:00:58
TW: That what they cared about was whether or not something was useful? That was very much in conflict with my expectations of pure math, that all that mattered was how beautiful it was. And how hard it was. When I was an assistant professor at the University of Pennsylvania coming up for a third-year review, I had to write a statement about myself and what I was working on and what I cared about and I—When I was doing that, I was realizing that what I cared about was doing stuff that was relevant to an application.

01:01:25
BA: Mm-hmm.

01:01:26
TW: That I would develop methods that were useful on biological data or that was useful on linguistic data and I didn't really feel comfortable admitting that because mathematicians don't care. And in fact, if anything, they don't want it to be useful. So, that was the, probably, the biggest challenge is that recognition of myself as having changed.

01:01:45
BA: Mm-hmm.

01:01:46
TW: And gone from being the pure high priest. [laugh] Or, you know, or at least trying to be a high priest.

01:01:53
BA: Right.

01:01:54
TW: In a religion to being someone who cared about something as mundane as analyzing data.

01:02:00
BA: Yeah. Have you oscillated at all back to your prior position or do you think you're still more interested in the usability aspect of your work?

01:02:08
TW: [overlapping] I like doing mathematical theorems periodically but it's more because I think it's fun. I'm way more driven by developing methods that will be useful on biological data, than I am in the theorem-proving. Theorem-proving for me now is like a luxury.

01:02:26
BA: [laugh] Hm. Yeah.

01:02:27
TW: If I get to do it, that's fun.

01:02:28
BA: Right.

01:02:28
TW: Yeah.

01:02:29
BA: So, could you talk about how the evolution of large scale computational science has influenced the nature of your work?

01:02:36
TW: The ability to do really massive exploration of algorithm design is essential to developing good methods, in testing them, and refining them. And I wouldn't be able to do that without things like TACC at Texas or Blue Waters here. It's absolutely essential. So, I think that for method developers who are dealing with real data and they need to explore things, high performance computing, supercomputing, is essential. And it is challenging our old ways of doing things where we just developed one technique and assumed it could translate to any dataset size but it's helping us make really valuable method development.

01:03:16
BA: Mm-hmm. [non-interview dialogue]

01:03:29
BA: Okay, so I just have a few more final questions. You've participated in multiple academic communities, computer science, evolutionary biology, and historical linguistics, so, how do the research practices of each of these different fields differ and has that affected your own approach or approaches to research?

01:03:53
TW: So, I think computer science is a really wonderful field. So, I actually, I'm going to put that one aside for a moment. I would add mathematics to this collection. Because that's where I start.

01:04:03
BA: Mm-hmm.

01:04:04
TW: And for me, and I came out of a pure math community, not an applied math community. And pure math, you know, it's about beauty and it's about rigor and it's about elegance and it's about difficulty. When you get to something like a

science (and math is not a science), it's about trying to understand the world somehow. And you can't, you are not creating the world, you are studying this thing that's external to you. In math, you can create it. So, what that means is that the things, the value systems are different. What [stammers] what manages to be really good work, that's important work, is really different in the communities.

01:04:41
BA: Mm-hmm.

01:04:42
TW: And in math departments, it's typically very hierarchical. There's the best person, the second person, you know. And in computer science departments, it's not. And because there's different ways of being good, doing good work, in computer science. And biology is a very vast field. So, anyway what I guess I would say is, when you want to work on stuff that's relevant to another community, you really have to understand what they care about. So, what does it mean to do good work in that area? And that's very different from different communities. The other thing is that different parts of biology are different from each other. So, molecular biology is a lot more connected to like medical schools and evolutionary biology, the people are out, in their you know, sandals, gathering stuff in the forest, right? You know, it's like different communities there too.

01:05:30
BA: Mm-hmm.

01:05:31
TW: So, I guess I would say it's just that I really appreciate the heterogeneity within a computer science department. And the fact that people can be good in different ways. And people appreciate that in each other. And I think the same thing is true in some biology departments. Historical linguistics, it's not, it's a subfield within linguistics. I don't know the linguistics community well enough. But it's a technical community in general. It's not soft. Linguistics is a pretty technical field as well.

01:06:04
BA: Mm-hmm. So, what do you hope for the future of these multiple fields at which you've been doing your research at the nexus at?

01:06:14
TW: I hope we continue to get some funding. [laugh] You know, whatever is happening in the world with the changes and the support for the, you know, from the administration is kind of scary. But let's just hope that people continue. People do research because they love it. That's one thing that's absolutely true in evolutionary biology. They're not doing it because they're getting paid well. They're doing it because they love it.

01:06:35
BA: Mm-hmm.

01:06:36
TW: You know, it's just they're there because they're driven by ideas. I think it's fantastic. And it's also nice, you know, in a lot of biology, you see a lot more women than you see in computer science. Computer science you just, you see very few women, and it's just great to see anyone driven by what they're curious about and what they love.

01:06:56
BA: Mm-hmm. And what do you love most about your own work?

01:07:01
TW: That it's so complicated and you can't understand it with only one way of looking at it. But it's also, you get quick feedback because you can do simulations, because you can develop methods because you can test things. I mean, you don't have to wait a long time to get a small improvement. You can get insights pretty quickly.

01:07:20
BA: Mm-hmm.

01:07:21
TW: So, I love that the fact that you can do that. You can think about things in a different way if you get tired or if you're not making progress. If you're not making progress with simulations, think about it mathematically. If you're not making progress with math, think about simulations. You know, try something new and you get ideas quickly.

01:07:35
BA: Mm-hmm. Well, great. Well, those were the only questions I had. Where there any other topics or questions I could have asked you about?

01:07:43
TW: I don't think so.

01:07:45
BA: Alright.

01:07:46
TW: But, thank you very much.

01:07:47
BA: Yeah, thank you so much for your time today. I really appreciate it.

End of interview