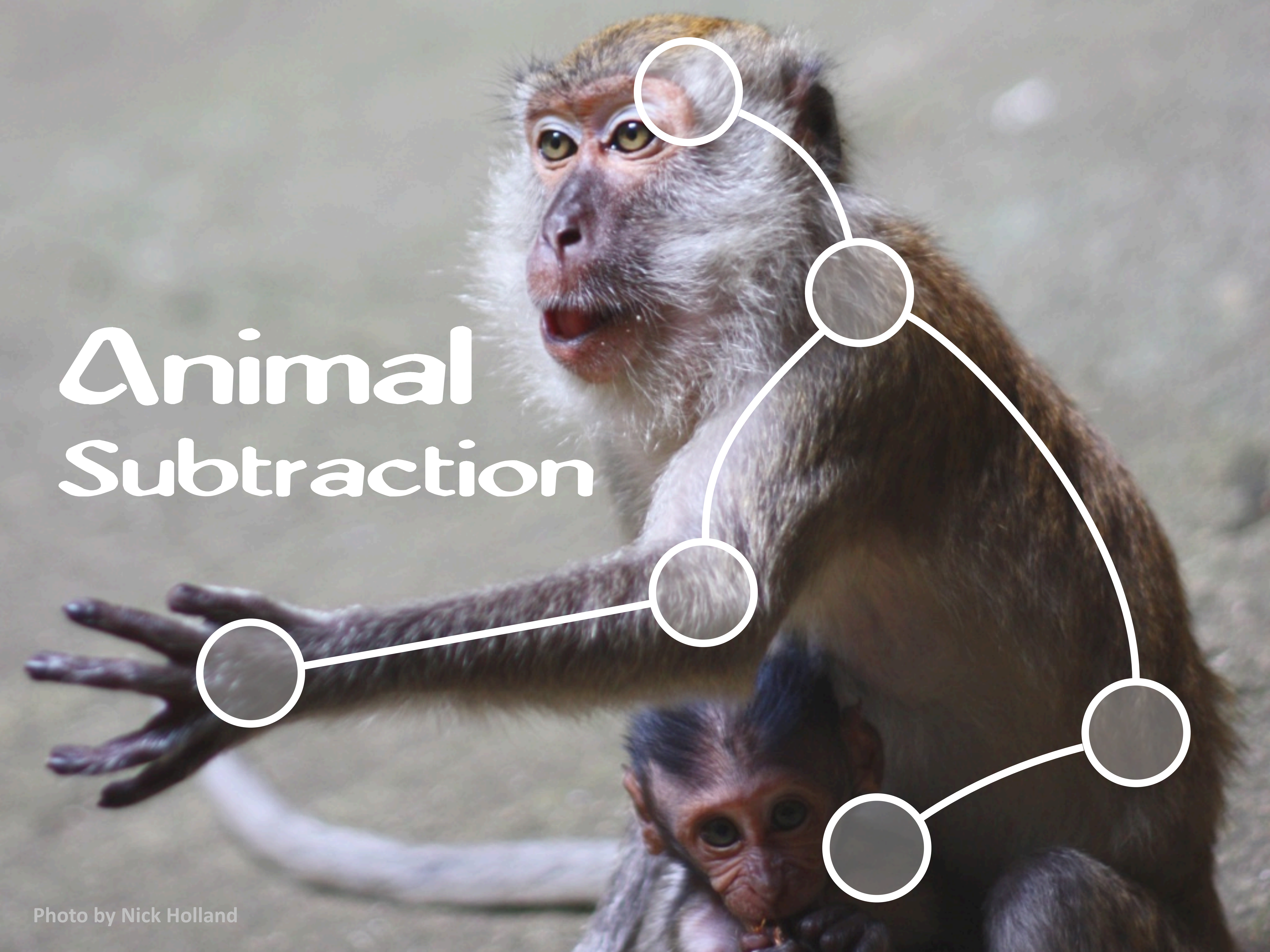

Animal
Subtraction
Photo by Nick Holland

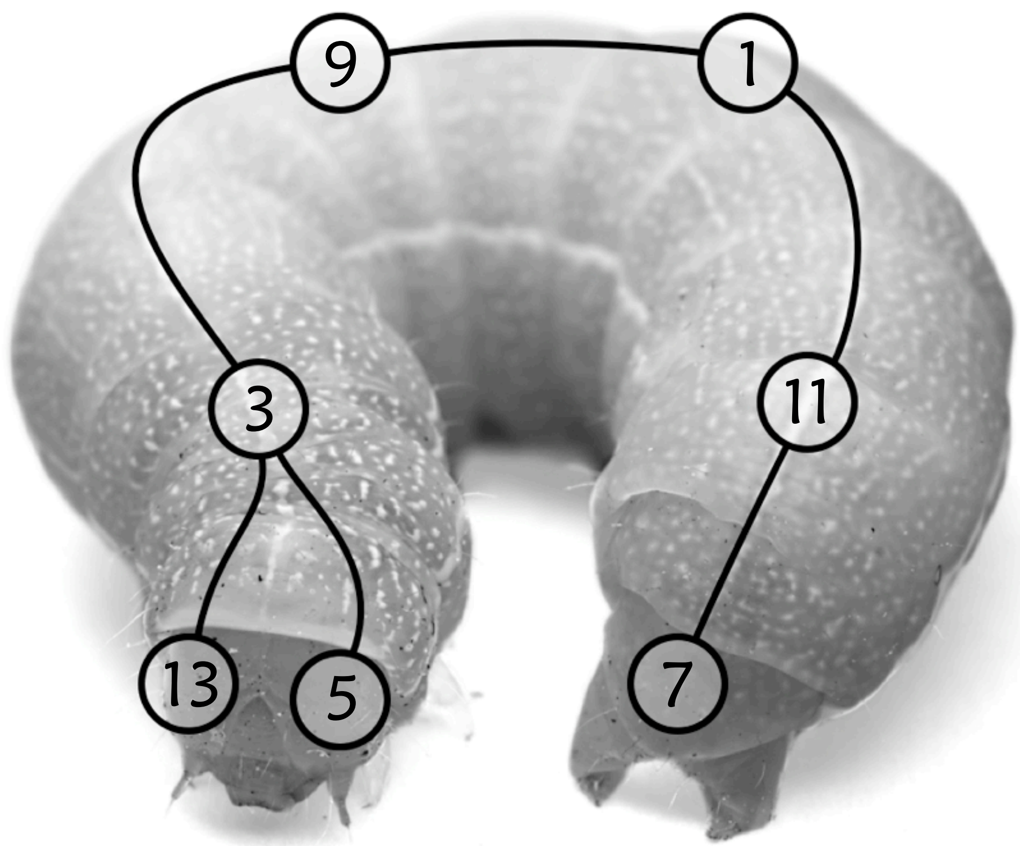
Contents

Copyright © 2015 MathPickle - All rights reserved

Animal Subtraction

Animals of all sizes love to offer rides to humans - provided we scale to their size.

