THE THREE STEPS TO CREATE A CLASSROOM WHERE STUDENTS ARE EXCITED TO LEARN MATHEMATICS

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WANT THE RESOURCES?

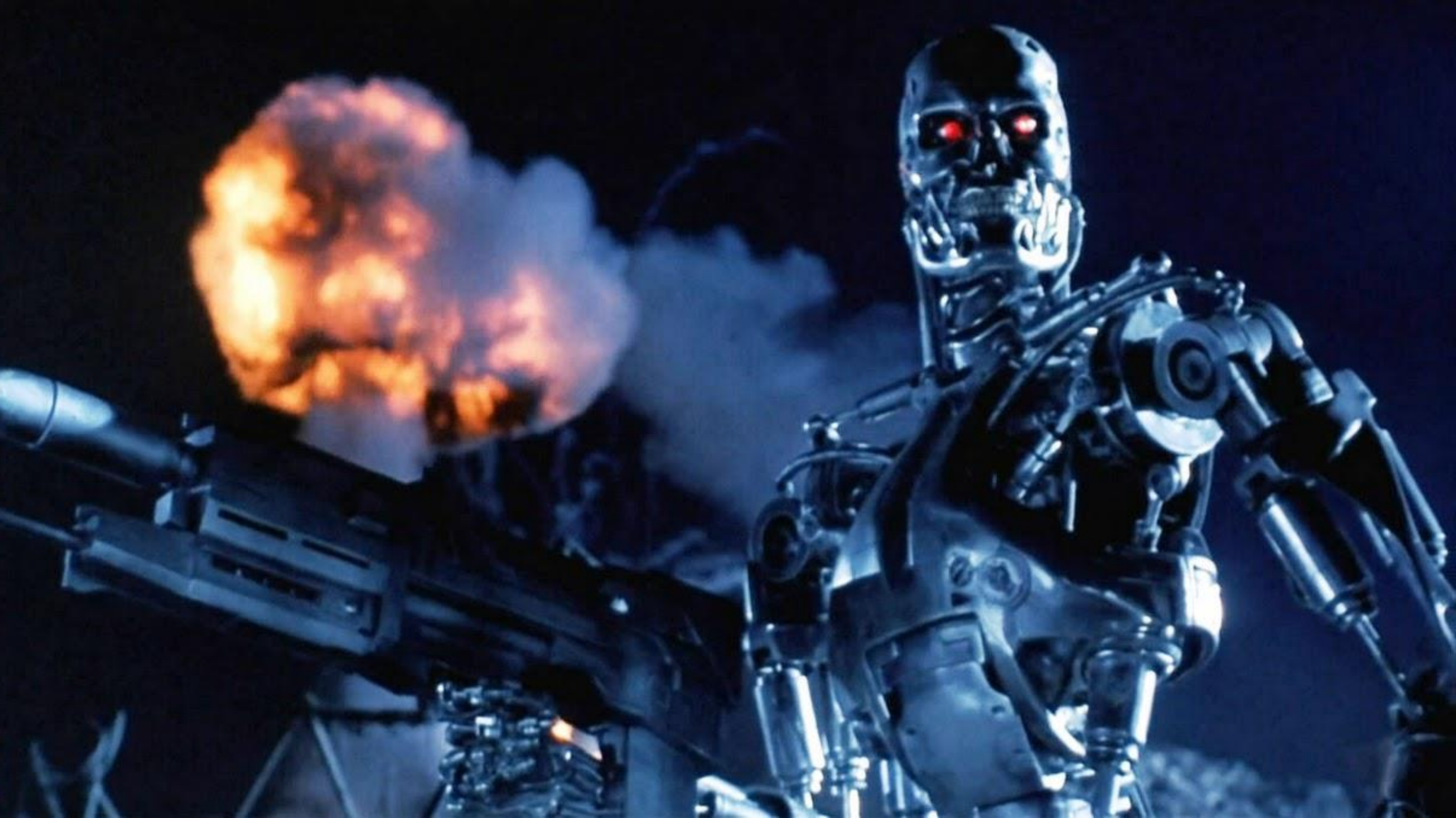
Download them at

robertkaplinsky.com/3steps

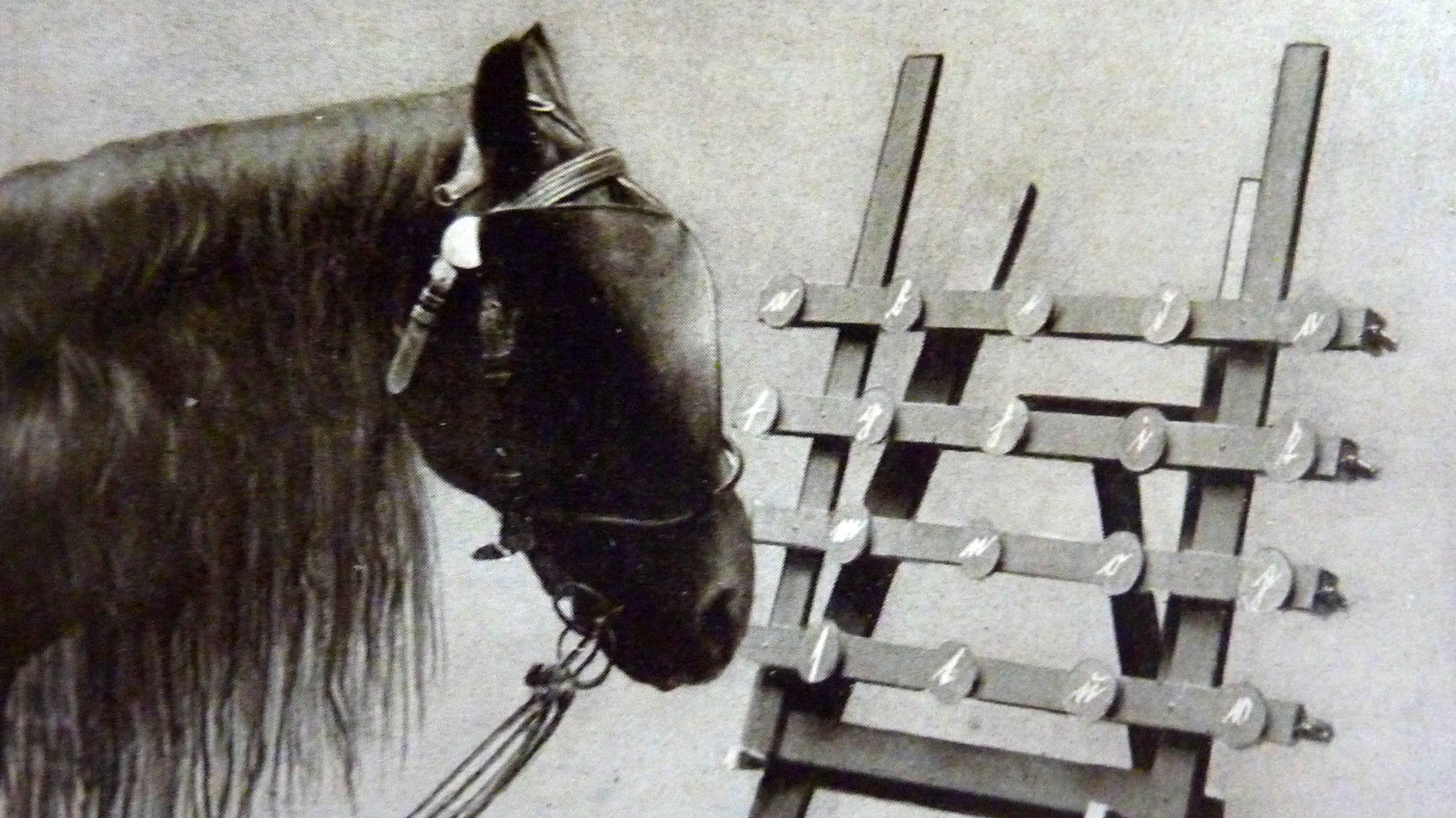
paradigm shift

GOALS

- ❑ CORRECT ANSWERS = UNDERSTANDING?
- ❑ RECONSIDER USING WORD PROBLEMS
- ❑ RECONSIDER USING WORKSHEETS



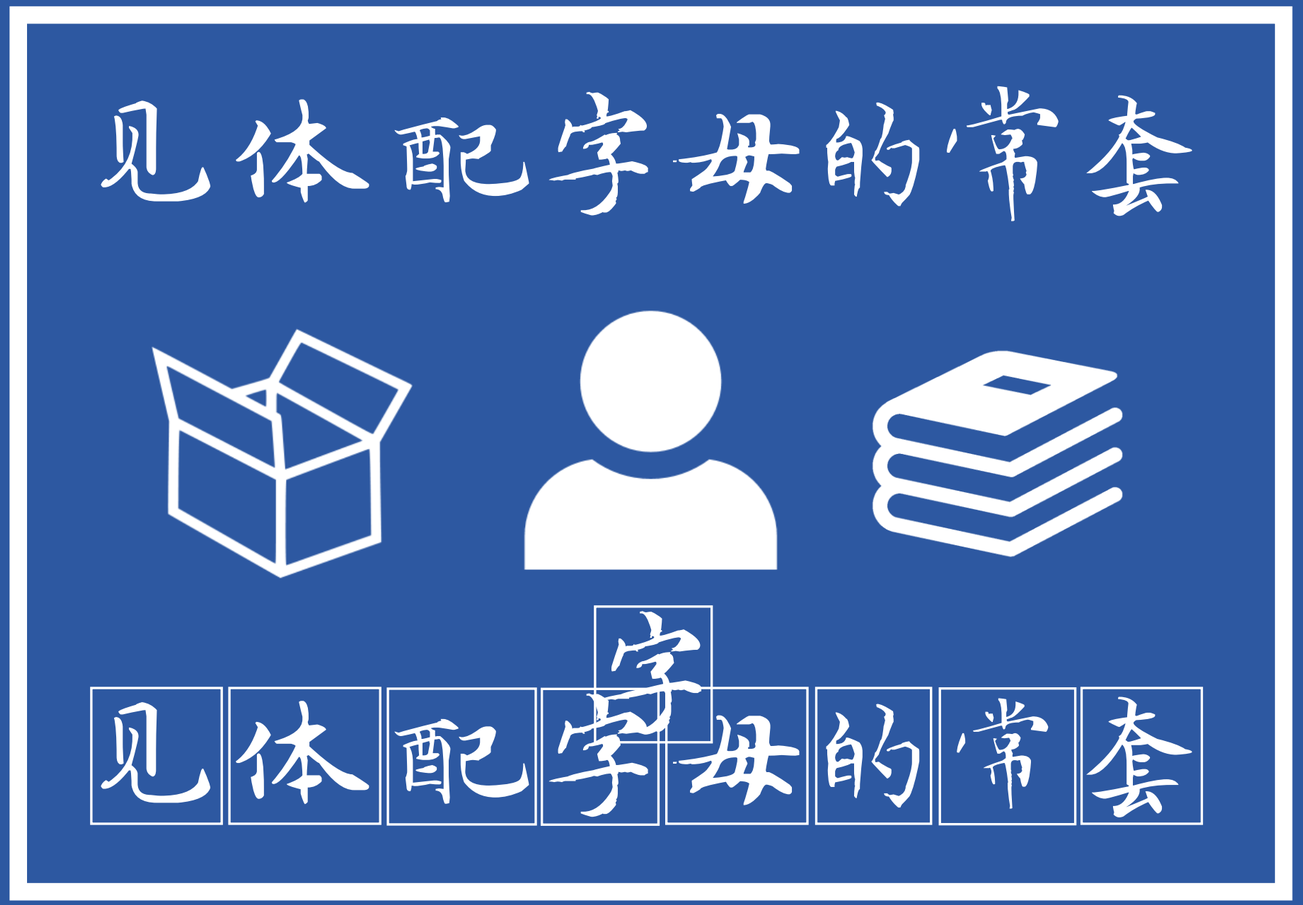

2/3 + 3/4 =
26743 : 8 =
12986 x 3 =



Yes… no… uh… yes… maybe?

MANY STUDENTS

CHINESE ROOM



DISCUSSION TIME

- How is it possible for students to get correct answers yet not understand what they did?
- How can we tell if the problems we use are Chinese room and horse proof?

GOALS

- ☑ CORRECT ANSWERS = UNDERSTANDING?
- ☐ RECONSIDER USING WORD PROBLEMS
- ☐ RECONSIDER USING WORKSHEETS

SAME OR DIFFERENT?

Describe at least three ways in which the problems are the same and three ways they are different:

A. How many pizzas do you need to buy?

B. You and your seven friends want to have pizza for dinner. Each person will eat three slices of pizza. Each pizza has eight slices. How many pizzas do you need to buy?

Robert Kaplinsky
@robertkaplinsky

Which of these are word problems:

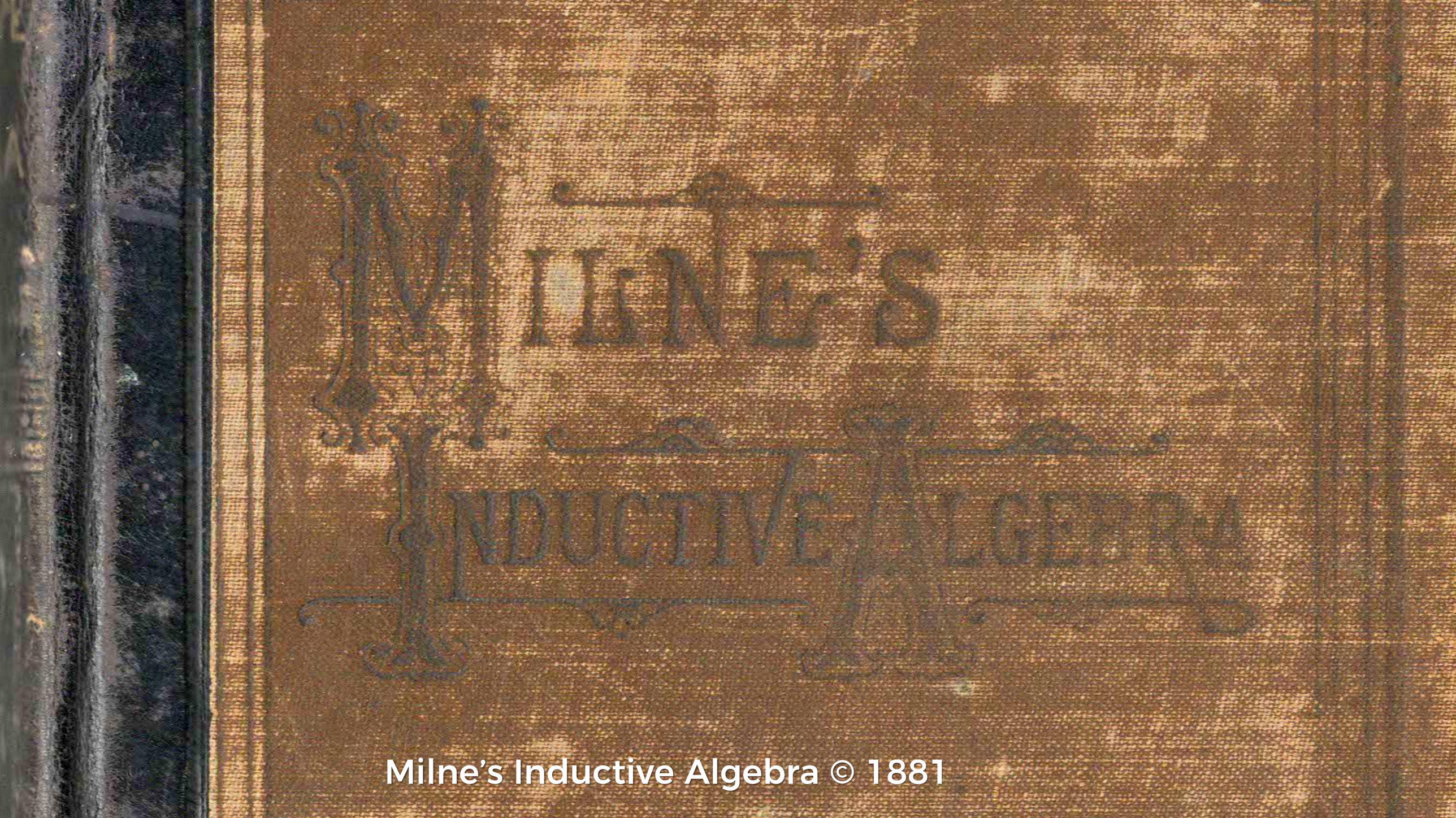
A) How many pizzas do you need to buy?

B) You and your seven friends want to have pizza for dinner. Each person will eat three slices of pizza. Each pizza has eight slices. How many pizzas do you need to buy?

#MTBoS #iteachmath

709 votes · Final results

Why do we have word problems?



Milne's Inductive Algebra © 1881

183. DIRECTIONS FOR SOLVING.—*Represent one of the unknown quantities by x, and from the conditions of the problem find an expression for each of the other quantities given.*

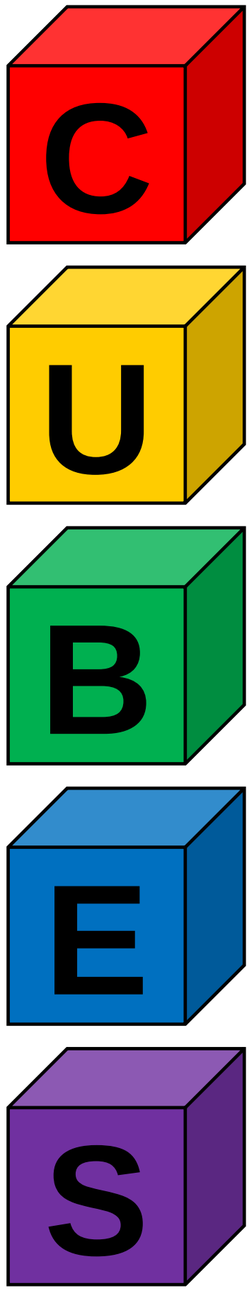
Find from the problem two expressions that are equal, and express them as an equation.

Solve the equation.

51. When the half of a certain number is added to the number, the sum is as much more than 60 as the number is less than 65. What is the number?

52. The difference between two numbers is 8, and the quotient arising from dividing the greater by the less is 3. What are the numbers?

53. A man left one-half of his property to his wife, one-sixth to his children, a twelfth to his brother, and the rest, which was $600, to charitable purposes. How much property had he?



CIRCLE the numbers

UNDERLINE the question

BOX the key words

~~ELIMINATE~~ info not needed

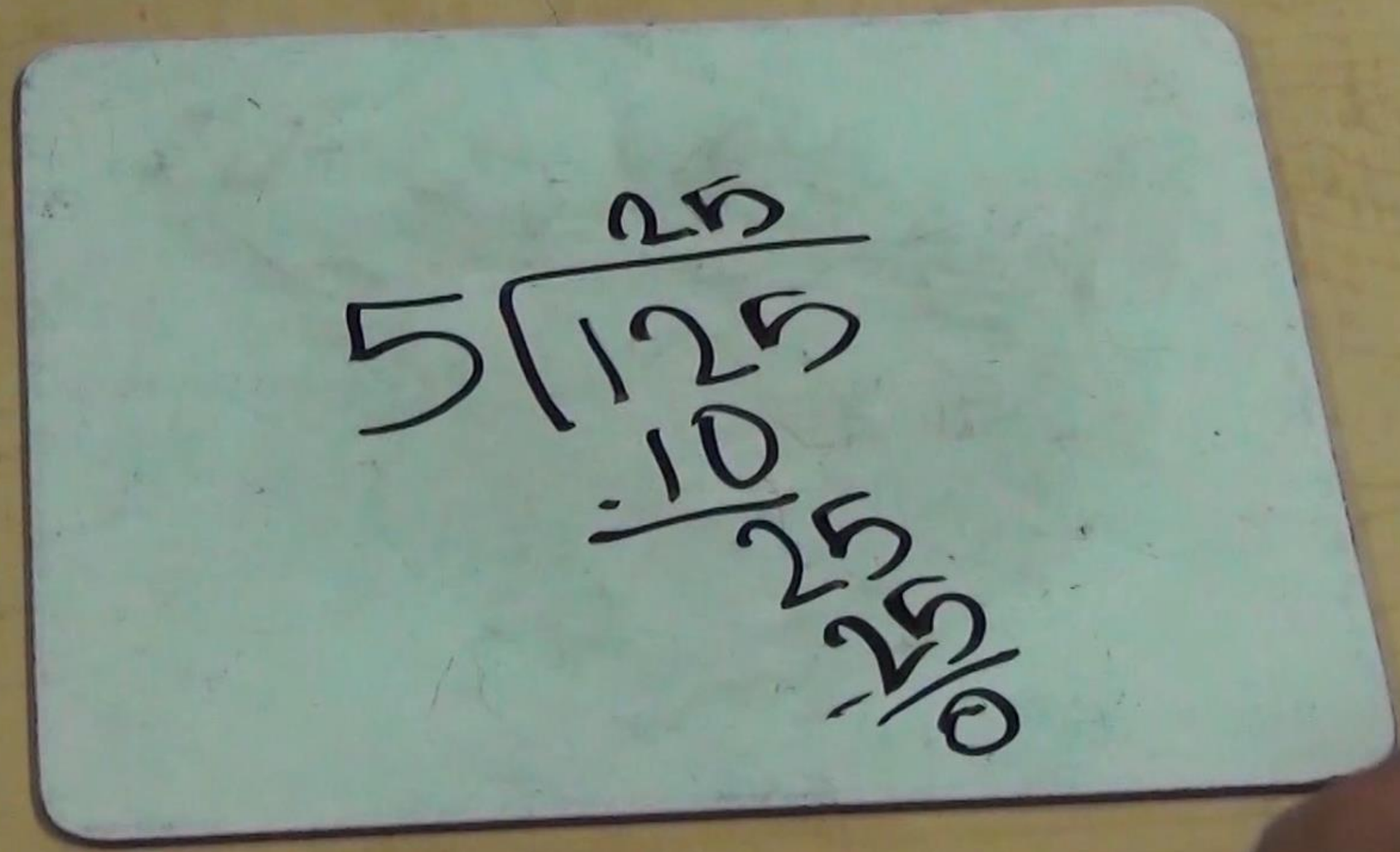
SOLVE and check ✓

In a class of 30 children, there are 3 girls for every 2 boys. How many girls are there altogether?

Source: Marilyn Burns

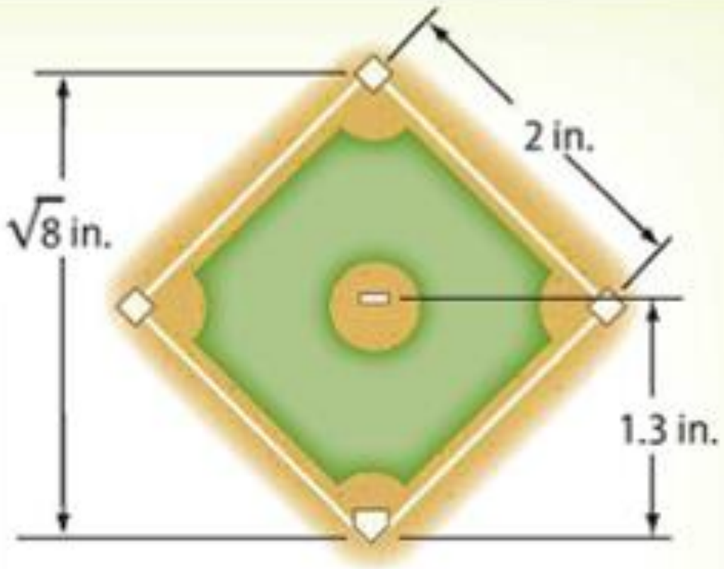
There are 125 sheep and 5 dogs in a flock. How old is the shepherd?

Making sense: 8
Not making sense: 24



Real-World Link

Sports Major League baseball has rules for the dimensions of the baseball diamond. A model of the diamond is shown.



1. On the model, the distance from the pitching mound to home plate is 1.3 inches. Is 1.3 a rational number? Explain.

2. On the model, the distance from first base to second base is 2 inches. Is 2 a rational number? Explain.

3. The distance from home plate to second base is $\sqrt{8}$ inches. Using a calculator, find $\sqrt{8}$. Does it appear to terminate or repeat?

Common Core State Standards

Content Standards
8.NS.1, 8.NS.2, 8.EE.2

Mathematical Practices
1, 3, 4, 6

When you remove a problem's context and it's still solvable, it's nothing more than a worksheet.

Doritos® & Cheetos® Mix

20 Singles

DORITOS® Nacho Cheese Flavored Tortilla Chips 1 OZ. EA. DORITOS® COOL RANCH® Flavored Tortilla Chips 1 OZ. EA. CHEETOS® Puffs Cheese Flavored Snacks ⅞ OZ. EA. CHEETOS® Crunchy Cheese Flavored Snacks 1 OZ. EA.

20 INDIVIDUAL BAGS: ⅞ OZ. EACH, 1 OZ. EACH, TOTAL NET WT. 19⅝ OZ. (1 LB. 3⅝ OZ.) 556.3 g

⚠ WARNING: PREVENT ENTANGLEMENT AND STRANGULATION. KEEP THIS BAG AWAY FROM YOUNG CHILDREN. IT IS NOT A TOY.

THINKING TIME

- Why did many of you expect there to be five of each?
- Why was it not five of each?
- How might they decide on this combination?

Classic Mix

20 Singles

LAY'S® Classic Potato Chips, DORITOS® Nacho Cheese Flavored Tortilla Chips, DORITOS® COOL RANCH® Flavored Tortilla Chips, CHEETOS® Crunchy Cheese Flavored Snacks, SUNCHIPS® Original Multigrain Snacks, FRITOS® Original Corn Chips (All 1 OZ. Each)

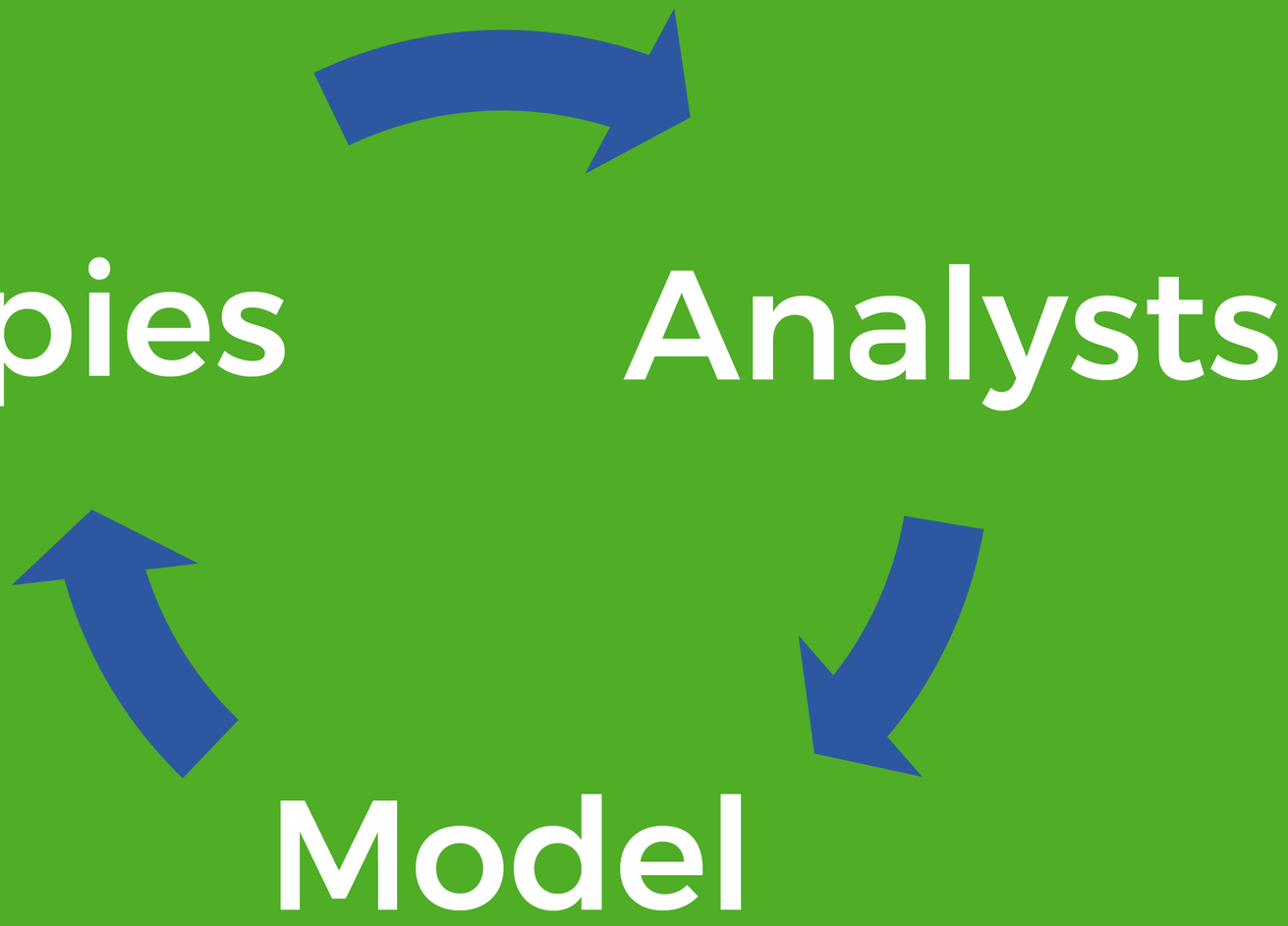
20 INDIVIDUAL BAGS: 1 OZ. EACH, TOTAL NET WT. 20 OZ. (1 LB. 4 OZ.) 567 g

⚠ WARNING: PREVENT ENTANGLEMENT AND STRANGULATION. KEEP THIS BAG AWAY FROM YOUNG CHILDREN. IT IS NOT A TOY.

MATH MODELING

- ❑ HOW DO WE MAKE SENSE OF MATH MODELING?
- ❑ IS IT JUST ANSWERING QUESTIONS?
- ❑ HOW IS MATH MODELING USED IN REAL LIFE?
- ❑ HOW DO WE HELP OUR STUDENTS IMPROVE?


