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The Theatre of Math: The Stage as a Tool for Abstract Math Education

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THE THEATRE OF MATH

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I. Introduction

In the long history of humanity, there has always been a need to tell stories. Even before recorded history, humans were painting, drawing, and passing down stories. These stories became a tool to teach other humans; teach them about how to stay safe, where there may be food or danger, or why the world is the way that it is. Before there was a way to write these stories down, however, they were passed on through the act of performance.

To this day, performance remains a tool of education. As children we are taught morals through puppet shows and songs and the books that our parents read to us in silly voices; we are engaged with theatrics, and the lessons we are being taught slip into our heads. Even as adults, many people still walk away from seeing a new movie or show with a new understanding of some facet of life. The theatre has always served, even in the modern era, as an arena where philosophy, morals, and new social ideas are presented and confronted, and from many differing viewpoints. In an example from the *Journal of Aesthetic Education*, Jonathan Levy writes about the ways that Jesuits used theatre as a moral tool, saying,

> On the Continent, the Jesuits made theatre an integral part of their educational system. The order was founded in 1540, and the first play, a tragedy in Latin, was performed in Messina in 1551. From then until the order was suppressed in 1773, by one account one hundred thousand plays were performed in over five hundred school theatres, first in Europe and, with the spread of the Counter-Reformation, in India, Japan, Mexico, and indeed in most of the known world. For among the many educational virtues the Jesuits found in theatre, they found it a most effective method of propaganda-propaganda fidei (the propagation of the faith)-which is what the order was founded to do (Levy 65).

In thinking over the history of theatre as a tool of education, I was struck by the realization that I was unaware of any examples of theatre being used to teach adult audiences about complex topics that lie more in the physical world than they do the philosophical world. My mind went from there to the world of mathematics, a world that, if my own personal experience of what others around me say is indicative of the general public, most people give up on, and often have a distaste for, learning about. Because of this, I decided to conduct research on and make my own attempt at creating a theatrical play that includes and introduces abstract mathematical ideas in a way that allows people with a base understanding of math to learn and understand them.

II. Research Questions

When approaching this problem, I wanted to examine not only the ways that theatre can be used as a tool to educate on complex mathematical subjects, but I also wanted to understand the ways in which math can be an influence on the stories and themes present in theatre. Because of these two parallel problems, the questions that motivated my research are essentially a inversion of each other. The first question around which my research is based is: How can theatre and the arts serve as an educational tool for more complex/abstract subjects? This required a great amount of study and research conducted on educational tactics, ways to measure learning, and the history of theatre and education.

The second question that guided my research was: Can theatre utilize mathematics thematically without requiring in-depth prior knowledge of the subject? This question required a much more complicated process, as in order to properly answer the question in as controlled a manner as possible I began writing an original stage play with abstract math and themes based on that math, and had volunteers read and respond to that stage play and their understanding of the math inside of it. These questions guided my process, and led me to the understanding that

theatre can educate people without in-depth knowledge of a subject through engaging them actively in the subject and intertwining it with dramatic elements, and that the realm of mathematics can be used to amplify and expand on the themes of a show without sacrificing its understandability.

III. Literature Review

In preparation for writing my playscript, I wanted to understand the history of how theatre and mathematics, and theatre and education in general, had been juxtaposed in the past. I studied previous plays that had been written with mathematical themes, plays that were designed to be educational tools for complex subjects, as well as non-theatrical educational tools on mathematics. On the educational side, I wanted to study ways to make instruction as engaging and enthralling for a learner as possible. In particular, studied active learning tactics, or methods of teaching that involve the student being an active participant in the process.

Ada and The Engine by Lauren Gunderson.

Ada and The Engine is a two-act play by Lauren Gunderson about the life of Ada Byron Lovelace as she begins her work on the new analytical engine that was recently invented. Throughout this play, Ada's work is explored, as is her passion for mathematics and the discovery of the new world of math that this engine is opening her up to. In reading this play, I was struck by the way that non-literal moments and dialogue reflect both the mathematical ideas and the emotional aspects of the play. Specifically, there is a moment at the end of the show where Ada sings a poem that becomes a string of ones and zeroes; binary code, as the future of technology (iPhones, laptops etc.) surrounds her. The intertwining of the math and science into

the themes of the show is a large takeaway that I drew from this, and strove to follow as an example in my own writing

Proof: A Play by David Auburn

This play includes a young woman who is attempting to solve a new mathematical problem and explores the events of her life that surround this work. This play serves as proof that mathematical ideas and themes can be utilized well in a dramatic setting without requiring the audience to have a vast amount of knowledge of the subject prior to watching the show. New information is presented naturally, and readers/viewers are given the opportunity to understand and follow along instead of just being expected to accept that they do not understand the central action of the play.

The drugs don't work, Ahmed, R. et al.

This production was designed as a tool to educate adults about the effectiveness of antimicrobial drugs. This complex topic was chosen to explore the ways that theatre can teach adults who, traditionally, are less receptive to learning. These adults were from all levels of understanding on the subject, and survey results from after watching the play showed that audiences went away from the show with a greater understanding of antimicrobial drugs and antimicrobial resistance than they had before. This method of survey would be the ideal means of measuring the effectiveness of this new play, however a discussion involving a small group will also be an effective tool. This source shows that theatre can educate people in very complicated, and adult oriented, subjects.

Theatre and Moral Education Levy, J.

This paper identifies the history, and explores the efficacy, of theatre as a tool for moral education. It discusses the ways that Jesuits used theatre to teach their own religious morals, as well as how other religions use stories and performance to teach their own parables. Levy goes on to suggest ways in which theatre can be used most effectively as a tool to teach viewers, in particular young viewers, new ideas. Through theatre, Levy sees that there is an opportunity to give the viewer a sense of experience of an event without them having to go through said event themselves, and alternatively Levy argues that theatre can work as a palate refiner for the emotional abilities of the viewers. These two complex methods of understanding the way that theatre teaches are utilized in my own writing as they allowed me to be unafraid of delving into more abstract and complicated methods of exploring the mathematical themes of the Collatz conjecture and fractals.

Witness as participation: The lecture theatre as site for mathematical awe and wonder. Rood, M.

This paper draws an important connection between the worlds of theatre and mathematics through the lecture style of education. Rood says as they draw this comparison,

> The lecture offers potential for awe and wonder, just as the theatre does. The study of theatre is relevant to mathematics education, if only because in universities across the globe young adults gather to listen, take notes and watch the story needed for the next stage in their life unfold: the mysteries of the calculus, the structure of algebraic objects, the solutions of differential equations. They are initiated (at least in part) by their experience in the lecture theatre.

Here, Rood identifies that the lecture, much like the theatre, is a place where mathematics students are opened up to the great mysteries of their field, and that curiosity can take hold of them. This can only be done, Rood says, if the lecturer is able to engage their audience with a theatrical enough performance of the material. This thought is one that is a driving force behind the use of dialogue to explain some of the math concepts in the script, as it allows the math to intertwine with the drama of the show, and become all the more theatrical.

Fractals, skylines, nature and beauty Stamps, A. E.

This paper served as an inspiration for the visual imagery present in the script. The appearance of fractals in nature is reflected in the discussion of fractals throughout the play, and ties into the themes of distance and complexity included. The paper identifies fractals as being organically and aesthetically beautiful, and their imagery is placed in the show's script.

The Collatz conjecture. A case study in mathematical problem solving. Van Bendegem, J. P.

This paper provides a description of the Collatz conjecture, as well as a description of many of the ways in which it has been explored and attempted to be solved. In exploring this paper, I was able to draw many different aspects of the conjecture out and place them into the script as I was in the process of writing. Also, this paper allowed me to explore my own thoughts on the conjecture, and align it with the more dramatic themes that are included in the play.

Uncrackable? The Collatz Conjecture Numberphile

This video provides both an explanation of the Collatz conjecture in a simple and easy to understand manner, and an example of the style of lecture video that the lecture sections of my script are modeled after. The comfortable manner of speaking, the direct address to the camera, and the relaxed and fun examples are all tools that this channel utilizes to be as informative to as

wide an audience as they possibly can, and these are tools that I attempt to utilize as well in my script.

MATHEATRE

MATHEATRE is a company that specializes in creating original works that educate on and explore math topics. The group aims their material more at grade-school audiences, however there is still much to be gleaned from their style of production, most notably the ways in which they tailor their shows to be understood with even a basic level of understanding of the material. This was an important problem in the writing of my script, as I continually had to reexamine my own explanations of the abstract concepts to see if they were still too complex, and needed to be broken down further.

Playwriting: Brief & Brilliant Jensen, J.

This book served as my main guide for writing a playscript and was my reference for how to explore any themes or ideas that I wished to place into the show. Jensen gives instructions on how to develop characters, dialogue, imagery, and how to focus the play in so that it continually ties back to its central theme. For the play that I have written, that central theme is the complexity of personhood, and how the closer we get to a person, the more complex and detailed they become. Jensen's advice, particularly her chapter on images and issues, was a great tool in developing the script and its themes.

