



Valparaiso
University

What is a
mathemati-
cian?

Lara Pudwell

What do I do?

Teaching &
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Research

How did I get
here?

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...and beyond

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Reading

What is a mathematician?

Lara Pudwell

Assistant Professor of Mathematics and Computer Science
Valparaiso University

Immanuel Lutheran School – Memphis, TN
December 18, 2012



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What do I do?



What does a mathematician do?

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At Valparaiso University, my job is

- 50% teaching
- 30% research
- 20% service

...but what does this mean?



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Teaching

- prepare lesson plans.
- lead class.
- grade student work.
- answer questions.



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Teaching

- prepare lesson plans.
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Service

- committee work.
- advise students.
- write math contests.
- edit math articles.



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Research

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- solve math problems that no one has ever solved before.
- collaborate with students to solve math problems.
- attend conferences to work with other mathematicians and present my research results.



I have been to conferences in...

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What is math research anyhow?

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- Conjecture/discover patterns/solutions.
- Write a “proof” of why a pattern/solution works.
- Mathematicians like to ask **“Why?”**



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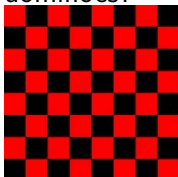
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- Conjecture/discover patterns/solutions.
- Write a “proof” of why a pattern/solution works.
- Mathematicians like to ask **“Why?”**
- Proof example: The checkerboard problem.
Can you cover these checkerboards with non-overlapping dominoes?



Why or why not?



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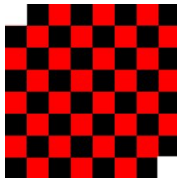
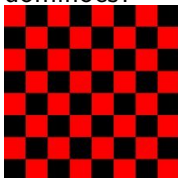
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Why or why not?



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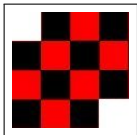
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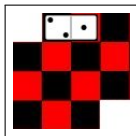
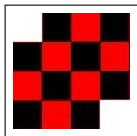
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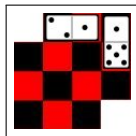
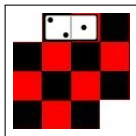
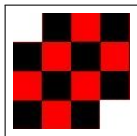
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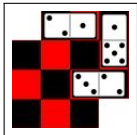
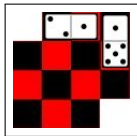
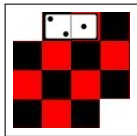
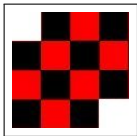
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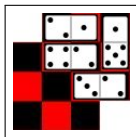
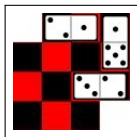
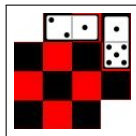
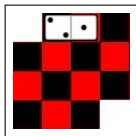
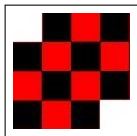
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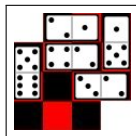
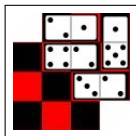
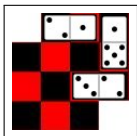
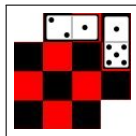
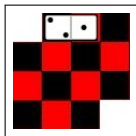
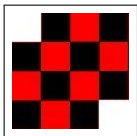
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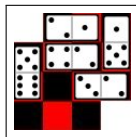
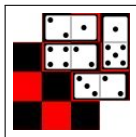
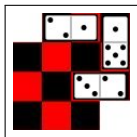
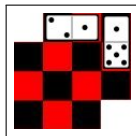
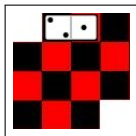
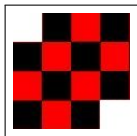
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- Each domino covers *one red square* and *one black square*.



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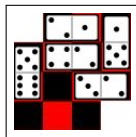
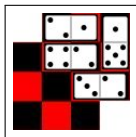
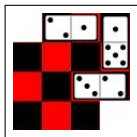
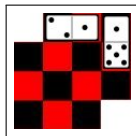
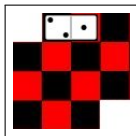
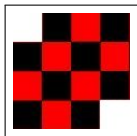
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- Each domino covers *one red square* and *one black square*.
- Any number of dominoes cover the *same number of red and black squares*.