CENTRAL INTELLIGENCE AGENCY
UNITED STATES OF AMERICA


Spies
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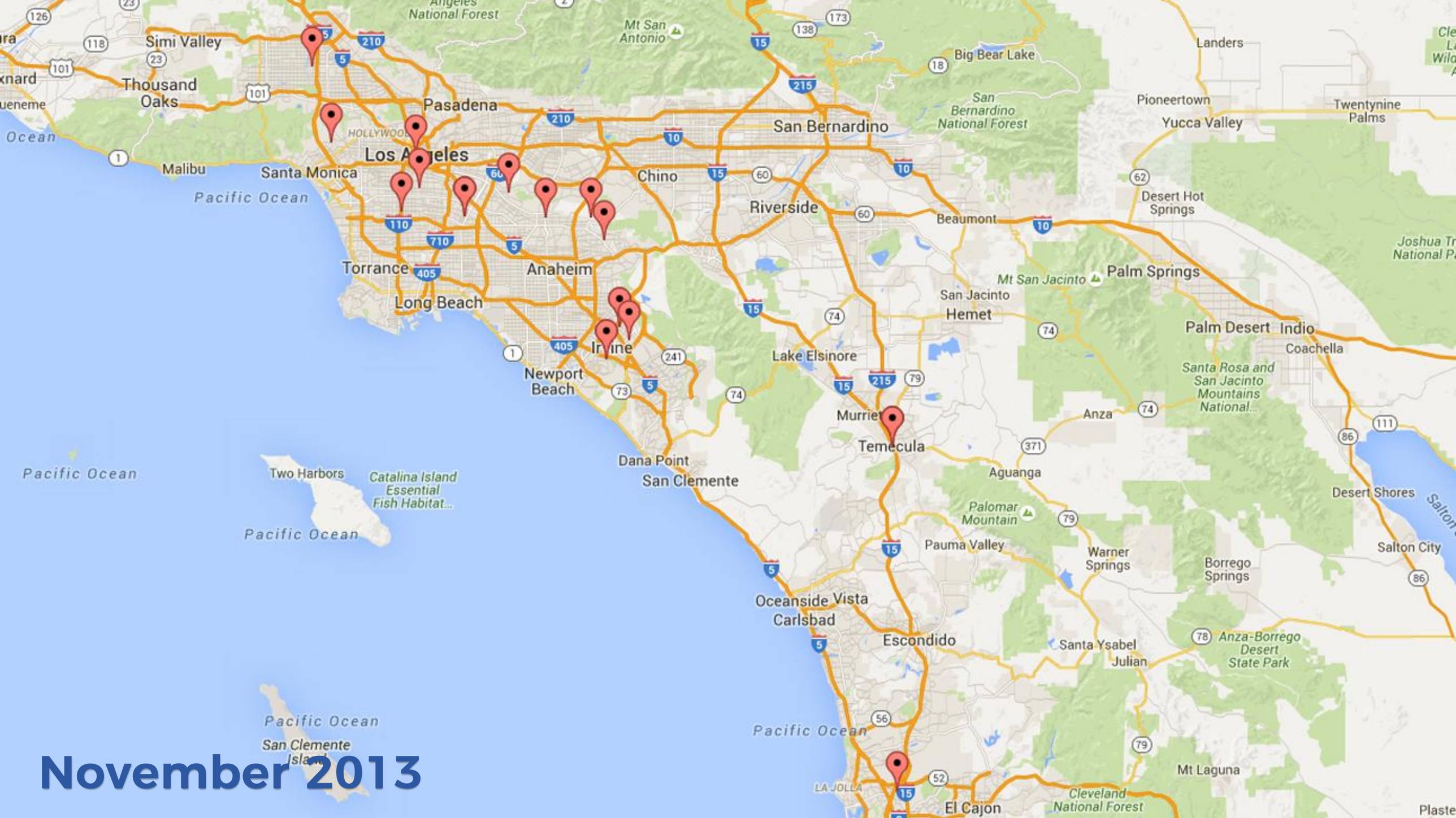

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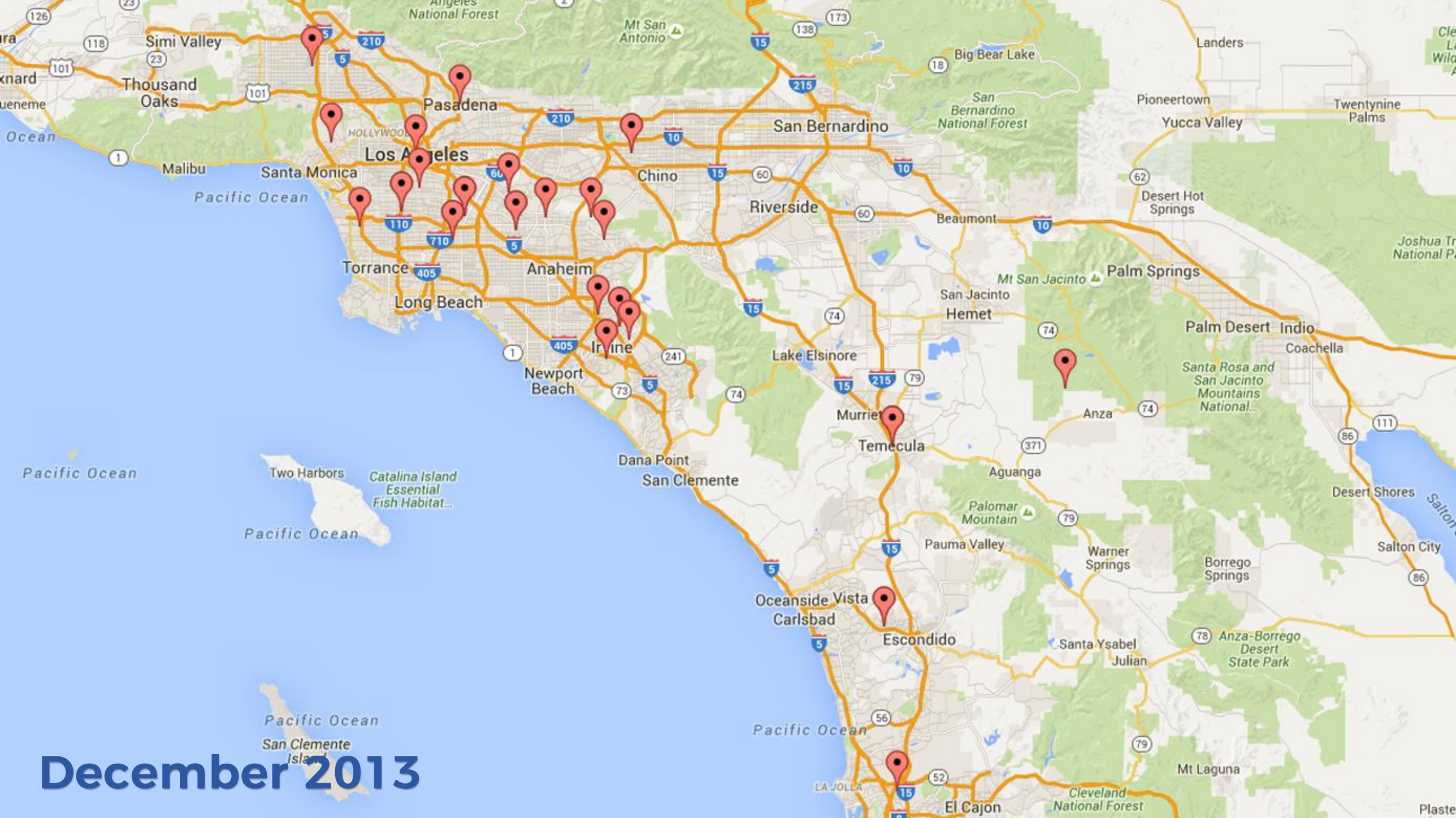

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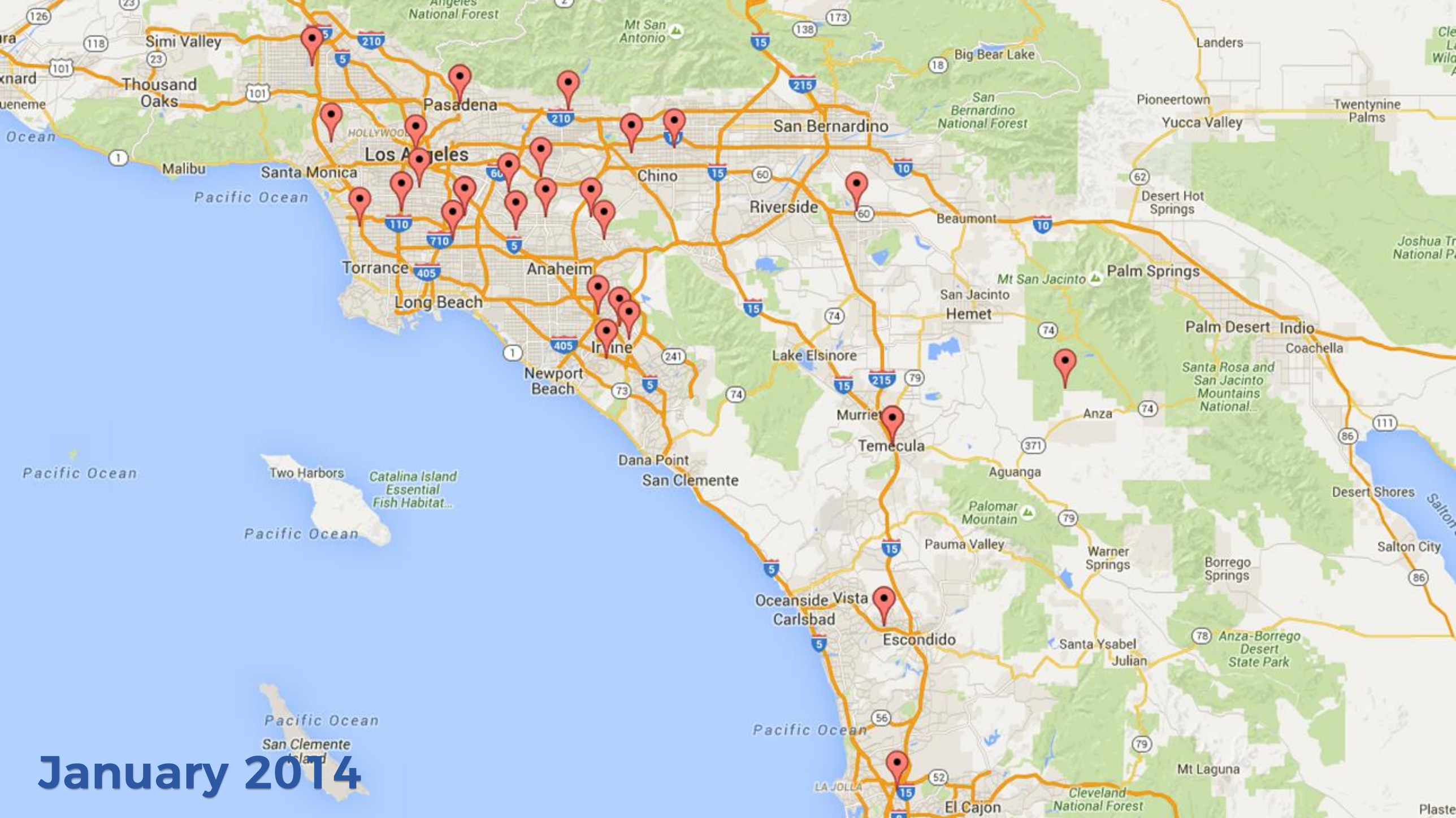

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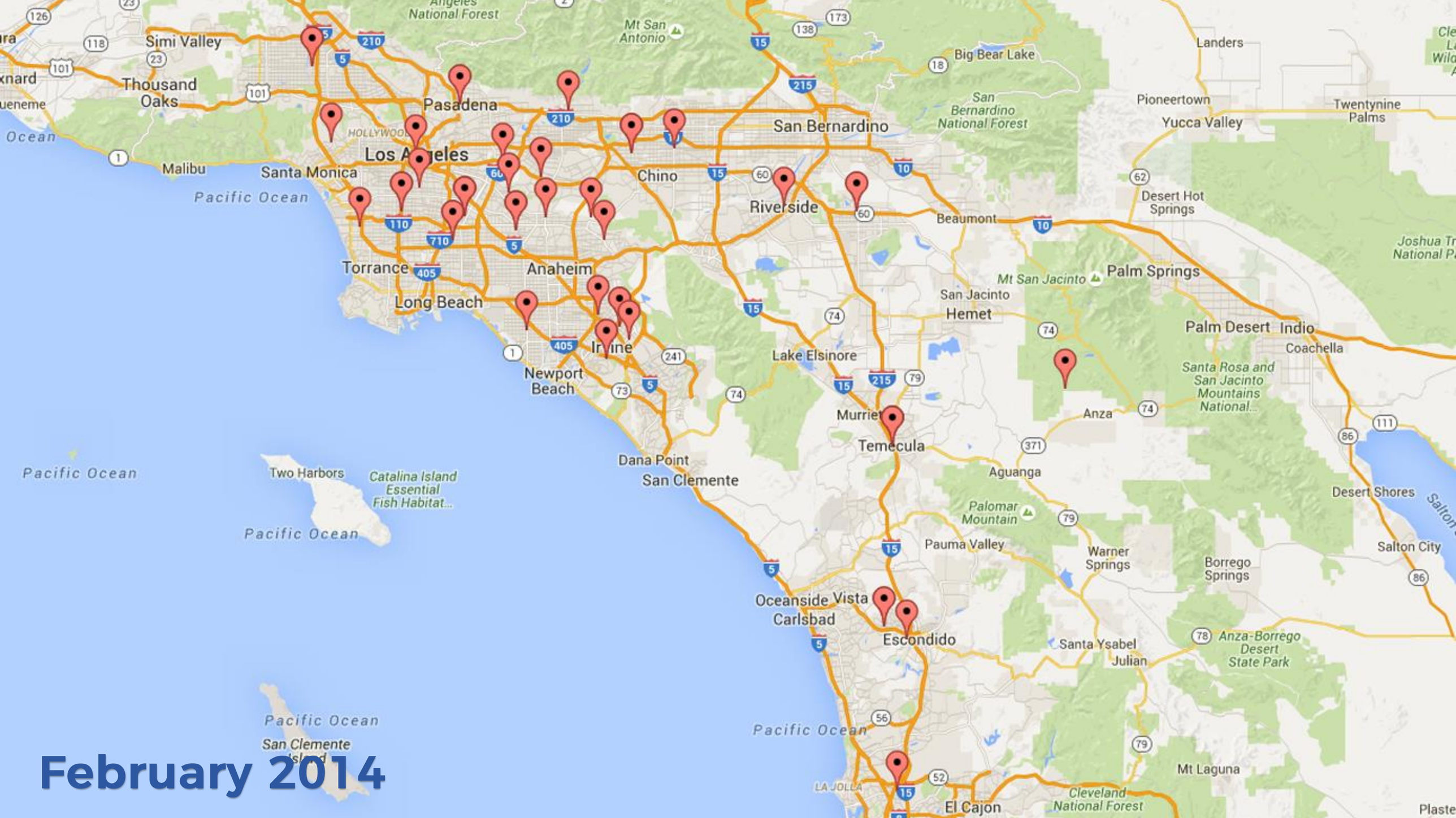

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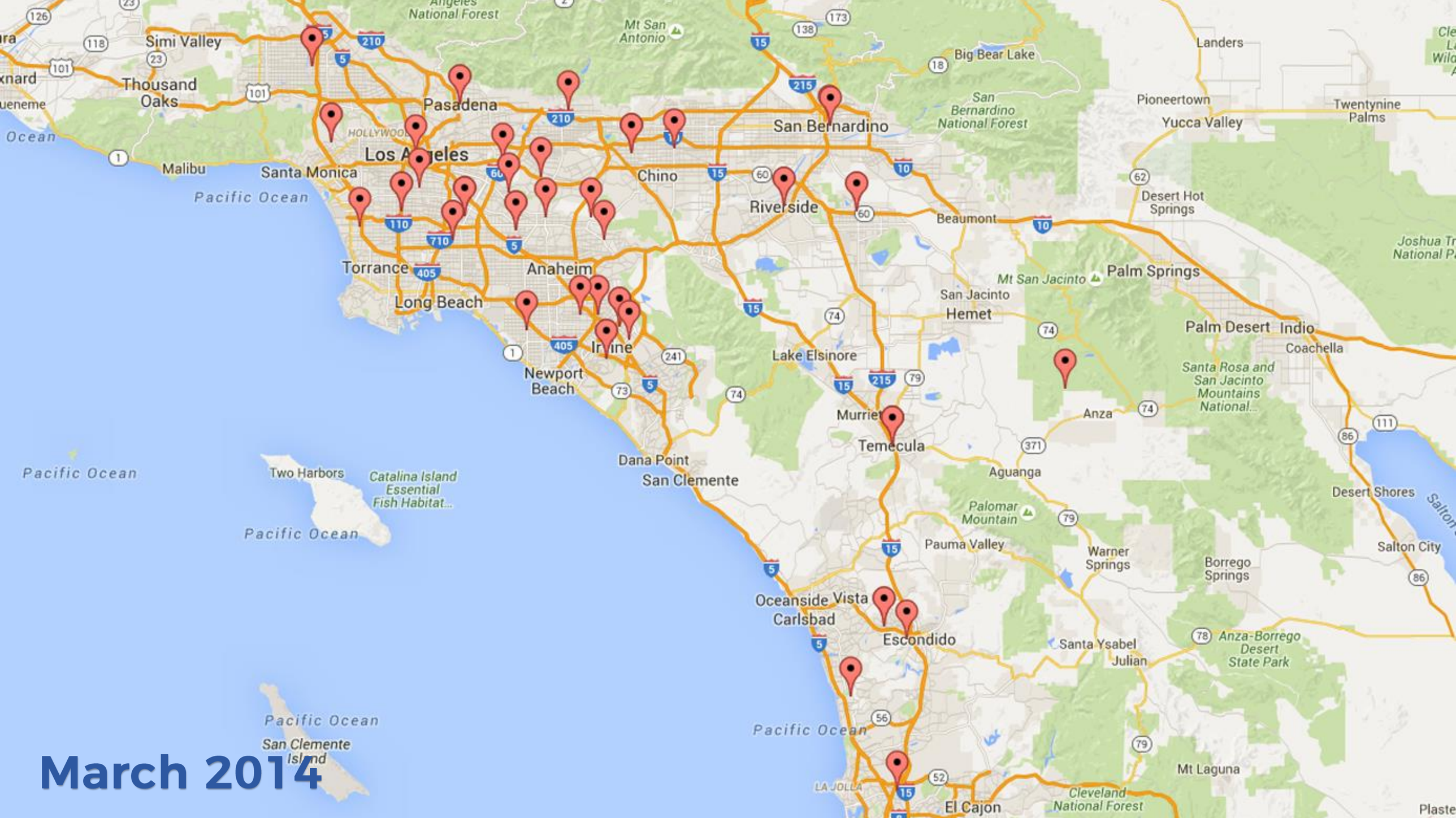
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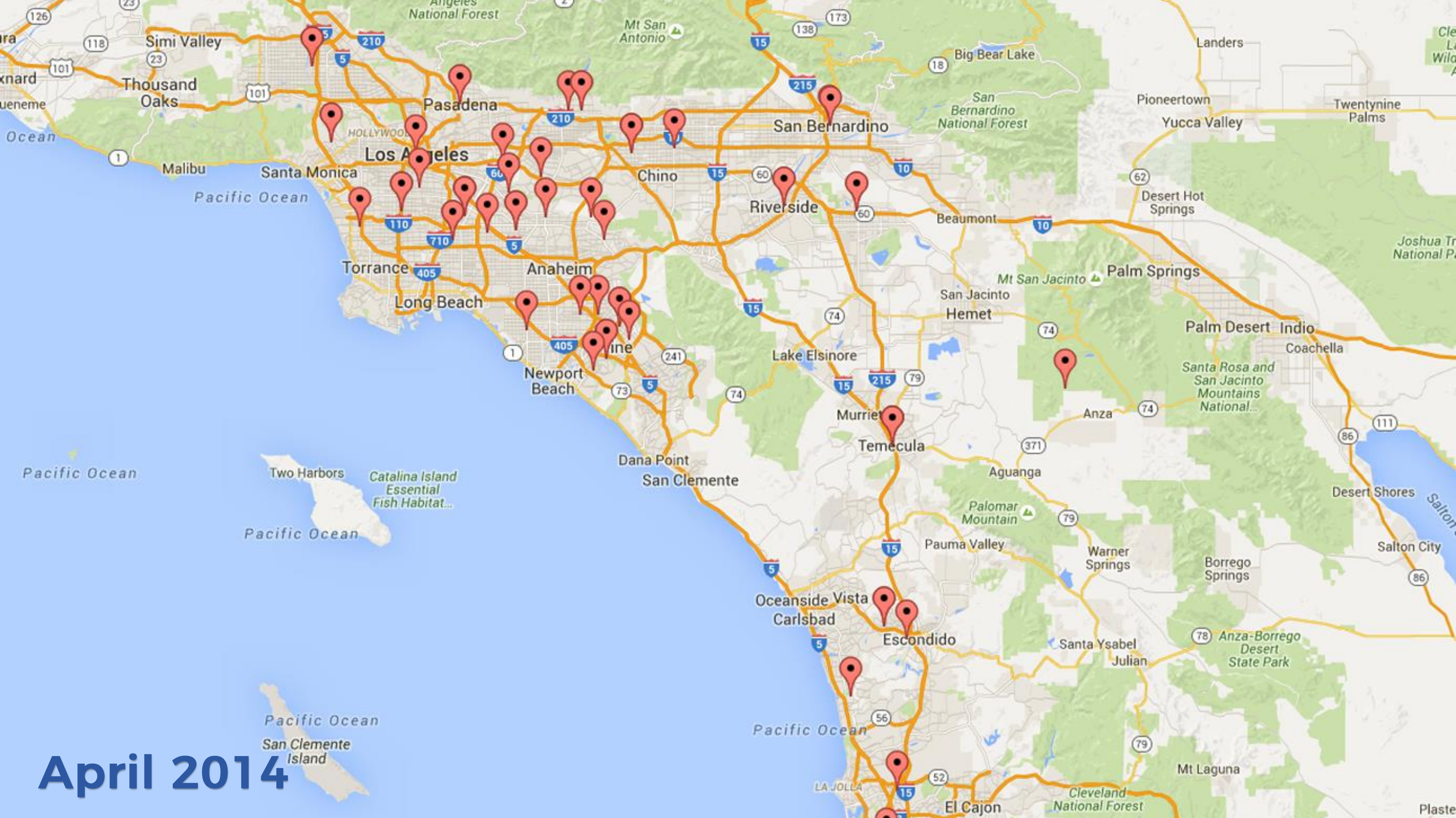
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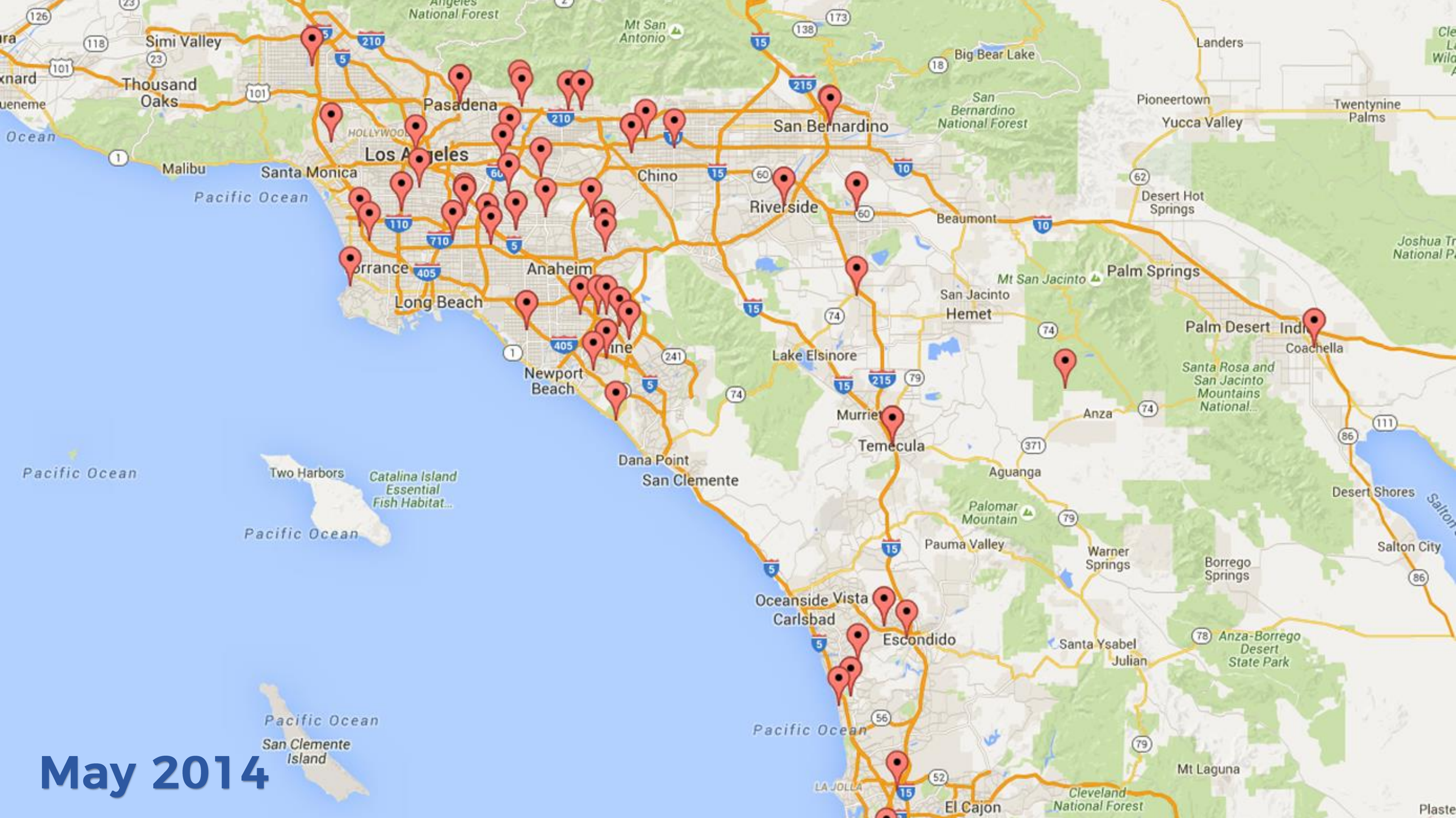
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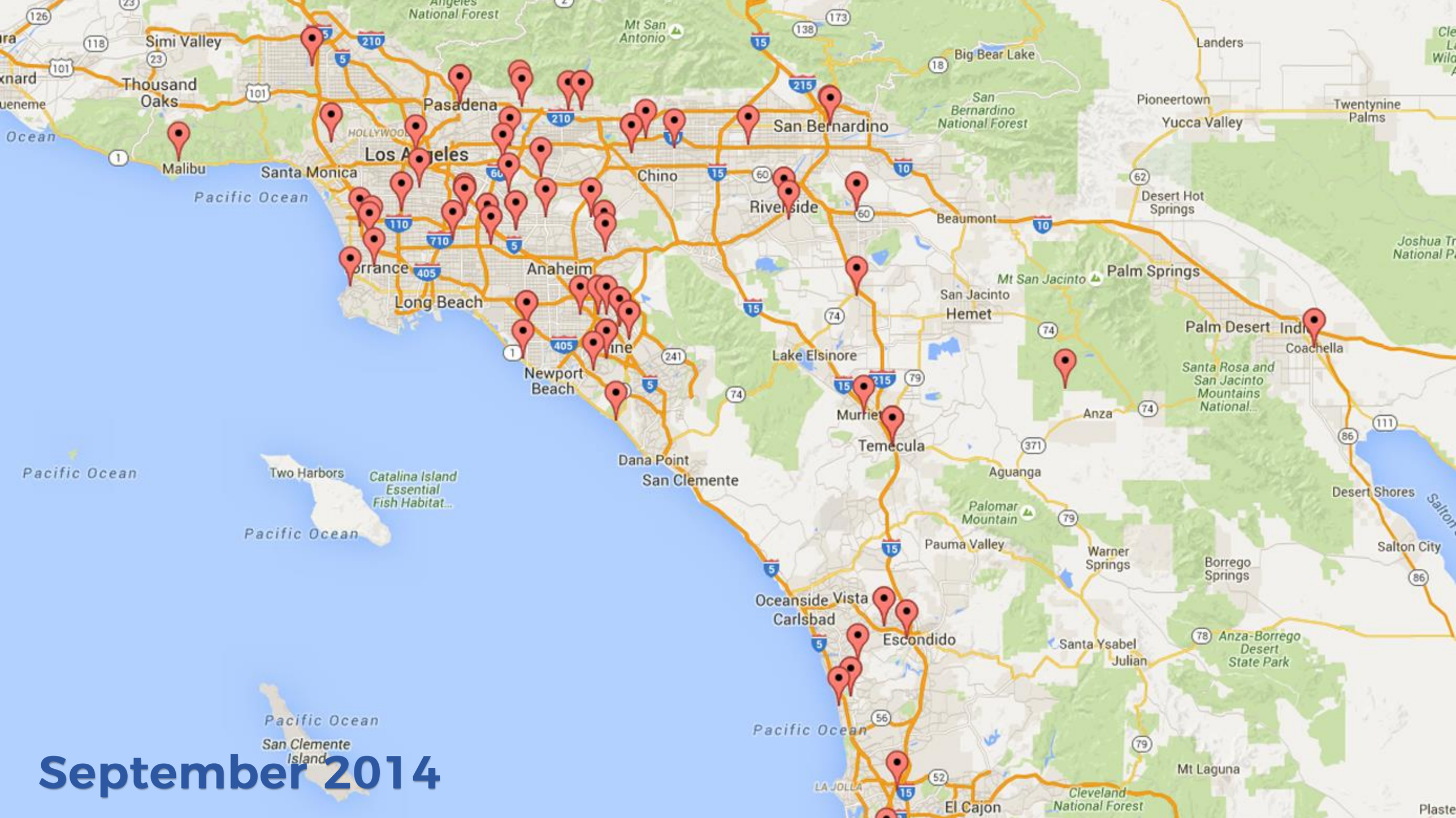