Active learning methods. Zayapragassarazan, Z., & Kumar, S.

This source serve as a list, and explanation, of several types of active learning. Active learning is a style of teaching that allows the recipient to be an active part of the learning process. Zayapragassarazan identifies active learning as being a tool that allows information to

be understood on a deeper level than "passive" learning styles, which can be described as traditional textbook readings or lecturing. These active learning methods allow students to be more connected to the progress of their learning, and, as Zayapragassarazan identifies,

> listening to teachers, memorizing prepackaged assignments, and giving out answers. They must talk about what they are learning, write reflectively about it, relate it to past experiences, engage themselves in learning by doing and apply it to their daily lives. The disadvantages of a traditional classroom are many. When it comes to learners and education, attempting to force all learners to learn in the same way is counterproductive to producing healthy, well-educated and all-rounded adults (Zayapragassarazan 3).

Overall, my readings led me to the conclusion that past explorations of the mixture of theatre and education have leaned to the side of education, a sort of "Schoolhouse Rock" style of performance that uses basic characters and basic dramatic elements to create a new facet for learning about the subjects they are presenting. These types of productions are similar to what I would like to produce, but they are not aligned exactly with the style of production and education that I envisioned. Instead of leaning more to the educational aspect of the script, I envisioned a style of giving information that is fully integrated into the text of the play. In other words, there would be no aspects of the show that are solely about teaching, and there are no moments in the show that do not follow or affect the emotional journey and characterization of the characters in the play. However, my research points me to the idea that this is possible to impart an audience with a new and complex understanding of abstract and complicated subject matter.

In my study of these readings, I was able to gather a good sense of the direction that I wished to take the script, and the project as whole, in. For the script, study of Jensen's instruction on the process, along with the examples provided by *Proof* and *Ada and The Engine* gave me a

sense that I wanted the show to be driven dramatically by conflict between the characters, instead of being driven by the desire to educate the audience. I sought out to ensure that the show itself was the educational tool, something that would give the audience an understanding of the topics at hand and encourage them to dive deeper into them instead of serving as the "Schoolhouse Rock" style of giving a lecture on a certain topic. This aligns with the process of active learning outlined by Zayapragassarazan and serves to engage the audience in the learning instead of having them be passive. In the script, this style of learning is an amalgamation of the personal lecture style of the Numberphile video, and the style of lecture outlined by Rood. Outside of the lecture sections, the inclusion of information through dialogue is based on the style of writing present in productions by MATHEATRE and *The Drugs Don't Work.* The mathematical exploration of the topics present in the dialogue comes from my study of Van Bendegem and Stumps' writings, as well as being informed by the proposed ideas on how the stage naturally teaches presented in *Theatre and Moral Education* by Levy.

IV. Method Section

During the Fall of 2022, I began to formulate the basic ideas for a stage play combining abstract math and emotional drama. I chose to base my play on the Collatz Conjecture, an abstract problem that lacks any real-world application at the point of writing this, that involves two simple arithmetic equations. If n is even, perform the function n/2. If n is odd, perform the function 3n+1. Repeat this process for as long as it is possible, or, until the pattern begins to repeat. The problem with this conjecture is that we do not know if every single starting positive integer will eventually end up leading to the number one (Van Bendegem 9).

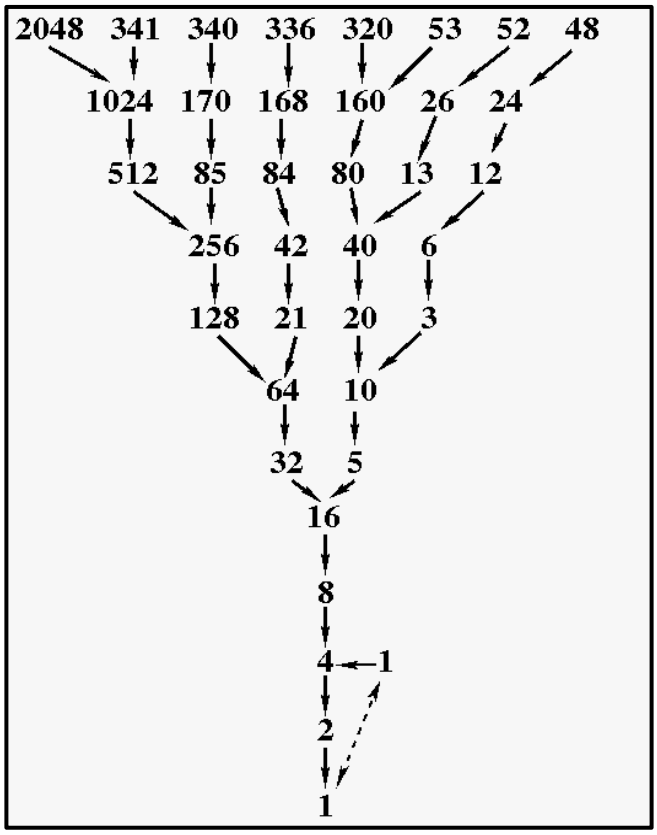

Figure 1: *Tree visualization of the Collatz Conjecture* (Ashlock)

In addition to this problem, the play contains themes of fractals. Fractals are sets of infinitely dividing patterns that become more complex as one looks closer at them. Specifically, fractals are described as being,

> …a visual image some features of which repeat at many different scales. In some fractals (regular fractals), the feature which is the same at different scales is a geometric shape, but the size, location, or rotation of the shape is different at different levels (Stamps 164).

The phenomenon Stamps describes can be called self-similarity. These two mathematical concepts make up the thematic bulk of the play, and as the writing process was beginning these were the ideas that propelled me forward.

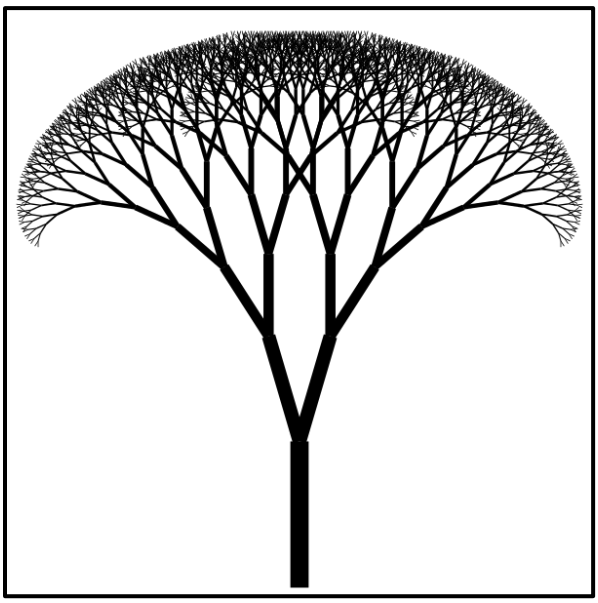

Figure 2: *Fractal Canopy* (Rocchini)

As these ideas began to take shape on the page, I considered how I could best apply educational tactics to my writing to ensure that the audience would not allow not be confused by these abstract ideas, but that they might go away from this performance with an understanding of the concepts that they did not have before. In study, I decided on three different avenues of education to present the ideas in. First, information would be given through dialogue, with characters discussing the problem between themselves. Secondly, I would include visual elements in the stage directions of the script that would appear on stage in a full production of the play. Finally, there would be portions of the show that included lectures given directly to the audience by the characters. The first and second method are outlined by Z. Zayapragassarazan as being two important methods of active learning, those being role playing and concept mapping respectively (Zayapragassarazan 3-4). The final teaching method is derived from *Witness as participation: The lecture theatre as site for mathematical awe and wonder. For the learning of mathematics* by M. Rood. This paper outlines the ways in which lectures can function as active learning tools as well (Rood 20).

With these three methods I began to work on applying the themes of the show dramatically, in an effort to make the story more engaging and keep viewers interested in the duration of the script. For this, I referenced *Playwriting: Brief & Brilliant* by Julie Jensen. By the end of the writing process, I had completed the entire first act of the play and was ready to present it for reading and discussion to any volunteer participants who might read it. For the final portion of my methodology, I gathered together one small group of five students to do a table reading of the script, and to hold a discussion afterwards to gauge their understanding of the themes and mathematical elements, as well as their opinions on the effectiveness of the play in teaching new mathematical ideas. With this discussion, I was able to draw some limited conclusions about the writing and educational value of theatre and mathematics together.

V. Results

The discussions and opinions that resulted from the reading of the play highlighted both the strengths and weaknesses of the project, as well as allowing me to draw a helpful conclusion on how the play functioned as a teaching tool, and how the mathematical themes functioned as dramatic tools. The primary strength identified by those who read the script was that it was highly effective in portraying the abstract mathematical concepts present without leaving the reader/viewer confused. Readers agreed that moments of lecture came at the appropriate time in the script in order to fit both dramatically and to serve as a good means of keeping the audience informed on the math being discussed. The lecture sections were also noted to be personable enough with dialogue that they remain engaging.