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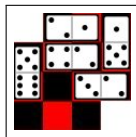
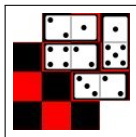
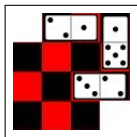
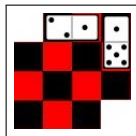
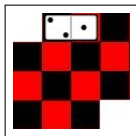
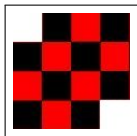
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- Each domino covers *one red square* and *one black square*.
- Any number of dominoes cover the *same number of red and black squares*.
- The board with missing corners has *more black squares than red squares* so it is impossible to cover it with dominoes.



We'll say a "word" is a list of numbers.
(examples: 01011, 1204252, etc.)

- A *double* in a word is two copies of the same smaller word back to back. (examples: 02**1**2**2**1234, 02**1**1312)
- Question: If you only use 0s and 1s, what's the longest word you can make without a double?

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Scratch work....
0 1

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A taste of research

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0	1		
00	01	10	11

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0	1		
00	01	10	11
010	011	100	101

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00	01	10	11
010	011	100	101

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00	01	10	11
010	011	100	101
0100	0101	1010	1011

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00	01	10	11
010	011	100	101
0100	0101	1010	1011

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0	1		
00	01	10	11
010	011	100	101
0100	0101	1010	1011

- Answer: 010 or 101

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Two more questions...

- Question: If you only use 0s, 1s, and 2s, what's the longest word you can make without a double?

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Two more questions...

- Question: If you only use 0s, 1s, and 2s, what's the longest word you can make without a double?
- Question: Start with 0. Then, append the smallest number possible without making a double. Repeat. Describe the pattern that you find!

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Two more questions...

- Question: If you only use 0s, 1s, and 2s, what's the longest word you can make without a double?
- Question: Start with 0. Then, append the smallest number possible without making a double. Repeat. Describe the pattern that you find!
 - 0

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 - 0
 - 00

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 - 0
 - 00
 - 01

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- Question: Start with 0. Then, append the smallest number possible without making a double. Repeat. Describe the pattern that you find!
 - 0
 - 00
 - 01
 - 010

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 - 0
 - 00
 - 01
 - 010
 - 0100

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- Question: Start with 0. Then, append the smallest number possible without making a double. Repeat. Describe the pattern that you find!
 - 0
 - 00
 - 01
 - 010
 - 0100
 - 0101



Two more questions...

- Question: If you only use 0s, 1s, and 2s, what's the longest word you can make without a double?
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- 0
- 00
- 01
- 010
- 0100
- 0101
- 0102

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 - 0
 - 00
 - 01
 - 010
 - 0100
 - 0101
 - 0102
 - etc.

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Patterns Revealed!

Question: If you only use 0s, 1s, and 2s, what's the longest word you can make without a double?

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Question: If you only use 0s, 1s, and 2s, what's the longest word you can make without a double?

- Answer: There are infinitely long double-free words with 0s, 1s, and 2s. (proved by Axel Thue in 1906).
- Example: 012021012102012021020121...

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More Patterns Revealed!

Question: Start with 0. Then, append the smallest number possible without making a double. Repeat. Describe the pattern that you find!

Answer: 0102010301020104010201030102010...

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Question: Start with 0. Then, append the smallest number possible without making a double. Repeat. Describe the pattern that you find!

Answer: 0102010301020104010201030102010...

- Every other number is 0.

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Question: Start with 0. Then, append the smallest number possible without making a double. Repeat. Describe the pattern that you find!

Answer: 0102010301020104010201030102010...

- Every other number is 0.
- If we look at the nonzero numbers: 121312141213121...

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Question: Start with 0. Then, append the smallest number possible without making a double. Repeat. Describe the pattern that you find!

Answer: 0102010301020104010201030102010...

- Every other number is 0.
- If we look at the nonzero numbers: 121312141213121...
- ...and subtract 1 from all of them 010201030102010...

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Question: Start with 0. Then, append the smallest number possible without making a double. Repeat. Describe the pattern that you find!

Answer: 0102010301020104010201030102010...

