What is Mathematical Research?

Engineering & Science Seminar
University of Detroit Mercy

Ioannis (Yiannis) Souldatos

Disclaimer: This talk was constructed with an undergraduate/graduate student in mind who is curious about Mathematics.

Outline

1. Mathematical research
   - What is mathematical research?
   - What are some famous open mathematical problems?
   - Some statistics about mathematical research
2. How does mathematical research work?
   - What does it take?
   - What is the peer-review process?
   - How much work does it take?
3. Sabbatical year overview
   - What are the applications?

What is Mathematical research?

- Mathematical research is the quest to prove new theorems
- These new theorems are about Mathematical objects, their properties and relations.
- E.g. Pythagorean Theorem is about right triangles. If a,b are the right sides of a right triangle and c is the hypotenuse, then

$$a^2 + b^2 = c^2.$$

- A collection of theorems that refer to the same Mathematical object is called a *theory*. E.g. Graph Theory, Group Theory, Set Theory etc.

What is Mathematical research?

- Mathematical research is the quest to prove new theorems
- These new theorems are about Mathematical objects, their properties and relations.
- E.g. Pythagorean Theorem is about right triangles. If a,b are the right sides of a right triangle and c is the hypotenuse, then

$$a^2 + b^2 = c^2.$$

- A collection of theorems that refer to the same Mathematical object is called a *theory*. E.g. Graph Theory, Group Theory, Set Theory etc.

What is Mathematical research?

- Mathematical research is the quest to prove new theorems
- These new theorems are about Mathematical objects, their properties and relations.
- E.g. Pythagorean Theorem is about right triangles. If a,b are the right sides of a right triangle and c is the hypotenuse, then

$$a^2 + b^2 = c^2.$$

- A collection of theorems that refer to the same Mathematical object is called a *theory*. E.g. Graph Theory, Group Theory, Set Theory etc.

What is Mathematical research?

- Mathematical research is the quest to prove new theorems
- These new theorems are about Mathematical objects, their properties and relations.
- E.g. Pythagorean Theorem is about right triangles. If a,b are the right sides of a right triangle and c is the hypotenuse, then

$$a^2 + b^2 = c^2.$$

- A collection of theorems that refer to the same Mathematical object is called a *theory*. E.g. Graph Theory, Group Theory, Set Theory etc.

What is Mathematical research?

- Mathematical research is the quest to prove new theorems
- These new theorems are about Mathematical objects, their properties and relations.
- E.g. Pythagorean Theorem is about right triangles. If a,b are the right sides of a right triangle and c is the hypotenuse, then

$$a^2 + b^2 = c^2.$$

- A collection of theorems that refer to the same Mathematical object is called a *theory*. E.g. Graph Theory, Group Theory, Set Theory etc.

- The first people to prove theorems were the Ancient Greeks.
- The Ancient Greeks wanted to go beyond what "seemed true", what "seemed reasonable", what is "almost true", what is "true in many cases" etc.
- They wanted to establish a method that beyond any doubt would settle their questions for ever.

- The first people to prove theorems were the Ancient Greeks.
- The Ancient Greeks wanted to go beyond what "seemed true", what "seemed reasonable", what is "almost true", what is "true in many cases" etc.
- They wanted to establish a method that beyond any doubt would settle their questions for ever.

- The first people to prove theorems were the Ancient Greeks.
- The Ancient Greeks wanted to go beyond what "seemed true", what "seemed reasonable", what is "almost true", what is "true in many cases" etc.
- They wanted to establish a method that beyond any doubt would settle their questions for ever.

- The first people to prove theorems were the Ancient Greeks.
- The Ancient Greeks wanted to go beyond what "seemed true", what "seemed reasonable", what is "almost true", what is "true in many cases" etc.
- They wanted to establish a method that beyond any doubt would settle their questions for ever.

- The first people to prove theorems were the Ancient Greeks.
- The Ancient Greeks wanted to go beyond what "seemed true", what "seemed reasonable", what is "almost true", what is "true in many cases" etc.
- They wanted to establish a method that beyond any doubt would settle their questions for ever.

- Once a theorem is proven (if the proof is correct), the theorem holds true *eternally*.
- The Pythagorean theorem was proved about 2500 years ago.
- It is still just as "fresh" and relevant today as it was in the days of Pythagoras.
- And it will stay the same for at least another 2500 years.

- Once a theorem is proven (if the proof is correct), the theorem holds true *eternally*.
- The Pythagorean theorem was proved about 2500 years ago.
- It is still just as "fresh" and relevant today as it was in the days of Pythagoras.
- And it will stay the same for at least another 2500 years.

- Once a theorem is proven (if the proof is correct), the theorem holds true *eternally*.
- The Pythagorean theorem was proved about 2500 years ago.
- It is still just as "fresh" and relevant today as it was in the days of Pythagoras.
- And it will stay the same for at least another 2500 years.

- Once a theorem is proven (if the proof is correct), the theorem holds true *eternally*.
- The Pythagorean theorem was proved about 2500 years ago.
- It is still just as "fresh" and relevant today as it was in the days of Pythagoras.
- And it will stay the same for at least another 2500 years.

Question

But what is left to be proved? Isn't it all done already?

Answer No, it is not all done. Maybe low-level Mathematics has all been worked out. But as you transition to higher- level Mathematics, you encounter *open problems*.
Open problems are problems which none has ever solved before.
If a problem is open, but people believe it to be true, this is called a *conjecture*.

Question

But what is left to be proved? Isn't it all done already?

Answer No, it is not all done. Maybe low-level Mathematics has all been worked out. But as you transition to higher- level Mathematics, you encounter *open problems*.
Open problems are problems which none has ever solved before.
If a problem is open, but people believe it to be true, this is called a *conjecture*.

Question

But what is left to be proved? Isn't it all done already?

Answer No, it is not all done. Maybe low-level Mathematics has all been worked out. But as you transition to higher- level Mathematics, you encounter *open problems*.
Open problems are problems which none has ever solved before.
If a problem is open, but people believe it to be true, this is called a *conjecture*.

Question

But what is left to be proved? Isn't it all done already?

Answer No, it is not all done. Maybe low-level Mathematics has all been worked out. But as you transition to higher- level Mathematics, you encounter *open problems*.

Open problems are problems which none has ever solved before.

If a problem is open, but people believe it to be true, this is called a *conjecture*.

Question

But what is left to be proved? Isn't it all done already?

Answer No, it is not all done. Maybe low-level Mathematics has all been worked out. But as you transition to higher- level Mathematics, you encounter *open problems*.

Open problems are problems which none has ever solved before.

If a problem is open, but people believe it to be true, this is called a *conjecture*.

Question

But what is left to be proved? Isn't it all done already?

Answer No, it is not all done. Maybe low-level Mathematics has all been worked out. But as you transition to higher- level Mathematics, you encounter *open problems*.
Open problems are problems which none has ever solved before.
If a problem is open, but people believe it to be true, this is called a *conjecture*.

Question

What are some famous mathematical problems that remain open today?

Answer The most famous open mathematical problems are the Millennium Problems of the Clay Mathematics Institute. This is a list of 6 problems the solution of each one of them will result in a $\$1,000,000$ award.

1. P versus NP
2. Hodge conjecture
3. Riemann hypothesis
4. Yang-Mills existence and mass gap
5. Navier-Stokes existence and smoothness
6. Birch and Swinnerton-Dyer conjecture

Question

What are some famous mathematical problems that remain open today?

Answer The most famous open mathematical problems are the Millennium Problems of the Clay Mathematics Institute. This is a list of 6 problems the solution of each one of them will result in a $\$1,000,000$ award.

1. P versus NP
2. Hodge conjecture
3. Riemann hypothesis
4. Yang-Mills existence and mass gap
5. Navier-Stokes existence and smoothness
6. Birch and Swinnerton-Dyer conjecture

Question

What are some famous mathematical problems that remain open today?

Answer The most famous open mathematical problems are the Millennium Problems of the Clay Mathematics Institute. This is a list of 6 problems the solution of each one of them will result in a $\$1,000,000$ award.

1. P versus NP
2. Hodge conjecture
3. Riemann hypothesis
4. Yang-Mills existence and mass gap
5. Navier-Stokes existence and smoothness
6. Birch and Swinnerton-Dyer conjecture

Question

What are some famous mathematical problems that remain open today?