Visually, the moments in the play where visual demonstrations of fractals and the Collatz conjecture appear as they are discussed were also noted as being effective. Visuals such as the Collatz tree and fractals are designated to be projected on the stage at certain points of the script

to highlight the mathematical elements as they are mentioned in dialogue. Participants described them as engaging, and in discussion after reading agreed that these visuals would help an audience to understand the abstract concepts.

Through the process of writing, I found that the mathematical topics I had selected to focus on in the script were very helpful tools in reflecting the dramatic themes in the show and its philosophy as well. The show focuses on an old man who is a professor of mathematics nearing the end of his career. He has spent his life trying to solve the Collatz conjecture and has recently taken a sabbatical to pour all of his energy into solving the problem as a response to an existential crisis in which he feels as though he has made no impact on the world. Thematically, the script is focused on themes of aging, uncertainty, complexity, and closeness with people. This was very easy to tie into the ideas of the Collatz conjecture and fractals, as fractals continue to grow more and more complex as you look closer at them. I found that this could be applied easily to people as well, as people that we do not know well seem very simple and easy to categorize, while those we are closer to are much more intricate and complicated. For themes of uncertainty, the Collatz conjecture was applicable as it is a problem that people are uncertain can ever be solved, as it may be something true but unprovable. The main character, in the planned second act, must face this uncertainty and accept that he may never know the solution to the conjecture, or the impact that his life has had on the world around him. The themes present in the show are continually reflected by the mathematical ideas that are explored by the characters inside of its world.

After having gone through this project, I believe that not only is theatre a powerful tool for the education of complex and abstract subjects, but that the world of mathematics is a rich vein for theatre to mine from. In discussions with readers of the play, they continually identified

that the focus on drama allowed them to become more invested in the math that was presented before them. Most readers were unaware of the Collatz Conjecture before contact with this play but identified that they now possess an understanding of the problem. Additionally, visual concepts present in the script were identified as being effective in portraying the more abstract ideas that may otherwise become confusing.

VI. Implications for Future Research

This script is not finished, and as such the amount of work that I want to continue doing in this area of study is also not finished. In the future, I plan to return to this script to continue developing the mathematical themes and the educational tactics, and ultimately finish the second act of the show. This may take a period of years to complete, but whenever that time may come, I would like to perform a more in-depth exploration into how these teachings and the information present in the show come across.

I would perform this future study by doing either a series of public readings of the full script, or a full production of the show, bringing to life all of the visual elements that exist only on paper currently. Following this larger, full production in front of an audience, I would hold a series of talkbacks and discussions, asking questions of the audience about the abstract subjects and themes of the show, and allowing the audience to ask questions on their own. Additionally, I would ask the audience to perform an exit survey on their impressions of the script, as well as how much of the math they understood and which parts of the show were the most effective at helping them to understand those topics. From this, I would have a much more thorough understanding of how effective the piece is in teaching these complex subjects, and the conclusions reached would be much firmer and more applicable for any future productions that might follow this formula.

VII. Conclusion

After having gone through this project, I believe that not only is theatre a powerful tool for the education of complex and abstract subjects, but that the world of mathematics is a rich vein for theatre to mine from. In discussions with readers of the play, they continually identified that the focus on drama allowed them to become more invested in the math that was presented before them. Most readers were unaware of the Collatz Conjecture before contact with this play but identified that they now possess an understanding of the problem. Additionally, visual concepts present in the script were identified as being effective in portraying the more abstract ideas that may otherwise become confusing.

Regarding the dramatic use of mathematics, readers responded positively to the use of math to explore emotional and personal themes. On my own end, I found that utilizing these topics in a story went smoothly; I was able to identify intersection points between the story that was happening dramatically, and the mathematics surrounding the story. These two sides of the script amplified each other, and I found much more thematic depth in the story because of the mathematical themes. Ultimately, I have found that utilizing abstract mathematical topics in theatre creates the possibility for both a rich and emotional story based on mathematical themes, and a tool for education on said abstract topics for those that do not have a deep understanding of the math behind theme already.

Ultimately, it appears that mathematics and theatre work well together in allowing learning math concepts and subjects to become more engaging and creating new emotional depth in stories through abstract mathematical themes.

VIII. Appendix

Appendix I. First Act Script

ACT I

Scene 1

SETTING: We are in VINCENT's house, inside his study. The room is very stern, filled with oak furniture and plants that must have once been proud and green, but have begun to wilt slowly. A gentle draft blows in from the door and brushes the curtains of the large window. On one side of the room is a desk strewn with blank papers and a home phone, just next to a disarrayed bookshelf. On the opposing side sits a couch fashioned into a bed. The only decorations on the walls are the vines of a hanging plant. The world outside the window is frosty, with gray clouds and a few peaks of sunlight.

AT RISE: VINCENT LASELL is asleep, head on his desk with a pen in his hand. His sleep is perfectly still. ADA LOVELACE and EUCLID are in the room. They are just watching over VINCENT, and where they go numbers follow. We can hear the sounds of wind outside, and the window curtain is drawn open to show gray clouds gathering outside.

EUCLID

Hello!

ADA

Hello.

EUCLID

Allow us to welcome you all into the study of VINCENT LASELL, professor and Mathematician.

ADA

VINCENT is resting now, but he will be awake soon enough. My name is ADA LOVELACE, and this is EUCLID OF ALEXANDRIA.

EUCLID

Now, in the effort of being completely clear and honest, we are not real.

ADA

But neither are you.

EUCLID

(Nods)

EUCLID (CONT.)

Yes, but VINCENT is real. And this study is real as well.

ADA

We are sure that you have a great many questions about these facts, and so we would like to offer you the clearest possible explanation: there is a great valley between the two poles of existence and non-existence. You may think that existence ends at something being either real or unreal, but it is much richer than this.

EUCLID

Take VINCENT, for example. Before today, before the first moment you saw him and heard his name, VINCENT LASELL did not exist to you. And even now, as you see him, he still does not exist to you in full. He is an idea, he has a form, but you could not shake the hand of VINCENT LASELL, you could not walk beside him, you could not learn more about him than has been written to be said.

ADA

This is only one example, perhaps a more apt one to the subject of this matter is that of Gödel's Incompleteness Theorem. In the 1930s, after my time-

EUCLID

And much after my time!

ADA

A man named Kurt Gödel published an astonishing mathematical proof.

EUCLID

He had proven that in the world of mathematics, there are statements which are entirely, completely true. They are factual, they are observable, and they are *real*.

ADA

But, despite the fact that they are true, they cannot be proven. No matter what we know, no matter how we apply our knowledge, no matter how much we can test and find examples, there will always be aspects of a system that are unknowable.

EUCLID

And so, are these facts real? They cannot be fully real; we will never know if they are truly unprovable or just wrong. But are

they un-real? How can something true be un-real?

ADA

This is the problem that Gödel has presented the world with: that we are doomed to an eternally incomplete knowledge of our existence.

EUCLID

Such a pleasant thought!

ADA

Isn't it? That is what we mean when we say that *you* are not real. To a mind, the only thing truly real is itself. And so we are not real, VINCENT and this study, not real.

EUCLID

Yes, so sorry, I did lie to you before. But despite the un-reality of everything, we still must try to understand, to reach our arms across that valley and embrace the lack of understanding that will always be there along with all of the knowledge we *can* gain.

ADA

That is all we will say for now, we will return you to the study, to VINCENT. Morning is coming soon.

(ADA and EUCLID disappear as light from the window creeps up to touch VINCENT's face. When it does, he begins to stir.)

VINCENT

(Mumbling)

Curtains again…

(VINCENT rises to pull the curtains closed, shuffling, and clutches his side, when the curtain closes the room lightens slightly in a cold way.)

There we are… Damn things…

(A knock at the door)

Yes?

ALEX

(Entering with a glass of water and a pile of mail)

Good morning VINCENT, here you are…

VINCENT

Thank you Alex. Ah! My mail, fantastic.

ALEX

Mm, how did you sleep last night? Any word from your niece?

VINCENT

(Grabbing books and notes)

Not yet, and just fine, do you see my… ah, there it is.

(VINCENT pulls one last book off the shelf and onto his desk before sitting again.)

Amy is busy though, but I hope she'll make her way here soon.

(VINCENT looks back up at his shelf)

Now, I ought to reorganize that thing someday, or maybe I could make it an extra credit project for some graduate student. How are they, by the way?

ALEX

Eh, this year's batch isn't bad. But maybe that's just because they finally look too young for me to feel like I'm still one of them.

VINCENT

Well, you'll always be one to me.

(Beat)

I mean that in a good way, you know that.

(ALEX LAUGHS)

ALEX

Yes I know… they ask so many questions, the masters students. More than usual, "Can this be applied to matrices? For which dimensions does this hold?"

VINCENT

And you tell them…?