- Every other number is 0.
- If we look at the nonzero numbers: 121312141213121...
- ...and subtract 1 from all of them 010201030102010...
- we get back the original word!

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More Patterns Revealed!

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Answer: 0102010301020104010201030102010...

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More Patterns Revealed!

Question: Start with 0. Then, append the smallest number possible without making a double. Repeat. Describe the pattern that you find!

Answer: 0102010301020104010201030102010...

In fact, if we factor every integer...

$1=1$	$2=2$	$3=3$	$4 = 2^2$	$5=5$	$6 = 2 \cdot 3$
$7=7$	$8 = 2^3$	$9 = 3^2$	$10 = 2 \cdot 5$	$11=11$	$12 = 2^2 \cdot 3$

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Answer: 0102010301020104010201030102010...

In fact, if we factor every integer...

1=1 0	2=2 1	3=3 0	4 = 2 ² 2	5=5 0	6 = 2 · 3 1
7=7 0	8 = 2 ³ 3	9 = 3 ² 0	10 = 2 · 5 1	11=11 0	12 = 2 ² · 3 2

then the i th number in our word is the number of 2s in the factorization of i !

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More Patterns Revealed!

Question: Start with 0. Then, append the smallest number possible without making a double. Repeat. Describe the pattern that you find!

Answer: 0102010301020104010201030102010...

In fact, if we factor every integer...

1=1 0	2=2 1	3=3 0	4 = 2 ² 2	5=5 0	6 = 2 · 3 1
7=7 0	8 = 2 ³ 3	9 = 3 ² 0	10 = 2 · 5 1	11=11 0	12 = 2 ² · 3 2

then the i th number in our word is the number of 2s in the factorization of $i!$

(proved by Guay-Paquet and Shallit in 2009.)

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Valparaiso
University

Math as a Tree

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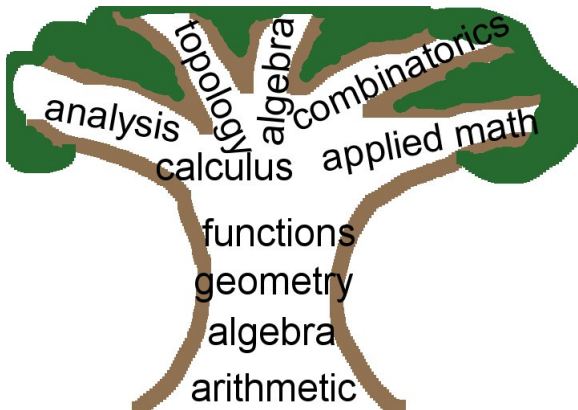
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- Algebra – structure of numbers
- Analysis – rates of change
- Combinatorics – counting, optimal arrangements
- Geometry/Topology – shape and symmetry
- Applied Mathematics – probability, statistics, computational math, math for other sciences

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Mathematics (since Feb 1992)

For a **specific paper**, enter the identifier into the top right search box.

Browse:

- new (most recent mailing, with abstracts)
- recent (last 5 mailings)
- current month's math listings
- specific year/month:

2012

Catch-up:

Changes since: , view results

Search within the math archive

Submission statistics:

2012 2011 2010 2009 2008 2007 2006 2005 2004 2003 2002 2001 2000 1999 1998 1997 1996 1995 1994 1993 1992 1991

• More information about the math archive

Categories within Mathematics

- **math.AG - Algebraic Geometry** (new, recent, current month)
Algebraic varieties, stacks, sheaves, schemes, moduli spaces, complex geometry, quantum cohomology (subsumes alg-geom)
- **math.AT - Algebraic Topology** (new, recent, current month)
homotopy theory, homological algebra, algebraic treatments of manifolds
- **math.AP - Analysis of PDEs** (new, recent, current month)
Existence and uniqueness, boundary conditions, linear and non-linear operators, stability, soliton theory, integrable PDE's, conservation laws, qualitative dynamics
- **math.CT - Category Theory** (new, recent, current month)
Enriched categories, topoi, abelian categories, monoidal categories, homological algebra
- **math.CA - Classical Analysis and ODEs** (new, recent, current month)



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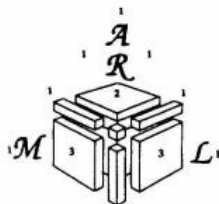
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- Took honors and AP math classes (geometry, algebra 1 and 2, precalculus, AP calculus BC).
- Participated in school, city, state, and national math contests.
- Participated in regional math team.
- Member of Mu Alpha Theta (national math honors society).
- Tutored other students in math classes.