Answer The most famous open mathematical problems are the Millennium Problems of the Clay Mathematics Institute. This is a list of 6 problems the solution of each one of them will result in a $\$1,000,000$ award.

1. P versus NP
2. Hodge conjecture
3. Riemann hypothesis
4. Yang-Mills existence and mass gap
5. Navier-Stokes existence and smoothness
6. Birch and Swinnerton-Dyer conjecture

Question

What are some famous mathematical problems that remain open today?

Answer The most famous open mathematical problems are the Millennium Problems of the Clay Mathematics Institute. This is a list of 6 problems the solution of each one of them will result in a $\$1,000,000$ award.

1. P versus NP
2. Hodge conjecture
3. Riemann hypothesis
4. Yang-Mills existence and mass gap
5. Navier-Stokes existence and smoothness
6. Birch and Swinnerton-Dyer conjecture

Question

What are some famous mathematical problems that remain open today?

Answer The most famous open mathematical problems are the Millennium Problems of the Clay Mathematics Institute. This is a list of 6 problems the solution of each one of them will result in a $\$1,000,000$ award.

1. P versus NP
2. Hodge conjecture
3. Riemann hypothesis
4. Yang-Mills existence and mass gap
5. Navier-Stokes existence and smoothness
6. Birch and Swinnerton-Dyer conjecture

Question

What are some famous mathematical problems that remain open today?

Answer The most famous open mathematical problems are the Millennium Problems of the Clay Mathematics Institute. This is a list of 6 problems the solution of each one of them will result in a $\$1,000,000$ award.

1. P versus NP
2. Hodge conjecture
3. Riemann hypothesis
4. Yang-Mills existence and mass gap
5. Navier-Stokes existence and smoothness
6. Birch and Swinnerton-Dyer conjecture

Question

What are some famous mathematical problems that remain open today?

Answer The most famous open mathematical problems are the Millennium Problems of the Clay Mathematics Institute. This is a list of 6 problems the solution of each one of them will result in a $\$1,000,000$ award.

1. P versus NP
2. Hodge conjecture
3. Riemann hypothesis
4. Yang-Mills existence and mass gap
5. Navier-Stokes existence and smoothness
6. Birch and Swinnerton-Dyer conjecture

Question

What are some famous mathematical problems that remain open today?

Answer The most famous open mathematical problems are the Millennium Problems of the Clay Mathematics Institute. This is a list of 6 problems the solution of each one of them will result in a $\$1,000,000$ award.

1. P versus NP
2. Hodge conjecture
3. Riemann hypothesis
4. Yang-Mills existence and mass gap
5. Navier-Stokes existence and smoothness
6. Birch and Swinnerton-Dyer conjecture

- If you want to engage in mathematical research, you need to study Mathematics at the doctoral level.
- You will not be able to even understand the statement of the Millennium Problems (much less to solve them), if you do not get training in the corresponding area.

- If you want to engage in mathematical research, you need to study Mathematics at the doctoral level.
- You will not be able to even understand the statement of the Millennium Problems (much less to solve them), if you do not get training in the corresponding area.

Some Statistics

- Every year in the US alone there are about $2,000$ Ph.D.s awarded in Mathematics, including about $500 - 600$ Ph.D.s in Statistics and Biostatistics.
- About 34% of these Ph.D. holders starts working for the Industry, 5% for the Government, and the rest for the Academia.
- Depending on the position, many of these Ph.D. holders engage in Mathematical research.
- So, there is a whole "army" of Mathematicians that ranks in the ten of thousands that engage in Mathematical Research.
- The output is some hundred of thousands of publications in Mathematics every year.

Some Statistics

- Every year in the US alone there are about $2,000$ Ph.D.s awarded in Mathematics, including about $500 - 600$ Ph.D.s in Statistics and Biostatistics.
- About 34% of these Ph.D. holders starts working for the Industry, 5% for the Government, and the rest for the Academia.
- Depending on the position, many of these Ph.D. holders engage in Mathematical research.
- So, there is a whole "army" of Mathematicians that ranks in the ten of thousands that engage in Mathematical Research.
- The output is some hundred of thousands of publications in Mathematics every year.

Some Statistics

- Every year in the US alone there are about $2,000$ Ph.D.s awarded in Mathematics, including about $500 - 600$ Ph.D.s in Statistics and Biostatistics.
- About 34% of these Ph.D. holders starts working for the Industry, 5% for the Government, and the rest for the Academia.
- Depending on the position, many of these Ph.D. holders engage in Mathematical research.
- So, there is a whole "army" of Mathematicians that ranks in the ten of thousands that engage in Mathematical Research.
- The output is some hundred of thousands of publications in Mathematics every year.

Some Statistics

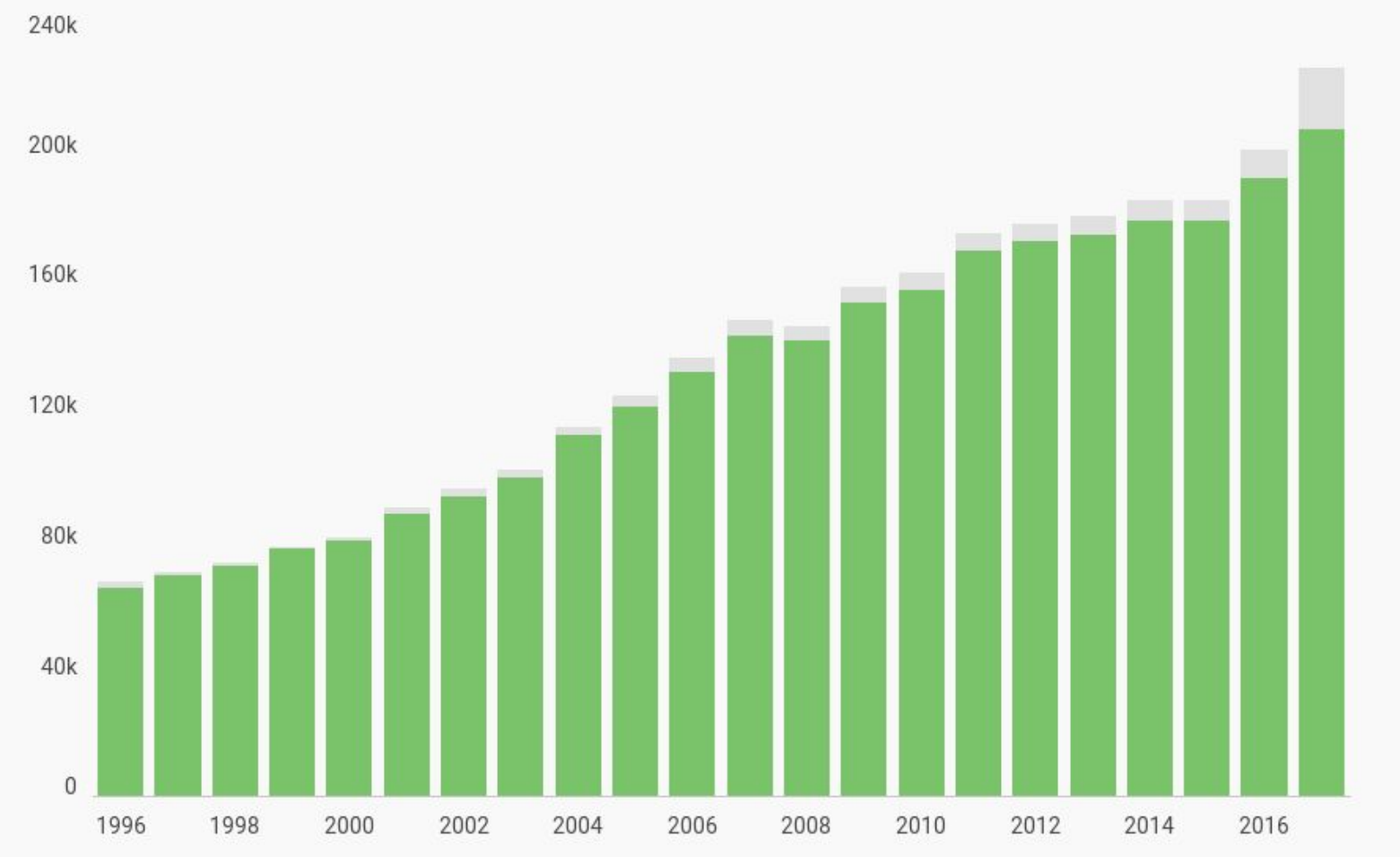
- Every year in the US alone there are about $2,000$ Ph.D.s awarded in Mathematics, including about $500 - 600$ Ph.D.s in Statistics and Biostatistics.
- About 34% of these Ph.D. holders starts working for the Industry, 5% for the Government, and the rest for the Academia.
- Depending on the position, many of these Ph.D. holders engage in Mathematical research.
- So, there is a whole "army" of Mathematicians that ranks in the ten of thousands that engage in Mathematical Research.
- The output is some hundred of thousands of publications in Mathematics every year.