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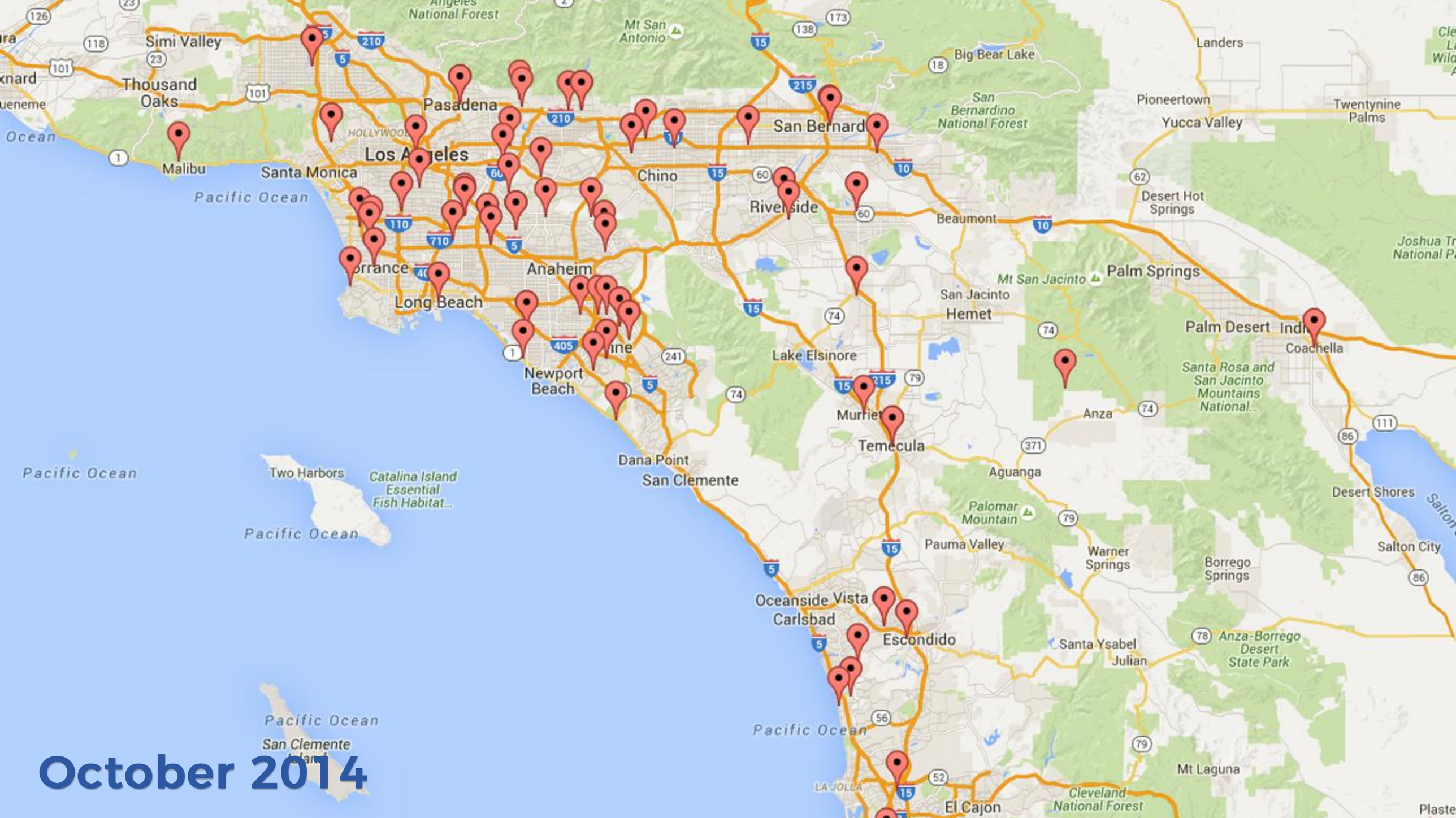

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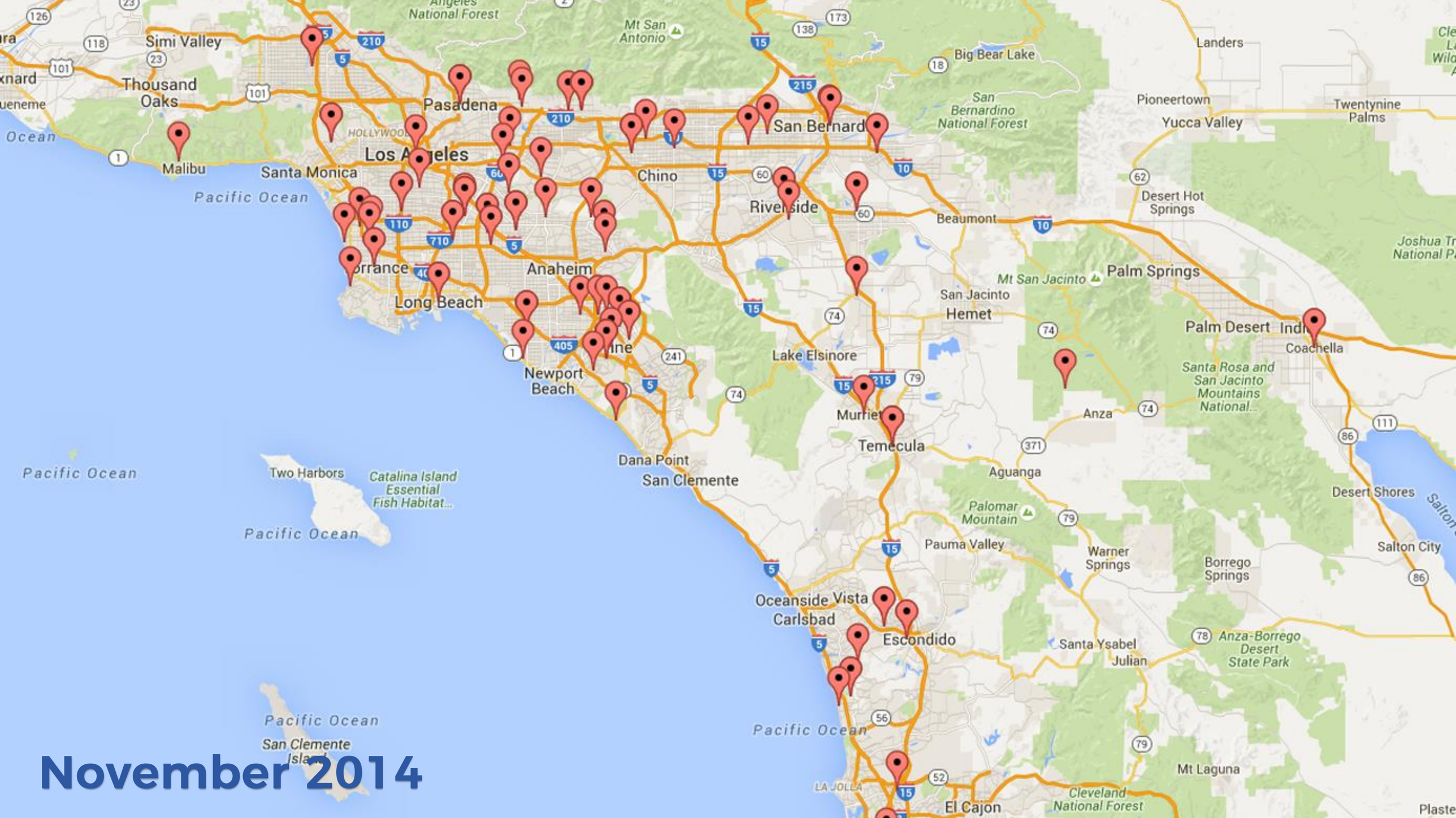

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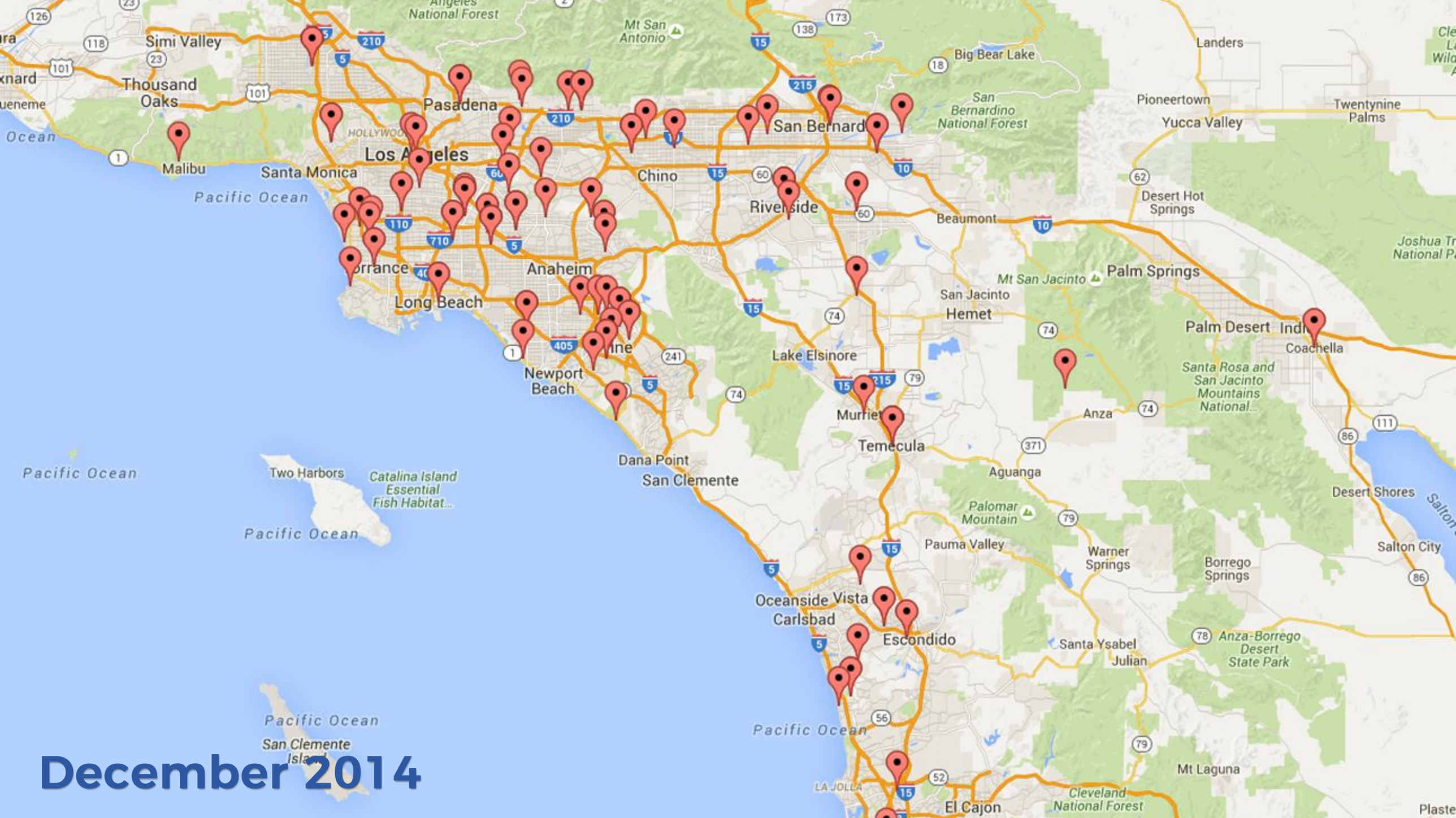

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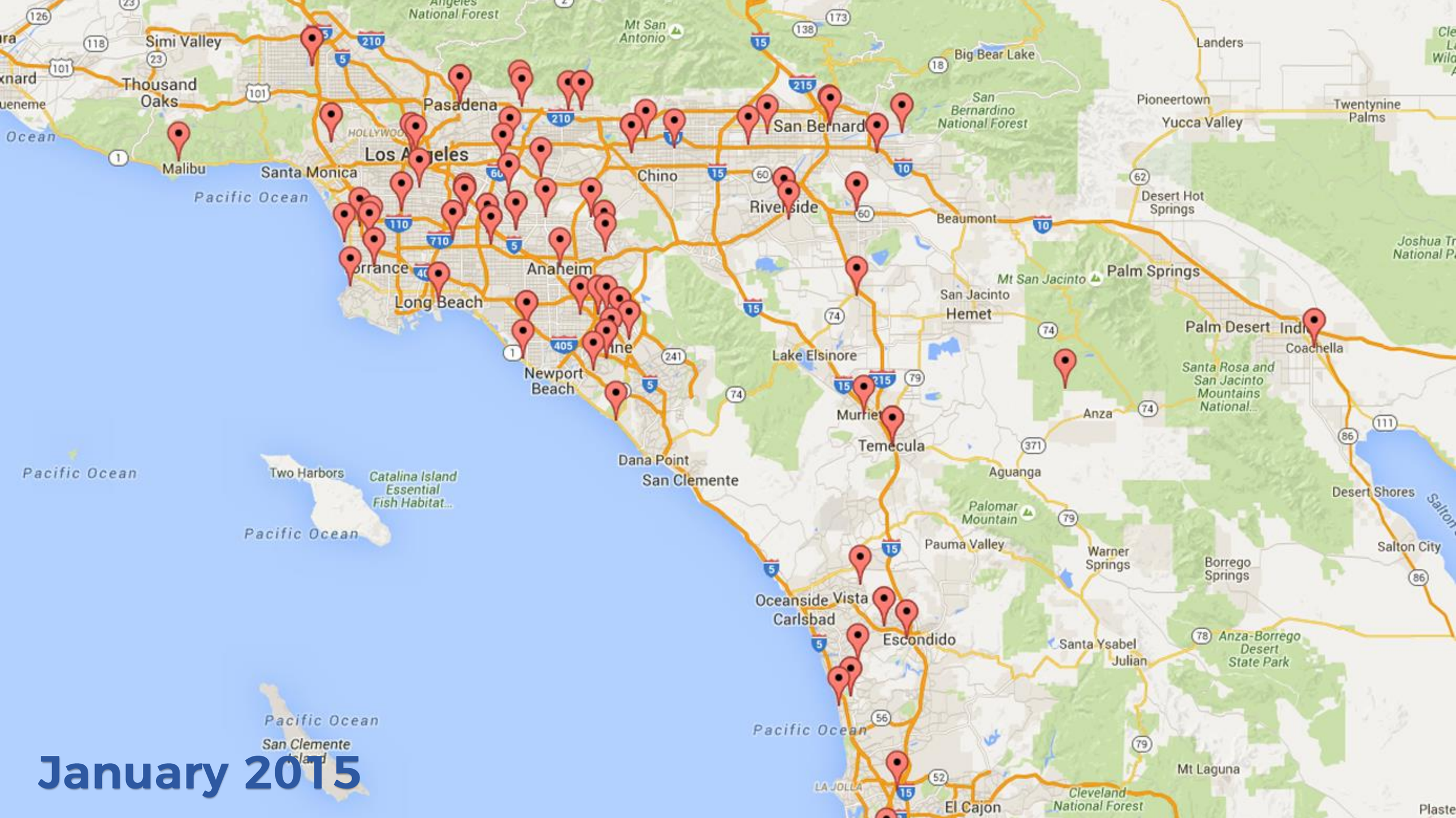
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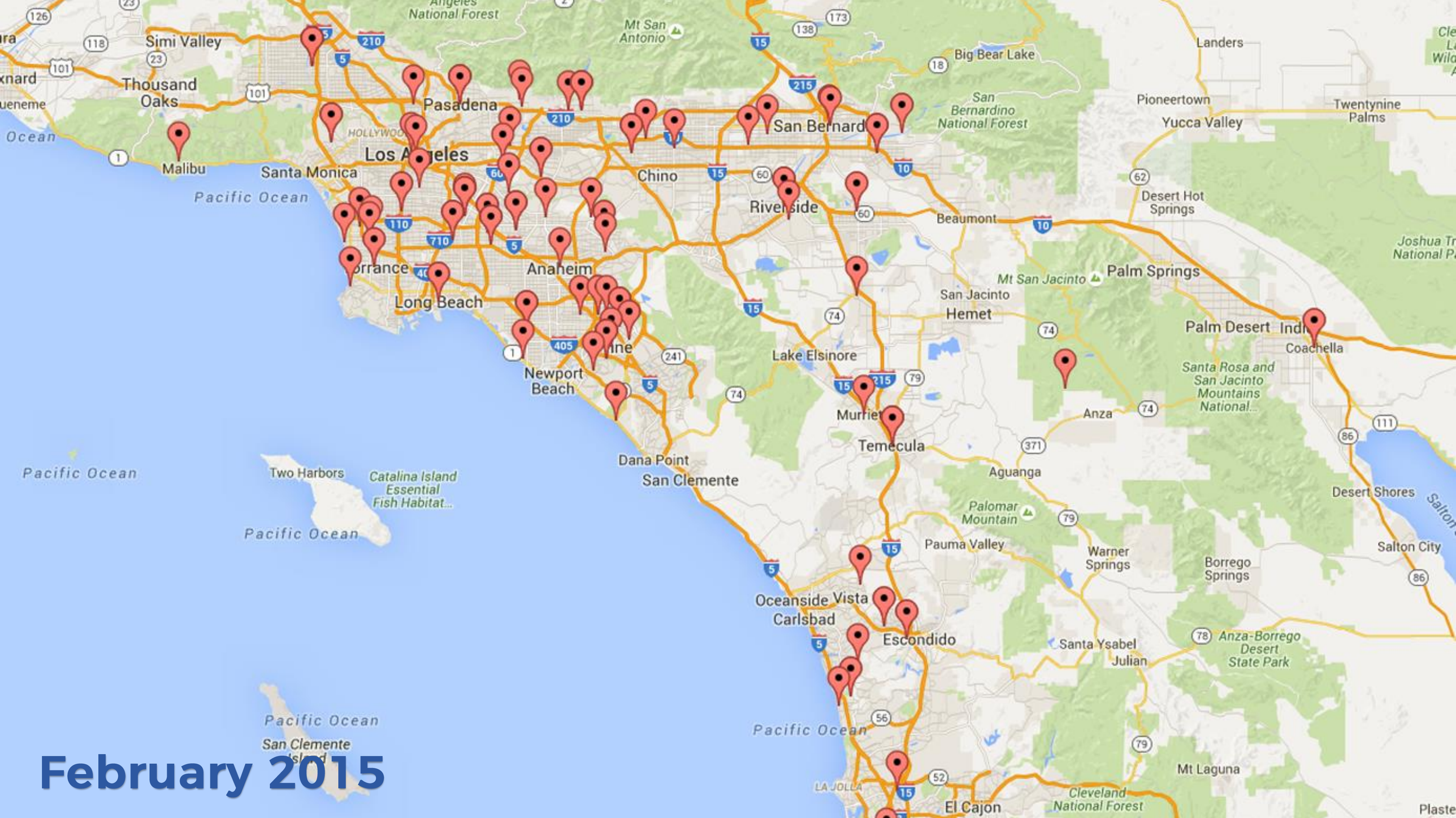

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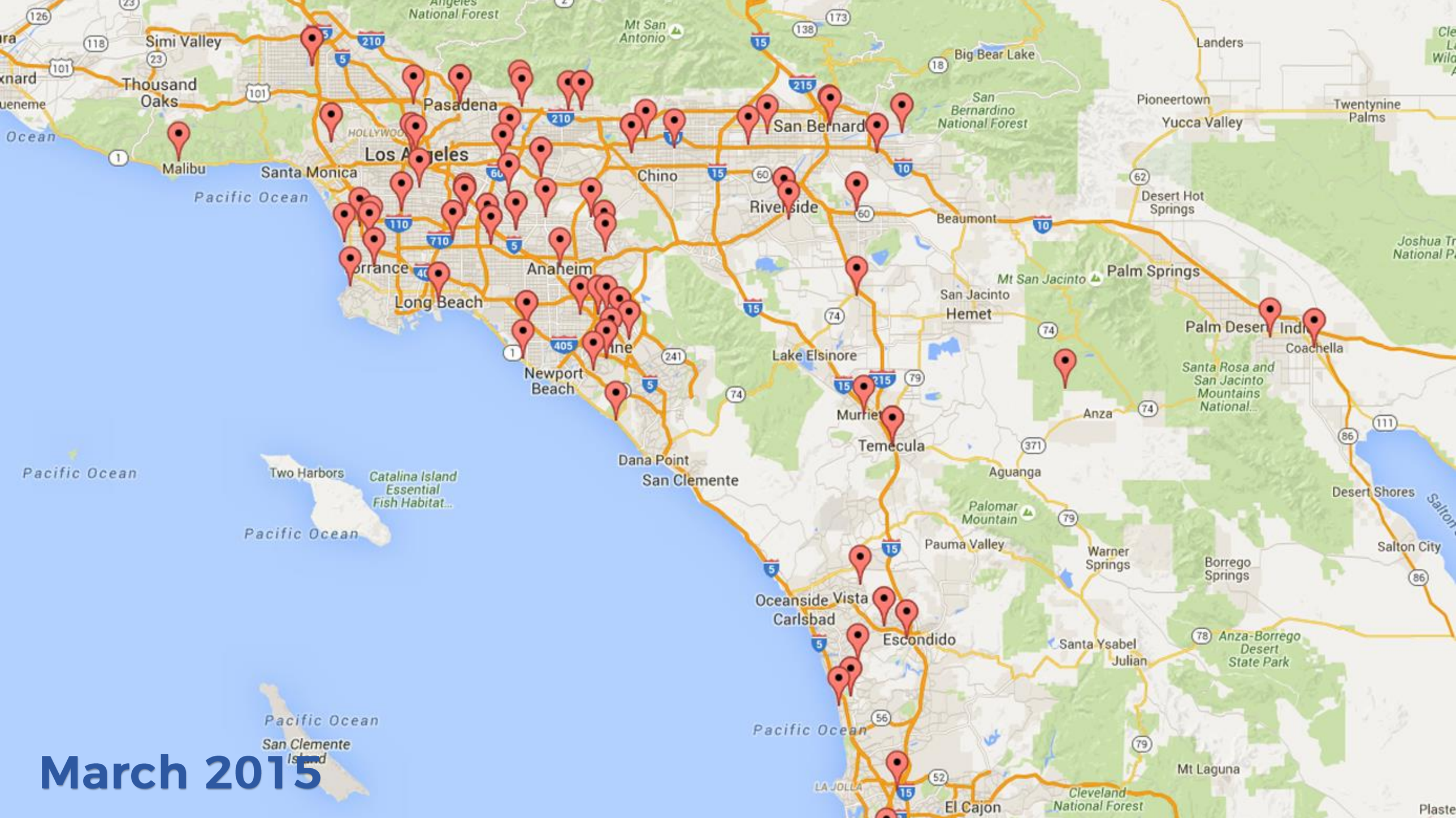
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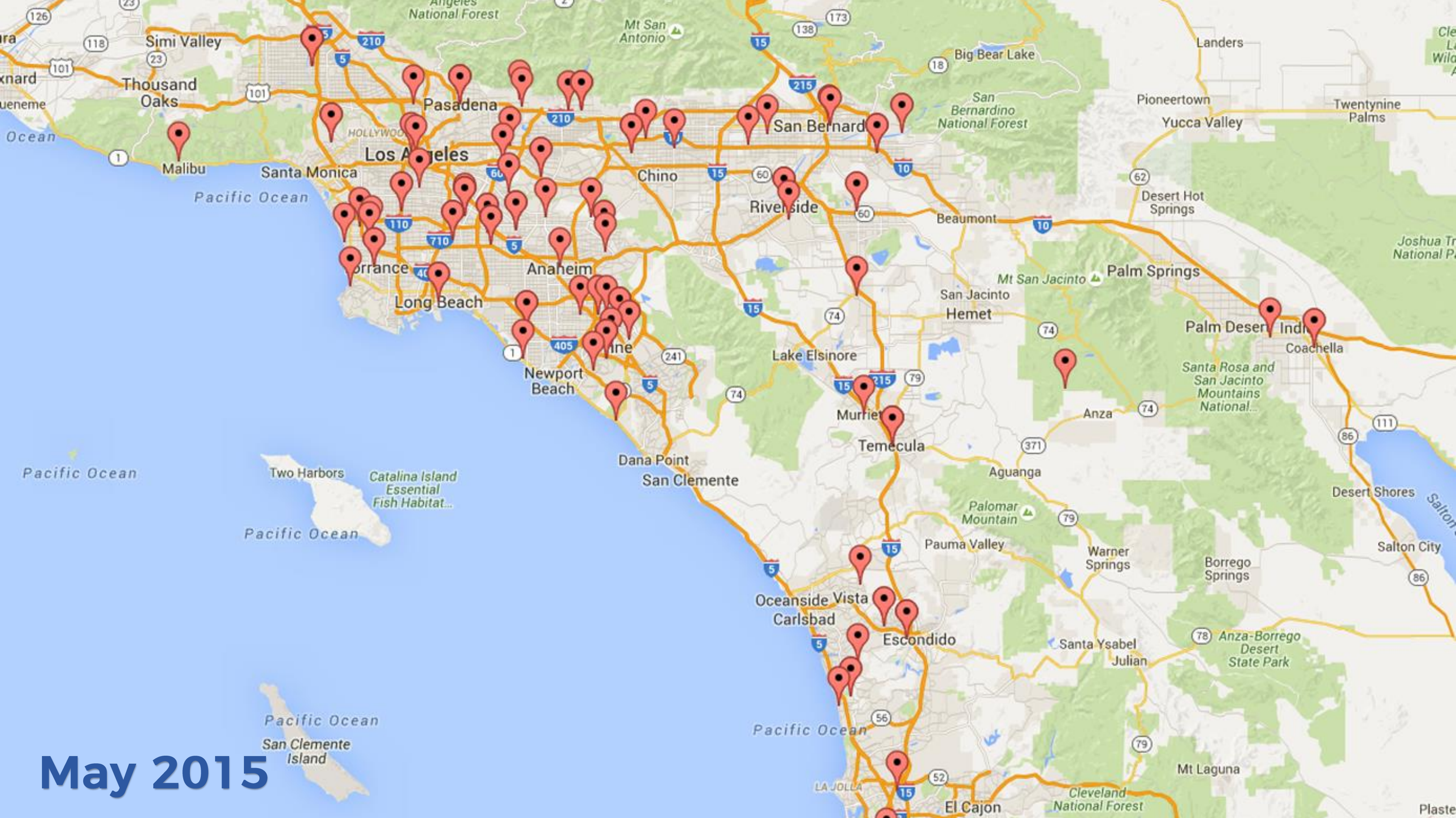
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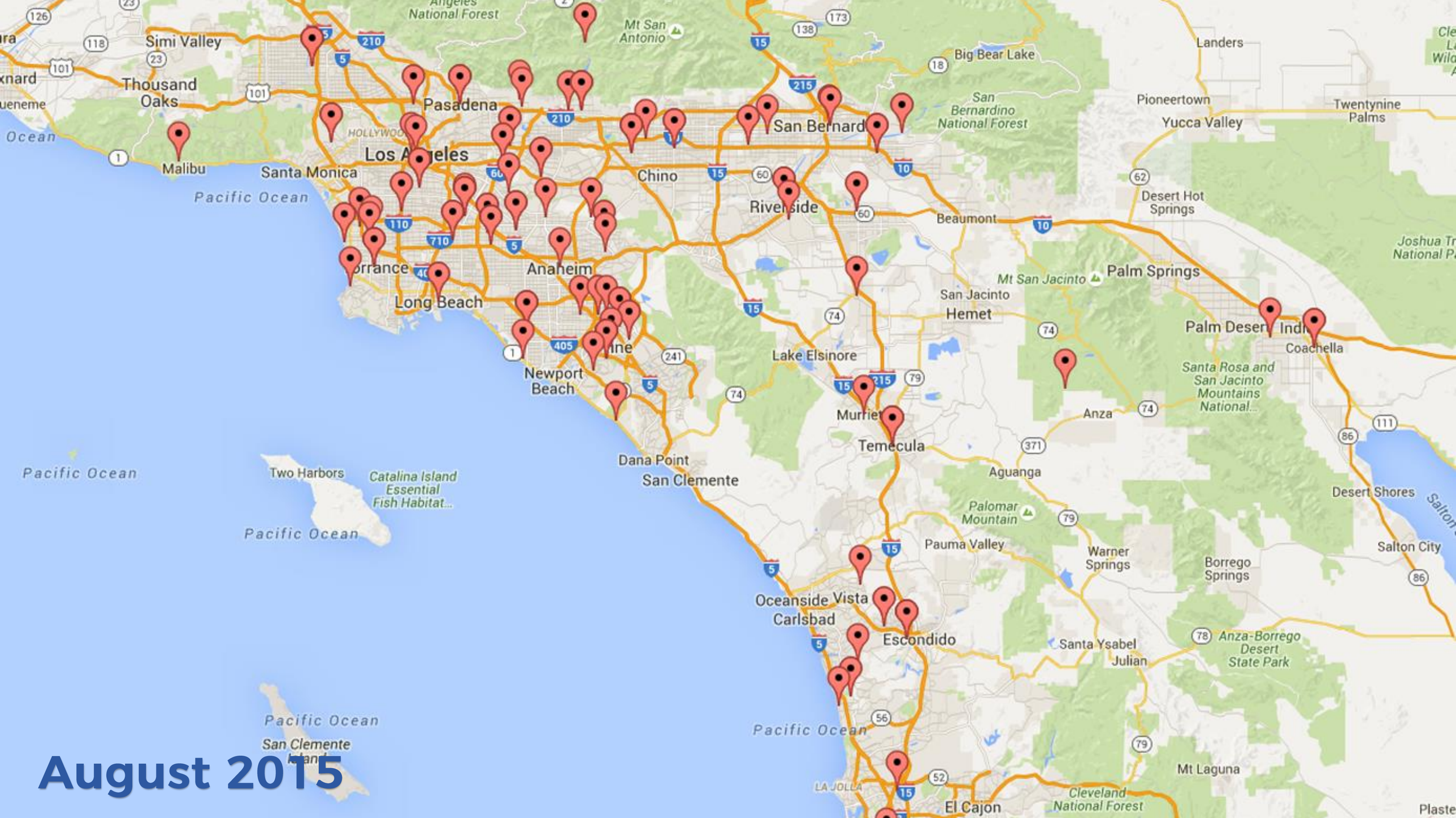
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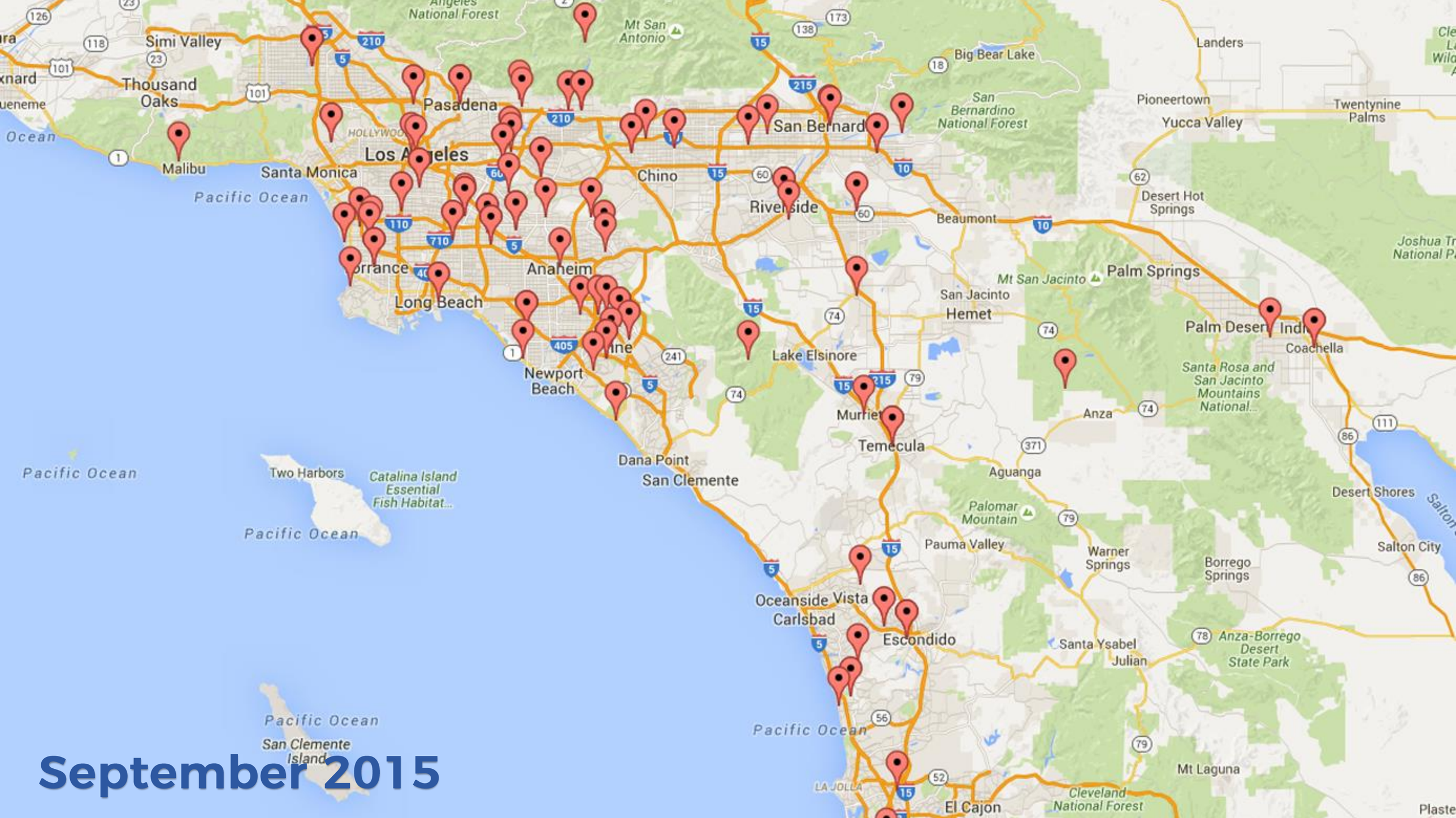