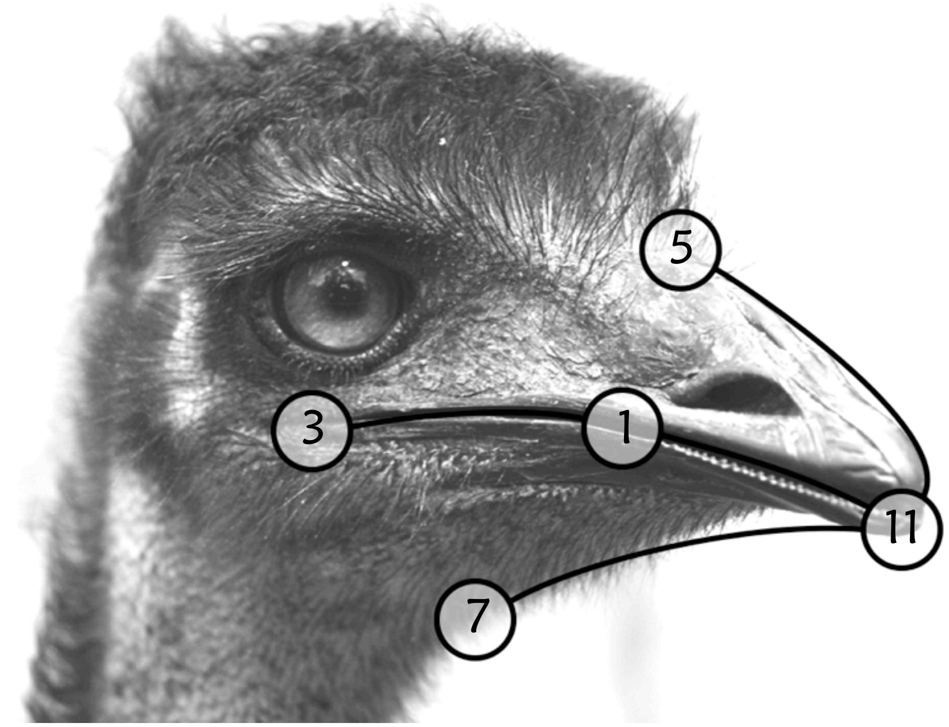
You can ride an animal if you can solve it. Here is the puzzle: Put odd consecutive integers into the circles starting with 1, 3, 5, 7… and not skipping any… If all the differences of connected circles are different - you've solved the puzzle and get a ride…



Can you ride this caterpillar? Not yet! 13 - 3 = 10 and 11 - 1 = 10 Duplicates!

All differences must be different.

Is this a solution for the emu?



No - for a five circle animal, we need to use the first five odd integers: 1, 3, 5, 7, 9. We made a mistake by forgetting to use a 9.

You can create your own puzzle by:

1) drawing a first circle
2) draw a new circle and connect it to a previous circle
3) repeat 2 as often as you want

Is it always possible to solve these puzzles by filling the circles with consecutive odd integers starting at 1? This problem is an important unsolved problem of mathematics from 1967 called the "Graceful Tree Conjecture." It is essential in every classroom learning subtraction.

Standards for Mathematical Practice

All MathPickle recommendations, including **Animal Subtraction**, are guaranteed to engage a wide spectrum of student abilities while targeting the following Standards for Mathematical Practice:

MP1 Toughen up!
This is problem solving where our students develop grit and resiliency in the face of nasty, thorny problems. It is the most sought after skill for our students.

MP3 Work together!
This is collaborative problem solving in which students discuss their strategies to solve a problem and identify missteps in a failed solution. MathPickle recommends pairing up students for all its puzzles.

MP6 Be precise!
This is where our students learn to communicate using precise terminology. MathPickle encourages students not only to use the precise terms of others, but to invent and rigorously define their own terms.

MP7 Be observant!
One of the things that the human brain does very well is identify pattern. We sometimes do this too well and identify patterns that don't really exist.

Common Core State Standards

Animal Subtraction targets Common Core State Standards for students learning subtraction. Together with the game Aggression (also sold on TpT) it is essential in every curriculum world wide.

Grades 1-3

CCSS.MATH.CONTENT.1.OA.C.6
Add and subtract within 20, demonstrating fluency for addition and subtraction within 10.

CCSS.MATH.CONTENT.2.OA.B.2
Fluently add and subtract within 20 using mental strategies. By end of Grade 2, know from memory all sums of two one-digit numbers.

CCSS.MATH.CONTENT.3.NBT.A.2
Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.

CCSS.MATH.CONTENT.1.OA.C.5
Relate counting to addition and subtraction.