Some Statistics

- Every year in the US alone there are about $2,000$ Ph.D.s awarded in Mathematics, including about $500 - 600$ Ph.D.s in Statistics and Biostatistics.
- About 34% of these Ph.D. holders starts working for the Industry, 5% for the Government, and the rest for the Academia.
- Depending on the position, many of these Ph.D. holders engage in Mathematical research.
- So, there is a whole "army" of Mathematicians that ranks in the ten of thousands that engage in Mathematical Research.
- The output is some hundred of thousands of publications in Mathematics every year.

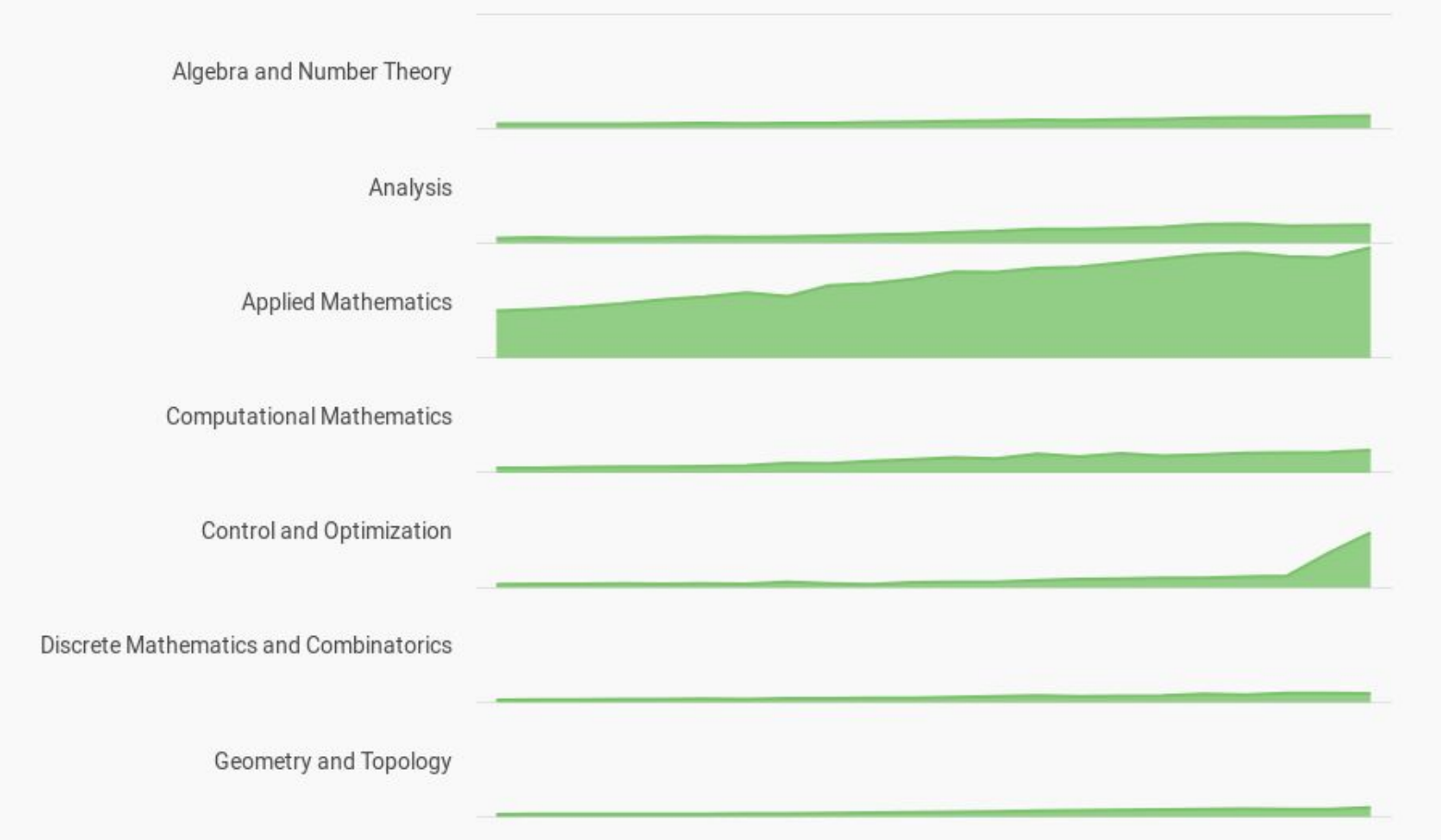
Some More Statistics

Annual Publications in Mathematics



Some More Statistics

Annual Publications in Mathematics Per Subject- 1



Some More Statistics

Annual Publications in Mathematics Per Subject- 2

How does mathematical research work?

- Mathematical research starts by reviewing the known literature.
- If you prove a theorem that is already known, you get no credit.
- So, the first step is to identify one or more open problems.

How does mathematical research work?

- Mathematical research starts by reviewing the known literature.
- If you prove a theorem that is already known, you get no credit.
- So, the first step is to identify one or more open problems.

How does mathematical research work?

- Mathematical research starts by reviewing the known literature.
- If you prove a theorem that is already known, you get no credit.
- So, the first step is to identify one or more open problems.

Second Step

- The second and most important step is to come up with some promising ideas.
- There is no guarantee that your ideas will work, or that you will have any ideas at all.
- You may spend a whole year and get no ideas.
- Or you may spend a month and come up with many fruitful ideas.
- Or you may end up solving a different open problem than you thought.
- Mathematicians are like poets in this regard. You never know what you will get.

Second Step

- The second and most important step is to come up with some promising ideas.
- There is no guarantee that your ideas will work, or that you will have any ideas at all.
- You may spend a whole year and get no ideas.
- Or you may spend a month and come up with many fruitful ideas.
- Or you may end up solving a different open problem than you thought.
- Mathematicians are like poets in this regard. You never know what you will get.

Second Step

- The second and most important step is to come up with some promising ideas.
- There is no guarantee that your ideas will work, or that you will have any ideas at all.
- You may spend a whole year and get no ideas.
- Or you may spend a month and come up with many fruitful ideas.
- Or you may end up solving a different open problem than you thought.
- Mathematicians are like poets in this regard. You never know what you will get.

Second Step

- The second and most important step is to come up with some promising ideas.
- There is no guarantee that your ideas will work, or that you will have any ideas at all.
- You may spend a whole year and get no ideas.
- Or you may spend a month and come up with many fruitful ideas.
- Or you may end up solving a different open problem than you thought.
- Mathematicians are like poets in this regard. You never know what you will get.

Second Step

- The second and most important step is to come up with some promising ideas.
- There is no guarantee that your ideas will work, or that you will have any ideas at all.
- You may spend a whole year and get no ideas.
- Or you may spend a month and come up with many fruitful ideas.
- Or you may end up solving a different open problem than you thought.
- Mathematicians are like poets in this regard. You never know what you will get.

Second Step

- The second and most important step is to come up with some promising ideas.
- There is no guarantee that your ideas will work, or that you will have any ideas at all.
- You may spend a whole year and get no ideas.
- Or you may spend a month and come up with many fruitful ideas.
- Or you may end up solving a different open problem than you thought.
- Mathematicians are like poets in this regard. You never know what you will get.