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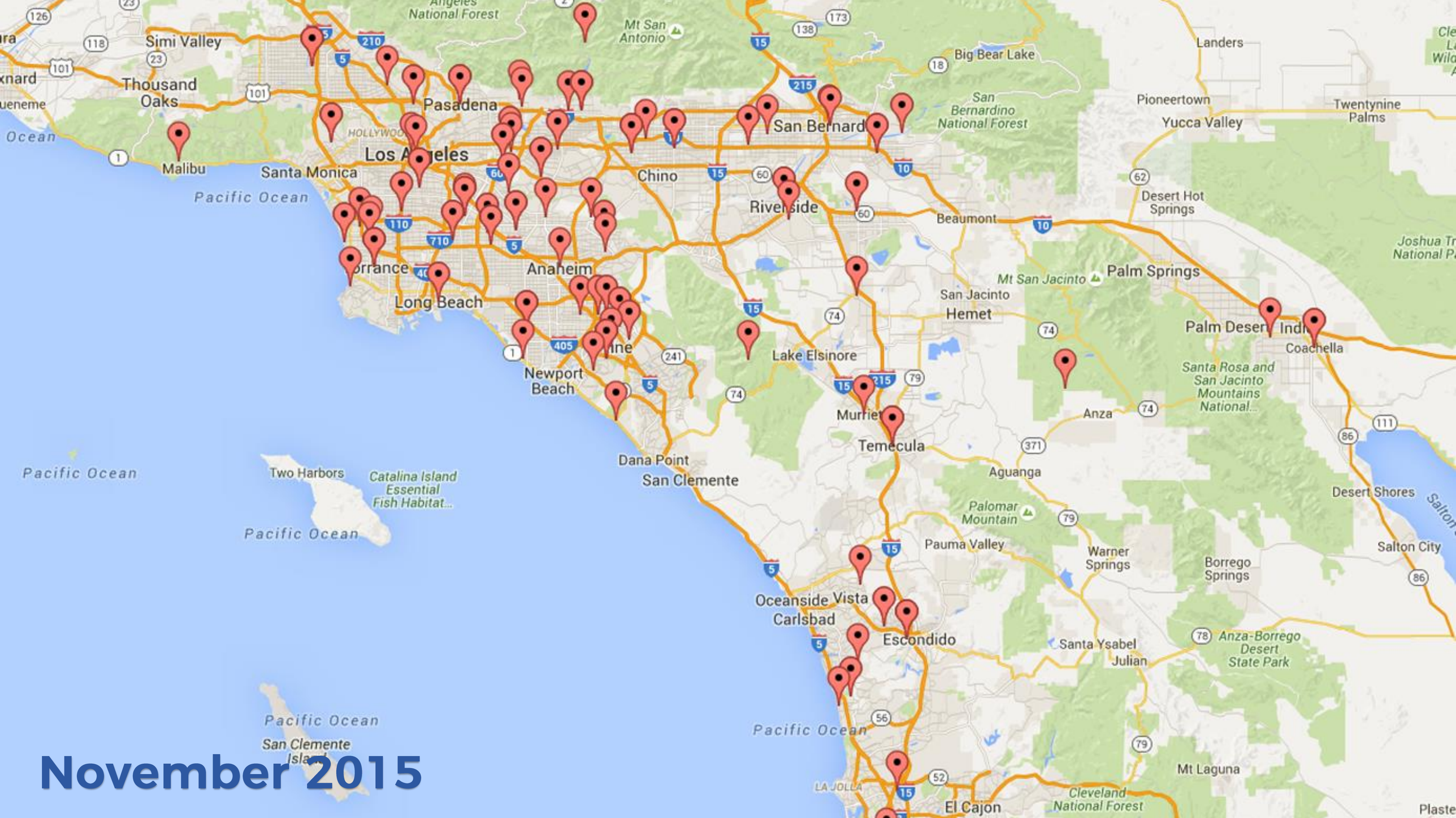

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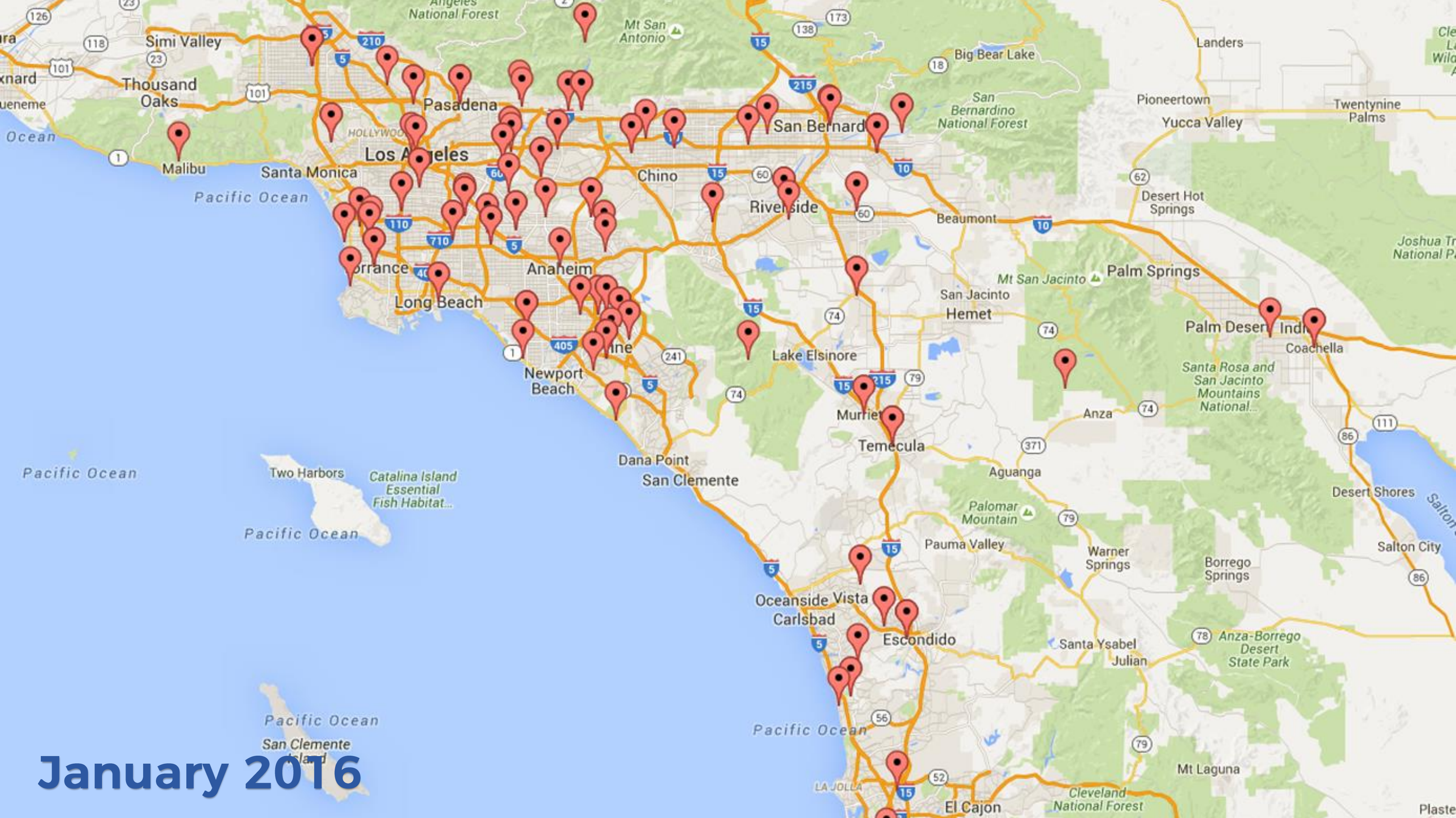

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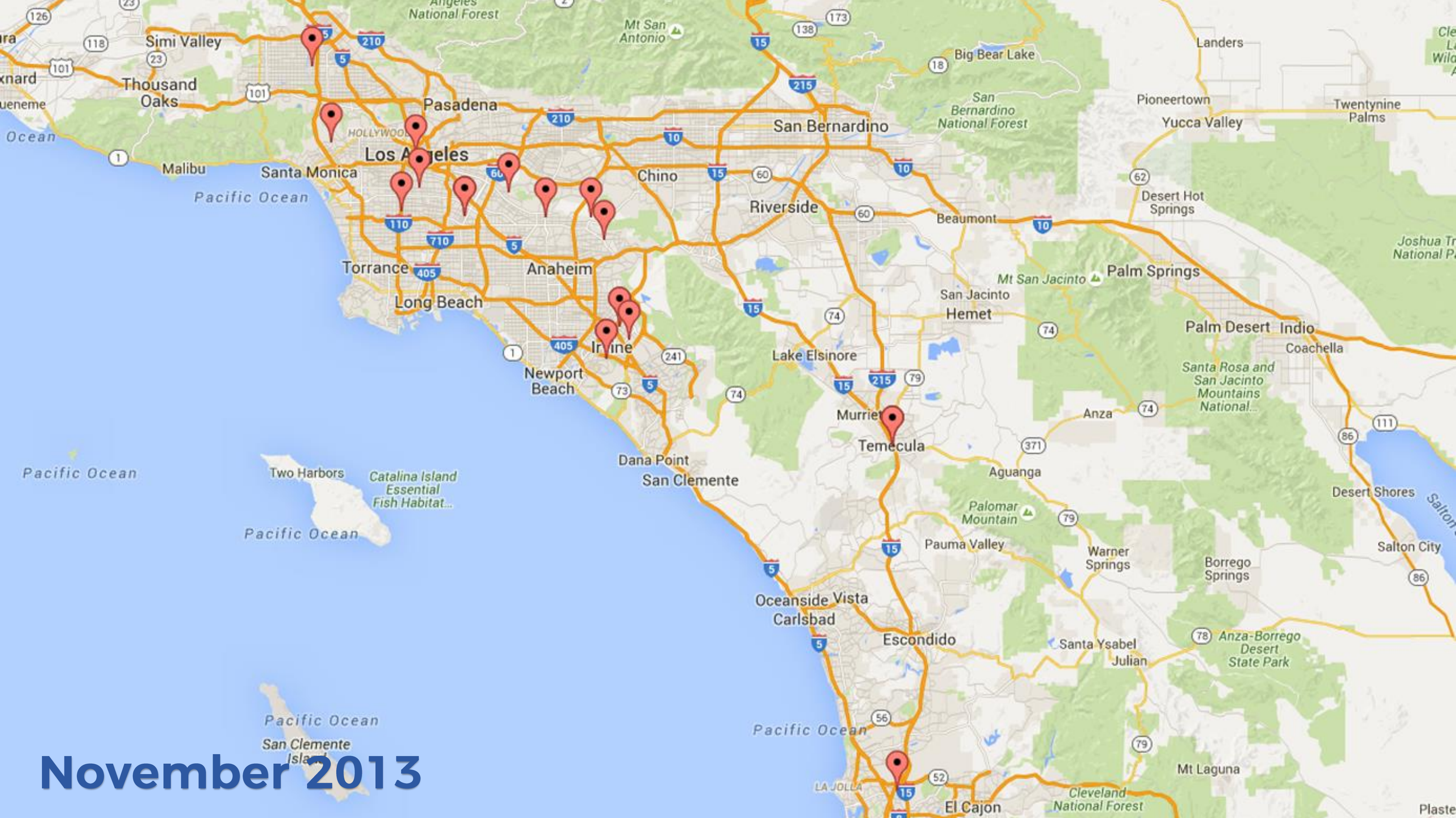

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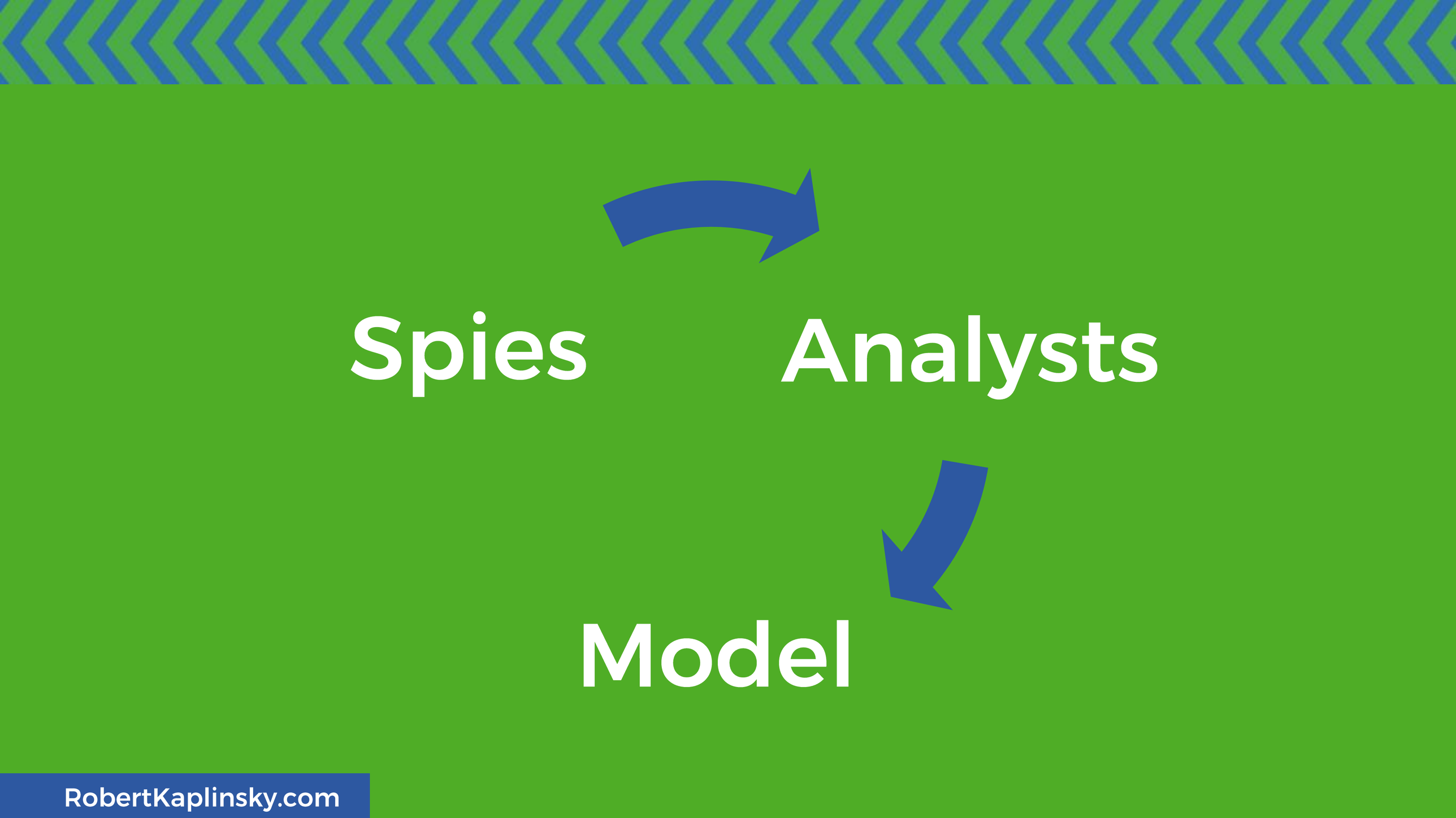
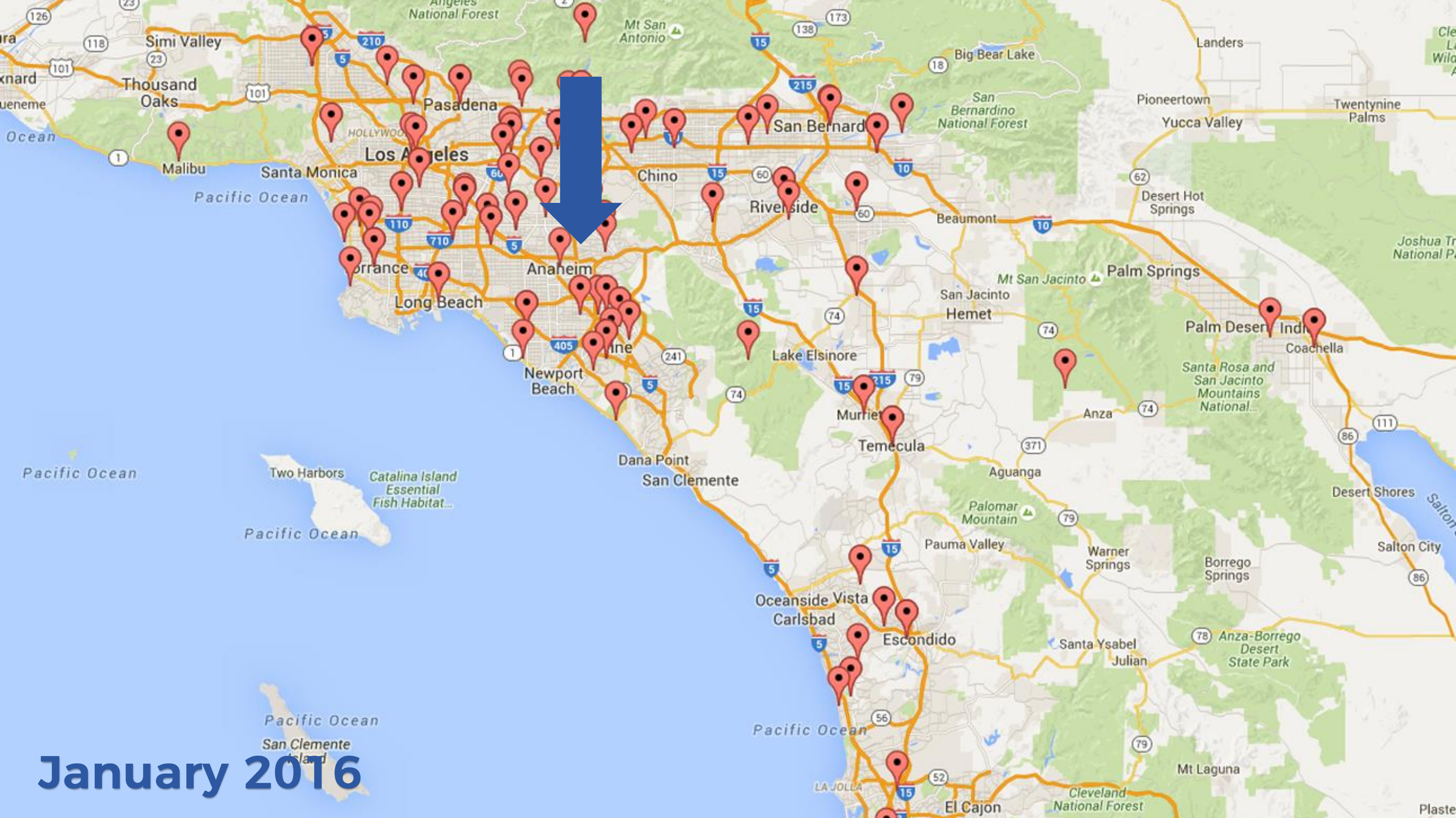

Spies
Analysts
Model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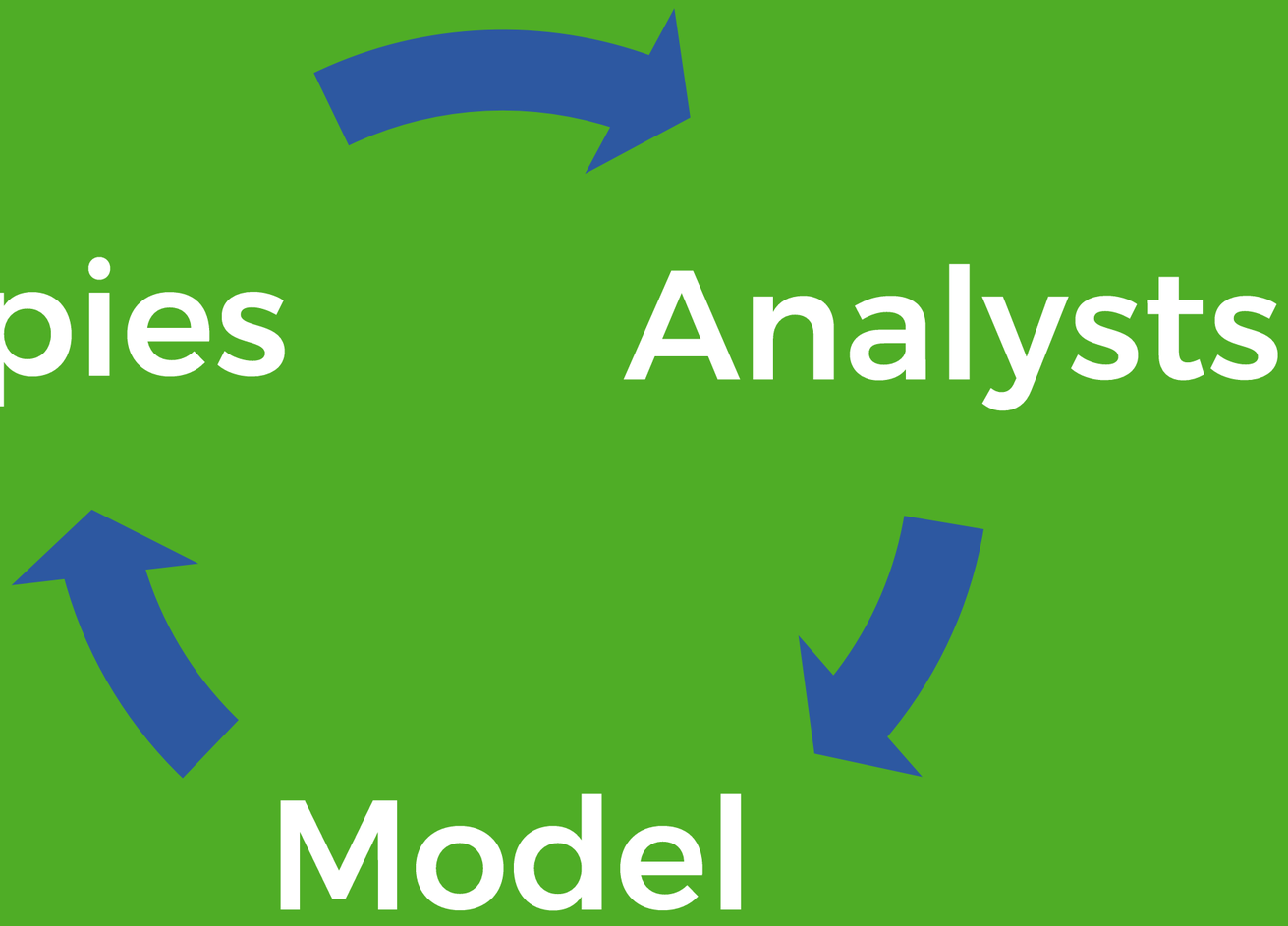
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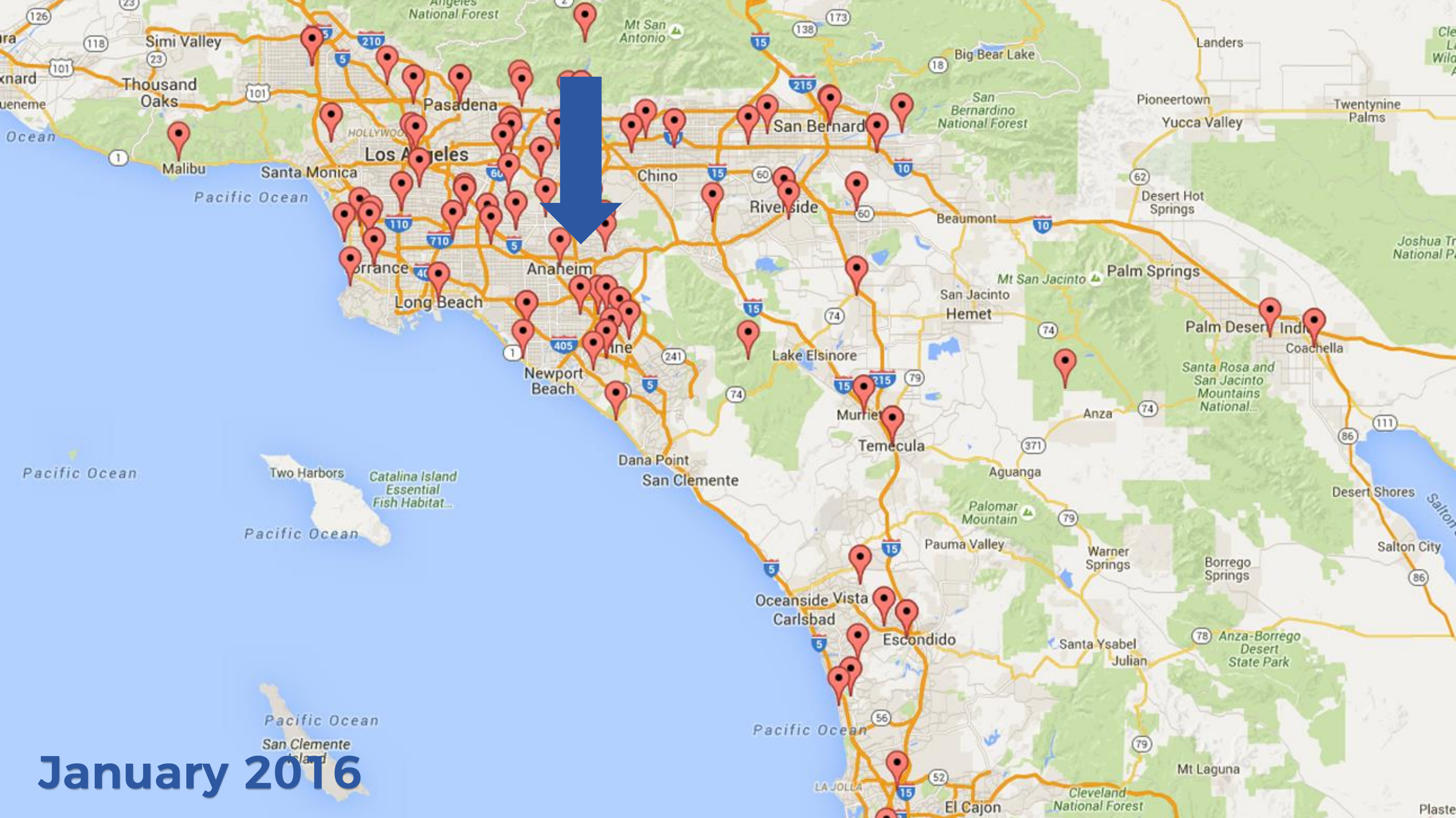
Analysts
Model


January 2016
Pacific Ocean
Simi Valley
Thousand Oaks
Malibu
Santa Monica
Pasadena
Los Angeles
Anaheim
Long Beach
Chino
San Bernardino
Riverside
Beaumont
Big Bear Lake
Yucca Valley
Palm Springs
Hemet
Lake Elsinore
Temecula
Murrieta
Newport Beach
Dana Point
San Clemente
Two Harbors
Catalina Island Essential Fish Habitat...
Oceanside
Vista
Carlsbad
Escondido
Pauma Valley
Warner Springs
Borrego Springs
Julian
Santa Ysabel
Aguanga
Anza
Coachella
Salton City
Desert Shores
Mt Laguna
El Cajon
LA JOLLA
Cleveland National Forest
Anza-Borrego Desert State Park
Santa Rosa and San Jacinto Mountains National...
Mt San Antonio
Mt San Jacinto
Palomar Mountain
San Bernardino National Forest
Angeles National Forest

All models are wrong, but some are useful.