ALEX

Exactly what you used to tell me, "If you have enough intelligence to ask, you have enough intelligence to see for yourself." I think they somehow hate that quote even more than I did.

(Both laugh together, VINCENT pulls out a bottle of pills.)

VINCENT

Well don't tell them I taught you that. I don't want them to hate me when I come back.

(VINCENT gives ALEX a glance, ALEX turns around as VINCENT swallows his medicine.)

VINCENT (CONT.)

Let them hate me on their own.

ALEX

You know they don't hate you… They don't all hate you yet, at least.

VINCENT

You did, didn't you?

ALEX

Why else would I torture you by becoming your colleague?

(ALEX turns back around.)

VINCENT

And somehow I can't avoid you even when I'm on sabbatical.

(ALEX laughs slightly and begins to water the plants around the study.)

ALEX

It's just a twisted joy I get from helping you feel better.

VINCENT

ALEX you don't need to do that, leave the water I can do it on my own. Here, if you want to be useful grab a wrench and fix my curtains. Damn things still won't stay closed.

ALEX

I don't know, maybe it's good they keep opening. Sunlight is good for you. The Doctors said that it can even speed up the healing process.

VINCENT

I think I'm healing just fine. Besides, it'll be storming for a few days, and that tree blocks most of the light anyways.

ALEX

Okay… well it doesn't seem like they're broken to me, maybe it's just the wind.

VINCENT

Maybe it is.

(A moment of silence.)

ALEX

VINCENT?

VINCENT

Yes?

ALEX

I noticed your bed was still made when I came in.

VINCENT

Yes. Well, I was up late last night, I must have fallen asleep in here.

ALEX

VINCENT… you know you shouldn't be doing that. Your bed has that therapeutic mattress.

VINCENT

I told you I sleep fine in here.

ALEX

Well, the Doctors said-

VINCENT

I am well aware of what the Doctors said. I haven't done anything but what they have been saying. I slept on that mattress; I did my therapy. Both kinds. I'm still taking my medicine. And now here I am. I keep telling them that I'm okay, I keep telling them I don't need any more visits, but…

ALEX

But what?

VINCENT

But… when's the last time the office called you?

ALEX

Well, it was this morning when I was in the car.

VINCENT

Do you know why they called you *then* ALEX?

ALEX

I guess not. Do you know?

(VINCENT rises, pacing the room slowly.)

VINCENT

Because, ALEX, they know that if you were with me, I wouldn't let you answer the phone. They know what time you get here in the morning, they know your whole schedule. They're using it to get to you, and they're using you to get to me.

ALEX

VINCENT that sounds…

VINCENT

Crazy? Hardly.

ALEX

No, it sounds like a good reason to call me when they did. Of course, they use me to get to you, they want you to get better.

VINCENT

They want me to get better, ergo they think that I'm unwell.

ALEX

You *are* unwell.

VINCENT

I WAS unwell. Physically. I am fine now, but they won't listen to me.

ALEX

Don't try to tell me that you feel fine, and you won't even talk to them.

VINCENT

(Gets close to ALEX.)

Do you know why I don't? I know my age, ALEX. You can guess why I won't talk to them, why they won't listen to me; I taught you how to reason well enough for that.

ALEX

We found you at the base of that tree after God knows how long. You were climbing it in the middle of the night, without anyone to watch you. VINCENT I know that you're sound and I know that you're still yourself but there are going to be questions when-

VINCENT

When you're older.

(ALEX says nothing to this, VINCENT shuffles slowly to the couch.)

Is that what they called you about? They want you to do their dirty work, huh? I told you those bastards want me locked away.

ALEX

It doesn't have to be in a home Dr. Lasell, it could be in-house care. They wouldn't even come every day. It would be just like it is with me, except with someone more qualified.

VINCENT

Don't say Dr. Lasell… you're not my student anymore. And don't try to paint it like anything other than what it is.

ALEX

And what is it then, VINCENT?

VINCENT

It’s the end of my damn life.

ALEX

VINCENT-

(VINCENT grabs a cushion off the couch.)

VINCENT

Do you see this? What is it?

(Beat)

It’s a cushion right? But it’s also a square. Now I am a cushion, that’s what I am to myself. I know what I’m made of, I know what’s inside of me, I know all the intricate little details. But you, you’re not as close to it as I am. You don’t see all that, you can’t feel how soft or hard it is, if it’s down or cotton inside. And so, to you, it loses that definition. It’s not a cushion, you can’t say for sure that it's a cushion, so you call it a square. Maybe you define some of its broader details; it’s got rounded edges; it’s got such and such colors. But that’s just what you can see, so you call me a modified square, right? But do you know what they see?

(Beat)

All they see are corners and edges. They don’t see a damn square, and they sure as *hell* don’t see a damn cushion.

(VINCENT throws the cushion down)

I saw it the first time I was in the hospital. They won’t even bother to try and see what you see, let alone ask me what I think of myself. They just look at me through a microscope. They are blessed with the curse of knowledge, and what they see scares them. But if they would just look at me with their own damn eyes…

ALEX

… Okay. I understand.

VINCENT

Right, I’m sure you do.

ALEX

Well, I have to go. I’m giving an exam in 30 minutes.

(ALEX begins to leave but pauses.)

ALEX (CONT.)

VINCENT… I just want you to get as much help as you need. And… maybe consider retirement.

(There is a silence, ALEX exits. When the door is closed VINCENT seems to take on 10 years as he shuffles back to his desk.)

VINCENT

Dammit… Dammit!

(VINCENT grips his side in pain, the stage glows brighter, though it soon subsides.)

I knew it. Dammit I knew it. ALEX's eyes too. They're too young to get it. I'm not stupid, and I'm not insane. Never should have… bah!

(VINCENT opens a book, as he does numbers begin to glow around the room, but only dimly. It is as though as soon as you can tell that one is there, it's already gone. Accompanying these numbers are drones of slow music and hushed voices speaking out sequences of numbers in the Collatz Conjecture. Eventually these sequences all align to repeat "4, 2, 1, 4, 2, 1…" before they are cut off.)

Damn it all!

(VINCENT gives up and leafs through his mail)

At what age do you stop being human and become prey to these vitamin supplement companies? I used to get coupons for sports equipment and fast food. Now my junk mail comes in an enlarged font size for ease of reading. "Dear sir, please enjoy this free sample of wart cream." "Dear sir, have you dreamed of travelling the Caribbean aboard a 5-star ocean liner?" Dear sir, congratulations on your recent birthday, did you know that by this time next year you could be well on your way to owning your very own oak casket?

(VINCENT tosses the mail on the floor.)

What's so "golden" about these years? Did I miss some magical moment of wizening that was supposed to reveal the secrets of life? I don't know any secrets, all I have are platitudes. And forgive me for saying it but platitudes feel a little less genuine the slower people say them.

(Spoken slowly)

"Thank you so much sir! Have a great day!" Jesus christ. It makes me want to scream "You are an I-DI-OT."

(EUCLID OF ALEXANDRIA has appeared in the study, he is clearly out of place, but he seems familiar with the space.)

But of course, I can't do that, because once you become the kind of person who yells at strangers it's a very slippery slope to having complete and utter disregard for all social norms. Everyone has an idea about you. They always have. They think they know where your life is going, they think you can't do anything to surprise them. They're wrong. *I* know where I'm going, *I* know what's to become of me. They can't see my future, they can barely even see my present.

(Continues muttering under EUCLID's next line)

EUCLID

(Addressing the audience)

I will spare you more of his misery-soaked opining, believe me he could continue for hours If I let him.

(To VINCENT)

And you, of course, have such a high regard for society.

VINCENT

(Scoffs)

And what do you know about modern society?

EUCLID

I know pieces; these times are not so different from mine as you would think.

VINCENT

Oh really? And you know this how? Are you spending nights out on the town that I don't know about?

EUCLID

What? Why so dismissive of the idea? Who says I can't have a life outside of you?

VINCENT

The fact that if I stop thinking of you, you cease to exist.

EUCLID

Oh, you could never be so cruel!

VINCENT

Oh yes I could. Maybe I'll think about a nice *quiet* beach-

EUCLID

Oh dear.

VINCENT

With beautiful white sand-

EUCLID

(Sarcastically)
Oh, the void approaches…

VINCENT
And peacefully crashing waves covering up every thought.

EUCLID
Torturous existence! To lose my life to the sea without stepping foot onboard a ship… and yet, in spite of what you say, Vincent, I am still here.

VINCENT
Well… sometimes it's more work than it's worth to get rid of a pest. But I could do it, I could remove you entirely if I wanted to.

EUCLID

But?

VINCENT

But I won't…

EUCLID

But I won't because…?

VINCENT
Because you're a *useful* pest.

EUCLID

(Addressing the audience)
Aha! Do you hear?? Useful! He thinks me useful! Never mind the part about being a "pest", for as long as I have known VINCENT, or, for as long as he has known me, "useful pest" is the closest to a word of fondness he has ever given me.

VINCENT
BUT, if you begin to bother me too much, I'm sure there are a number of other geometricians I could speak with.