Second Step

- The second and most important step is to come up with some promising ideas.
- There is no guarantee that your ideas will work, or that you will have any ideas at all.
- You may spend a whole year and get no ideas.
- Or you may spend a month and come up with many fruitful ideas.
- Or you may end up solving a different open problem than you thought.
- Mathematicians are like poets in this regard. You never know what you will get.

Further Steps

- Then you implement your ideas and you see if they work.
- Most of the times the ideas do not work!
- But hopefully get some insight on why they do not work and you modify the original ideas so as to make them work.
- You repeat the process multiple times.
- Usually this happens in conjunction to further looking the literature and/or asking colleagues for help.
- After several months and after several attempts, if everything goes well, you have a result that is interesting enough and which deserves to be published. But again there are no guarantees.

Further Steps

- Then you implement your ideas and you see if they work.
- Most of the times the ideas do not work!
- But hopefully get some insight on why they do not work and you modify the original ideas so as to make them work.
- You repeat the process multiple times.
- Usually this happens in conjunction to further looking the literature and/or asking colleagues for help.
- After several months and after several attempts, if everything goes well, you have a result that is interesting enough and which deserves to be published. But again there are no guarantees.

Further Steps

- Then you implement your ideas and you see if they work.
- Most of the times the ideas do not work!
- But hopefully get some insight on why they do not work and you modify the original ideas so as to make them work.
- You repeat the process multiple times.
- Usually this happens in conjunction to further looking the literature and/or asking colleagues for help.
- After several months and after several attempts, if everything goes well, you have a result that is interesting enough and which deserves to be published. But again there are no guarantees.

Further Steps

- Then you implement your ideas and you see if they work.
- Most of the times the ideas do not work!
- But hopefully get some insight on why they do not work and you modify the original ideas so as to make them work.
- You repeat the process multiple times.
- Usually this happens in conjunction to further looking the literature and/or asking colleagues for help.
- After several months and after several attempts, if everything goes well, you have a result that is interesting enough and which deserves to be published. But again there are no guarantees.

Further Steps

- Then you implement your ideas and you see if they work.
- Most of the times the ideas do not work!
- But hopefully get some insight on why they do not work and you modify the original ideas so as to make them work.
- You repeat the process multiple times.
- Usually this happens in conjunction to further looking the literature and/or asking colleagues for help.
- After several months and after several attempts, if everything goes well, you have a result that is interesting enough and which deserves to be published. But again there are no guarantees.

Further Steps

- Then you implement your ideas and you see if they work.
- Most of the times the ideas do not work!
- But hopefully get some insight on why they do not work and you modify the original ideas so as to make them work.
- You repeat the process multiple times.
- Usually this happens in conjunction to further looking the literature and/or asking colleagues for help.
- After several months and after several attempts, if everything goes well, you have a result that is interesting enough and which deserves to be published. But again there are no guarantees.

Further Steps

- Then you implement your ideas and you see if they work.
- Most of the times the ideas do not work!
- But hopefully get some insight on why they do not work and you modify the original ideas so as to make them work.
- You repeat the process multiple times.
- Usually this happens in conjunction to further looking the literature and/or asking colleagues for help.
- After several months and after several attempts, if everything goes well, you have a result that is interesting enough and which deserves to be published. But again there are no guarantees.

Journal Submission

- The next step is to write down the result in a way that is clear and which proves beyond any doubt that the result is true.
- The manuscript is then submitted to a journal to be considered for publication.
- The manuscript is assigned to a Mathematician (or two) who is familiar with the problem you are solving.
- This person is called the *referee* and referee's job is to verify the validity of your proposed proof.

Journal Submission

- The next step is to write down the result in a way that is clear and which proves beyond any doubt that the result is true.
- The manuscript is then submitted to a journal to be considered for publication.
- The manuscript is assigned to a Mathematician (or two) who is familiar with the problem you are solving.
- This person is called the *referee* and referee's job is to verify the validity of your proposed proof.

Journal Submission

- The next step is to write down the result in a way that is clear and which proves beyond any doubt that the result is true.
- The manuscript is then submitted to a journal to be considered for publication.
- The manuscript is assigned to a Mathematician (or two) who is familiar with the problem you are solving.
- This person is called the *referee* and referee's job is to verify the validity of your proposed proof.

Journal Submission

- The next step is to write down the result in a way that is clear and which proves beyond any doubt that the result is true.
- The manuscript is then submitted to a journal to be considered for publication.
- The manuscript is assigned to a Mathematician (or two) who is familiar with the problem you are solving.
- This person is called the *referee* and referee's job is to verify the validity of your proposed proof.

Peer-Review Process

- Usually the referee comes back to the author with questions or requests for revision. This may repeat multiple times.
- Once the referee is satisfied the manuscript can be published.
- If the referee is not satisfied, the manuscript gets rejected and you have to start all over again.
- This whole process is called the *peer-review process*.
- Publication in a peer-review journal is the hallmark that your research has been "approved".

Peer-Review Process

- Usually the referee comes back to the author with questions or requests for revision. This may repeat multiple times.
- Once the referee is satisfied the manuscript can be published.
- If the referee is not satisfied, the manuscript gets rejected and you have to start all over again.
- This whole process is called the *peer-review process*.
- Publication in a peer-review journal is the hallmark that your research has been "approved".

Peer-Review Process

- Usually the referee comes back to the author with questions or requests for revision. This may repeat multiple times.
- Once the referee is satisfied the manuscript can be published.
- If the referee is not satisfied, the manuscript gets rejected and you have to start all over again.
- This whole process is called the *peer-review process*.
- Publication in a peer-review journal is the hallmark that your research has been "approved".

Peer-Review Process

- Usually the referee comes back to the author with questions or requests for revision. This may repeat multiple times.
- Once the referee is satisfied the manuscript can be published.
- If the referee is not satisfied, the manuscript gets rejected and you have to start all over again.
- This whole process is called the *peer-review process*.
- Publication in a peer-review journal is the hallmark that your research has been "approved".

Peer-Review Process

- Usually the referee comes back to the author with questions or requests for revision. This may repeat multiple times.
- Once the referee is satisfied the manuscript can be published.
- If the referee is not satisfied, the manuscript gets rejected and you have to start all over again.
- This whole process is called the *peer-review process*.
- Publication in a peer-review journal is the hallmark that your research has been "approved".

What does it take?

- Mathematicians work based on their knowledge of Mathematics, their experience and on their critical thinking skills.
- Some Mathematicians may also use computers for calculations.
- There is no step-by-step instruction on how to solve open problems.
- You analyze, synthesize, apply, evaluate, create etc. in any way you deem appropriate.
- Did I say there is no guarantee?
- One day you think you solved a hard problem. The next day you realize that your idea does not work.
- You may end up with nothing and you must be able to handle your emotions, and start over.

What does it take?

- Mathematicians work based on their knowledge of Mathematics, their experience and on their critical thinking skills.
- Some Mathematicians may also use computers for calculations.
- There is no step-by-step instruction on how to solve open problems.
- You analyze, synthesize, apply, evaluate, create etc. in any way you deem appropriate.
- Did I say there is no guarantee?
- One day you think you solved a hard problem. The next day you realize that your idea does not work.
- You may end up with nothing and you must be able to handle your emotions, and start over.

What does it take?

- Mathematicians work based on their knowledge of Mathematics, their experience and on their critical thinking skills.
- Some Mathematicians may also use computers for calculations.
- There is no step-by-step instruction on how to solve open problems.
- You analyze, synthesize, apply, evaluate, create etc. in any way you deem appropriate.
- Did I say there is no guarantee?
- One day you think you solved a hard problem. The next day you realize that your idea does not work.
- You may end up with nothing and you must be able to handle your emotions, and start over.

What does it take?

- Mathematicians work based on their knowledge of Mathematics, their experience and on their critical thinking skills.
- Some Mathematicians may also use computers for calculations.
- There is no step-by-step instruction on how to solve open problems.
- You analyze, synthesize, apply, evaluate, create etc. in any way you deem appropriate.
- Did I say there is no guarantee?
- One day you think you solved a hard problem. The next day you realize that your idea does not work.
- You may end up with nothing and you must be able to handle your emotions, and start over.

What does it take?