GEORGE E. P. BOX

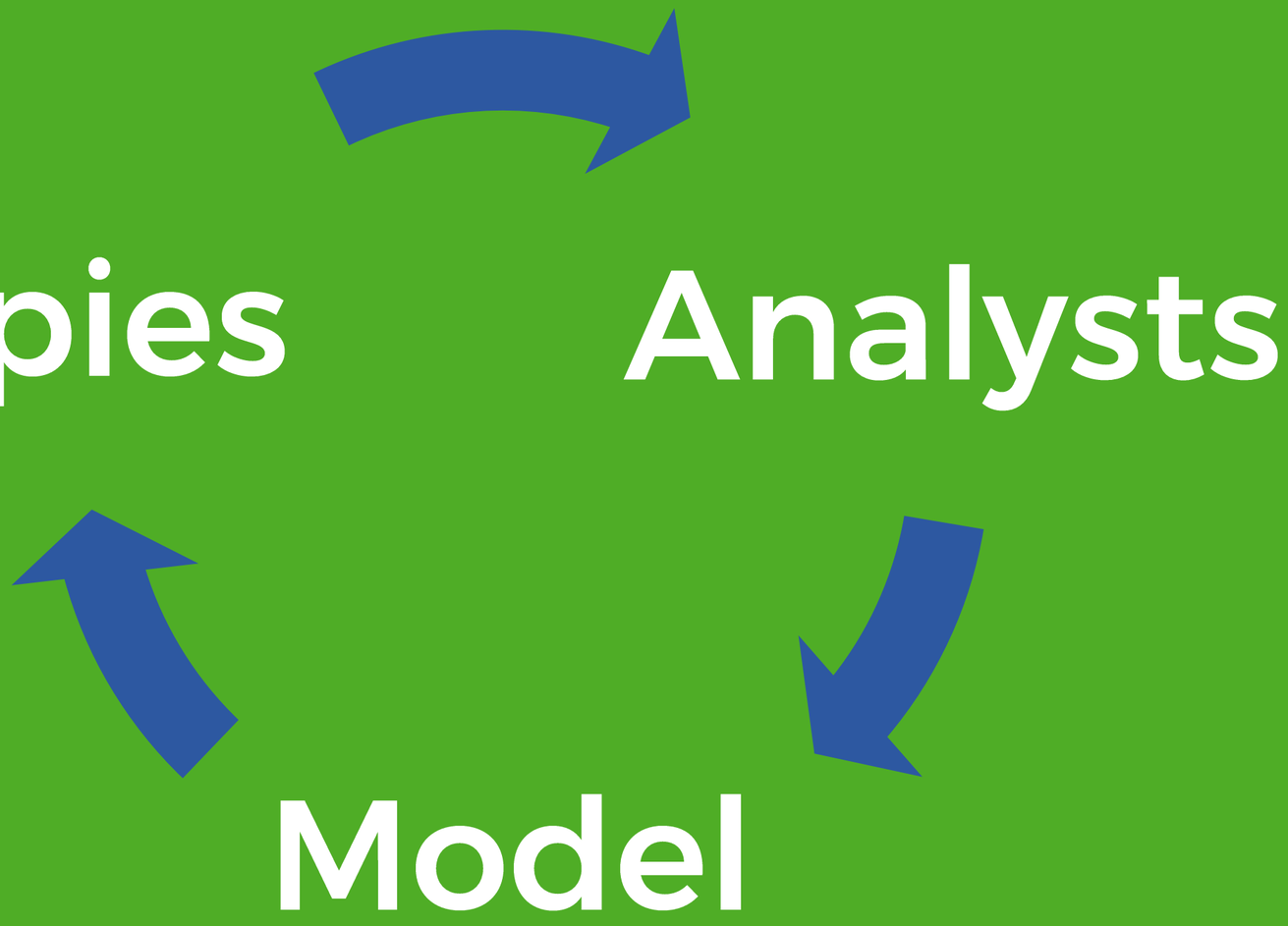
Classic Mix

20 Singles

LAY'S® Classic Potato Chips, DORITOS® Nacho Cheese Flavored Tortilla Chips, DORITOS® COOL RANCH® Flavored Tortilla Chips, CHEETOS® Crunchy Cheese Flavored Snacks, SUNCHIPS® Original Multigrain Snacks, FRITOS® Original Corn Chips (All 1 OZ. Each)

20 INDIVIDUAL BAGS: 1 OZ. EACH, TOTAL NET WT. 20 OZ. (1 LB. 4 OZ.) 567 g

⚠ WARNING: PREVENT ENTANGLEMENT AND STRANGULATION. KEEP THIS BAG AWAY FROM YOUNG CHILDREN. IT IS NOT A TOY.


Spies
Analysts
Model

THINKING TIME

RobertKaplinsky.com

Robert Kaplinsky
@robertkaplinsky

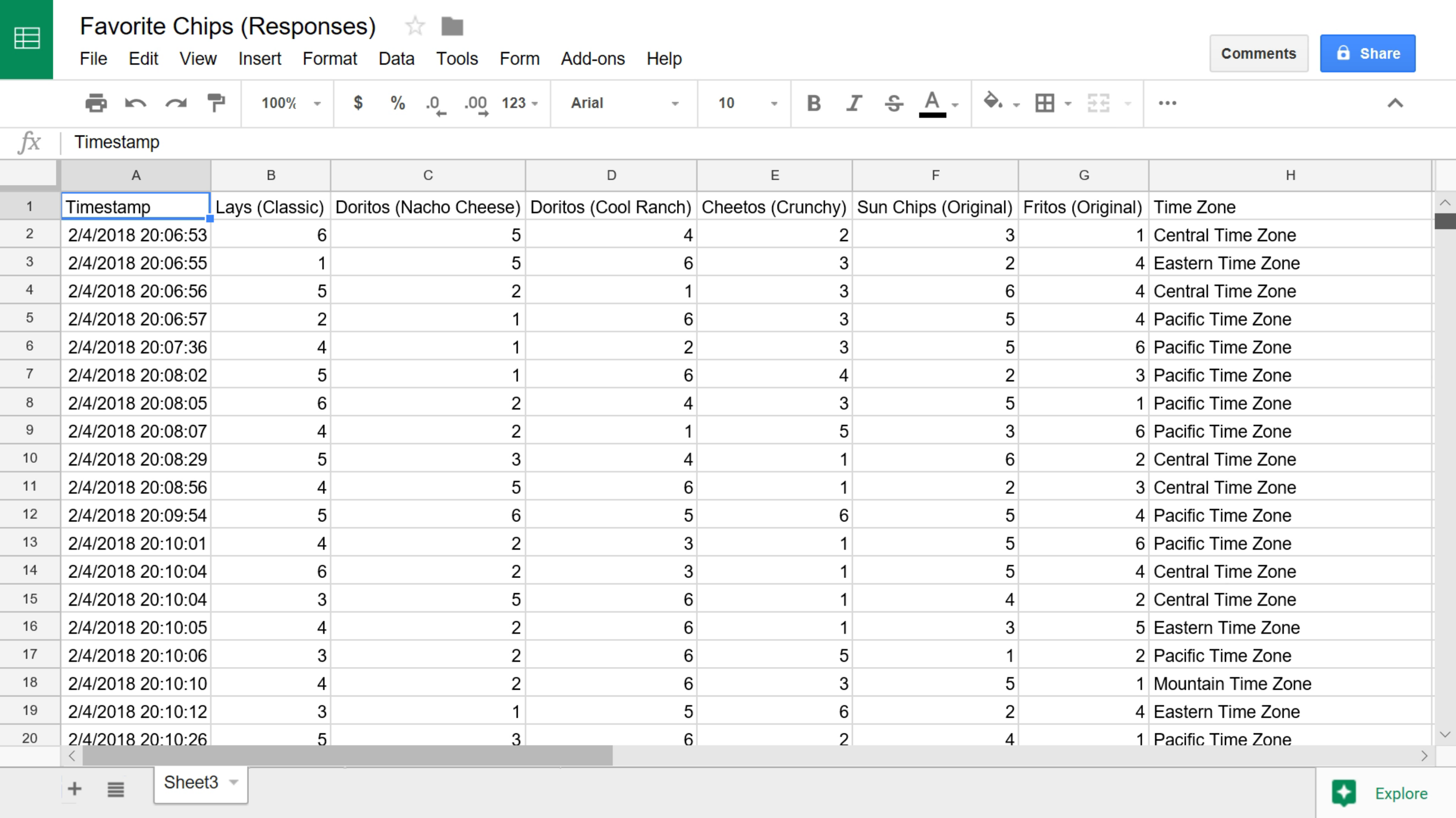
Hey #MTBoS, can you do me a favor and complete this 3 question anonymous survey about your favorite chips? I need data for a presentation. Please RT.
goo.gl/forms/etPtujII… #iteachmath

Favorite Chips
Please complete this anonymous survey. I'll be using this data in a presentation.
docs.google.com

8:05 PM - 4 Feb 2018

63 Retweets **45** Likes

18 63 45



	A	B	C	D	E	F	G	H
1	Timestamp	Lays (Classic)	Doritos (Nacho Cheese)	Doritos (Cool Ranch)	Cheetos (Crunchy)	Sun Chips (Original)	Fritos (Original)	Time Zone
2	2/4/2018 20:06:53	6	5	4	2	3	1	Central Time Zone
3	2/4/2018 20:06:55	1	5	6	3	2	4	Eastern Time Zone
4	2/4/2018 20:06:56	5	2	1	3	6	4	Central Time Zone
5	2/4/2018 20:06:57	2	1	6	3	5	4	Pacific Time Zone
6	2/4/2018 20:07:36	4	1	2	3	5	6	Pacific Time Zone
7	2/4/2018 20:08:02	5	1	6	4	2	3	Pacific Time Zone
8	2/4/2018 20:08:05	6	2	4	3	5	1	Pacific Time Zone
9	2/4/2018 20:08:07	4	2	1	5	3	6	Pacific Time Zone
10	2/4/2018 20:08:29	5	3	4	1	6	2	Central Time Zone
11	2/4/2018 20:08:56	4	5	6	1	2	3	Central Time Zone
12	2/4/2018 20:09:54	5	6	5	6	5	4	Pacific Time Zone
13	2/4/2018 20:10:01	4	2	3	1	5	6	Pacific Time Zone
14	2/4/2018 20:10:04	6	2	3	1	5	4	Central Time Zone
15	2/4/2018 20:10:04	3	5	6	1	4	2	Central Time Zone
16	2/4/2018 20:10:05	4	2	6	1	3	5	Eastern Time Zone
17	2/4/2018 20:10:06	3	2	6	5	1	2	Pacific Time Zone
18	2/4/2018 20:10:10	4	2	6	3	5	1	Mountain Time Zone
19	2/4/2018 20:10:12	3	1	5	6	2	4	Eastern Time Zone
20	2/4/2018 20:10:26	5	3	6	2	4	1	Pacific Time Zone

THINKING TIME

- The available data includes:
  - Lays, Nacho Cheese Doritos, Cool Ranch Doritos, Cheetos, Sun Chips, and Fritos ranked from 1 to 6
  - Geographic region: West, Central, or Eastern

ANALYSTS' JOB FOR THE TOP 1

1. Count all the first place votes for each chip type.
2. Divide the total first place votes for each chip type by the total number of votes.
3. Multiply that fraction by 20 to find how many bags there would be in a twenty pack, rounding as necessary.

Teaching students skills without chances to apply them is like teaching a child to walk and expecting them to safely exit during a fire.

ANALYSTS' EXAMPLE

CHIP BAG RESULTS

20. **Food** Frito-Lay puts a variety of flavors in each package of chips. Survey your classmates and use proportions to figure out how many of each flavor there should be, then fill in the blanks.

Kate Hayes
@MsHayesOG

Follow

We used a @robertkaplinsky video scinario to talk about chip bags. The lesson here was how math applies to the real world, solving word problems, and spies/analysts 😉😎🤓 the best part was reading student reflections of what they learned today ❤️🤗
@oakgrovees @WCPSS @OtterBias

8:32 AM - 14 Feb 2019

2 Retweets **18** Likes

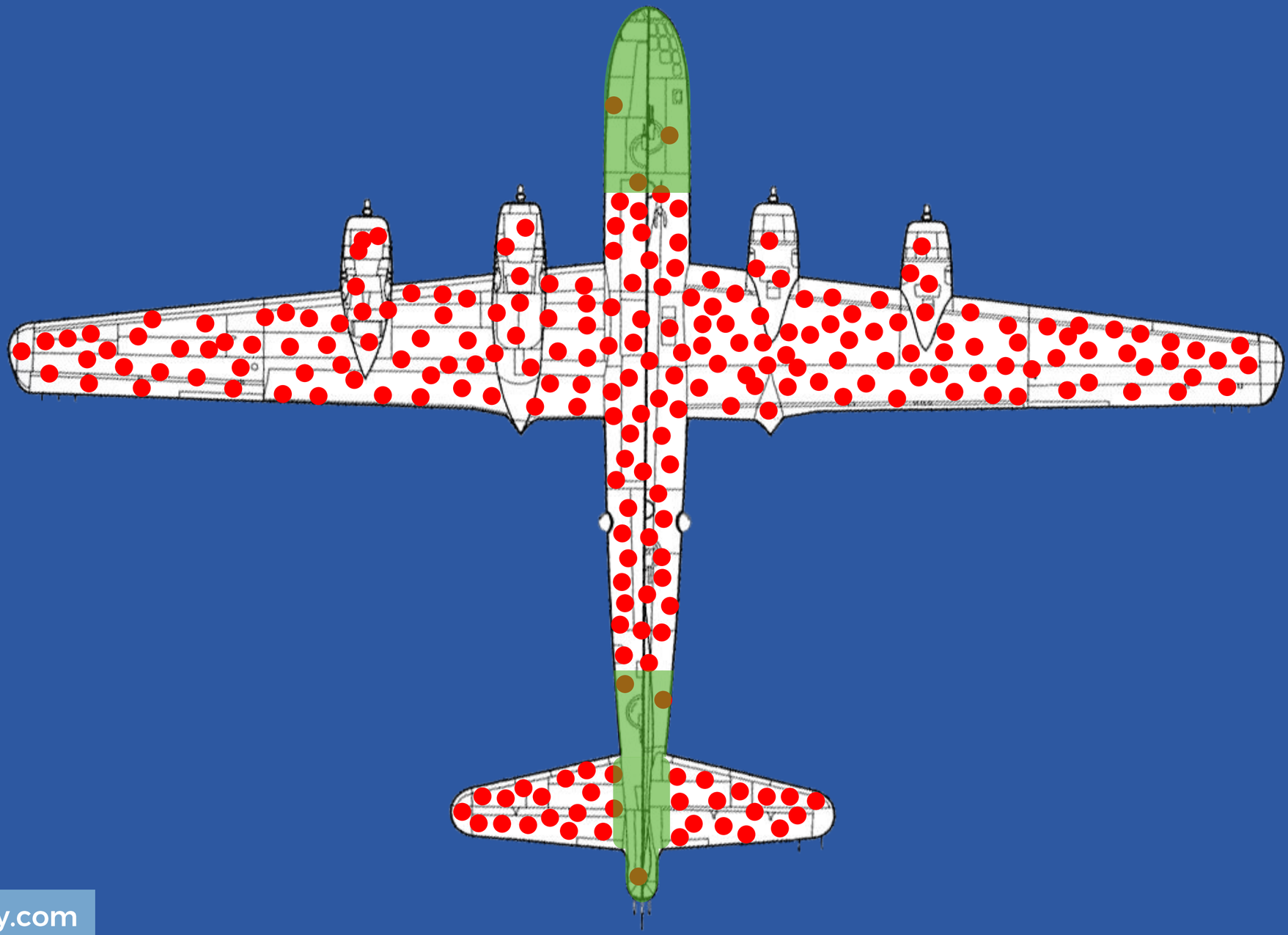
2 2 18

Spies get the info.
Analysts use the info
to create the model.

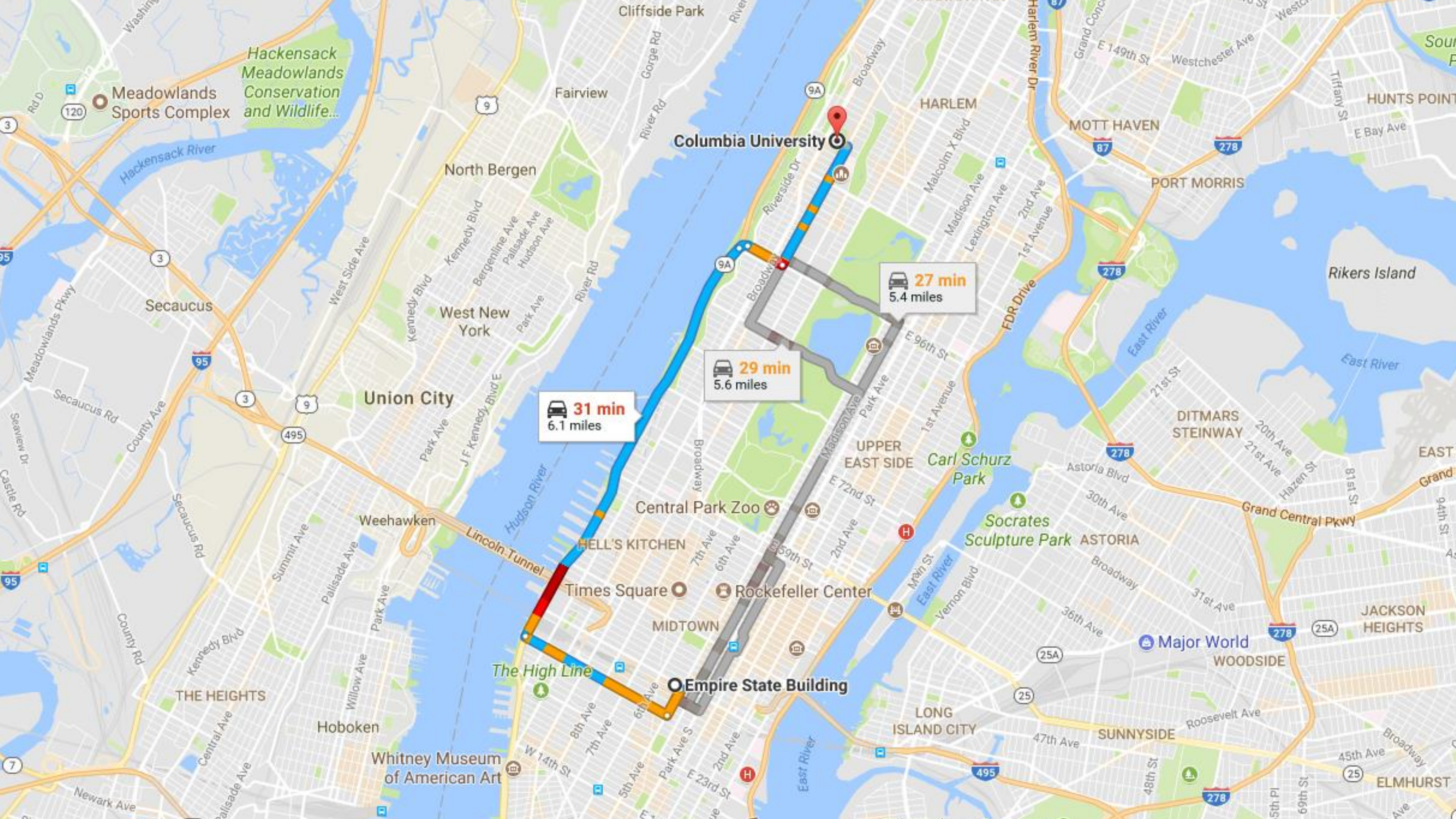
MATH MODELING

- [x] HOW DO WE MAKE SENSE OF MATH MODELING?
- [ ] IS IT JUST ANSWERING QUESTIONS?
- [ ] HOW IS MATH MODELING USED IN REAL LIFE?
- [ ] HOW DO WE HELP OUR STUDENTS IMPROVE?


224612



- ~~How do we protect our planes?~~
- ~~Which parts of the plane are being hit by the most bullets?~~
- Which parts of the plane are the most critical to protect?


Columbia University
Empire State Building
31 min
6.1 miles
29 min
5.6 miles
27 min
5.4 miles
Meadowlands Sports Complex
Hackensack Meadowlands Conservation and Wildlife...
Hackensack River
Cliffside Park
Fairview
North Bergen
Secaucus
West New York
Union City
Weehawken
Lincoln Tunnel
Hudson River
HELL'S KITCHEN
Times Square
Rockefeller Center
MIDTOWN
Central Park Zoo
The High Line
THE HEIGHTS
Hoboken
Whitney Museum of American Art
HARLEM
MOTT HAVEN
HUNTS POINT
PORT MORRIS
Rikers Island
East River
UPPER EAST SIDE
Carl Schurz Park
Socrates Sculpture Park
ASTORIA
DITMARS STEINWAY
JACKSON HEIGHTS
Major World
WOODSIDE
LONG ISLAND CITY
SUNNYSIDE
ELMHURST
Grand Central Pkwy
FDR Drive
Broadway
Riverside Dr
E 96th St
E 72nd St
59th St
W 14th St
E 23rd St

- ~~How do we find the fastest route for each customer?~~
- How do we find the fastest route for each customer without impacting our other customers?

Classic Mix

20 Singles

4 LAY'S® Classic Potato Chips, 4 DORITOS® Nacho Cheese Flavored Tortilla Chips, 2 DORITOS® COOL RANCH® Flavored Tortilla Chips, 4 CHEETOS® Crunchy Cheese Flavored Snacks, 2 SUNCHIPS® Original Multigrain Snacks, 4 FRITOS® Original Corn Chips (All 1 OZ. Each)

20 INDIVIDUAL BAGS: 1 OZ. EACH, TOTAL NET WT. 20 OZ. (1 LB. 4 OZ.) 567 g

⚠ WARNING: PREVENT ENTANGLEMENT AND STRANGULATION. KEEP THIS BAG AWAY FROM YOUNG CHILDREN. IT IS NOT A TOY.

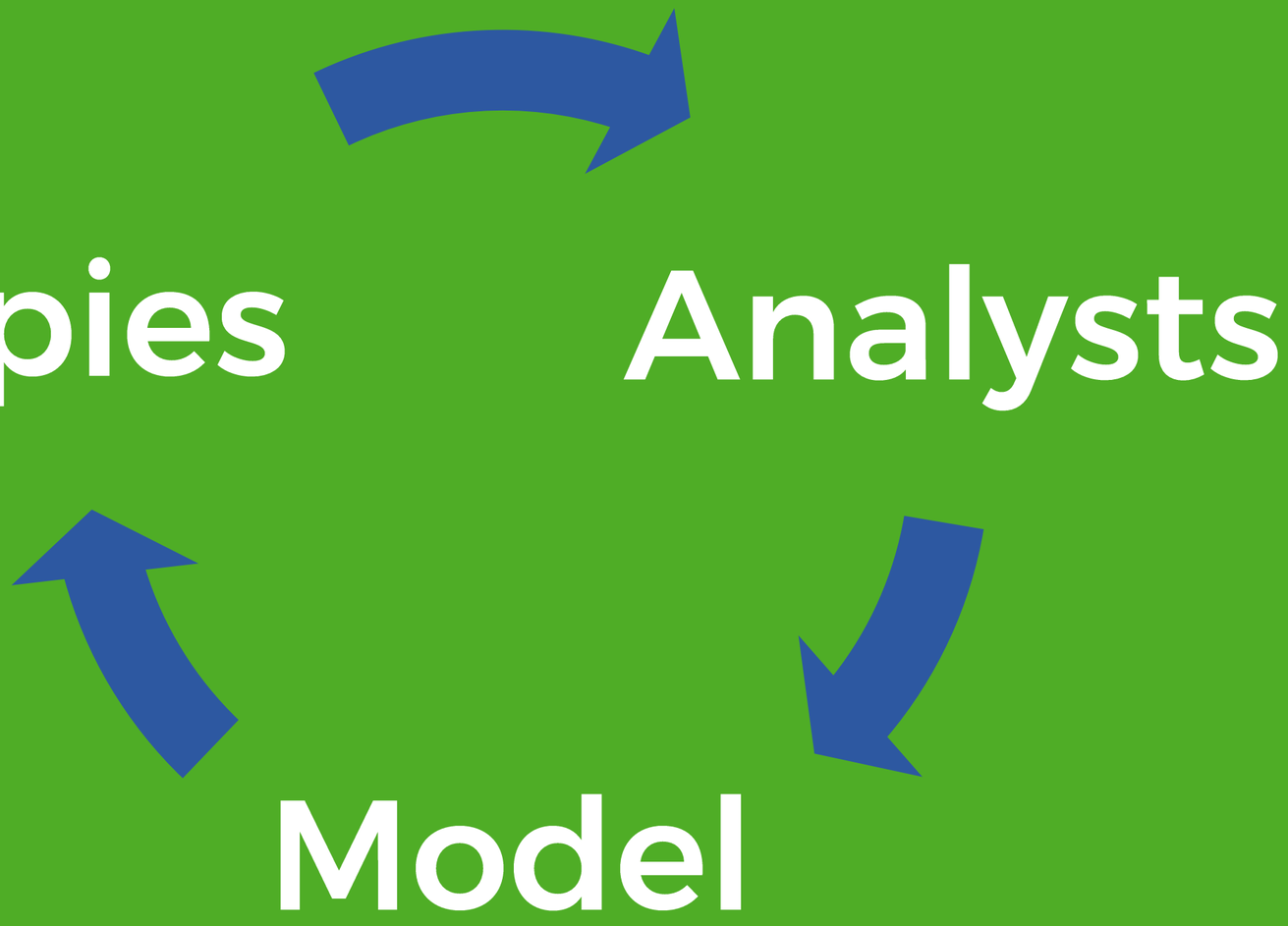
- ~~How many of each flavor should we put in a package?~~
- ~~How many of each flavor should we put in a package for each region?~~
- How can we determine if the extra cost of creating different packages will make us more money?

Mathematical modeling is not just about answering a question. It's also about determining if you're asking the right question.

MATH MODELING

- [x] HOW DO WE MAKE SENSE OF MATH MODELING?
- [x] IS IT JUST ANSWERING QUESTIONS?
- [ ] HOW IS MATH MODELING USED IN REAL LIFE?
- [ ] HOW DO WE HELP OUR STUDENTS IMPROVE?


TARGET
TARGET PARKING

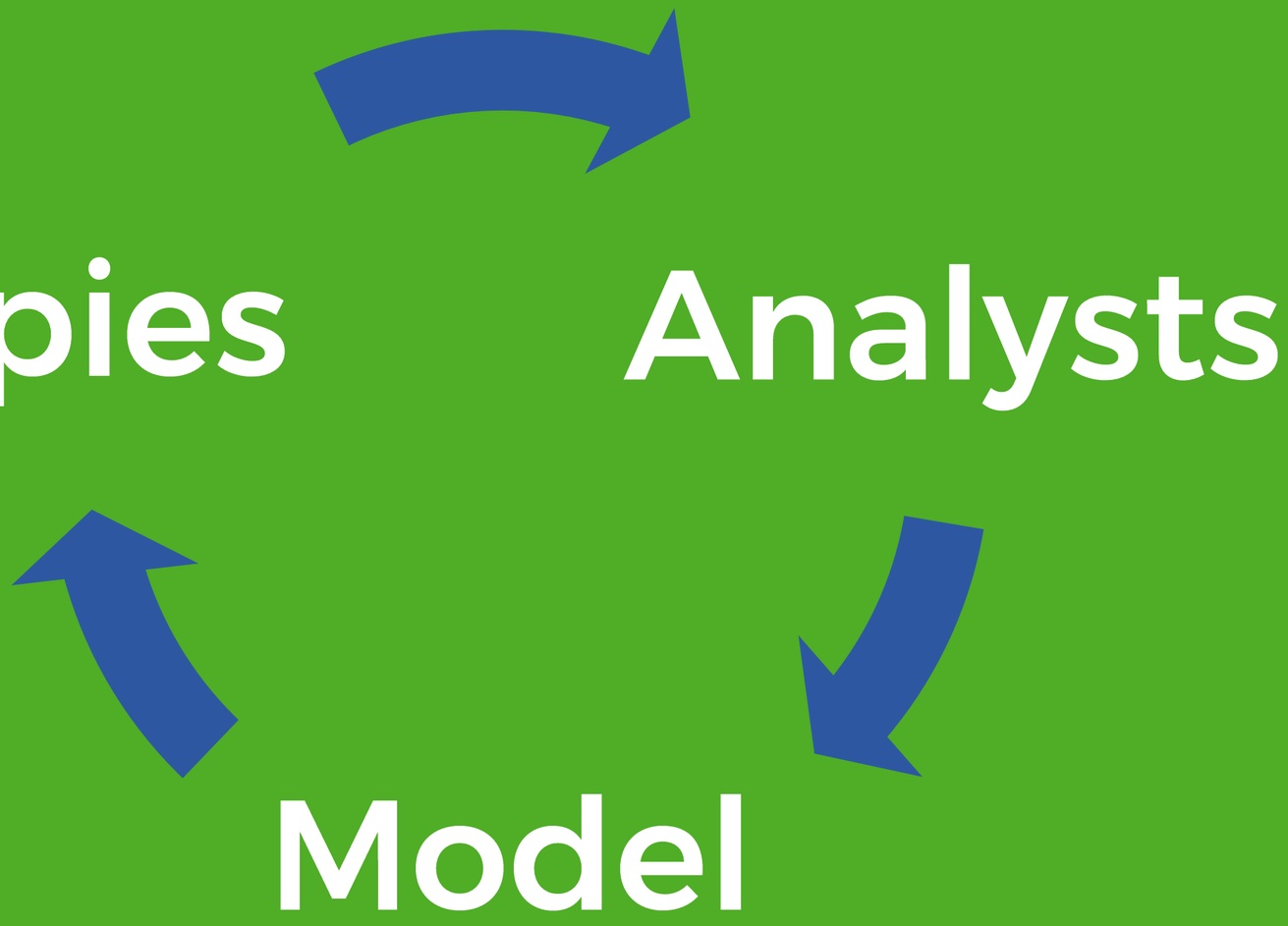

Spies
Analysts
Model

They used 25 products for a pregnancy prediction' score including:

- unscented lotion
- mineral supplements
- cotton balls

Source: New York Times


UNITED


Spies
Analysts
Model

Priority is determined by:

- passenger's fare class
- itinerary
- frequent flyer program membership
- check-in time

Source: United Airlines

Search

Robert | Home

Robert Kaplinsky

- News Feed
- Messenger
- Watch
- Marketplace

Explore

- Pages
- Events
- Groups
- Friend Lists
- On This Day 3
- Insights
- Games 7
- Fundraisers
- Live Video
- Pokes
- See More...

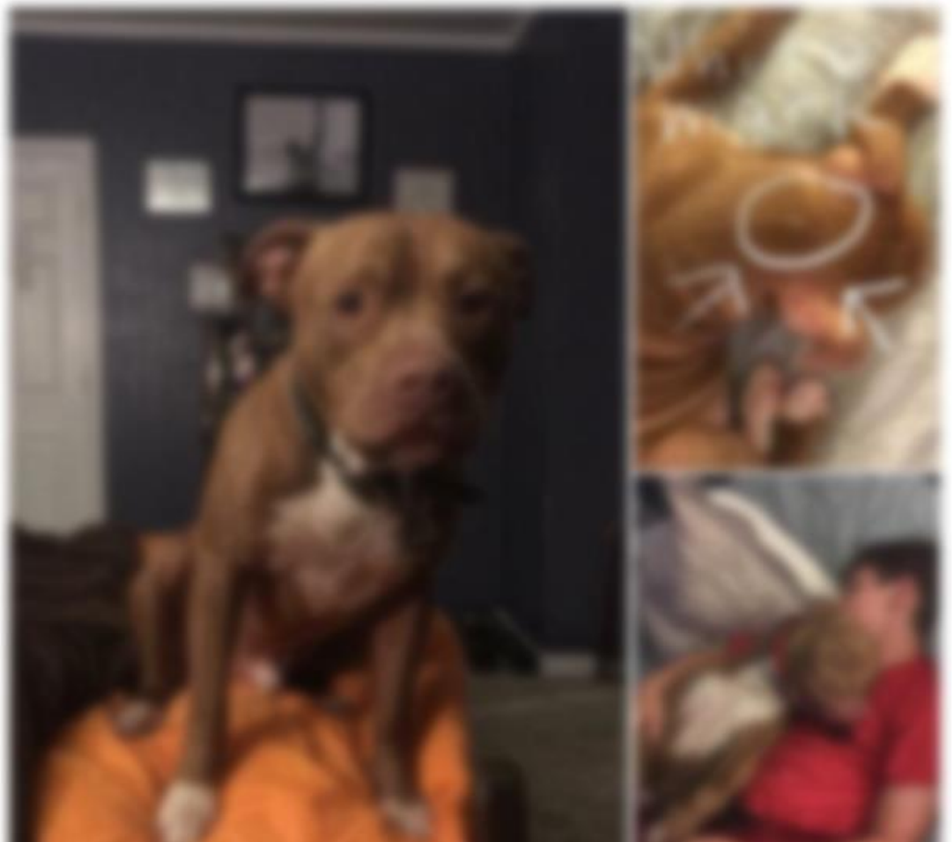
Create

Ad · Page · Group · Event · Fundraiser

Make Post | Photo/Video Album | Live Video

What's on your mind, Robert?