EUCLID
Then our friendship means nothing to you?

VINCENT
Can you really be my friend if you aren't real?

EUCLID

(Smiling brightly)
Am I not real?

VINCENT
I don't… can't we just get to the part of this where you watch me work in *silence*?

EUCLID
I don’t know, I miss the times when we used to really discuss things. This is the most we’ve spoken in months.

VINCENT
Don’t call it speaking, this isn’t a conversation.

EUCLID
Fine then, this is the most *you’ve* said to *me* in months. Is that fair?

VINCENT
Yes. Okay. Now can I please get back to work?

EUCLID
Oh, you were working before?

VINCENT
There are many schools of thought about how a man should think about his problems.

EUCLID
And you have chosen to take the noble route of ignoring that problem?

VINCENT
I’m not ignoring anything; I just need to get all of my affairs in order before I can start.

(Beat)
Not get my affairs in order, I mean that I need to have nothing else to think about. Then I can really start working.

EUCLID
Fine then, you’ve checked your mail, what else is there?

VINCENT
I… need to water my plants. Look at them, they’re bone dry the poor things.

EUCLID
Ah yes of course, well don’t let me keep you another second from that.

VINCENT
Good. Thank you.

(VINCENT stands and grabs his watering tool, he hobbles over to the plants on the wall and feels their leaves.)

VINCENT (CONT.)
There we are… just a little bit of water.

(VINCENT has a spasm of pain, spilling too much water into the plant and onto himself.)

VINCENT (CONT.)

Ah! Dammit… dammit.

(The phone rings.)

Good, great. Could you answer that?

(EUCLID stares at VINCENT.)

Right, of course not just let it go then. Damn doctors.

(He grabs the mail and places it under the plant to soak up excess water as the phone stops ringing.)

There, finally a good use for this garbage.

EUCLID

Are your affairs in order now?

VINCENT

I told you, not that phrase. I didn't mean to say that.

EUCLID

Alright, well are there any distractions remaining?

VINCENT

…no, no I think I can work in peace and *quiet* now, thank you.

(VINCENT sits at his desk, opens a book and begins to stare at it. Occasionally he crumbles up a blank piece of paper and throws it to the ground. After a moment, EUCLID speaks to the audience.)

EUCLID

And now he will continue on like this for the rest of the day. There's nothing that I can do to stop him, my only chance of getting a few more words from him come whenever he decides to eat his lone daily meal.

(EUCLID walks through the papers on the ground, kicking them gently.)

It wasn't always this quiet. When he was a graduate student we would sit in his apartment and discuss proofs and problems for hours on end. He would ask me for insight, question my observations, and share his whole thought process with me. But now I have been blocked out. The most surprising part of it all though, is that I'm still here.

There was a time when I was older than VINCENT. It was a long, long time, but now it was so long ago. It didn't start when he became older than me, of course there's no real

knowing when exactly that was; reports of any lives in ancient Greece tend to be fuzzy around the edges. No, it took 20 years for the coldness to set in. I thought that perhaps someday, if he had no use for me, I would simply stop appearing. But I am still here. Whenever he is alone, I am brought back to watch him.

I often think about the past, his past. The lectures he used to give, the joy you could sense in his eyes when mathematics became a topic in any conversation. When he first started work on this problem he was so excited, he was so… This problem, yes. The Collatz Conjecture. It was something that had always excited him and… perhaps I should leave any explanation to VINCENT.

(The stage dims, and a flickering projection appears on the curtains. It is of VINCENT sitting in a chair, framed in the style of an interview. VINCENT appears to be slightly younger, with more energy.)

VINCENT (VIDEO)

In 1937, a young mathematician named Lother Collatz posed a very simple question. And despite our best efforts, all these decades later that question remains unanswered. Imagine that you have a number. Well, I guess you don't need to imagine it, let's take… 3 for example. We take our number and we determine whether it is odd or even, this is the easiest part – and it doesn't really get much more complicated.

(The number 3 glows in the room.)

So we have two, I guess, formulas that we can apply to our numbers. If we have an odd number, like 3 is, we take it and we multiply it by 3 and we add 1 to it. And the way us mathematicians like to write this down is by saying that if n is odd, n being whatever number we have, then you do 3n+1.

(3n+1 glows in the room.)

VINCENT (VIDEO CONT.)

Now, 3 times 3 is 9 plus 1 is 10, like I said easy, and so now we have an even number, right? So it's even simpler with our even numbers, all we do is we take them and we divide them by 2! So again, we mathematicians would say that if n is even, you do n/2.

(n/2 glows in the room. As each of the numbers are spoken they too glow for a moment.)

And now, you know everything you need to know about this problem! 10/2 gets you to 5, 5 is odd so multiply by 3 and add 1

to get to 16, then 16 becomes 8, 8 becomes 4, 4 becomes 2, and 2 becomes 1. Anytime we get to any of the powers of 2 we've, to give you a good image, we sort of enter a waterslide, because all of the powers of two, you know 2, 4, 8, 16, 32 and so on, they'll just keep dividing by 2 and always slide back down to 1. And from 1, we go right back up to 4, then to 2, and then to 1. So anytime one of these number sequences leads us to a power of two, we can just ride that waterslide all the way back down to 1, no matter how high up we are! And that, is what we call the Collatz conjecture.

(VINCENT smiles as applause is heard, the numbers 4, 2, and 1 glow brighter, as do 3n+1 and n/2. The video fades, and the lights return to VINCENT staring intently at his books. EUCLID is lounging on the couch, whistling "The September of My Years" by Frank Sinatra. VINCENT discards another blank piece of paper more violently than before, giving EUCLID a glare that he does not see. EUCLID continues whistling, and VINCENT tosses another piece of paper that almost reaches EUCLID. EUCLID still takes no notice and continues to whistle. VINCENT rises, scoops up several pieces of paper off the ground, carries them over to the couch and drops them all on EUCLID's head.)

EUCLID

Hey!

VINCENT

Would you cut that out??

EUCLID

Cut what out?

VINCENT

Your whistling. It's like you insist on bothering me at your every convenience!

EUCLID

(pause)
Was I whistling?

VINCENT

YES!

(VINCENT takes one last paper and drops it on EUCLID's face.)

EUCLID

Okay! Alright I have received your very courteous message, but I

thought that you liked Sinatra?

VINCENT

I do but not when I'm trying to focus on my work.

EUCLID

(Picks up the papers and throws them into the air.)

Of course! Your work! How terrible of me to interrupt these precious notes, let's see here… blank, blank, blank, and… oh, this is a breakthrough! This has to be the single blankest page I've ever seen!

VINCENT

Oh god…

EUCLID

The white is so pure, so untainted by even the thought of a pen…

VINCENT

Would you just be quiet?

EUCLID

I won't be quiet until your pen begins to speak.

VINCENT

Oh, how poetic of you.

EUCLID

I thought it was very clever. But look! My whistling has done something! When was the last time we had two conversations in one day?

VINCENT

For the last time these are not conversations. You aren't talking. You aren't real. All you are is a figment of my imagination. What did Dickens say? You could be a speck of mustard that didn't sit well in my stomach. These papers are blank because sometimes, when you fill up a page with too many bad ideas even the thought of writing on it becomes pointless.

EUCLID

Now look who's poetic! And maybe I am a speck, but I'm here to help you. Just talk to me, for goodness' sake. Do you know how unbearable it is to sit here day after day and watch you do nothing? You say that you're working, you've been working all year. Working and working, without any help from me, and yet there is nothing here to show for it.

VINCENT

Maybe I would have something to show if you weren't here!

EUCLID

But how can I be here if I'm not even real, Vincent?

(VINCENT rushes over to his bookshelf and pulls out a book.)

What now?

VINCENT

I know what you are. You are *this*! "The Elements", by EUCLID. I got this book when I was still in school. You were a gift from my mother.

EUCLID

And what a gift!

VINCENT

But THIS is all you are! You're pages and a spine and glue and ink. You're the imagination of a recreation of a translation of the man who sat down and wrote *this*! I remember, I remember when you weren't so real. When you were just this book, when if I was stuck on a problem I would open you and read you to clear my head. I started to imagine what EUCLID might say to me… I started to wonder what it would be like to speak with the man himself. The first time I saw you it was in a dream, you were so stoic and… so much older than I was then. Soon after that my dreams migrated to my waking hours, and you would sit on the window sill, prodding me towards the answers I needed.

EUCLID

So why not let me keep prodding you? Why not be that way again?

VINCENT

Because you're not really EUCLID. You're just me, you're just my imagination running too freely. I mean, I don't even really know anything about EUCLID, and neither do you.

EUCLID

You're right, I'm not that man. But I am a version.

VINCENT

A version that I invented, that only knows the things that I know.

EUCLID

But does that mean that I'm not really EUCLID? Just because I'm not the man as he lived and breathed, does that make me any less of who I am? EUCLID is the name you gave me. That's how you know me, that's who I am.