- Mathematicians work based on their knowledge of Mathematics, their experience and on their critical thinking skills.
- Some Mathematicians may also use computers for calculations.
- There is no step-by-step instruction on how to solve open problems.
- You analyze, synthesize, apply, evaluate, create etc. in any way you deem appropriate.
- Did I say there is no guarantee?
- One day you think you solved a hard problem. The next day you realize that your idea does not work.
- You may end up with nothing and you must be able to handle your emotions, and start over.

What does it take?

- Mathematicians work based on their knowledge of Mathematics, their experience and on their critical thinking skills.
- Some Mathematicians may also use computers for calculations.
- There is no step-by-step instruction on how to solve open problems.
- You analyze, synthesize, apply, evaluate, create etc. in any way you deem appropriate.
- Did I say there is no guarantee?
- One day you think you solved a hard problem. The next day you realize that your idea does not work.
- You may end up with nothing and you must be able to handle your emotions, and start over.

What does it take?

- Mathematicians work based on their knowledge of Mathematics, their experience and on their critical thinking skills.
- Some Mathematicians may also use computers for calculations.
- There is no step-by-step instruction on how to solve open problems.
- You analyze, synthesize, apply, evaluate, create etc. in any way you deem appropriate.
- Did I say there is no guarantee?
- One day you think you solved a hard problem. The next day you realize that your idea does not work.
- You may end up with nothing and you must be able to handle your emotions, and start over.

How long does it take?

- How long before you can submit a manuscript for publication varies a lot by person and by manuscript.
- I personally need about 1000 hours of work to conceive a project, work on it, write the results and submit for publication in a good journal.
- This is approximately 4-6 months of full-time work.
- After you submit you have to wait around 6 months before you hear back from the referee.
- If you go back and forth with the referee multiple times, you may spend a couple of years in the peer-review process.

How long does it take?

- How long before you can submit a manuscript for publication varies a lot by person and by manuscript.
- I personally need about 1000 hours of work to conceive a project, work on it, write the results and submit for publication in a good journal.
- This is approximately 4-6 months of full-time work.
- After you submit you have to wait around 6 months before you hear back from the referee.
- If you go back and forth with the referee multiple times, you may spend a couple of years in the peer-review process.

How long does it take?

- How long before you can submit a manuscript for publication varies a lot by person and by manuscript.
- I personally need about 1000 hours of work to conceive a project, work on it, write the results and submit for publication in a good journal.
- This is approximately 4-6 months of full-time work.
- After you submit you have to wait around 6 months before you hear back from the referee.
- If you go back and forth with the referee multiple times, you may spend a couple of years in the peer-review process.

How long does it take?

- How long before you can submit a manuscript for publication varies a lot by person and by manuscript.
- I personally need about 1000 hours of work to conceive a project, work on it, write the results and submit for publication in a good journal.
- This is approximately 4-6 months of full-time work.
- After you submit you have to wait around 6 months before you hear back from the referee.
- If you go back and forth with the referee multiple times, you may spend a couple of years in the peer-review process.

How long does it take?

- How long before you can submit a manuscript for publication varies a lot by person and by manuscript.
- I personally need about 1000 hours of work to conceive a project, work on it, write the results and submit for publication in a good journal.
- This is approximately 4-6 months of full-time work.
- After you submit you have to wait around 6 months before you hear back from the referee.
- If you go back and forth with the referee multiple times, you may spend a couple of years in the peer-review process.

How long does it take?

- After your manuscript has been accepted for publication, the last step is to wait until the editor(s) decide when your work will be published.
- For journals with a big backlog this can take a year or more.
- Finally, after all this work and all these years, you work is published!

How long does it take?

- After your manuscript has been accepted for publication, the last step is to wait until the editor(s) decide when your work will be published.
- For journals with a big backlog this can take a year or more.
- Finally, after all this work and all these years, you work is published!

How long does it take?

- After your manuscript has been accepted for publication, the last step is to wait until the editor(s) decide when your work will be published.
- For journals with a big backlog this can take a year or more.
- Finally, after all this work and all these years, you work is published!

Sabbatical Leave

- Last year I was on a sabbatical leave.
- I spent the whole year with my family in Thessaloniki, Greece.
- I worked out of the Aristotle University of Thessaloniki, Greece.
- My research area is Mathematical Logic.

Sabbatical Leave

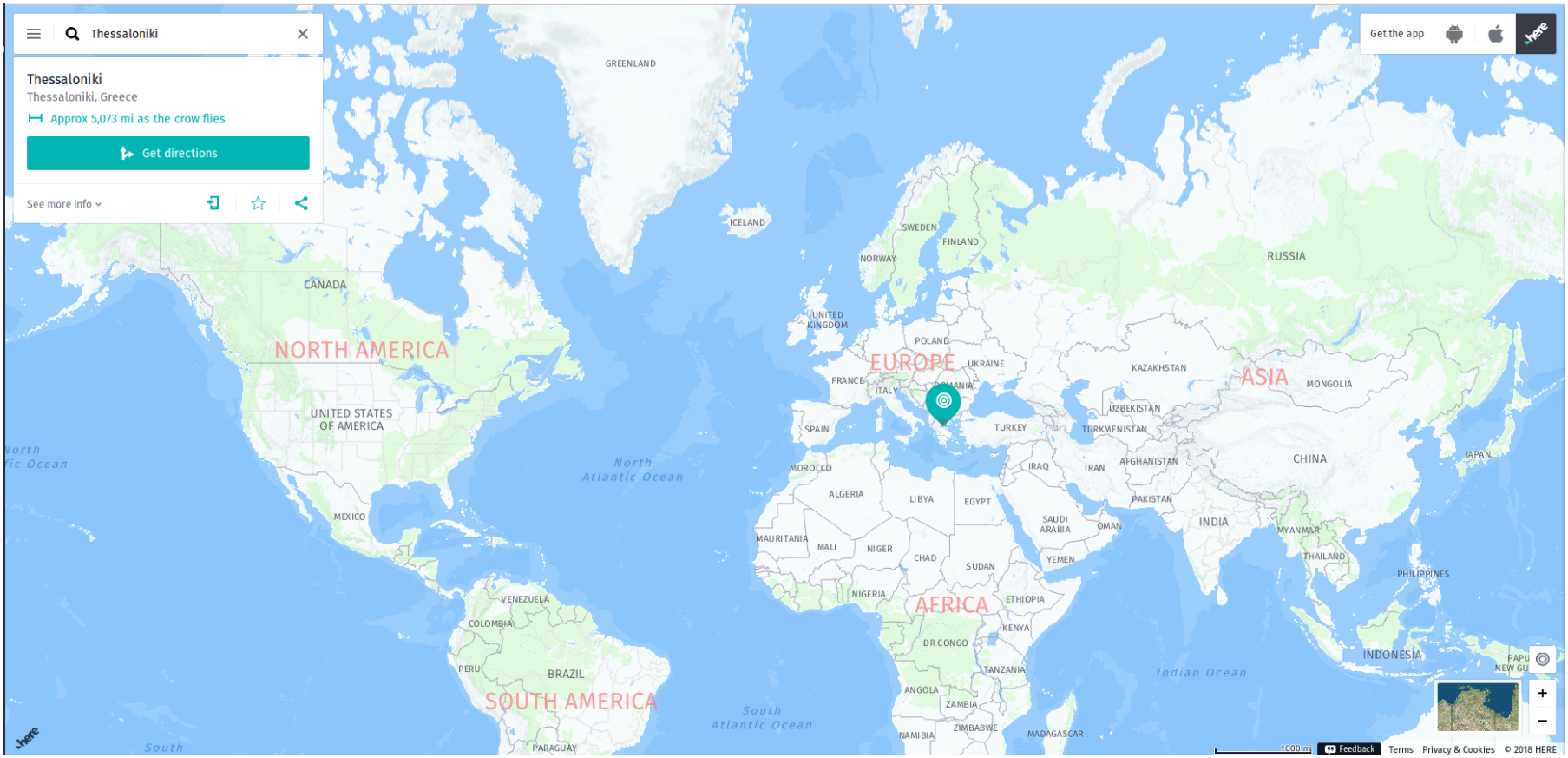
- Last year I was on a sabbatical leave.
- I spent the whole year with my family in Thessaloniki, Greece.
- I worked out of the Aristotle University of Thessaloniki, Greece.
- My research area is Mathematical Logic.