Photo/Video | Feeling/Activity | ...

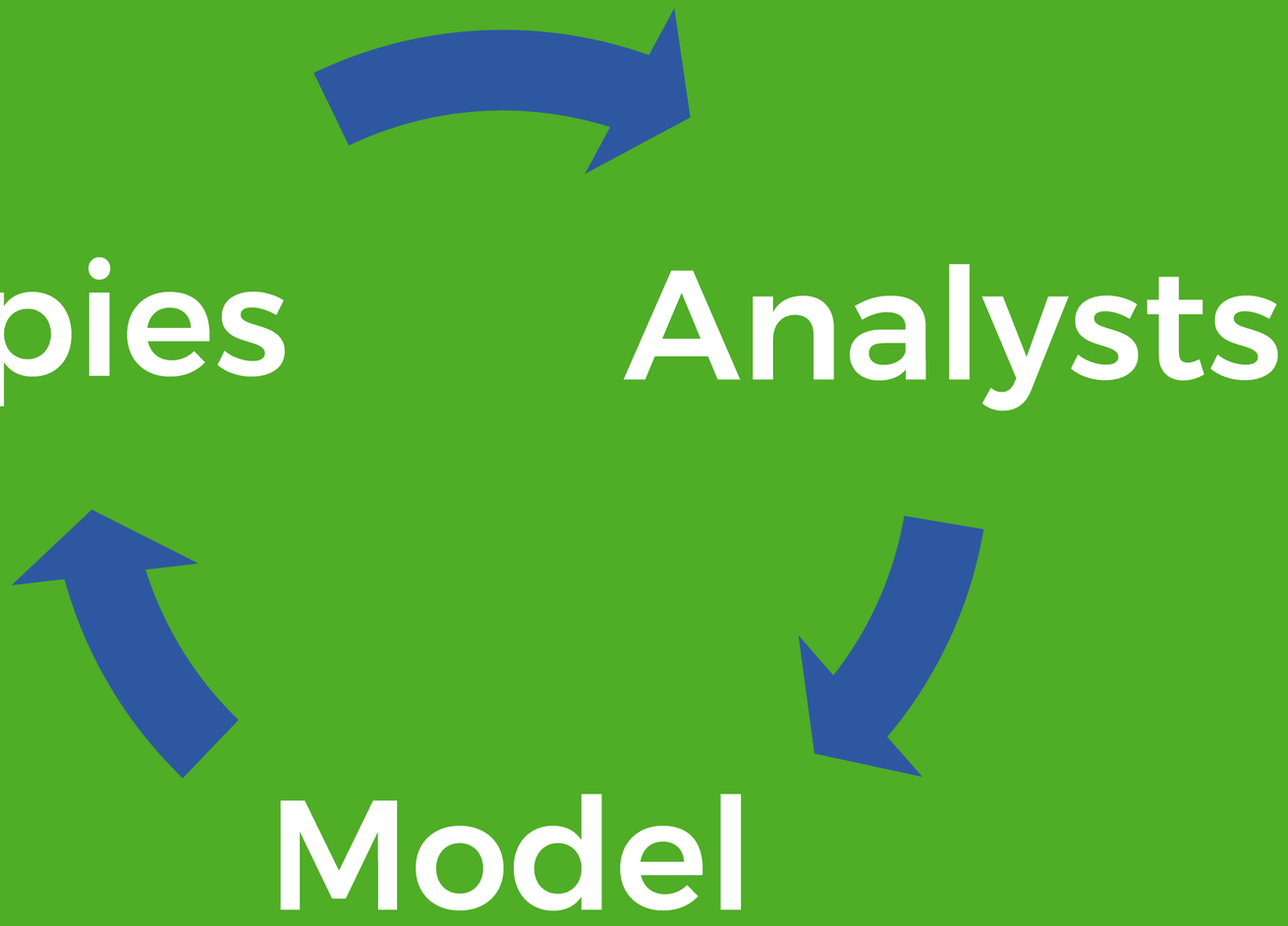


Trending

Watchlist: Latest Episodes

See All

Sponsored Create Ad


Spies
Analysts
Model

The stories that show in your News Feed are influenced by:

- friends you interact with the most
- the number of comments and likes a post receives
- what kind of story it is (ex: photo, video, status update)

Source: Facebook

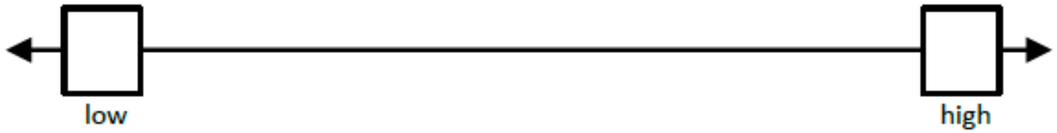
MORE EXAMPLES

- How does US News and World Reports rank colleges?
- How does Google know which results to show?
- How do sports teams know who to draft?
- How does Amazon know what products to recommend?
- How does Zillow estimate home prices?
- How does eHarmony know which people to show you?
- How does a school decide which students should take advanced math classes?
- How do they figure out who should speak at a conference?

MATH MODELING

- [x] HOW DO WE MAKE SENSE OF MATH MODELING?
- [x] IS IT JUST ANSWERING QUESTIONS?
- [x] HOW IS MATH MODELING USED IN REAL LIFE?
- [ ] HOW DO WE HELP OUR STUDENTS IMPROVE?

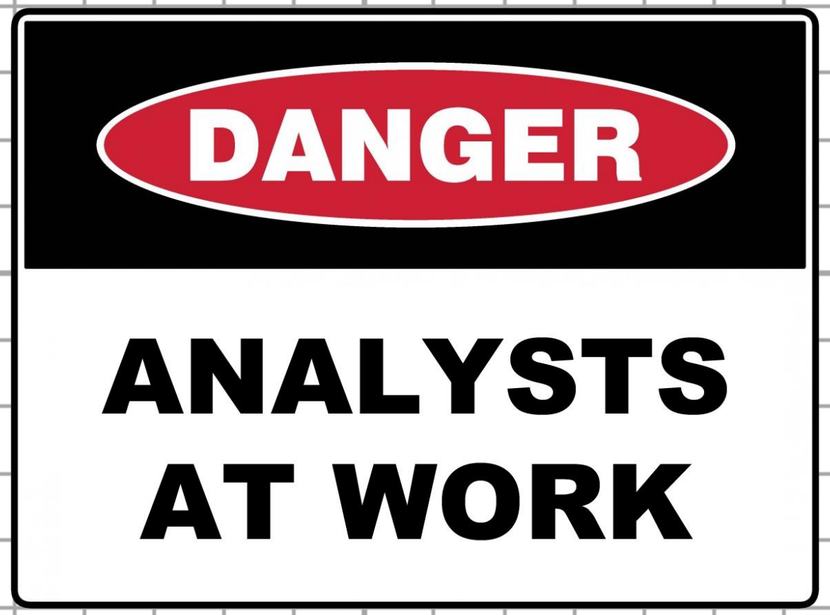
Name: _____ Period: _____ Date: _____

What problem are you trying to figure out?	What estimates do you have?
	 Place your estimate on the number line.
What info do you already know about the problem?	**What info do you need about the problem?**

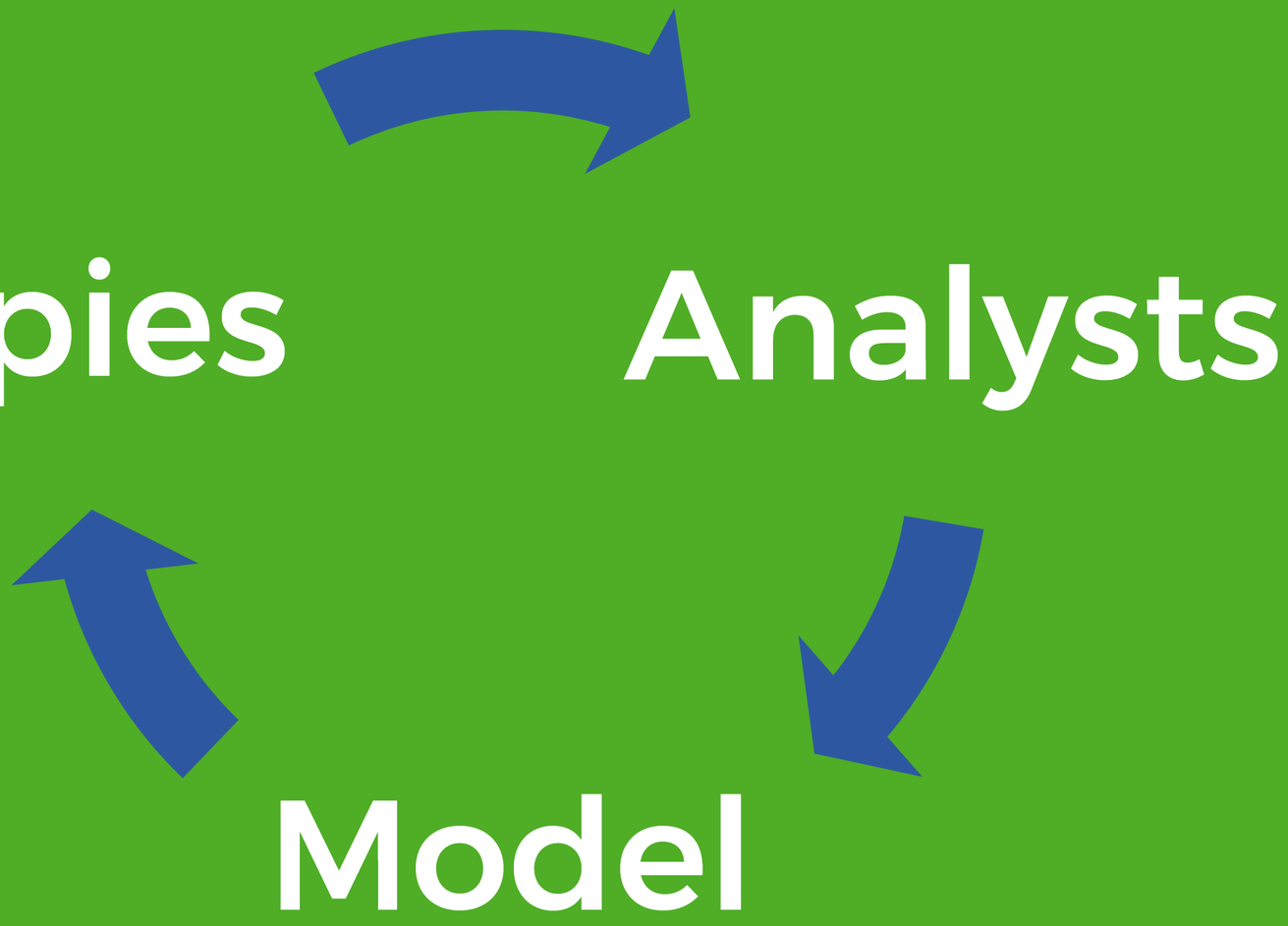
TOP SECRET! SPIES ONLY

What is your conclusion? How did you reach that conclusion?

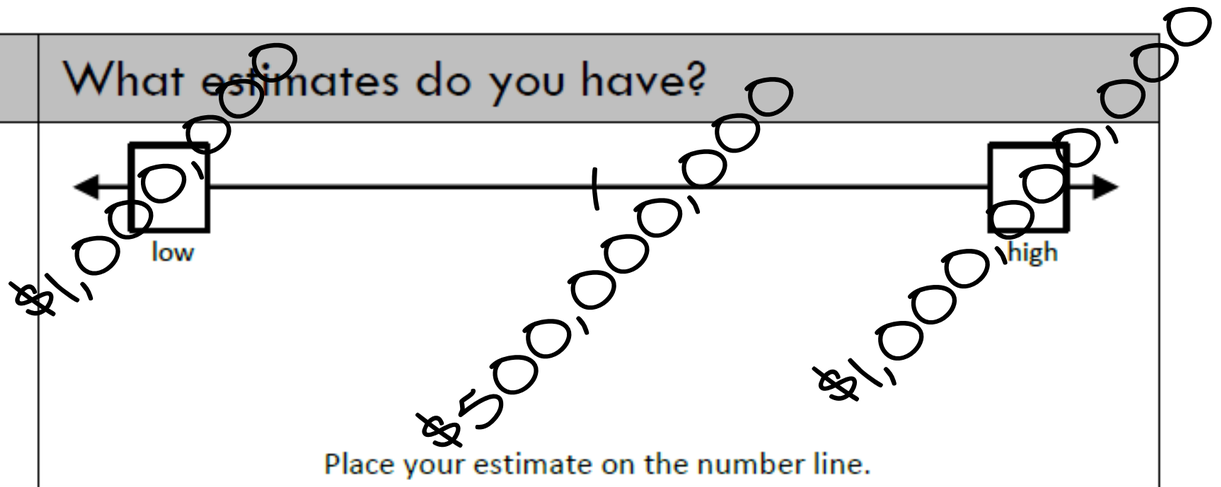
Your work



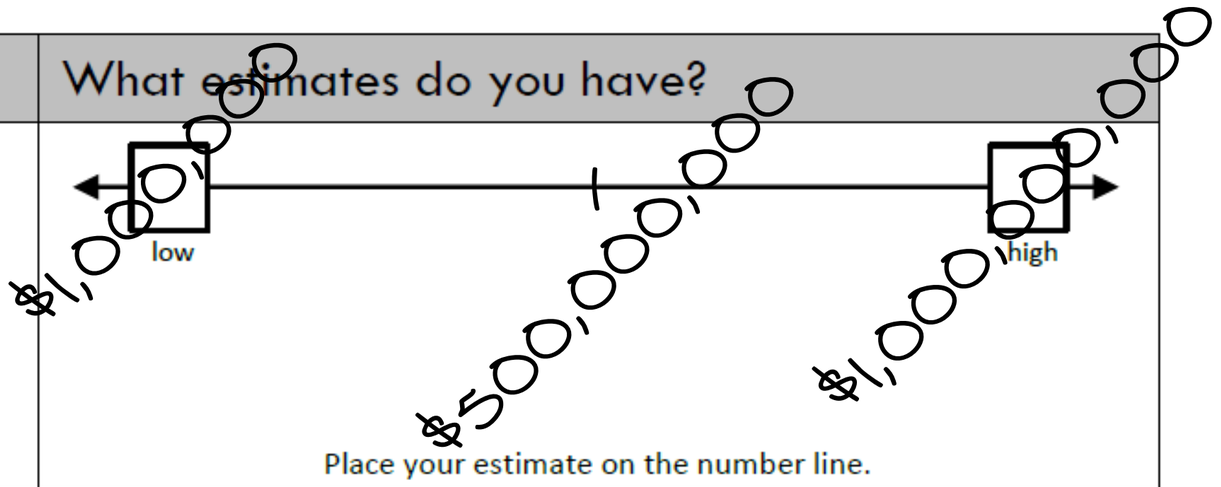
Source: robertkaplinsky.com/lessons


Spies
Analysts
Model

Name: _____ Period: _____ Date: _____

What problem are you trying to figure out?	What estimates do you have?
How much money was that?	 Place your estimate on the number line.
What info do you already know about the problem?	**What info do you need about the problem?**
• There is a lot of money. • It is in a pile. • It is in bundles.	• Is it all the same denomination? • ~~How much does one bill weigh?~~ • ~~How much does all the money weigh?~~
What is your conclusion? How did you reach that conclusion?	

Name: _____ Period: _____ Date: _____

What problem are you trying to figure out?	What estimates do you have?
How much money was that?	 Place your estimate on the number line.
What info do you already know about the problem?	**What info do you need about the problem?**
• There is a lot of money. • It is in a pile. • It is in bundles.	• Is it all the same denomination? • How many rows and columns are there? • How many bills are in one stack?
What is your conclusion? How did you reach that conclusion?	


PGR
SIEDO

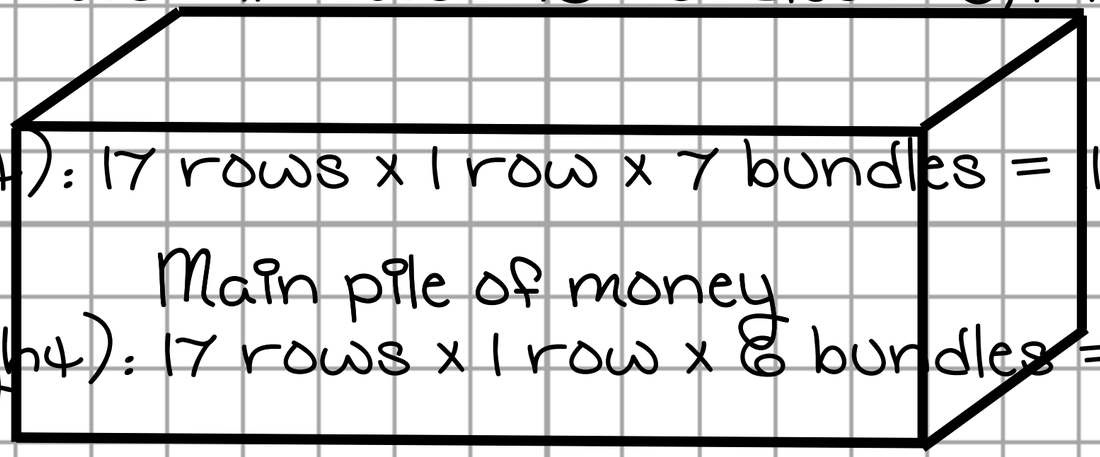

PGR
SIEDO
PGR
SIEDO

Your work

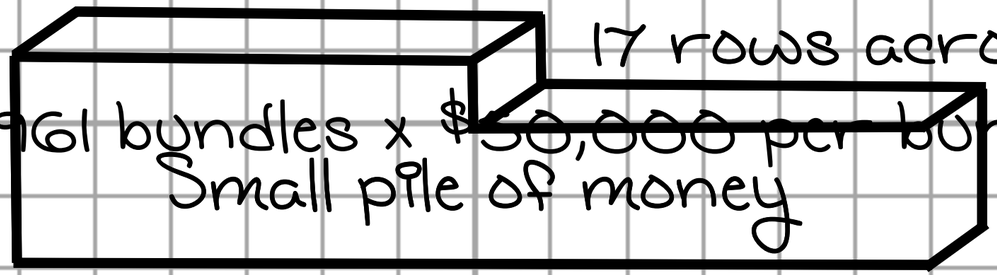
Main pile: 34 rows x 11 rows across x 10 bundles = 3,740 bundles

Small pile (left): 17 rows x 1 row x 7 bundles = 119 bundles

Small pile (right): 17 rows x 1 row x 8 bundles = 136 bundles



Total bundles: 3,740 + 119 + 136 = 3,961 bundles



Total money: 3,961 bundles x $50,000 per bundle = $198,050,000

Source: robertkaplinsky.com/lessons

Holly Keeton
@holly_keeton

Follow

@WGBulldogs 5th graders were VERY ENGAGED yesterday with @robertkaplinsky 's math lesson "How Much Money Is That?!". Students worked with money, adding & multiplying numbers, and solving for volume to estimate the cash! 💵 $
#AllMeansAllMCSS #mathisfun #mathisreal

2:49 PM - 6 Mar 2019

3 Retweets **15** Likes

3 15

MATH MODELING

- ☑ HOW DO WE MAKE SENSE OF MATH MODELING?
- ☑ IS IT JUST ANSWERING QUESTIONS?
- ☑ HOW IS MATH MODELING USED IN REAL LIFE?
- ☑ HOW DO WE HELP OUR STUDENTS IMPROVE?

DISCUSSION TIME

- Why should we reconsider using word problems?
- How is math modeling different from traditional word problems?

GOALS

- ☑ CORRECT ANSWERS = UNDERSTANDING?
- ☑ RECONSIDER USING WORD PROBLEMS
- ☐ RECONSIDER USING WORKSHEETS

WORKSHEETS

- ❑ WHAT'S WRONG WITH WORKSHEETS?
- ❑ WHAT SHOULD WE BE DOING INSTEAD?
- ❑ HOW DO WE DO IT IN OUR CLASSROOMS?
- ❑ WHERE DO WE GET MORE PROBLEMS?
- ❑ WHAT COMES NEXT?

Algebra 1

Name_____

One-Step Equations

Date_____ Period____

Solve each equation.

1) $26 = 8 + v$

2) $3 + p = 8$

3) $15 + b = 23$

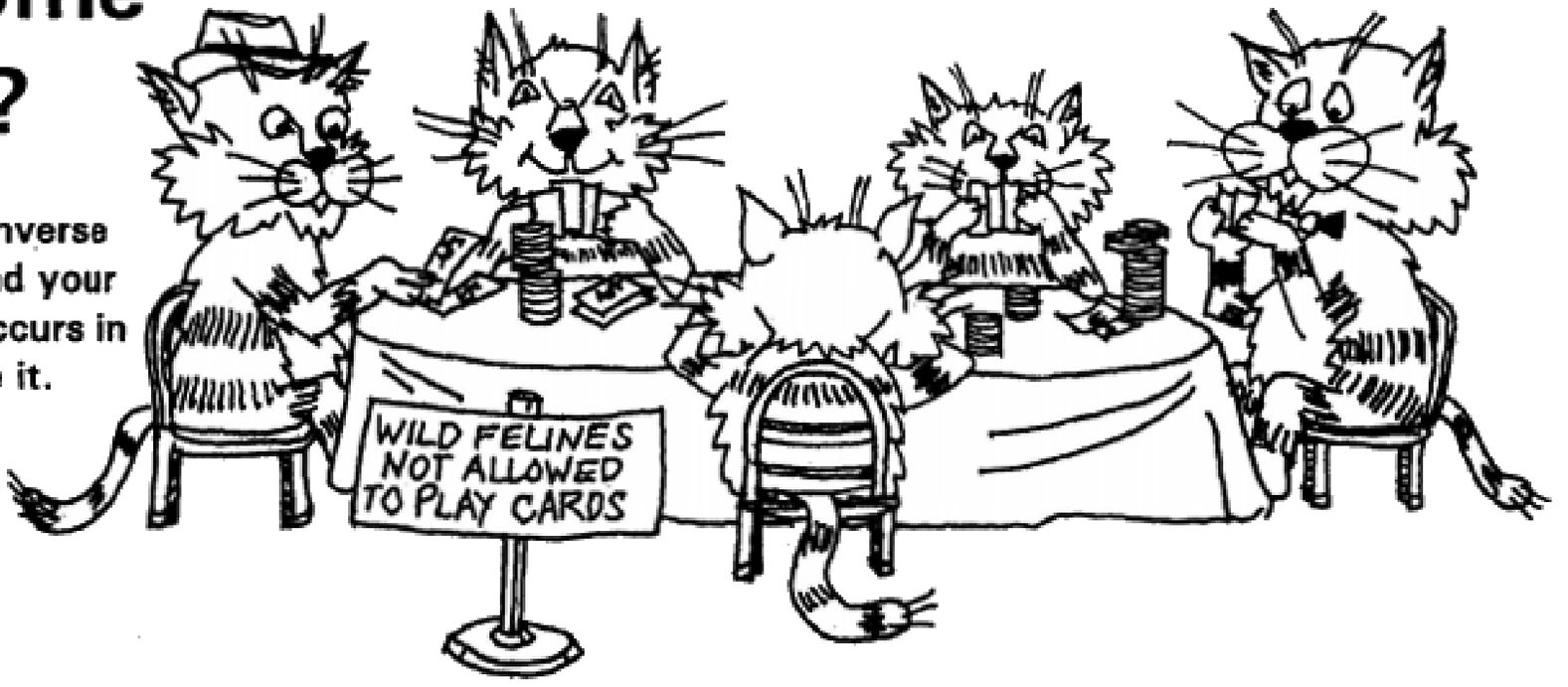
4) $-15 + n = -9$

5) $m + 4 = -12$

6) $x - 7 = 13$

NAME_____

Why shouldn't some cats play cards?



DIRECTIONS: Solve each equation by using the inverse operation. Use a calculator where necessary. Find your answer in the decoder. Each time your answer occurs in the decoder, write the letter of the problem above it.

1. $3 + g = 13$ (g= _____)

2. $34 = a \cdot 2$ (a = _____)

3. $\frac{h}{15} = 10$ (h = _____)

4. $15 = d - 18$ (d = _____)

5. $132 = m \times 11$ (m = _____)

6. $15o = 210$ (o = _____)

7. $\frac{i}{2.3} = 6.7$ (i = _____)

8. $2.5e = 40$ (e = _____)

9. $180 = t - 35$ (t = _____)

10. $90 = 3l$ (l= _____)

11. $7.2 = 0.36n$ (n = _____)

12. $\frac{b}{5} = 31$ (b= _____)

13. $4c = 60$ (c= _____)

WORKSHEET CONCERNS

- OFTEN FEELS LIKE BUSY WORK
- DON’T REALLY BUILD SENSE MAKING
- RARELY LEAD TO GREAT CONVERSATIONS
- DON’T GIVE US RICH INFORMATION

WORKSHEET CONCERNS

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WORKSHEETS

- ☑ WHAT'S WRONG WITH WORKSHEETS?
- ❑ WHAT SHOULD WE BE DOING INSTEAD?
- ❑ HOW DO WE DO IT IN OUR CLASSROOMS?
- ❑ WHERE DO WE GET MORE PROBLEMS?
- ❑ WHAT COMES NEXT?

PROBLEM ONE

Solve for *x*.

$$21 + x = 70$$

PROBLEM TWO

Using the digits 1 to 9 at most one time each, fill in the boxes to create two equations: one where *x* has a positive value and one where *x* has a negative value. You may reuse digits for each equation.

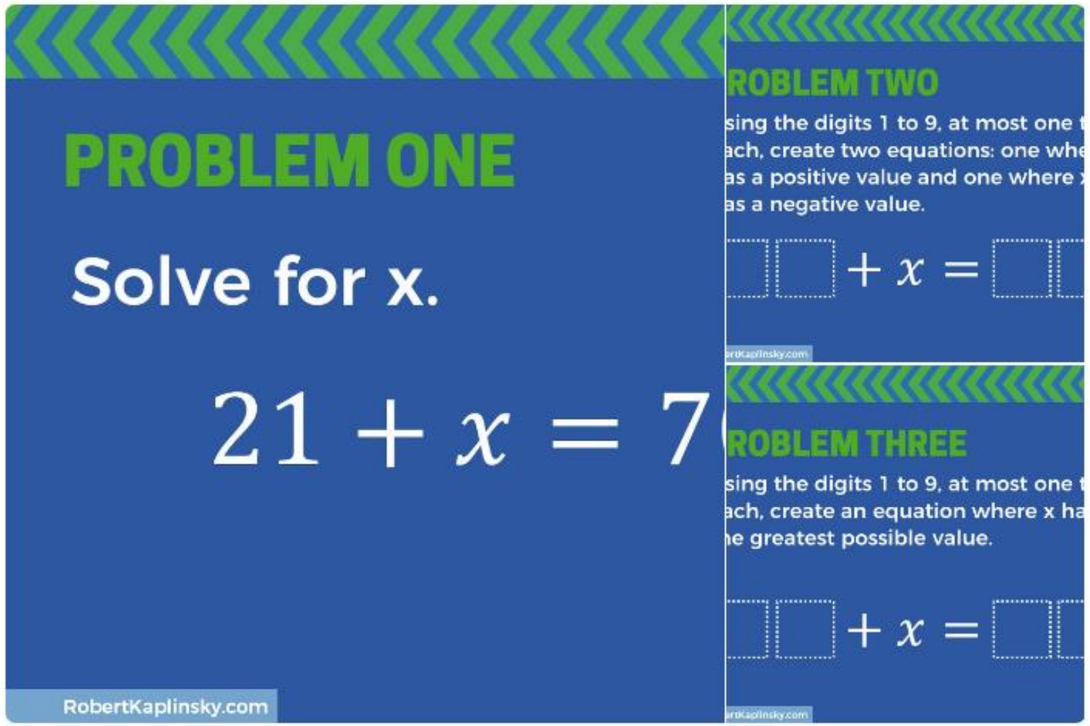
PROBLEM THREE

Using the digits 1 to 9 at most one time each, fill in the boxes to create an equation where x has the greatest possible value.

$$\square\square + x = \square\square$$

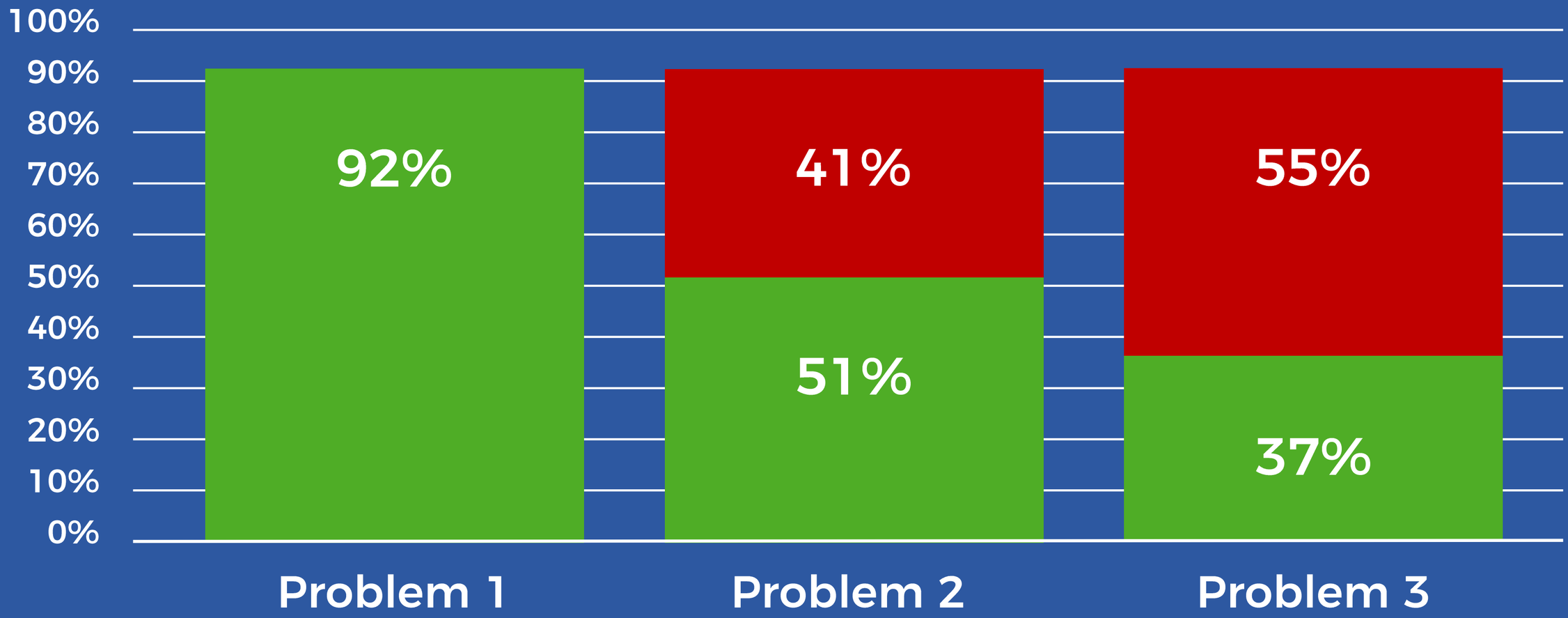
Robert Kaplinsky
@robertkaplinsky

MS & HS #MTBoS Ts, please ask your Ss these 3 ?s and put the % who answered correctly here: docs.google.com/forms/d/e/1FAI …. Answers at top of form.