VINCENT

I… I guess that's all true.

EUCLID

So why not talk about this problem with me?

VINCENT

Because… because of the thoughts you've put in my head. Because of what of seeing you makes me think of myself.

EUCLID

And what is that, VINCENT?

(VINCENT sits, pauses, and takes out his medicine. He swallows another pill and lets out a sigh. As he does this, part of the study's wall disappears, giving a glimpse at the lawn and tree outside.)

VINCENT

Your success, or EUCLID's success. The original you, the one that's more real. He did something. He *did* something. Do you understand what I'm saying? He did something so important that all of these millennia later children learn his name in grade school. He left something behind, and because of that, when I look at you I think that maybe…

EUCLID

Maybe he became immortal.

VINCENT

Yes… and then I look at myself. I know my age, and maybe these thoughts have started to come about because when I look at you, you seem like a young man to me now. Not the elder, wizened man you seemed to be once, but so young… Maybe because of that, I've realized that all I have to leave behind is garbage. Papers in books that will be discontinued in a decade, maybe a name on a plaque in my department that will be replaced when somebody with more money dies. Nothing to be remembered by, nothing to make me live forever.

EUCLID

And it's the sight of me that makes you think this?

VINCENT

Yes… yes.

EUCLID

Then, if that is what you truly want, I can help you. Just as I always have, VINCENT.

VINCENT

I know you can…

EUCLID

Accept my help, before it’s too late.

(EUCLID extends a hand, and VINCENT stands slowly. VINCENT hesitantly begins to extend his own hand, but before the two touch a door is heard closing. VINCENT turns to the sound, and when he looks back EUCLID is gone.)

ALEX

VINCENT? I have some more food for you.

(VINCENT is silent)

May I enter?

(We see ALEX onstage, but they are still behind the study door.)

Well, if you aren’t asleep, your groceries are in the kitchen. Oh, and I just wanted to tell you that I spoke with your doctor and she said that it’s okay if you’re not sleeping on that mattress. Well, she said that she “discourages” you not sleeping on it, but I won’t tell her that you aren’t.

(ALEX pauses for a moment)

And I wanted to let you know that I’m probably not going to be coming around as much, once the semester is over. I’ll have summer classes to teach and I’m working on a new piece of research and… anyway, I’ll still see you the next two days, but after that I… I’ll see you at work, next semester, probably… well, goodnight VINCENT.

(ALEX begins to exit)

VINCENT

ALEX?

ALEX

VINCENT?

VINCENT

Just wanted to say thank you, and goodnight to you as well.

ALEX

Ah, goodnight.

VINCENT

And… when the doctor’s office calls you tomorrow morning, tell them to schedule me a check-up.

ALEX

I will.

(ALEX exits, and another piece of the wall disappears. VINCENT extends a hand to where EUCLID was standing, and then grasps it with his other hand. He moves to the couch, lays himself down, and falls asleep. After a moment, ALEX returns.)

ALEX

Oh, VINCENT. There was a message from your niece. VINCENT. VINCENT…?

(Silence)

Goodnight.

(Lights out)

SCENE II

SETTING: The study. Dreamlike.

ADA

Hello again. I hope you haven't forgotten about me. ADA BYRON LOVELACE, the world's first programmer. I theorized your modern computers and software over a century before the technology finally existed. Or at least the original ADA did. Now, do you see why we tried to explain this to you before? It can get confusing. Here and now, I am another of VINCENT's "visitors".

(VINCENT stirs on the couch and sits up.)

A dream begins, let it be of good things.

VINCENT

ADA?

ADA

VINCENT, you're asleep.

VINCENT

I could already tell this was a dream; the pain is gone.

ADA

Very good, and are you seeing things?

VINCENT

I see you… and I see eyes. Young eyes. Many, many eyes. And they are splitting off, becoming more and more eyes.

ADA

Fractalizing?

VINCENT

Yes… yes, fractals. The closer and deeper I look the more eyes there seem to be.

ADA

Take your focus away from the eyes, do you see any other fractals?

VINCENT

I see them in the lightning outside. I see a frozen bolt, stuck in the air. It branches out into infinity. I have it right here with me… I can almost touch it.

(VINCENT begins to laugh.)

ADA

And what is that?

VINCENT

It tickles…

ADA

Focus on the fractals, VINCENT.

VINCENT

Right. I see… I see the tree.

(A glowing vertical line illuminates the wall.)
There, the powers of two forming the trunk, and branching off in buds are all of the odd numbers that lead there. 5, 21… each one is splitting even further.

(Branches appear off of the line, numbers appear on those branches in line with the Collatz Conjecture diagram[1].)

ADA

Yes, there it is. Now look deeper, what does that tell you?

VINCENT

It… tells me…

ADA

It’s alright VINCENT, just look and think.

VINCENT

It’s telling me that there has to be a way to prove that these branches catch every integer… but I can’t see the whole tree.

ADA

Why not try a different angle?

VINCENT

I’m trying, but there’s something in the way. The tree is too tall, it’s reaching past the storm clouds. If I could see past those maybe…

ADA

VINCENT, it’s okay.

(ADA touches VINCENT on the shoulder, he looks up at her, they have a moment of silence and he nods at her.)

VINCENT

How many years have I been dreaming of you?

ADA

Well, it’s hard for me to tell. 10, 20?

VINCENT

Have I ever struggled this much with thinking?

ADA

Occasionally, if a problem is difficult.

VINCENT

But for this long?

ADA

I can’t say that I know, but fractals are a complicated world.

VINCENT

But mathematics is a complicated world on its own. If it were easy there wouldn’t be so much glory in solving it.

ADA

Mapping the plains is not so righteous a task as the mountains for a cartographer, I understand.

(VINCENT moves over to the lines on the wall.)

VINCENT

And this summit is uncharted…

ADA

Then let’s climb higher.

VINCENT

My niece AMY used to say that to me… I used to teach her about fractals while we climbed the trees in her mother's backyard. She was never very interested in the lessons, she always cared more about the next branch.

ADA

And she's all grown up now, yes?

VINCENT

Yes, but you know my thoughts already. You're part of my mind after all.

ADA

I know your thoughts only if you want me to.

VINCENT

Right, of course.

ADA

Would you like to talk more about AMY?

VINCENT

No… not right now, I need to figure this out… I can't go back without a solution.

ADA

But you're on leave, right? From your university position? Surely they will understand that you have had much on your mind, and the work you have already done I think would be enough to satisfy your university.

VINCENT

Yes they would probably understand but I can't… I just can't. I need the solution, I need to know.

ADA

Vincent…

(ADA sits on the couch)

I see memories in your mind, I know what you need. Or what you think that you need. But you want answers for more than just this conjecture. You want to know everything.

VINCENT

Don't all thinkers?

ADA

I suppose so, but all thinkers must one day recognize that the pursuit of infinite knowledge will never end.

VINCENT

I know that. I know I can't know everything, but I need answers

for just a *few* things. Do I know myself; *can* I know myself? Can other people ever know me? What happens if my mind goes?

ADA

All of those are important questions… none of those are questions I have the answers to.

VINCENT

Yes, I know that too.

ADA

Look back at the fractals, look closely at everything. What else fractalizes when you look into it?

(ADA leads VINCENT back to the couch and he lays down. Lines continue to branch out all around the room and pulsate as ambient droning noise fills the silent space. Slowly, this all fades away into darkness. A projection comes up on the window curtain, it is again of VINCENT in the interview style.)

VINCENT (VIDEO)

So fractals are, fractals are amazing! Imagine you have a stick, and at the end of the stick, it branches off into two. So you choose either end and look closer at it. When you look closer you see that that end, too, branches off. And each of those branch off into two more, and even though it's getting smaller and smaller and smaller, they continue to branch off into infinity. That’s what we call “fractalizing.” Now fractals can come in other forms, like
atoms, the further you zoom in on atoms the more you see what they’re made up of, and the more you zoom in on the stuff they’re made up you see that that stuff is also made of… well, even smaller stuff. But this, we think, also goes on into infinity. That’s why fractals are so interesting, and I think, important. They tell us that everything around us is infinitely complex, and the deeper you dive into things, the more and more complex they get.

(Fractals begin to spread out from the curtain to the rest of the study, filling the room.)

I decided to study fractals after my mother gifted me a copy of EUCLID’s *Elements* when I was in college. That book changed my life more than you could imagine. I wanted to study more and more geometry, and geometry led me down the infinitely branching path of fractals. These fractals are… look at them, don’t you think they look like veins? I think that if there were a human body that were infinitely large, that’s what it would look like if you took a close look at their skin. Fractal veins, pumping my blood back to the source.

(The Collatz Conjecture diagram pulses softly as the video fades away. Soon, the stage is completely dark.)

SCENE III

SETTING: The study. Morning. More sections of wall have disappeared.

AT RISE: VINCENT is asleep on the couch. We see ALEX walk in slowly and quietly open the curtains, it is a little brighter outside. ALEX hovers for a moment, about to say something, but then they exit the study. EUCLID appears.