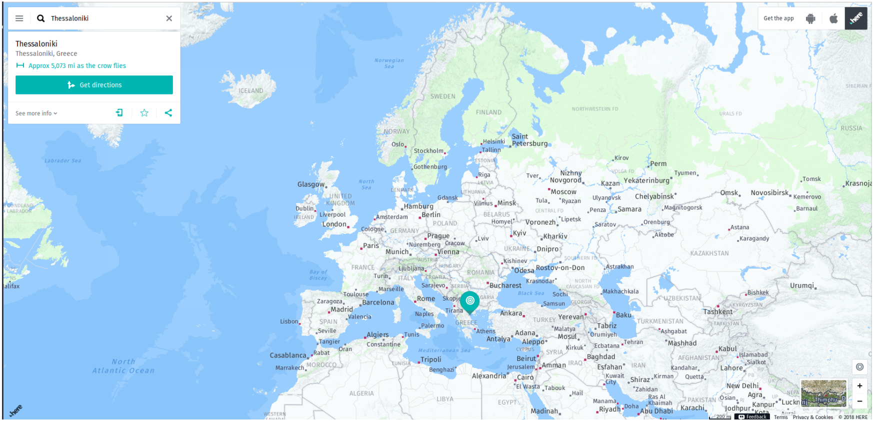
Sabbatical Leave

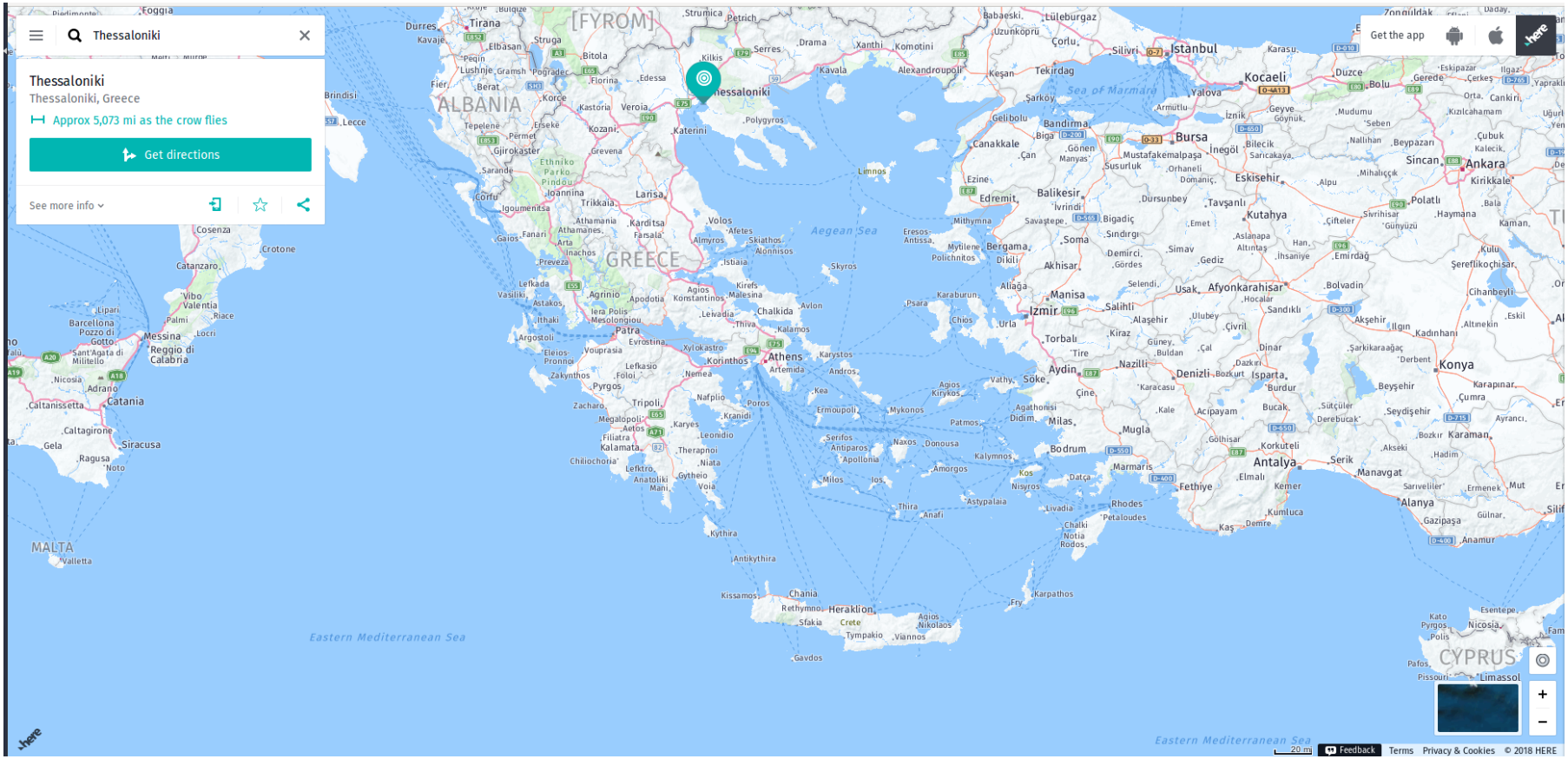
- Last year I was on a sabbatical leave.
- I spent the whole year with my family in Thessaloniki, Greece.
- I worked out of the Aristotle University of Thessaloniki, Greece.
- My research area is Mathematical Logic.

Sabbatical Leave

- Last year I was on a sabbatical leave.
- I spent the whole year with my family in Thessaloniki, Greece.
- I worked out of the Aristotle University of Thessaloniki, Greece.
- My research area is Mathematical Logic.


Thessaloniki
Thessaloniki
Thessaloniki, Greece
Approx 5,073 mi as the crow flies
Get directions
See more info
Get the app
GREENLAND
ICELAND
CANADA
NORTH AMERICA
UNITED STATES OF AMERICA
MEXICO
North Atlantic Ocean
SWEDEN
FINLAND
NORWAY
RUSSIA
UNITED KINGDOM
POLAND
EUROPE
UKRAINE
FRANCE
ITALY
SPAIN
KAZAKHSTAN
ASIA
MONGOLIA
UZBEKISTAN
TURKEY
TURKMENISTAN
IRAQ
IRAN
AFGHANISTAN
CHINA
JAPAN
MOROCCO
ALGERIA
LIBYA
EGYPT
PAKISTAN
INDIA
SAUDI ARABIA
OMAN
MYANMAR
THAILAND
PHILIPPINES
MAURITANIA
MALI
NIGER
CHAD
SUDAN
YEMEN
NIGERIA
AFRICA
ETHIOPIA
KENYA
DR CONGO
TANZANIA
INDONESIA
Indian Ocean
VENEZUELA
COLOMBIA
PERU
BRAZIL
SOUTH AMERICA
ANGOLA
ZAMBIA
ZIMBABWE
NAMIBIA
MADAGASCAR
South Atlantic Ocean
PARAGUAY
1000 mi
Feedback
Terms
Privacy & Cookies
© 2018 HERE


Thessaloniki
Thessaloniki
Thessaloniki, Greece
Approx 5,073 mi as the crow flies
Get directions
See more info
Get the app
ICELAND
SWEDEN
FINLAND
NORWAY
RUSSIA
KAZAKHSTAN
TURKEY
UNITED KINGDOM
FRANCE
GERMANY
SPAIN
ITALY
ROMANIA
UKRAINE
POLAND
GREECE
ALGERIA
LIBYA
EGYPT
IRAN
North Atlantic Ocean
Mediterranean Sea
Black Sea
Moscow
Saint Petersburg
London
Paris
Berlin
Rome
Madrid
Barcelona
Vienna
Bucharest
Ankara
Athens
Cairo
Baghdad
Tehran
Kyiv
Terms
Privacy & Cookies
© 2018 HERE


Thessaloniki
Thessaloniki
Thessaloniki, Greece
Approx 5,073 mi as the crow flies
Get directions
See more info
Get the app
ALBANIA
GREECE
[FYROM]
Aegean Sea
Eastern Mediterranean Sea
MALTA
CYPRUS
Istanbul
Ankara
Izmir
Athens
Antalya
Bursa
Konya
Feedback
Terms
Privacy & Cookies
© 2018 HERE

Sign by the entrance of Aristotle University.