RETWEETS 36 LIKES 54

PROBLEM RESULTS



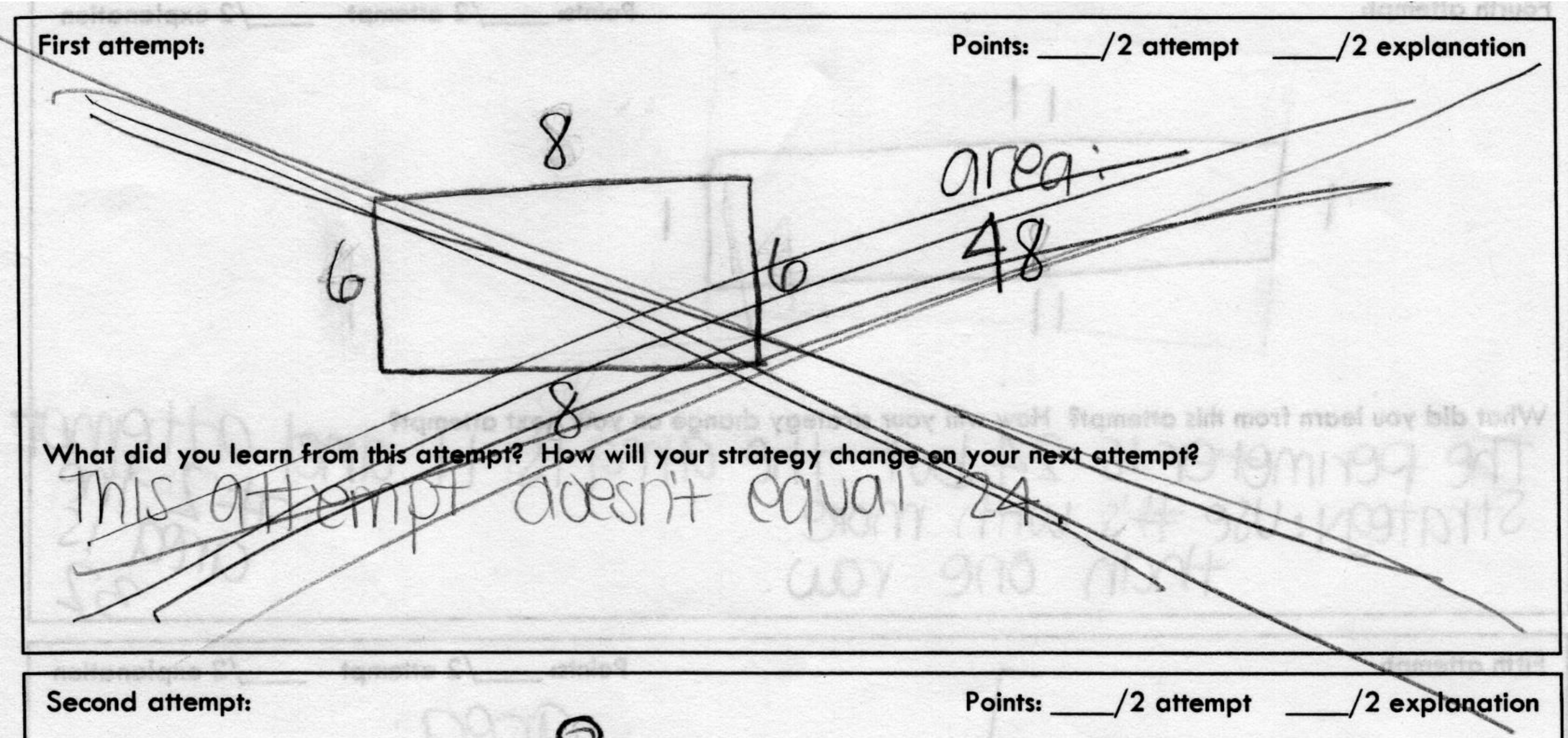
What is the perimeter of a rectangle that measures 8 units by 4 units?

List the dimensions of a rectangle with a perimeter of 24 units.

What is the greatest area you can make from a rectangle with a perimeter of 24 units?

First attempt:

Points: ____/2 attempt ____/2 explanation



What did you learn from this attempt? How will your strategy change on your next attempt?

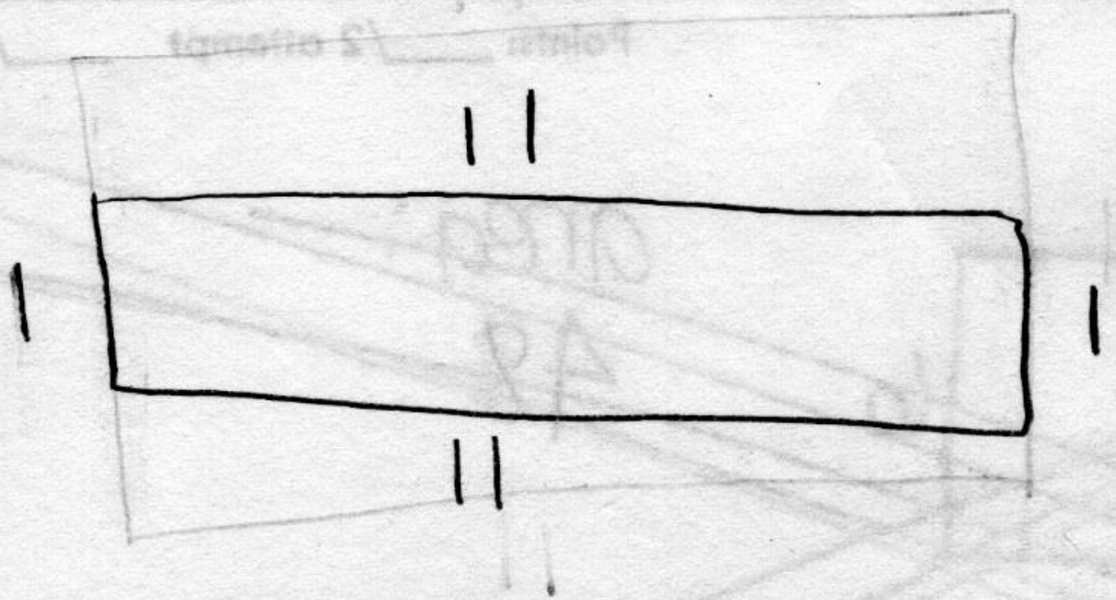
This attempt doesn't equal 24.

Second attempt:

Points: ____/2 attempt ____/2 explanation

Fourth attempt:

Points: ____/2 attempt ____/2 explanation



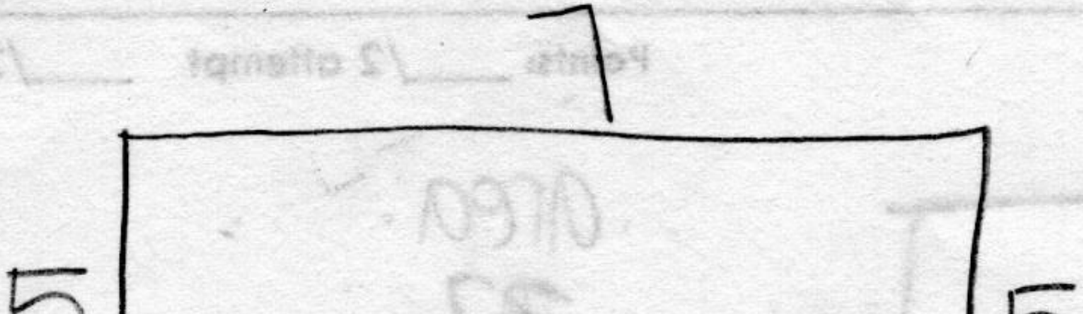
What did you learn from this attempt? How will your strategy change on your next attempt?

The perimeter is 24, but the area is 11 and attempt #2 the area is 32

Strategy: Use #'s with more than one raw.

Fifth attempt:

Points: ____/2 attempt ____/2 explanation



area:

35

11 units

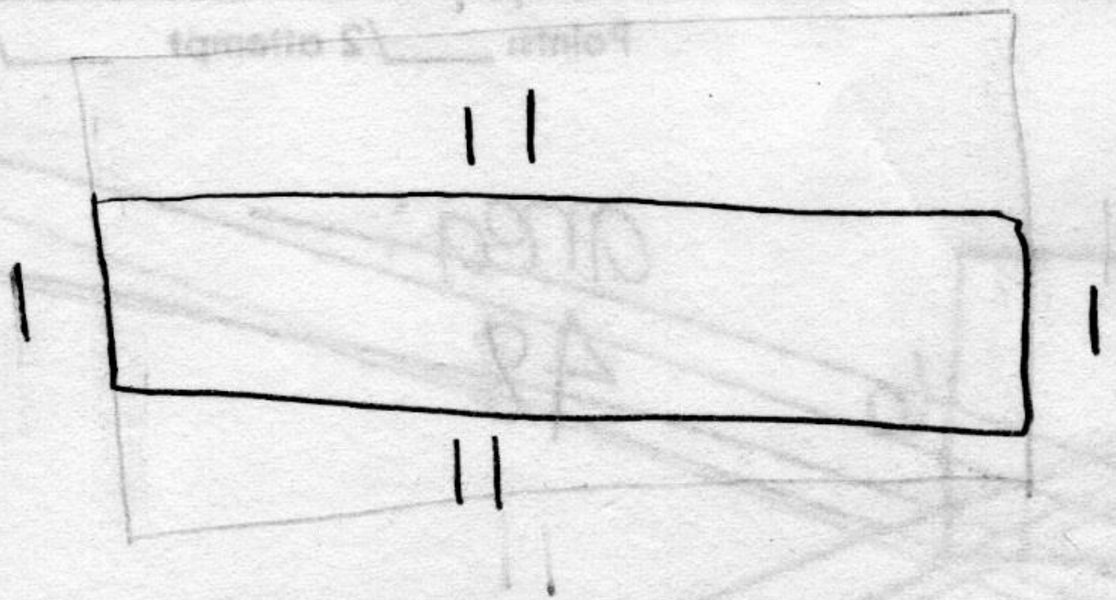
1 unit

10 units

2 units

Fourth attempt:

Points: ____/2 attempt ____/2 explanation



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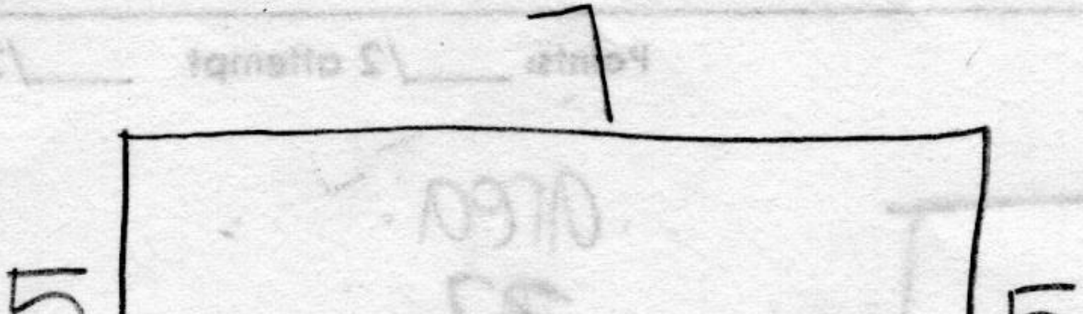
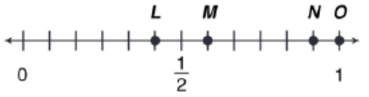
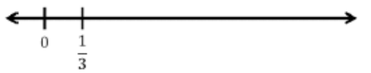


area:

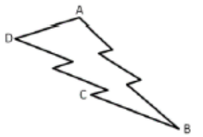
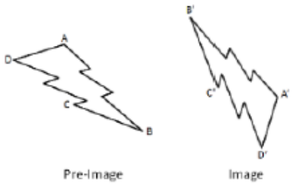
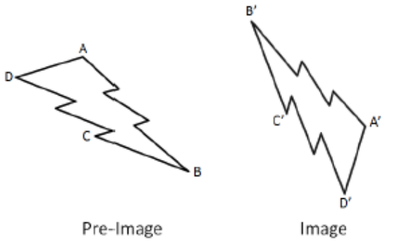
35

Depth of Knowledge Matrix - Elementary & Secondary Math

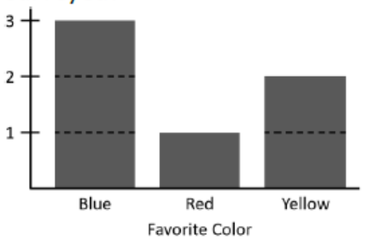
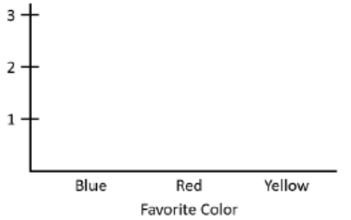
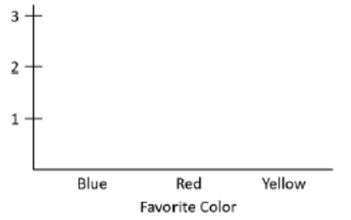
Topic	Adding Whole Numbers	Money	Fractions on a Number Line	Area and Perimeter	Subtracting Mixed Numbers
CCSS Standard(s)	• 1.NBT.4 • 2.NBT.5	• 2.MD.8	• 3.NF.2	• 3.MD.8 • 4.MD.3	• 5.NF.1
DOK 1 Example	Find the sum. $44 + 27 =$	If you have 2 dimes and 3 pennies, how many cents do you have?	Which point is located at $\frac{7}{12}$ below? 	Find the perimeter of a rectangle that measures 4 units by 8 units.	Find the difference. $5\frac{1}{2} - 4\frac{2}{3} =$
DOK 2 Example	Using the digits 1 to 9 at most one time each, fill in the boxes so that you make a true equation. $\square\square + 53 = \square\square$	Make 47¢ in three different ways with either quarters, dimes, nickels, or pennies.	Label the point where $\frac{3}{4}$ belongs on the number line below. Be as precise as possible. 	List the measurements of three different rectangles that each has a perimeter of 20 units.	Using the digits 1 to 9 at most one time each, fill in the boxes to create three different mixed numbers that will make the equation true. You may reuse the same digits for each of the three mixed numbers. $5\frac{4}{5} - \square\frac{\square}{\square} = 3\frac{1}{20}$
DOK 3 Example	Using the digits 1 to 9 at most one time each, fill in the boxes to make the largest sum. $\square\square + \square\square =$	Make 47¢ using exactly 6 coins with either quarters, dimes, nickels, or pennies.	Using the digits 0 to 9 at most one time each, create five fractions with a digit for each numerator and denominator and place them all on a number line.	What is the greatest area you can make with a rectangle that has a perimeter of 24 units?	Using the digits 1 to 9 at most one time each, fill in the boxes to make the smallest difference. $\square\frac{\square}{\square} - \square\frac{\square}{\square}$

Version 1.18

Depth of Knowledge Matrix - Elementary & Secondary Math

Topic	Surface Area and Volume	Probability	Transformations	Factoring Quadratics	Quadratics in Vertex Form
CCSS Standard(s)	• 6.G.4 • 7.G.6	• 7.SP.5 • 7.SP.7	• 8.G.1 • G-CO.5	• A-SSE.3a	• F-IF.7a
DOK 1 Example	Find the surface area of a rectangular prism that measures 3 units by 4 units by 5 units.	What is the probability of rolling a sum of 5 using two 6-sided dice?	Rotate the image below 90° counterclockwise about point D and reflect it across a horizontal line. 	Find the factors: $2x^2 + 7x + 3$	Find the roots and maximum of the quadratic equation below. $y = -3(x-4)^2 - 3$
DOK 2 Example	List the measurements of three different rectangular prisms that each have a surface area of 20 square units.	What value(s) have a 1/12 probability of being rolled as the sum of two 6-sided dice?	List three sequences of transformations that take pre-image ABCD to image A'B'C'D'. 	Find three different integers to put in the blank that will make the quadratic expression factorable. $x^2 + \_\_x + 4$	Create three equations for quadratics in vertex form that have roots at 3 and 5 but have different maximum and/or minimum values.
DOK 3 Example	What is the greatest volume you can make with a rectangular prism that has a surface area of 20 square units?	Using the digits 1 to 9 at most one time each, fill in the blanks to make this sentence true. Rolling a sum of ___ on two ___-sided dice is the same probability as rolling a sum of ___ on two ___-sided dice.	What is the fewest number of transformations needed to take pre-image ABCD to image A'B'C'D'? 	Fill the blank by finding the largest and smallest integers that will make the quadratic expression factorable. $2x^2 + 3x + \_\_$	Using the digits 1 to 9 at most one time each, fill in the boxes to create a quadratic equation with the largest maximum value. $y = -\square(x-\square)^2 + \square$

Depth of Knowledge Matrix - Elementary Math

Topic	Adding 1-Digit Numbers (< 5)	Equality	Interpreting Data	Money
CCSS Stand.	• K.OA.5	• 1.OA.7	• 1.MD.4	• 2.MD.8
DOK 1 Example	Solve. $3 + 1 =$	Determine whether the number sentence is true or false. $4 + 1 = 5 - 2$	How many people were surveyed? 	If you have 1 quarter, 4 dimes, 2 nickels, and 3 pennies, how many cents do you have?
DOK 2 Example	Using the digits 1 to 5 at most one time each, fill in the boxes to create two true number sentences. $\square + \square = \square$	Using the digits 1 to 9 at most one time each, fill in the boxes to create two true number sentences. $\square + \square = \square - \square$	Make a graph that shows a possible result of 7 students' favorite color. 	Make 72¢ in two different ways with either quarters, dimes, nickels, or pennies.
DOK 3 Example	Using the digits 1 to 5 at most one time each, fill in the boxes to create a true number sentences with the greatest possible sum. $\square + \square = \square$	Using the digits 1 to 9 at most one time each, fill in the boxes to create a true number sentence with the greatest possible value. $\square + \square = \square - \square$	Make a graph that shows a possible result of 7 students' favorite color with red being the most popular color. 	Make 72¢ using exactly 9 coins that are either quarters, dimes, nickels, or pennies.

Version 1.3

Depth of Knowledge Matrix - Elementary Math

Topic	Subtracting 3-Digit Numbers	Operations with Time	Comparing Fractions	Multiplying Decimals
CCSS Stand.	• 3.NBT.2	• 3.MD.1	• 4.NF.2	• 5.NBT.7
DOK 1 Example	Solve. $821 - 357 =$	What time will it be 14 minutes after 1:27 pm?	Place a < or > between the two fractions to make a true number sentence. $\frac{4}{7} \quad \frac{3}{5}$	Solve. $3.4 \times 2.5 =$
DOK 2 Example	Using the digits 1 to 9 at most one time each, fill in the boxes to make two different pairs of three-digit numbers that form a true number sentence. □□□-291=□□□	Using the digits 1 to 9 at most one time each, fill in the boxes to make a time that is 4:37 pm. □□ minutes after □:□□ pm	Using the digits 1 to 9 at most one time each, fill in the boxes to create two different fractions: one that is less than one half and one that is more than one half. $\frac{\square}{\square} < \frac{1}{2}$ and $\frac{\square}{\square} > \frac{1}{2}$	Using the digits 1 to 9 at most one time each, fill in the boxes to make a true number sentence. □.□ × 3.2=□.□
DOK 3 Example	Using the digits 1 to 9 at most one time each, fill in the boxes to make a difference that is as close to 329 as possible. □□□-□□□=	Using the digits 1 to 9 at most one time each, fill in the boxes to make the latest possible time. □□ minutes after □:□□ pm	Using the digits 1 to 9 at most one time each, fill in the boxes to create a fraction that is as close to 5/11 as possible. $\frac{\square}{\square}$	Using the digits 1 to 9 at most one time each, fill in the boxes so that the product is as close to 50 as possible. □.□ × □.□ =

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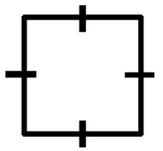
Version 1.3

Depth of Knowledge Matrix - Secondary Math

Topic	Dividing Fractions	Solving Two-Step Equations	Exponents	Solving Equations with Variables on Both Sides
CCSS Standard(s)	• 6.NS.1	• 7.EE.4a	• 8.EE.1	• 8.EE.8 • A-REI.3
DOK 1 Example	Evaluate. $\frac{4}{9} \div \frac{2}{5}$	Solve for x. $2x + 3 = 9$	Evaluate. 3^4	Solve for x. $3x + 2 = -2x + 4$
DOK 2 Example	Using the digits 1 to 9 at most one time each, fill in the boxes to make two different pairs of fractions that have a quotient of 2/3. $\frac{\square}{\square} \div \frac{\square}{\square} = \frac{2}{3}$	Using the digits 1 to 9 at most one time each, fill in the boxes to create two equations: one where x has a positive value and one where x has a negative value. $\square x + \square = \square$	Using the digits 1 to 9 at most one time each, fill in the boxes to make two true number sentences. $\square^{\square} = 64$	Using the digits 1 to 9 at most *two* times each, fill in the boxes to make an equation with no solutions. $\square x + \square = \square x + \square$
DOK 3 Example	Using the digits 1 to 9 at most one time each, fill in the boxes to make two fractions that have a quotient that is as close to 4/11 as possible. $\frac{\square}{\square} \div \frac{\square}{\square}$	Using the digits 1 to 9 at most one time each, fill in the boxes to create an equation where x has the greatest possible value. $\square x + \square = \square$	Using the digits 1 to 9 at most one time each, fill in the boxes to make a result that has the greatest value possible. $\square^{\square} = \square\square\square$	Using the digits 1 to 9 at most one time each, fill in the boxes so that the solution is closest to zero. $\square x + \square = \square x + \square$

Version 1.8

Depth of Knowledge Matrix - Secondary Math

Topic	Geometric Proofs	Complex Numbers	Trigonometric Functions	Definite Integrals
CCSS Standard(s)	• G-CO.11	• N-CN.2	• F-TF.3	• N/A
DOK 1 Example	Add one geometric marking to demonstrate the quadrilateral is a square. 	Multiply the binomials. $(3+4i)(2+3i)$	Evaluate. $\sin\frac{\pi}{3}$	Solve. $\int_2^6 x^3\,dx$
DOK 2 Example	Use exactly five geometric markings to show that a quadrilateral is a square.	Using the integers -9 to 9 at most one time each, fill in the boxes twice: once to make a positive real number product and once to make a negative real number product. $(\square+\square i)(\square+\square i)$	Using the digits 1 to 9 at most one time each, fill in the boxes to make two true number sentences. $\sin\frac{\square\pi}{\square}=1$	Using the digits 1 to 9 at most one time each, fill in the boxes to make a positive and a negative solution. $\int_{\square}^{\square} x^{\square}\,dx$
DOK 3 Example	What is the least number of geometric markings needed to demonstrate that a quadrilateral is a square?	Using the integers -9 to 9 at most one time each, fill in the boxes to make a real number product with the greatest value. $(\square+\square i)(\square+\square i)$	Using the digits 1 to 9 at most one time each, fill in the boxes to find the function's greatest possible value. $\sin\frac{\square\pi}{\square}=\frac{\sqrt{\square}}{\square}$	Using the digits 1 to 9 at most one time each, fill in the boxes to make a solution that is as close to 100 as possible. $\int_{\square}^{\square} x^{\square}\,dx$

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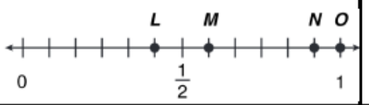
Depth of Knowledge Matrix – Third Grade Math

Topic	Rounding	Adding 3-Digit Numbers	Subtracting 3-Digit Numbers	Multiplying Multiples Of Ten
CCSS Stand.	• 3.NBT.1	• 3.NBT.2	• 3.NBT.2	• 3.NBT.3
DOK 1 Example	Round to the nearest hundred. 436	Add. $253 + 419 =$	Solve. $821 - 357 =$	Multiply. 4×60
DOK 2 Example	Using the digits 0 to 9 at most one time each, place a digit in each box to make two different three-digit numbers that round (to the nearest hundred) to 500. □□□ and □□□	Using the digits 1 to 9 exactly one time each, place a digit in each box two times: once to make a sum that is greater than 700 and once to make a sum that is less than 700. You may reuse all the digits for each sum. □□□ + □□□	Using the digits 1 to 9 at most one time each, place a digit in each box to make two different pairs of three-digit numbers that form a true number sentence. You may reuse all the digits each difference. □□□-291=□□□	Using the digits 0 to 9 at most one time each, place a digit in each box to make two different true number sentences: one with a product that's less than 500 and one with a product that's greater than 500. You may reuse all the digits each product. □ x □0 = □□□
DOK 3 Example	Using the digits 0 to 9 at most one time each, place a digit in each box to make the greatest possible three-digit number that still rounds (to the nearest hundred) to 500. □□□	Using the digits 1 to 9 exactly one time each, place a digit in each box to make the sum as close to 1000 as possible. □□□ □□□ + □□□	Using the digits 1 to 9 at most one time each, place a digit in the boxes to make a difference that is as close to 329 as possible. □□□-□□□=	Using the digits 0 to 9 at most one time each, place a digit in each box to make a product that's as close to 500 as possible. □ x □0 = □□□

Version 1.1

Depth of Knowledge Matrix – Fourth Grade Math

Topic	Fractions on a Number Line	Comparing Fractions	Adding Mixed Numbers	Comparing Decimals
CCSS Stand.	• 4.NF.2	• 4.NF.2	• 4.NF.3a	• 4.NF.7
DOK 1 Example	Which point is located at $\frac{7}{12}$ below? 	Compare the fractions using a <, >, or = sign. $\frac{3}{8} \quad \frac{4}{7}$	Find the sum. $3\frac{5}{8} + 2\frac{7}{8} =$	Compare the decimals using a <, >, or = sign. $6.714 \quad 8.023$
DOK 2 Example	Label the point where $\frac{3}{5}$ belongs on the number line below. Be as precise as possible. 	Using the digits 1 to 9 at most one time each, place a digit in each box to create a true statement. $\frac{\square}{\square} < \frac{\square}{\square} < \frac{\square}{\square}$	Using the digits 1 to 9 at most one time each, place a digit in each box to make a true equation. $\square\frac{\square}{8} + \square\frac{\square}{8} = \square\frac{\square}{8}$	Using the digits 0 to 9 at most one time each, place a digit in each box to create two different decimals: one that is greater than 5 and one that is less than 5. $\square.\square\square\square$ $\square.\square\square\square$
DOK 3 Example	Using the digits 0 to 9 at most one time each, place a digit in each box to create five fractions and place them all on a number line with the correct order and spacing. $\frac{\square}{\square}, \frac{\square}{\square}, \frac{\square}{\square}, \frac{\square}{\square}, \frac{\square}{\square}$	Using the digits 1 to 9 at most one time each, place a digit in each box to create a fraction as close to one as possible. $\frac{\square\square}{\square\square}$	Using the digits 1 to 9 at most one time each, place a digit in each box to make a true equation with the smallest possible sum. $\square\frac{\square}{8} + \square\frac{\square}{8} = \square\frac{\square}{8}$	Using the digits 0 to 9 at most one time each, place a digit in each box to create two decimals that are close to 5 as possible but also equally far away from 5. $\square.\square\square\square$ $\square.\square\square\square$

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Depth of Knowledge Matrix – Fifth Grade Math

Topic	Evaluating Expressions	Rounding Decimals	Multi-Digit Multiplication	Multiplying Decimals
CCSS Stand.	• 5.OA.1	• 5. NBT.4	• 5.NBT.5	• 5.NBT.7
DOK 1 Example	Evaluate the expression. $56 \div (8 - 1)$	Round the decimal to the nearest tenth. 7.163	Find the product. 37×45	Solve. $3.4 \times 2.5 =$
DOK 2 Example	Using the digits 0 through 9, at most one time each, place a digit in each box to create two true statements: one where the value on each side of the equal sign is greater than 30 and one where it's less than 30. You may reuse all the digits for each equation. □□ ÷ (□ − □) = □ + □ × □	Using the digits 0 to 9 at most one time each, place a digit in each box to create two different decimals that are equivalent when rounded to the nearest tenth. □.□□□ □.□□□	Using the digits 0 to 9 at most one time each, place a digit in each box to create a true equation. □□ × □□ = □□□	Using the digits 1 to 9 at most one time each, fill in the boxes to make a true number sentence. □.□ × 3.2 = □.□
DOK 3 Example	Using the digits 0 through 9, at most one time each, place a digit in each box to create the greatest possible value. □□ ÷ (□ − □) = □ + □ × □	Using the digits 0 to 9 at most one time each, place a digit in each box to create two different decimals that are equivalent when rounded to the nearest tenth and have the least possible value. □.□□□ □.□□□	Using the digits 0 to 9 at most one time each, place a digit in each box to create a true equation with the greatest possible product. □□ × □□ = □□□	Using the digits 1 to 9 at most one time each, fill in the boxes so that the product is as close to 50 as possible. □.□ × □.□ =

Version 1.3

Depth of Knowledge Matrix – Sixth Grade Math

Topic	Percent of a Quantity	Ratios and Unit Rates	Dividing Fractions	Multiplying Decimals
CCSS Stand.	• 6.RP.3c	• 6.RP1 & 6.RP.2	• 6.NS.1	• 6.NS.3
DOK 1 Example	Evaluate. 24 is 30% of what number?	Fill in the blank to make an equivalent ratio. $\_\_ : 7 = 8 : 14$	Find the quotient. $\frac{4}{9} \div \frac{2}{5}$	Find the product. $3.74 \cdot 4.29$
DOK 2 Example	Using the digits 0 to 9 at most one time each, fill in the boxes to make two true statements without rounding. You may reuse all the digits for your second statement. □□ is □□% of □□	Using the digits 0 to 9 at most one time each, fill in the boxes to make an equivalent ratio. □:□ = □□:□	Using the digits 1 to 9 at most one time each, fill in the boxes to make two different pairs of fractions that have a quotient of 2/3. You may reuse all the digits for each equation. $\frac{\square}{\square} \div \frac{\square}{\square} = \frac{2}{3}$	Using the digits 1 to 9 at most one time each, fill in the boxes to make a whole number product. □.□ · □.□□
DOK 3 Example	Using the digits 0 to 9 at most one time each, fill in the boxes to make a true statement with the greatest possible whole without rounding. □□ is □□% of □□	Using the digits 0 to 9 at most one time each, fill in the boxes to make an equivalent ratio with a unit rate that has greatest possible value. □:□ = □□:□	Using the digits 1 to 9 at most one time each, fill in the boxes to make two fractions that have a quotient that is as close to 4/11 as possible. $\frac{\square}{\square} \div \frac{\square}{\square}$	Using the digits 1 to 9 at most one time each, fill in the boxes to make a product with the greatest possible value. □.□□ · □.□□