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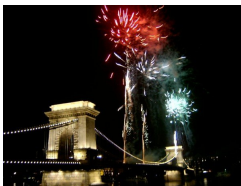
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- B.S. in mathematics and B.A. in computer science.
- student grader for various math classes.
- was paid to participate in a summer research program.
- undergraduate research – published 4 papers!
- studied abroad in Budapest, Hungary.





Math

- Abstract Algebra 1 & 2
- Analysis 1 & 2
- Calculus 1, 2, & 3
- Combinatorics
- Differential Equations
- Discrete Math
- Graph Theory
- Linear Algebra
- Number Theory
- Research in Mathematics
- Statistics
- Topology

Computer Science

- Analysis of Algorithms
- Artificial Intelligence
- Computer Architecture
- Database Management Systems
- Introduction to Programming 1, 2, & 3
- Organization of Programming Languages
- Theory of Computation

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- Ph.D. in mathematics (5 years of classes and research after college).
- took advanced classes that go beyond college-level math.
- discovered and proved new mathematical facts to write a Ph.D. thesis.
- taught undergraduate students.
- got paid an annual stipend to be in graduate school.



- Assistant Professor at Valparaiso University since 2008.
- Next: Associate Professor, then Full Professor.
- continue to solve problems and study new math ideas, and teach math to others.
- run summer research program for undergraduate students at Valpo.
- travel to conferences to talk about research with other mathematicians.



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work at

- national labs.
- NASA.
- National Security Agency. (largest employer of mathematicians in the country!)
 - NSA internships exist for college students.



Some companies have entire mathematics departments or hire lots of mathematicians to solve problems or build mathematical models.

- IBM (computers)
- AT&T
- Telcordia (phones)
- Epic (medical software)
- Amazon.com
- Google
- Pixar
- banks and investment companies (finance industry)
- ... and many more!

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Operations Research Specialists

- help companies operate more efficiently.
- use statistics, modeling, and optimization ideas from math to help companies make better decisions.
- require strong background in math as well as business.

Actuaries

- assess risk for insurance and other industries.
- after college, take actuarial exams.
- require strong background in math as well as economics, and finance.



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Really, math can be combined with just about any other area to make you even more successful!

Recent Valpo student examples:

- Math + art = art conservationist
- Math + political science = policy analyst
- Math + geography = urban planner



Valparaiso
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- There's more variety to being a professor than just teaching.
- There are many unsolved math questions just waiting to be explored!
- Math research can be *pure* or *applied*.
- Most careers in math require at least a bachelor's degree, some require a Masters, or Ph.D.
- Math can be combined with just about any other interest to make you an excellent candidate for whatever career you want.



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WHEN WILL I USE MATH?

WeUseMath.org

SUPPORT SOCIAL SIGN IN REGISTER SEARCH

- HOME
- CAREERS
- BLOG
- HOW TO SUCCEED
- DID YOU KNOW?
- RESOURCES FOR TEACHERS
- STORE

We Use Math In Careers

CAREERS

- ACTUARY
- AIR TRAFFIC CONTROLLER
- ANIMATOR
- ARCHITECT
- ASTRONAUT
- ATTORNEY
- BIOLOGIST
- BIOSTATISTICIAN
- BUDGET ANALYST
- CARTOGRAPHER
- CHEMICAL ENGINEER
- CHEMIST
- CLIMATOLOGIST
- COMPUTATIONAL BIOLOGIST



According to the Wall Street Journal:
Mathematician is considered the Best Job of All Jobs.
Mathematicians median annual income was pegged at \$94,160.

The top 2 jobs on the list were



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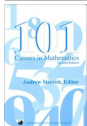
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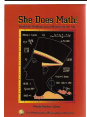
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- 101 Careers in Mathematics edited by Andrew Sterrett



- She Does Math! edited by Marla Parker



- Letters to a Young Mathematician by Ian Stewart