Statue of Aristotle at the Aristotle University

Statue of Aristotle at the Aristotle University


ΣΧΟΛΗ ΘΕΤΙΚΩΝ ΕΠΙΣΤΗΜΩΝ

Research Work

- During the year I worked on six different projects.
- Not all projects started from point zero. Some of them were going on for a while.
- Good news: All projects were successful! (so far!!)

Research Work

- During the year I worked on six different projects.
- Not all projects started from point zero. Some of them were going on for a while.
- Good news: All projects were successful! (so far!!)

Research Work

- During the year I worked on six different projects.
- Not all projects started from point zero. Some of them were going on for a while.
- Good news: All projects were successful! (so far!!)

Research Work

- During the year I worked on six different projects.
- Not all projects started from point zero. Some of them were going on for a while.
- Good news: All projects were successful! (so far!!)

Project #1

Title	Hanf number for Scott sentences of computable structures
Collaborator(s)	Julia Knight (Notre Dame, IN) Sergey Goncharov (Sobolev Institute, Russia)
Goal	Show that the Hanf number for the Scott sentences of computable structures is $\beth_{\omega_1^{CK}}$. The same argument proves that $\beth_{\omega_1^{CK}}$ is the Hanf number for Scott sentences of hyperarithmetical structures.
Result(s)	Goncharov, S.S., Knight, J.F. & Souldatos, I. Arch. Math. Logic (2018) 57: 889. https://doi.org/10.1007/s00153-018-0615-6

Project #2

Title	Non-Absoluteness of Model Existence at $\aleph_\omega$
Collaborator(s)	David Milovich (Texas A&M)
Goal	Prove that for $\mathcal{L}_{\omega_1,\omega}$-sentences model-existence in $\aleph_\omega$ is not absolute for models of ZFC+GCH.
Result(s)	David Milovich, Ioannis Souldatos Fundamenta Mathematicae 243 (2018), 179-193 https://doi.org/10.4064/fm419-12-2017

Project #3

Title	Complete $\mathcal{L}_{\omega_1,\omega}$-Sentences with Maximal Models in Multiple Cardinalities
Collaborator(s)	John Baldwin (UIC)
Goal	Prove there is a complete $\mathcal{L}_{\omega_1,\omega}$-sentence with maximal models in more than one cardinality.
Result(s)	Submitted; went back-and-fourth with the referee a few times already; waiting for the referee's response. Pre-print: `https://arxiv.org/abs/1508.06620`

Project #4

Title	Kurepa trees and spectra of $\mathcal{L}_{\omega_1,\omega}$-sentences
Collaborator(s)	Dima Sinapova (UIC)
Goal	Use Kurepa trees to prove that there is an $\mathcal{L}_{\omega_1,\omega}$-sentence whose amalgamation spectrum is consistently equal to $[\aleph_1, \aleph_{\omega_1}]$ and consistently equal to $[\aleph_1, 2^{\aleph_1})$, where $2^{\aleph_1}$ is weakly inaccessible.
Result(s)	Submitted; heard from the referee once; resubmitted and waiting for the referee's response. Pre-print: `https://arxiv.org/abs/1705.05821`

Project #5

Title	A Lower Bound for the Hanf Number for Joint Embedding
Collaborator(s)	Will Boney (Harvard)
Goal	Prove that the first measurable cardinal is a lower bound for the Hanf number for joint embedding.
Result(s)	Submitted; did not heard from the referee yet Pre-print: `https://arxiv.org/abs/1808.03017`

Project #6

Title	Implementing WeBWorK in Teaching Undergraduate Mathematics Courses (Math Education Research)
Collaborator(s)	Mustafa Demir (Detroit Mercy)
Goal	Examine college students' usage of the web-based homework system WeBWorK and the impact of WeBWorK on students' course performance.
Result(s)	We are finishing writing up the results; hope to submit within the next month.

Question

I do not understand the results. Can you explain them in a simple way?

Answer: Yes and No. In one sentence, we describe properties of infinite structures using infinity long (Mathematical) sentences. I will need a 50-minute lecture to explain the big picture behind for each one of these results. Some details are even harder to explain because they are very technical.

Question

I do not understand the results. Can you explain them in a simple way?

Answer: Yes and No. In one sentence, we describe properties of infinite structures using infinity long (Mathematical) sentences. I will need a 50-minute lecture to explain the big picture behind for each one of these results. Some details are even harder to explain because they are very technical.

Question

I do not understand the results. Can you explain them in a simple way?

Answer: Yes and No. In one sentence, we describe properties of infinite structures using infinity long (Mathematical) sentences. I will need a 50-minute lecture to explain the big picture behind for each one of these results. Some details are even harder to explain because they are very technical.

Question

I do not understand the results. Can you explain them in a simple way?

Answer: Yes and No. In one sentence, we describe properties of infinite structures using infinity long (Mathematical) sentences. I will need a 50-minute lecture to explain the big picture behind for each one of these results. Some details are even harder to explain because they are very technical.

Question

I do not understand the results. Can you explain them in a simple way?

Answer: Yes and No. In one sentence, we describe properties of infinite structures using infinity long (Mathematical) sentences. I will need a 50-minute lecture to explain the big picture behind for each one of these results. Some details are even harder to explain because they are very technical.

Applications?

Question

I do not understand the results. Can you tell me what the applications are?

Answer: It works like this

1. These results plus many other results in the same area explain a certain Mathematical object, e.g. amalgamation spectrum.
2. Once this Mathematical object has been well understood, this knowledge finds applications to other areas of Mathematical Logic.
3. Once Mathematical Logic has been well understood, it finds applications to other areas of Mathematics.
4. Once Mathematics has been well understood, it finds applications to other areas of Science and beyond.

Applications?

Question

I do not understand the results. Can you tell me what the applications are?

Answer: It works like this

1. These results plus many other results in the same area explain a certain Mathematical object, e.g. amalgamation spectrum.
2. Once this Mathematical object has been well understood, this knowledge finds applications to other areas of Mathematical Logic.
3. Once Mathematical Logic has been well understood, it finds applications to other areas of Mathematics.
4. Once Mathematics has been well understood, it finds applications to other areas of Science and beyond.

Applications?

Question

I do not understand the results. Can you tell me what the applications are?

Answer: It works like this

1. These results plus many other results in the same area explain a certain Mathematical object, e.g. amalgamation spectrum.
2. Once this Mathematical object has been well understood, this knowledge finds applications to other areas of Mathematical Logic.
3. Once Mathematical Logic has been well understood, it finds applications to other areas of Mathematics.
4. Once Mathematics has been well understood, it finds applications to other areas of Science and beyond.

Applications?

Question

I do not understand the results. Can you tell me what the applications are?

Answer: It works like this

1. These results plus many other results in the same area explain a certain Mathematical object, e.g. amalgamation spectrum.
2. Once this Mathematical object has been well understood, this knowledge finds applications to other areas of Mathematical Logic.
3. Once Mathematical Logic has been well understood, it finds applications to other areas of Mathematics.
4. Once Mathematics has been well understood, it finds applications to other areas of Science and beyond.

Applications?

Question

I do not understand the results. Can you tell me what the applications are?

Answer: It works like this

1. These results plus many other results in the same area explain a certain Mathematical object, e.g. amalgamation spectrum.
2. Once this Mathematical object has been well understood, this knowledge finds applications to other areas of Mathematical Logic.
3. Once Mathematical Logic has been well understood, it finds applications to other areas of Mathematics.
4. Once Mathematics has been well understood, it finds applications to other areas of Science and beyond.

Applications?

Question

I do not understand the results. Can you tell me what the applications are?

Answer: It works like this

1. These results plus many other results in the same area explain a certain Mathematical object, e.g. amalgamation spectrum.
2. Once this Mathematical object has been well understood, this knowledge finds applications to other areas of Mathematical Logic.
3. Once Mathematical Logic has been well understood, it finds applications to other areas of Mathematics.
4. Once Mathematics has been well understood, it finds applications to other areas of Science and beyond.