Version 1.2

Depth of Knowledge Matrix – Seventh Grade Math

Topic	Markup & Discount	Unit Rates with Fractions	+ and – Rational Numbers	x and ÷ Rational Numbers
CCSS Stand.	• 7.RP.3	• 7.RP.1	• 7.NS.1	• 7.NS.2
DOK 1 Example	Find the final price of a $75 item after a 45% discount.	Find the unit rate. $\frac{2/9}{3/8} = \frac{}{1}$	Find the sum. $-12 + -7$	Find the quotient. $\frac{-3}{4} \div \frac{7}{5}$
DOK 2 Example	Using the digits 0 to 9 at most one time each, fill in the boxes to create two true statements without rounding. You may reuse all the digits for each statement. $\square\square$ item at a $\square\square$% discount costs $\square\square$	Using the digits 0 to 9 at most one time each, fill in the boxes to create two unit rates. You may reuse all the digits each equation. $\frac{\square/\square}{\square/\square} = \frac{\square}{1}$	Using the integers -9 to 9 at most one time each, fill in the boxes to create two equations. You may reuse all the integers for each equation. $-\square + \square = \square - (-\square)$	Using the integers -9 to 9 at most one time each, fill in the boxes to create two equations. You may reuse all the integers for each equation. $-\frac{\square}{\square} \div \frac{\square}{\square} = \frac{\square}{\square}$
DOK 3 Example	Using the digits 0 to 9 at most one time each, fill in the boxes to create the least expensive item after discount. $\square\square$ item at a $\square\square$% discount costs $\square\square$	Using the digits 0 to 9 at most one time each, fill in the boxes to create a unit rate with the greatest possible value. $\frac{\square/\square}{\square/\square} = \frac{\square}{1}$	Using the integers -9 to 9 at most one time each, fill in the boxes to create an equation where each side has the greatest possible value. $-\square + \square = \square - (-\square)$	Using the integers -9 to 9 at most one time each, fill in the boxes to create a quotient with the greatest possible value. $-\frac{\square}{\square} \div \frac{\square}{\square} = \frac{\square}{\square}$

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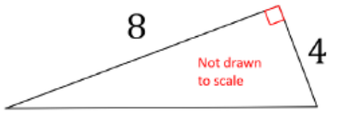
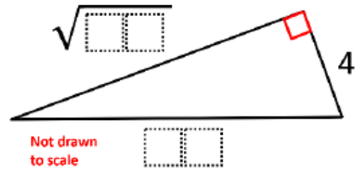
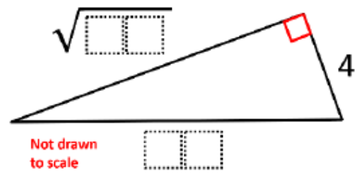
Depth of Knowledge Matrix – Eighth Grade Math

Topic	Approximating Irrationals	Properties of Exponents	Scientific Notation	Pythagorean Theorem
CCSS Stand.	• 8.NS.2	• 8.EE.1	• 8.EE.4	• 8.G.8
DOK 1 Example	The irrational number $\sqrt{70}$ is between which two integers?	Simplify. $4^3 \cdot -6^2$	Simplify. $2 \cdot 10^{-4} \cdot 5 \cdot 10^{7}$	Find the length of the missing side. 
DOK 2 Example	Using the digits 0 to 9 at most one time each, fill in the boxes twice to make two different true statements. You may reuse all the digits for each statement. $\sqrt{\square\square}$ is greater than $\square$ and less than $\square$	Using the integers -9 to 9 at most one time each, fill in the boxes twice to make a positive product and a negative product. You may reuse all the integers each product. $\square^{\square} \cdot \square^{\square}$	Using the digits 1 to 9 at most one time each, fill in the boxes twice to make a product that equals 800,000,000. You may reuse all the digits for each product. $\square \cdot 10^{\square} \cdot \square \cdot 10^{\square}$	Using the digits 0 to 9 at most one time each, fill in the boxes to find two pairs of possible lengths for the missing sides. 
DOK 3 Example	Using the digits 0 to 9 at most one time each, fill in the boxes twice to make the greatest possible irrational number. $\sqrt{\square\square}$ is greater than $\square$ and less than $\square$	Using the integers -9 to 9 at most one time each, fill in the boxes to make a product that is as close to zero as possible without being exactly zero. $\square^{\square} \cdot \square^{\square}$	Using the digits 1 to 9 at most one time each, fill in the boxes to make the greatest product. $\square \cdot 10^{\square} \cdot \square \cdot 10^{\square}$	Using the digits 0 to 9 at most one time each, fill in the boxes to find the lengths of the missing sides such that the missing leg's length is as long as possible. 

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Depth of Knowledge Matrix – Algebra 1 (Integrated 1)

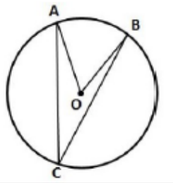
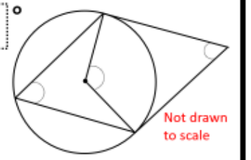
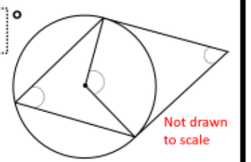
Topic	Solving Equations with Variables on Both Sides	Factoring Quadratics	Quadratics in Vertex Form	Adding polynomials
CCSS Stand.	• A-REI.3	• A-SSE.3a	• F-IF.7a	• A-APR.1
DOK 1 Example	Solve for x. $3x + 2 = -2x + 4$	Find the factors: $2x^2 + 7x + 3$	Find the roots and maximum of the quadratic equation below. $y = -3(x-4)^2 - 3$	Add the polynomials. $(4x^2 - 3x + 1) + (-6x^2 + 5x)$
DOK 2 Example	Using the digits 1 to 9 at most *two* times each, fill in the boxes to make an equation with no solutions. $\square x + \square = \square x + \square$	Find three different integers to put in the blank that will make the quadratic expression factorable. $x^2 + \_\_x + 4$	Create three equations for quadratics in vertex form that have roots at 3 and 5 but have different maximum and/or minimum values.	Using the integers −9 to 9 at most one time each, place an integer in each box to make two expressions: one that has three or more terms and one that has fewer than three terms. You may reuse all the integers for each expression. $(\square x^{\square} - \square x + \square) + (\square x^{\square} + \square x)$
DOK 3 Example	Using the digits 1 to 9 at most one time each, fill in the boxes so that the solution is closest to zero. $\square x + \square = \square x + \square$	Fill the blank by finding the largest and smallest integers that will make the quadratic expression factorable. $2x^2 + 3x + \_\_$	Using the digits 1 to 9 at most one time each, fill in the boxes to create a quadratic equation with the largest maximum value. $y = -\square(x - \square)^2 + \square$	Using the integers −9 to 9 at most one time each, place an integer in each box to create a polynomial with the least amount of terms. $(\square x^{\square} - \square x + \square) + (\square x^{\square} + \square x)$

Robert Kaplinsky

More free DOK 2 & 3 problems available at openmiddle.com

Version 1.3

Depth of Knowledge Matrix – Geometry (Integrated 2)

Topic	Equation of a Circle	Central, Inscribed, & Circumscribed Angles	Perpendicular Lines	Area on a Coordinate Plane
CCSS Stand.	• G-MG.1	• G-C.2	• G-GPE.5	• G-GPE.7
DOK 1 Example	Write the equation of a circle with a radius of 7 units.	If the measure of angle AOB is 40°, what is the measure of angle ACB? 	Determine whether the lines are perpendicular. $3x + 4y = 7$ $y = \frac{2}{3}x + 5$	Find the area of the triangle with vertices at (-4, -1), (-2, 5), and (3, -3)
DOK 2 Example	Using the digits 1 to 9 at most two times each, place a digit in each box to make two circles: one with an area of less than 100 units^2 and one with more than 100 units^2. $\square x^2 + \square y^2 = \square$	Using the digits 0 to 9 at most one time each, place a digit in each box two times: once where the central angle is greater than 130° and once where it is less than 130°. You may reuse all the digits each time. central angle measure = $\square\square\square$° inscribed angle measure = $\square\square$° circumscribed angle measure = $\square\square$° 	Using the digits 0 to 9 at most one time each, fill in the boxes to create two perpendicular lines. $y = \frac{\square}{\square}x + \square$ $\square x + \square y = \square$	Using the integers -9 to 9 at most one time each, fill in the boxes to create coordinates that represent the vertices of two triangles: one with an area of less than 55 units^2 and one with an area of more than 55 units^2. You may reuse all the integers each time. $A:(\square, \square)$ $B:(\square, \square)$ $C:(\square, \square)$
DOK 3 Example	Using the digits 1 to 9 at most two times each, place a digit in each box to make a circle with the least possible area. $\square x^2 + \square y^2 = \square$	Using the digits 0 to 9 at most one time each, place a digit in each box so that the central angle has the greatest possible value. central angle measure = $\square\square\square$° inscribed angle measure = $\square\square$° circumscribed angle measure = $\square\square$° 	Using the digits 0 to 9 at most one time each, fill in the boxes to create two perpendicular lines whose solution is as close to the origin as possible. $y = \frac{\square}{\square}x + \square$ $\square x + \square y = \square$	Using the integers -9 to 9 at most one time each, fill in the boxes to create coordinates that represent the vertices of the triangle with the smallest possible area. $A:(\square, \square)$ $B:(\square, \square)$ $C:(\square, \square)$

Version 1.0

Depth of Knowledge Matrix – Algebra 2 (Integrated 3)

Topic	Rational Function Features	Square Root Function Features	Exponential Function Features	Logarithmic Function Features
CCSS Stand.	• F-IF.7d	• F-IF.7b	• F-IF.7e	• F-IF.7e
DOK 1 Example	Identify the function's vertical asymptote and its solution. $y = \frac{5}{x+8} + -3$	Find the domain and x-intercept of the square root function. $y = -5\sqrt{x+7} + 3$	Find the y-intercept of the exponential function. $y = -2 \cdot 3^{(x+1)} + 4$	Find the y-intercept of the logarithmic function. $y = 3\log_6(x-(-4)) + 4$
DOK 2 Example	Using the integers -9 to 9, at most one time each, fill in the boxes to create a rational function, its vertical asymptote, and its solution. $y = \frac{\square}{x+\square} + \square$ solution: $x = \square$ vertical asymptote: $x = \square$	Using the integers -9 to 9, at most one time each, fill in the boxes to create a square root function, its domain, and the x-intercept. $y = \square\sqrt{x+\square} + \square$ domain: $x \geq \square$ x-intercept: $(\square, \square)$	Use the integers -9 to 9, at most two times each, fill in the boxes to create an exponential growth function with its y-intercept. $y = \square \cdot \square^{(x+\square)} + \square$ y-intercept: $(0, \square)$	Using the integers -9 to 9, at most one time each, fill in the boxes and create a logarithmic function with its corresponding y-intercept. $y = \square\log_{\square}(x-\square) + \square$ y-intercept: $(0, \square)$
DOK 3 Example	Using the integers -9 to 9, at most one time each, fill in the boxes to create a rational function, its vertical asymptote, and the greatest possible solution. $y = \frac{\square}{x+\square} + \square$ solution: $x = \square$ vertical asymptote: $x = \square$	Using the integers -9 to 9, at most one time each, fill in the boxes to create a square root function, its domain, and the greatest possible x-intercept. $y = \square\sqrt{x+\square} + \square$ domain: $x \geq \square$ x-intercept: $(\square, \square)$	Use the integers -9 to 9, at most two times each, fill in the boxes to create an exponential growth function with the greatest possible y-intercept. $y = \square \cdot \square^{(x+\square)} + \square$ y-intercept: $(0, \square)$	Using the integers -9 to 9, at most one time each, fill in the boxes to create a logarithmic function with the greatest possible y-intercept. $y = \square\log_{\square}(x-\square) + \square$ y-intercept: $(0, \square)$

Robert Kaplinsky

More free DOK 2 & 3 problems available at openmiddle.com

Version 1.3

Chrissy Day
@ChrissyDay1974

I LOVE Open Middle @robertkaplinsky second graders were working on ____ ___ - ____ ____ Make the smallest difference possible using the digits 1-9 once only. The conversation and perseverance was something I had never seen from these kids!

5:20 PM · Mar 9, 2019 · Twitter for iPhone

6 Retweets **62** Likes

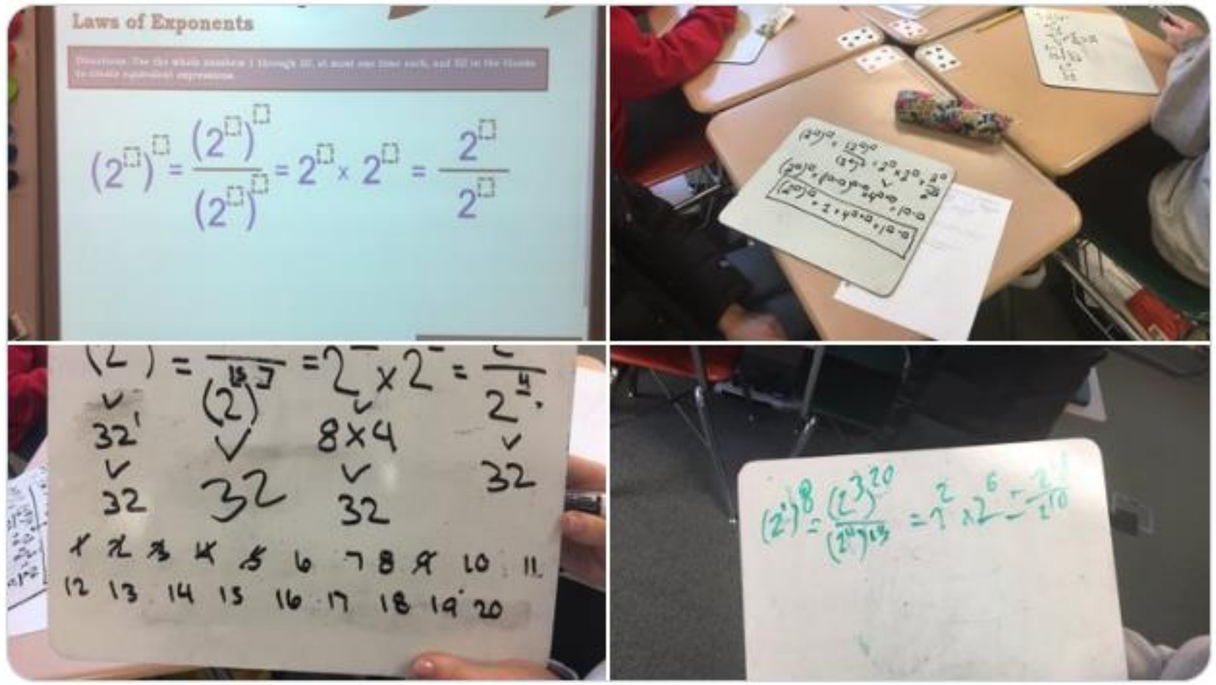
DeLaina Ellis @dellis5th · Jan 11

It was an @openmiddle **showdown** in 5th grade! They could NOT stop! One student even asked me for his paper during recess so he could try to get even closer! #wearegrandview #iteachmath #mtbos #productivestruggle

1 2 8

Wendy Kozina
@wkozina

Kids begging for more time and yelling, “No” when I asked if they wanted a hint! Amazing activity @robertkaplinsky @openmiddle

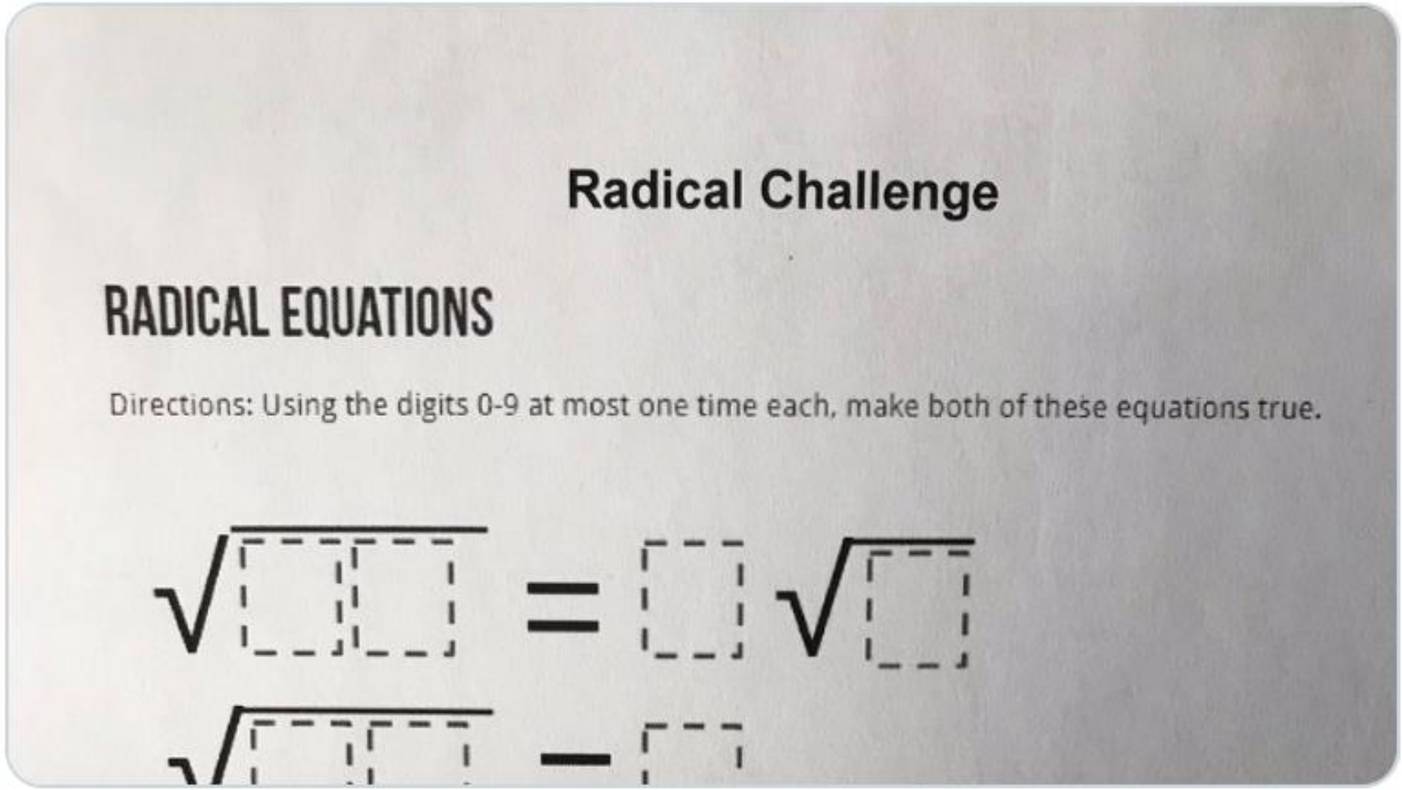


1:30 PM · Mar 8, 2019 · Twitter for iPhone

14 Retweets **98** Likes

Marguerite Spriggs @mspriggs30 · Nov 16, 2018

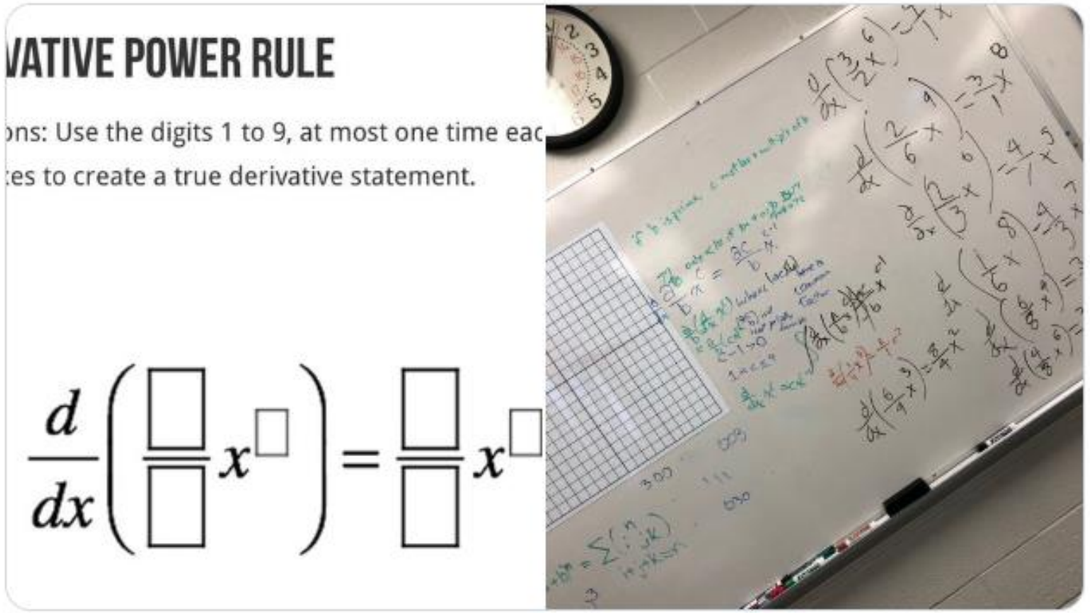
My **first time trying** an **@openmiddle** problem with my students today. Wasn't sure how it would go or if they'd solve it. After a few minutes going at it (and coming up with more than one solution) they asked "can we do another one?" "That was fun - we should do it more!"



1 1 7

Katherine MacKenzie
@kmackenzie7

Tried an @openmiddle problem (for the 1st time) with my calculus crew. Left it on the board went to grab a photocopy before class start. Came back and Ss were crowded around the board sharing ideas. It's was magical. I *must* bring these to all my classes #MTBoS #iteachmath



2:17 PM · Apr 18, 2019 · Twitter for iPhone

20 Retweets **156** Likes

OPEN MIDDLE PROBLEM BENEFITS

- KIDS LOVE DOING THEM
- BUILD CONCEPTUAL UNDERSTANDING
- OFTEN LEAD TO GREAT CONVERSATIONS
- REVEAL HIDDEN MISCONCEPTIONS

WORKSHEETS

- ☑ WHAT'S WRONG WITH WORKSHEETS?
- ☑ WHAT SHOULD WE BE DOING INSTEAD?
- ❑ HOW DO WE DO IT IN OUR CLASSROOMS?
- ❑ WHERE DO WE GET MORE PROBLEMS?
- ❑ WHAT COMES NEXT?

HOW DO WE DO IT?

- Open Middle Worksheet

Name: _____ Period: _____ Date: _____

First attempt: Points: ____/2 attempt ____/2 explanation

What did you learn from this attempt? How will your strategy change on your next attempt?

Second attempt: Points: ____/2 attempt ____/2 explanation

First attempt: Points: _____/2 attempt _____/2 explanation

What did you learn from this attempt? How will your strategy change on your next attempt?

Closest to 1000 - Google Slides | Presentation Session

app.peardeck.com/presenter/tvfkmygyt/dash?returnTo=gslides

Sort by: Time | xtsnc | 11/12 Students

Directions: Using the digits 1 to 9 exactly one time each, place a digit in each box to make the sum as close to 1000 as possible.

What did you learn from this attempt? How will your strategy change on your next attempt?

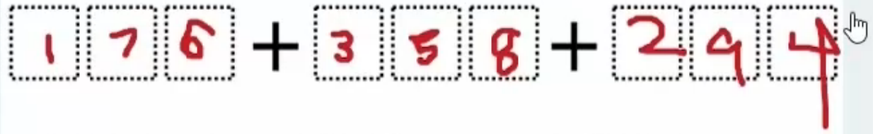
1044

Students, draw anywhere on this slide!

Pear Deck Interactive Slide
Do not remove this bar

Robert Thomas

Directions: Using the digits 1 to 9 exactly one time each, place a digit in each box to make the sum as close to 1000 as possible.



What did you learn from this attempt? How will your strategy change on your next attempt?

i tried

10 of 12 Responses | Student-Paced | Show Responses | Stop Student-Paced | END

Student Strategy Tracker (Grades

docs.google.com/document/d/11It6LAhlKZLAZUFn70QsiXL1cr8mc1Ffs4FGWd...

Student Strategy Tracker (Grades 6 to 12)

File Edit View Insert Format Tools Add-ons Help Last edit was yesterday at 11:...

Share

100% | Normal text | Times New... | 12

Strategy	Student Name(s) and Notes	Order
Guess and check (Students are picking all digits randomly)		
Guess and check followed by strategic digit swapping		
Begin with estimated values that roughly sum to 1000 and then try to make the numbers accordingly.		
Begin with estimated values that roughly sum to 1000 and then try to make the numbers accordingly followed by strategic digit swapping		
Students don't understand which digits can be swapped to without changing values.		
Students don't understand which digits can be swapped to change values.		

HOW DO WE DO IT?

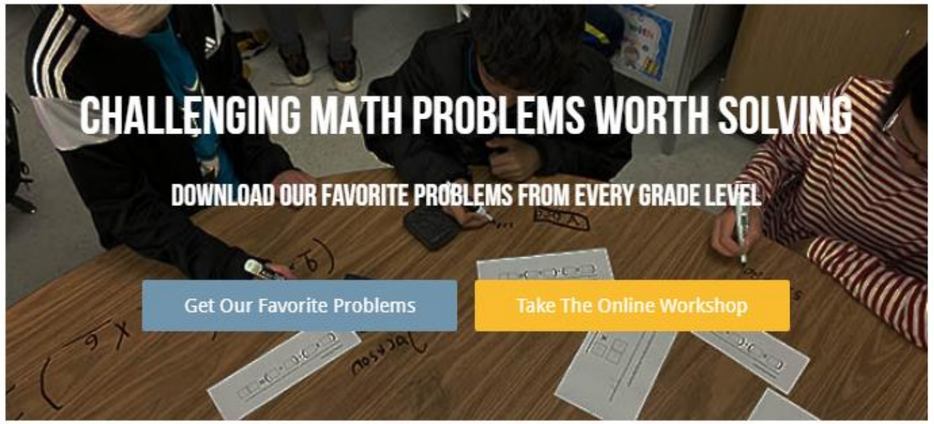
- Open Middle Worksheet
- Classwork
- Homework
- Assessments

WORKSHEETS

- [x] WHAT'S WRONG WITH WORKSHEETS?
- [x] WHAT SHOULD WE BE DOING INSTEAD?
- [x] HOW DO WE DO IT IN OUR CLASSROOMS?
- [ ] WHERE DO WE GET MORE PROBLEMS?
- [ ] WHAT COMES NEXT?

OPEN MIDDLE

Take The Online Workshop



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HERE'S OUR GROWING COLLECTION

Get Google Slide Versions

WANT TO SHARE OPEN MIDDLE WITH OTHERS?

Search

OPEN MIDDLE STICKERS

Get an Open Middle sticker

BROWSE BY COMMON CORE STATE STANDARDS

Select Category

OPEN MIDDLE WORKSHEET

English (student version)
English (document camera version)
English (Google Doc version)
French (student version)
French (document camera version)
French (Google Doc version)
Spanish (student version)
Spanish (document camera version)
Spanish (Google Doc version)

NUMBER TILES

Printable PDF with the digits 0 to 9
Printable PDF with the integers -9 to 9

BROWSE BY DEPTH OF KNOWLEDGE LEVEL

CLOSE TO 1000

Directions: Using the digits 1 to 9 exactly one time each, place a digit in each box to make the sum as close to 1000 as possible.

Hint

How do you know you can't get any closer to 1000? What should be true about the hundreds places of your three numbers? How do the tens places affect your answer?

Answer

Lots of answers will get you 999. One would be 247 + 563 + 189.
Is exactly 1000 even possible? Here's a Geogebra tool you can use to check your answer.

Source: John Ulbright and Robert Kaplinsky

Tags 2.NBT.7 • 3.NBT.2 • DOK 3: STRATEGIC THINKING • JOHN ULBRIGHT • ROBERT KAPLINSKY

Previous
Creating Right Triangles 2

Next
Inequalities with Same Number

WORKSHEETS

- [x] WHAT'S WRONG WITH WORKSHEETS?
- [x] WHAT SHOULD WE BE DOING INSTEAD?
- [x] HOW DO WE DO IT IN OUR CLASSROOMS?
- [x] WHERE DO WE GET MORE PROBLEMS?
- [ ] WHAT COMES NEXT?

WHAT COMES NEXT?

Action	Do Now	Start Planning	Don't Do
Try Open Middle problems out with your students	✓		
Find more problems I can use on the Open Middle website.	✓		
Incorporate Open Middle problems on assessments.		✓	
Replace all traditional problems with Open Middle problems.			✓
Share these resources with colleagues to make them aware.	✓		

WORKSHEETS

- ☑ WHAT'S WRONG WITH WORKSHEETS?
- ☑ WHAT SHOULD WE BE DOING INSTEAD?
- ☑ HOW DO WE DO IT IN OUR CLASSROOMS?
- ☑ WHERE DO WE GET MORE PROBLEMS?
- ☑ WHAT COMES NEXT?

Open Middle @openmiddle · Jan 11

Open Middle
@openmiddle

Hey @openmiddle fans, we want to hear from you. Why do you use our problems with your students? Share your success stories or lessons learned.

RETWEETS	LIKES
7	6

2:10 PM - 11 Jan 2017

8 7 6 •••

1 2 •••

DISCUSSION TIME

- Why should we reconsider using word problems?
- Why do Open Middle problems help build conceptual understanding, lead to great conversations, and help uncover hidden misconceptions?

GOALS

- ☑ CORRECT ANSWERS = UNDERSTANDING?
- ☑ RECONSIDER USING WORD PROBLEMS
- ☑ RECONSIDER USING WORKSHEETS

I share math strategies and resources that create problem solvers, not robots.

Download my favorite lessons for elementary, middle, and high school.

GET FREE LESSONS TAKE MY WORKSHOP

What happens next?

1

Get my free lessons and resources.

2

Learn tips from my book, webinars, and blog.

3

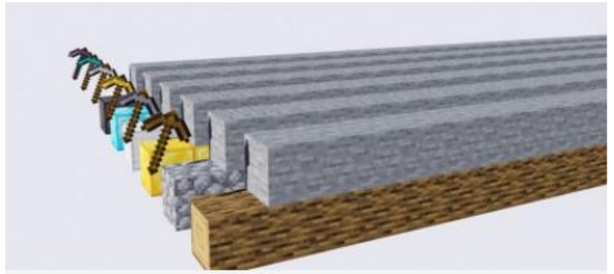
Take one of my online workshops for more support.

Lessons

How Much Money Do You Earn For 1,000,000 Streams On Spotify?

How Many Ducklings Are There?

How Many Hanukkah Candles Will We Need?



When Will The Winning Minecraft Pickaxe Finish?

Scary & Dangerous

THE THREE STEPS TO CREATE A CLASSROOM WHERE STUDENTS ARE EXCITED TO LEARN MATHEMATICS

ROBERT KAPLINSKY

robert@robertkaplinsky.com

robertkaplinsky.com

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WANT THE RESOURCES?

Download them at

robertkaplinsky.com/3steps