EUCLID

Good morning, old friend.

VINCENT

Hello ALEX… ah, sorry.

(VINCENT rises and closes the curtains, then moves to his desk, there is a note.)
"VINCENT, I spoke to the doctor's office, they'd like to see you next Tuesday at 5. I didn't think this would be a problem, seeing as how you don't really have many plans. Thank you for agreeing to this, it's going to be very good for you. -ALEX."

EUCLID

You reached out?

VINCENT

(Sighs)
Yes, I did. I thought about what you were saying last night and… I think, in part, you might have been right.

EUCLID

Thank you!

VINCENT

Which, actually, means that I was right, since I was the one who thought up you saying all that. So, thank you to me.

(VINCENT shakes his own hand.)
You're welcome.

EUCLID

Being a part of you I will accept that. Now, does that mean you'll talk to me about this conjecture?

VINCENT

…yes, fine. We'll talk about it. But if I tell you to stop, you have to stop. Understand?

EUCLID

Understood. Now…

(The conjecture diagram reappears)
What exactly is the point of this thing?

VINCENT

(Sighs)
The point is that we don't know if every sequence eventually converges to one or not.

EUCLID

(To audience)
Finally, the good stuff! I know you've all been waiting with your hairs on edge for the serious mathematical discussion to begin.

(To VINCENT)
Okay, and what's stopping us from proving it?

VINCENT

Well, the fact that there's an infinite amount of numbers to check. People have been trying to prove it based on general cases for decades but that's a dead end.

EUCLID

And you're trying something different then?

VINCENT

I am, I'm trying to approach it geometrically. See, I figured that since we can model it as a branching tree, there might be some way to use what we know about fractals to prove that this tree is going to contain every positive integer.

EUCLID

And how can we do that geometrically?

VINCENT

Well, I started thinking about it as if it were a coordinate plane. You said that if there exist any two points on a plane, you can always connect them with a straight line, yes?

EUCLID

A version of me said that, yes.

VINCENT

Right! And so I was thinking if we could find some sort of plane to plot the sequences on, I could find a way to construct an arbitrarily large set of lines that would contain all points in the plane.

EUCLID

Of course!

VINCENT

But that didn't work.

EUCLID

Ah!

(To audience)
Is this all making sense to everyone?

VINCENT

And so my next thought was, if we create a plane in which each of the integers can be represented by their shortest distance from 4, then we-

(The doorbell rings, VINCENT calls out)
Come in ALEX! Anyway, if we could categorize them that way, perhaps there might be a way that those categories would be able to be mapped in a series of functions that cover the entirety of the integers!

EUCLID

And have you had any luck with that so far?

VINCENT

Well, I've been trying to categorize them manually, my programming skills are not quite the sharpest, but I think I'm going to need a program to…

(The study door has opened, AMY is standing in the doorway, puzzled.)

AMY

Uncle VINCENT?

VINCENT

I… AMY?

(VINCENT moves quickly to her)
AMY, oh my goodness, you're…

AMY

An actual adult now?

VINCENT

Yes, you are aren't you?

(The two hug.)
What are you doing here? I thought that you weren't going to make it for another week.

AMY

Well my exams ended up all being at the start of the week so I started driving up here yesterday. I called you, I even left a message. You do have a phone now, right? Dad said he basically had to force you into getting one instead of another fax machine.

VINCENT

I… I do have a phone, I must have just missed your call while I was working. Oh, and speaking of working… you have to excuse my mess here, if I had known you were coming today I-

(VINCENT turns around to gesture at the room and sees that EUCLID is still there. He is shocked by this.)
Um, I… I would have done a much better job of cleaning up in here…

AMY

That's okay, VINCENT. Do you remember when I was a toddler and mom would drop me off at your office for the day? God if she saw how many unguarded stacks of books there were in that room she probably would've *killed* you.

VINCENT

Ah, I do… I remember that.

AMY

Dad says hi, by the way. Hey VINCENT, when I walked in here I heard you talking.

VINCENT

(Staring at EUCLID. EUCLID realizes that he is still here. This has not happened before. EUCLID examines himself.)
Um, well I…

EUCLID

VINCENT…

AMY

Were you talking to EUCLID?

VINCENT

What?

EUCLID

VINCENT!

AMY

You remember! When I was in your office, you always used to talk to EUCLID when you were thinking about stuff. I used to say hi to him whenever I came to visit. Hi EUCLID!

EUCLID

Hello!

VINCENT

Don’t say that!

AMY

What?

VINCENT

I just, I *was* talking to EUCLID, yes. He still helps me, sometimes, but I think right now I’d just rather not think about him.

AMY

Oh… well that’s fine, I wanted to talk-

VINCENT

How has college been? I haven’t seen you since you graduated high school.

(AMY moves into the room, taking in the mess and touching the curtains. VINCENT gestures for EUCLID to leave, who moves to the couch and sits, trying to take up as little space as possible.)

AMY

Well, everything is fine, Discrete Math is much more fun than I thought it was going to be. OH and I was in a group that got an honorable mention in a game jam!

VINCENT

Oh that’s wonderful!

AMY

VINCENT, do you know what the words “game” and “jam” mean when they’re used together?

VINCENT

No, not at all.

AMY

(Laughs)
It’s just where you get a team together and you have a weekend or however much time to make a video game from scratch. I did

half the programming for my team, and on the next one they're making me the team manager.

VINCENT

Ahhhh, then I was right! That is wonderful!

AMY

Yeah! And outside of that everything is fine. I'm living with a few of my computer science friends off-campus next year.

THERE'S SUPPOSED TO BE A LINE HERE

(The two laugh, AMY sits on the couch. EUCLID freezes.)

AMY

So, my dad didn't just say "Hi". He wanted me to talk to you about something.

EUCLID

VINCENT, make me go away.

(EUCLID moves to behind VINCENT swiftly.)

VINCENT

(Hushed)
That's not normally something I have to do!

EUCLID

Well, I don't usually do anything either it just happens!

AMY

He wanted me to talk to you about the "r word".

VINCENT

What?

EUCLID

VINCENT!

VINCENT

(To EUCLID)
Can't you just leave by yourself?

AMY

I know…

VINCENT

He thinks I should retire? What the hell does he know about what I should do?

EUCLID

I can't do anything by myself, I have no self!

AMY

I know… and I think maybe he's just being overly cautious, y'know, after everything that happened with my mom.

VINCENT

Did he say that's why he thinks I should retire?

(AMY is silent and looks away.)

Of course. Does he think I'm not aware of the chances? I know I'm at risk. I saw what it did to my father, and I saw what it did to Mary. Your mother. I can't forget that. So you can tell him that I'm well aware of what to look out for and that I don't need him trying to diagnose me from a hundred miles away.

AMY

(Waits for a moment, then smiles.)

I told him you would say something like that.

VINCENT

Good. Did he say anything else?

AMY

No, just that.

VINCENT

Good.

(There is a longer than normal silence, VINCENT is staring at EUCLID.)

EUCLID

Stop looking at me. I'm not here, focus on your niece.

AMY

Um, is it alright if I go to the bathroom?

VINCENT

Yes of course, do you still remember where it is?

AMY

Of course I do, I'll be right back.

(AMY exits, a moment after the door closes…)

VINCENT

What the hell are you still doing here?

EUCLID

Clearly I can answer that question, seeing as how I have always been in control of when and where I show up.

VINCENT

Don't give me that. You shouldn't be here now. You should be in the back of my mind.

EUCLID

Then why aren't I?

VINCENT

I don't know! But you can't be sticking around with other people

around and you can, under no circumstances, *talk* to me with other people around. Do you understand what that does to me? Anything you want to say, you keep it to yourself until she leaves.

EUCLID

I can try to keep quiet, but I told you, *my*self is *your*self.

VINCENT

I'm well aware! Alright? But you can at least do me the favor of *telling* me you're going to try. Even if you can't do anything, maybe then I won't think about you.

EUCLID

Okay, I will.

(EUCLID lies down at the front of the study, facing the ceiling. VINCENT turns to the window, fussing with the curtains as AMY reenters.)

AMY

How come you keep those closed? The curtains.

VINCENT

Oh, just because the light can be distracting. If I'm trying to do a lot of thinking sometimes the sun just pokes my eyes, and it's a two person job moving this desk away from the window, so I just close them.

AMY

That's a shame, I always thought it looked nice out there. Plus, the sun gives you vitamins and stuff, right?

VINCENT

Well even if it does, there's no sun out there now. It's supposed to storm all this week.

(AMY is peeking behind the curtains.)

AMY

Shame… that tree is still there though, I remember you used to-

VINCENT

Yes. I did, you're right. Please keep those closed.

AMY

Oh. I was just looking.

VINCENT

I'm sorry, you can look. I'd just… I'd like to talk to you, about this conjecture.

AMY

Conjecture?