Applications?

1. The process is not linear. It has feedback loops too.
2. It can take a couple of decades (if not centuries) before a theory finds applications to other areas.
3. Theories that do not find applications to other areas eventually "die", which means that none works on them anymore.

Applications?

1. The process is not linear. It has feedback loops too.
2. It can take a couple of decades (if not centuries) before a theory finds applications to other areas.
3. Theories that do not find applications to other areas eventually "die", which means that none works on them anymore.

Applications?

1. The process is not linear. It has feedback loops too.
2. It can take a couple of decades (if not centuries) before a theory finds applications to other areas.
3. Theories that do not find applications to other areas eventually "die", which means that none works on them anymore.

General Relativity

- Albert Einstein published his General Theory of Relativity in 1915.
- The geometry of the space-time in General Relativity is non-Euclidean.
- Non-Euclidean geometries were developed in the late 1800's.
- None had the slightest clue that non-Euclidean geometries will find applications to General Relativity (and Star Trek!)

General Relativity

- Albert Einstein published his General Theory of Relativity in 1915.
- The geometry of the space-time in General Relativity is non-Euclidean.
- Non-Euclidean geometries were developed in the late 1800's.
- None had the slightest clue that non-Euclidean geometries will find applications to General Relativity (and Star Trek!)

General Relativity

- Albert Einstein published his General Theory of Relativity in 1915.
- The geometry of the space-time in General Relativity is non-Euclidean.
- Non-Euclidean geometries were developed in the late 1800's.
- None had the slightest clue that non-Euclidean geometries will find applications to General Relativity (and Star Trek!)

General Relativity

- Albert Einstein published his General Theory of Relativity in 1915.
- The geometry of the space-time in General Relativity is non-Euclidean.
- Non-Euclidean geometries were developed in the late 1800's.
- None had the slightest clue that non-Euclidean geometries will find applications to General Relativity (and Star Trek!)

General Relativity

- Albert Einstein published his General Theory of Relativity in 1915.
- The geometry of the space-time in General Relativity is non-Euclidean.
- Non-Euclidean geometries were developed in the late 1800's.
- None had the slightest clue that non-Euclidean geometries will find applications to General Relativity (and Star Trek!)

Turing Machines

- Computer Science was founded by Alan Turing when he defined his Turing machines.
- Turing built upon previous work on the undecidability of Peano Arithmetic that preceded Turing by a couple of decades.
- None had the slightest clue that Peano Arithmetic will find applications to Computers.

Turing Machines

- Computer Science was founded by Alan Turing when he defined his Turing machines.
- Turing built upon previous work on the undecidability of Peano Arithmetic that preceded Turing by a couple of decades.
- None had the slightest clue that Peano Arithmetic will find applications to Computers.

Turing Machines

- Computer Science was founded by Alan Turing when he defined his Turing machines.
- Turing built upon previous work on the undecidability of Peano Arithmetic that preceded Turing by a couple of decades.
- None had the slightest clue that Peano Arithmetic will find applications to Computers.

Internet Security and Cryptocurrencies

- Internet security and cryptocurrencies like Bitcoin, build on properties of prime numbers.
- Mathematicians have been studying prime numbers since Euclid.
- None had the slightest clue that prime numbers will find applications to Internet security and cryptocurrencies.

Internet Security and Cryptocurrencies

- Internet security and cryptocurrencies like Bitcoin, build on properties of prime numbers.
- Mathematicians have been studying prime numbers since Euclid.
- None had the slightest clue that prime numbers will find applications to Internet security and cryptocurrencies.

Internet Security and Cryptocurrencies

- Internet security and cryptocurrencies like Bitcoin, build on properties of prime numbers.
- Mathematicians have been studying prime numbers since Euclid.
- None had the slightest clue that prime numbers will find applications to Internet security and cryptocurrencies.

Moral of the story:

1. Applications are always useful, but sometimes Mathematical theories find applications that go beyond the wildest dreams of the people of the past.
2. Only time can tell what a Mathematical theory is good for.

Moral of the story:

1. Applications are always useful, but sometimes Mathematical theories find applications that go beyond the wildest dreams of the people of the past.
2. Only time can tell what a Mathematical theory is good for.

Moral of the story:

1. Applications are always useful, but sometimes Mathematical theories find applications that go beyond the wildest dreams of the people of the past.
2. Only time can tell what a Mathematical theory is good for.

References

- Graphs on paper productivity are from https://www.scimagojr.com/index.php
- Statistics are from https://www.ams.org/profession/data/annual-survey/annual-survey
- Maps are from https://wego.here.com/
- The Millennium problems can be found at http://www.claymath.org/millennium-problems/
- Pictures are mine.
- Copy of my work can be found at https://arxiv.org/a/souldatos_i_1.html
- Copy of these slides can be found at http://souldatosresearch.wordpress.com/
- Thank you! Questions?

References

- Graphs on paper productivity are from `https://www.scimagojr.com/index.php`
- Statistics are from `https://www.ams.org/profession/data/annual-survey/annual-survey`
- Maps are from `https://wego.here.com/`
- The Millennium problems can be found at `http://www.claymath.org/millennium-problems/`
- Pictures are mine.
- Copy of my work can be found at `https://arxiv.org/a/souldatos_i_1.html`
- Copy of these slides can be found at `http://souldatosresearch.wordpress.com/`
- Thank you! Questions?

References

- Graphs on paper productivity are from https://www.scimagojr.com/index.php
- Statistics are from https://www.ams.org/profession/data/annual-survey/annual-survey
- Maps are from https://wego.here.com/
- The Millennium problems can be found at http://www.claymath.org/millennium-problems/
- Pictures are mine.
- Copy of my work can be found at https://arxiv.org/a/souldatos_i_1.html
- Copy of these slides can be found at http://souldatosresearch.wordpress.com/
- Thank you! Questions?

References

- Graphs on paper productivity are from https://www.scimagojr.com/index.php
- Statistics are from https://www.ams.org/profession/data/annual-survey/annual-survey
- Maps are from https://wego.here.com/
- The Millennium problems can be found at http://www.claymath.org/millennium-problems/
- Pictures are mine.
- Copy of my work can be found at https://arxiv.org/a/souldatos_i_1.html
- Copy of these slides can be found at http://souldatosresearch.wordpress.com/
- Thank you! Questions?

References

- Graphs on paper productivity are from https://www.scimagojr.com/index.php
- Statistics are from https://www.ams.org/profession/data/annual-survey/annual-survey
- Maps are from https://wego.here.com/
- The Millennium problems can be found at http://www.claymath.org/millennium-problems/
- Pictures are mine.
- Copy of my work can be found at https://arxiv.org/a/souldatos_i_1.html
- Copy of these slides can be found at http://souldatosresearch.wordpress.com/
- Thank you! Questions?

References

- Graphs on paper productivity are from https://www.scimagojr.com/index.php
- Statistics are from https://www.ams.org/profession/data/annual-survey/annual-survey
- Maps are from https://wego.here.com/
- The Millennium problems can be found at http://www.claymath.org/millennium-problems/
- Pictures are mine.
- Copy of my work can be found at https://arxiv.org/a/souldatos_i_1.html
- Copy of these slides can be found at http://souldatosresearch.wordpress.com/
- Thank you! Questions?

References

- Graphs on paper productivity are from https://www.scimagojr.com/index.php
- Statistics are from https://www.ams.org/profession/data/annual-survey/annual-survey
- Maps are from https://wego.here.com/
- The Millennium problems can be found at http://www.claymath.org/millennium-problems/
- Pictures are mine.
- Copy of my work can be found at https://arxiv.org/a/souldatos_i_1.html
- Copy of these slides can be found at http://souldatosresearch.wordpress.com/
- Thank you! Questions?

References

- Graphs on paper productivity are from https://www.scimagojr.com/index.php
- Statistics are from https://www.ams.org/profession/data/annual-survey/annual-survey
- Maps are from https://wego.here.com/
- The Millennium problems can be found at http://www.claymath.org/millennium-problems/
- Pictures are mine.
- Copy of my work can be found at https://arxiv.org/a/souldatos_i_1.html
- Copy of these slides can be found at http://souldatosresearch.wordpress.com/
- Thank you! Questions?