VINCENT

The Collatz Conjecture, I wrote you a letter about it. The one with the odd numbers and-

AMY

Ohhhh, right, how could I forget. Your great magnum opus. Haven't you been working at that for years?

VINCENT

I have, but this is the end of it.

AMY

You have a solution?

VINCENT

Well, I will. Amy, my leave is ending soon and I need to present my research to the department; the only thing that I need to get my answer is a program. You know I'm not very good with the computers, do you think that, if I explain it to you, you could help me?

AMY

(Taken aback)
Help? You want me to… VINCENT this problem is… it's yours, I couldn't take part of it away from you.

VINCENT

You wouldn't be taking anything. I'm an old dog, and this is the last trick I need to finish this problem. AMY, do this for me. Our names are going to be in textbooks until the universe collapses. We can leave something behind that is going to enrich the lives of everyone on this planet!

AMY

VINCENT… alright, I'll do it.

VINCENT

(Hugging AMY)
I knew you would… our names, our names next to the greatest minds in history.

AMY

Don't get too ahead of yourself, I'm barely even a senior.

VINCENT

Here, let me find some of the notes that I was getting ready for you…

(VINCENT begins to root through his desk.)
Okay, let's see… No, It's not… I thought it was… No, I just checked there…

(VINCENT continues as AMY walks over to the pile of papers on

the ground)

AMY

Well what about some of these…

(She picks one up, smoothing it and noticing that it is completely blank. She does this with more pages before VINCENT notices.)

VINCENT

Oh, don't worry about those. They're just bad ideas.

(AMY wants to speak but backs away from the papers. She watches VINCENT continue to struggle, he keeps looking over at EUCLID.)
Dammit I know that I… maybe they're on my shelf. Let me take a look. Here…

AMY

Hey VINCENT?

VINCENT

Just a moment… it's here somewhere… it's about categorizing them by distance… if you see anything like that…

AMY

(Speaking softly and slowly)
VINCENT, you can keep looking, I'm going to get my computer, it's still in my car, okay? I'll be right back.

VINCENT

What? Oh, fine, that's fine. We can get started then, I'll find those notes before you make it back.

(AMY lingers for a moment, looking at the papers, the curtains, the dying plant on the wall, and VINCENT. She exits quickly. Euclid begins whistling a random tune.)
You're whistling again.

EUCLID

I know I am. See? I can be as out of the way as I need to be.

VINCENT

Yes I'm very proud, but you're still here; that's the problem.

EUCLID

Maybe so, but this isn't so bad, right?

VINCENT

I guess, but you're still a distraction. I can't find my notes.

EUCLID

Maybe you're distracted because you're excited. All that talk of history and your names resting in the highest afterlives, I haven't seen you with this much energy in a long time.

VINCENT

Can you blame me? It’s exciting! I finally am going to get that solution, and sooner than I thought. If I can just find these damn notes…

EUCLID

What do you think you’ll do if you do find the answer?

VINCENT

What? I’m going to tell people.

EUCLID

No, once you’ve found an answer for this conjecture, are you going to retire?

VINCENT

Why would I? There’s so many things I can do after.

EUCLID

But what will you do then?

VINCENT

(VINCENT pauses)
I don’t… I’ll keep working. What are you talking about?

EUCLID

You know you can’t keep working forever. Look at AMY, she has her whole life in front of her.

(VINCENT stops looking for the notes.)

VINCENT

Where is this coming from?

EUCLID

From me, from you. It’s a strange view from all the way down here.

VINCENT

I’m not talking about this with you. Amy’s going to be back any moment and I do not need you and your nonsense clouding my head.

(We see, outside of the house, AMY and ALEX.)

AMY

He’s in there. He looks like he hasn’t been sleeping… God, thank you for warning me…

ALEX

It’s alright, I’m just glad you were able to get here earlier. I don’t know where he’s gonna be at in a couple days and I just can’t keep watching it by myself like this…

AMY

I understand. It was the same way with my mom, she was so

obsessed with her garden that sometimes she just wouldn't sleep or eat… She would sit there at the dinner table and ask me about my day, and when I would try to talk to her about she would just get up and go out into her garden.

EUCLID

(To VINCENT)
It isn't nonsense, you're thinking it. You just don't have the ability to say it.

ALEX

And the forgetting?

AMY

Yeah, I don't know it was like he was talking to me but he wasn't really hearing me. Like he was confused the whole time.

EUCLID

(To VINCENT)
You think that you're so certain about the way things are. You believe that you truly, truly know what is going on. But I can see here, there is doubt. You have doubts about your answer: maybe this isn't the right way, maybe you're wrong about the solution, maybe your whole conjecture is just wrong.

ALEX

I'm glad I called you this morning, he'll listen to you. He talks about you an awful lot.

AMY

He does?

ALEX

He does. He used to.

EUCLID

(To VINCENT)
You want so desperately for what you *think* to be what's true. You can't even carry the weight of imagining what will happen if you're wrong.

VINCENT

(Seething)
I am not wrong. I know how it's going to go. I know the truth. I just need to prove it.

AMY

What should I say?

ALEX

Just tell him that you want to ask him some questions.

AMY

I know VINCENT, he's not going to go for that.

ALEX

Then just say that you want to talk to him, make sure he knows that you love him.

EUCLID

(Rising, but still speaking calmly)
And what if you can't? What are you going to do? Are you going to accept that you're wrong? Are you going to come back to the world outside of your mind? Can you?

VINCENT

(Exploding)
YES I CAN! I'M RIGHT DAMMIT, I KNOW I AM.

(AMY and ALEX hear this, and rush off.)
Everyone has their own ideas about my work, about my *life*. Well dammit I have my own ideas, and I'm a hell of a lot closer to it all than they are! They think that I'm sick. They think there's something wrong with me. They think that all of this, all of everything, is because I'm losing it. When I was obsessed with my work 50 years ago it was "drive" I was "passionate". Oh but how dare I make the same sacrifices I made then when I'm past 65!

(VINCENT scatters papers violently off his desk.)

I AM ME. DAMMIT I AM. THEY'RE NOT ME. YOU'RE NOT ME. SO WHO THE HELL ARE YOU TO TELL ME WHAT I THINK.

EUCLID

I can *only* tell you what you think.

VINCENT

Don't give me that crap. You think you can tell me what to do just like everyone else. You think you have the RIGHT TO-

(ALEX and AMY burst in through the door)

AMY

VINCENT? Sit down, okay? You need to rest right now.

(AMY approaches VINCENT, he knocks her away.)

VINCENT

Don't do that, don't talk to me like that. It's… It's me…

(VINCENT sees ALEX.)
You. What the hell did you say to her? AMY don't listen to ALEX I-

ALEX

I only told her what I've been seeing for months now VINCENT. You've completely shut yourself away, you forget things, you're talking to people that don't exist.

VINCENT

I've always done that! Ask AMY, I've been doing that since she was little! Remember AMY? My office? You would talk to EUCLID.

AMY

VINCENT…

ALEX

We just want you to get the help you need VINCENT…

VINCENT

Dammit I don't need help!

(To AMY.)

You wanted to do this? You want me gone too? You want to lock me away so nobody has to be so worried anymore? Did you ever think that maybe I know *myself* better than you can?

AMY

We're not saying you'd have to go away anywhere… you could live with me and my dad, we already have all of the stuff still from mom…

VINCENT

Oh, so that's what it is. You think the same thing is happening to me.

ALEX

VINCENT that's all we *can* think, now please, we called the doctor and they'll be here any minute. Just come with us.

AMY

If you're right they'll know that.

VINCENT

But they can't be sure. They can never be sure. You line me up with enough of their symptoms and they'll say that anything is possible.

AMY

Please VINCENT…

(VINCENT looks back and forth, backing up into the papers. EUCLID stands behind him. He breathes heavily, and after a moment stands still.)

VINCENT

Alright. I… I will. I'll go. Just let me get my notes and I'll be outside.

ALEX

VINCENT we can’t-

AMY

Fine. We trust you.

(ALEX, AMY, and VINCENT all stare at each other for a moment before ALEX and AMY turn to slowly exit. Once they are gone, VINCENT rushes to the door, locking it and pushing his chair under the handle.)

AMY

VINCENT!

ALEX

VINCENT what the hell are you doing?!

VINCENT

I’m not… I can’t… I’m too close. Stay the hell away from me.

(The two bang on the outside of the door and yell for VINCENT repeatedly as the rest of the walls disappear. All that is left is the door and the window. VINCENT begins grabbing the books off his shelf and moving them all to his desk. As he does this the regular lights dim, and the stage is filled with the fractal veins, pulsing faster and faster. VINCENT cries out in pain, gripping his side, but keeps on. EUCLID, during this whole sequence, slowly makes his way to the center of the stage. He is joined by ADA, and once the two have reached the center, all lights and noise cut out. After a moment a spotlight appears on EUCLID and ADA.)

ADA

The study of VINCENT LASELL has fallen apart.

EUCLID

The study of VINCENT LASELL will continue.
(Blackout, end ACT I.)

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