http://www.corestandards.org/Math/Practice/

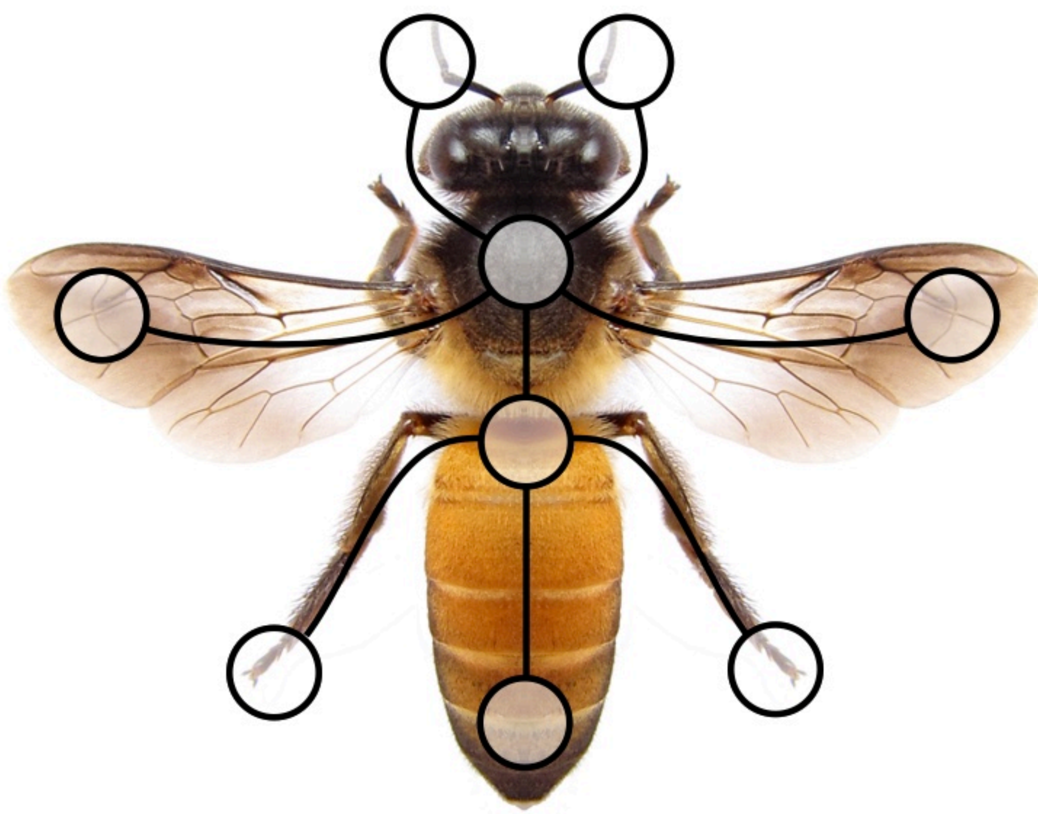
For the Teacher...

How to introduce a new puzzle like Animal Subtraction:

Instead of introducing a new puzzle by explaining rules to the class, just jump in and ask students to contribute numbers WITHOUT KNOWING THE RULES. Get all students to contribute - systematically going around the class. Students do not raise their hands... We want all students to contribute.

After students fail, reveal one rule. Repeat until most students understand the rules. Then students can break off into pairs to solve by themselves - leaving you to help the few who still need it.

This strategy efficiently engages more students than going through the rules at the start. Students get engaged when they contribute. They also enjoy the tongue-in-cheek failure.



Start with the emu in front of the whole class. I just draw the circles on the board and ask the students what it is. Of course the get it wrong and we all laugh when I tell them that it is obviously a bird... We solve the emu together over the next 5 minutes.

Then they split into pairs. For each pair I have printed up the starfish (page 7) and lizard head (page 8) and had them laminated so students can use dry-erase markers on them. Before I printed them up without laminating them and told students that they could copy the animals into their workbooks. Both work well.

When students finish a sheet they have the anticipation of swapping their sheet for a new one.

Either through laminating or getting the students to copy the circles into their books, the puzzles are preserved for future years.

Be Miserly:

The photos of animals are really cool for a subset of students. Do not let students see them. Keep the mystery alive.

Creativity within bounds:

After students have solved several puzzles they might want to draw their own animals and monsters, however you should keep control of the number of circles. Six circles makes a puzzle that is of medium difficulty. Eight circles can be very difficult!

$500 challenge for a grade 2 or 3 classroom

Perhaps your students have created a beautiful (and not too difficult) animal subtraction puzzle. Perhaps a student who is not usually excited about math has become engaged. Perhaps a student discovers that they can solve large insectoids with many circles - so long as the circles are arranged just so... Whatever your inspirational experience with this gem of a puzzle, I'd like to know.

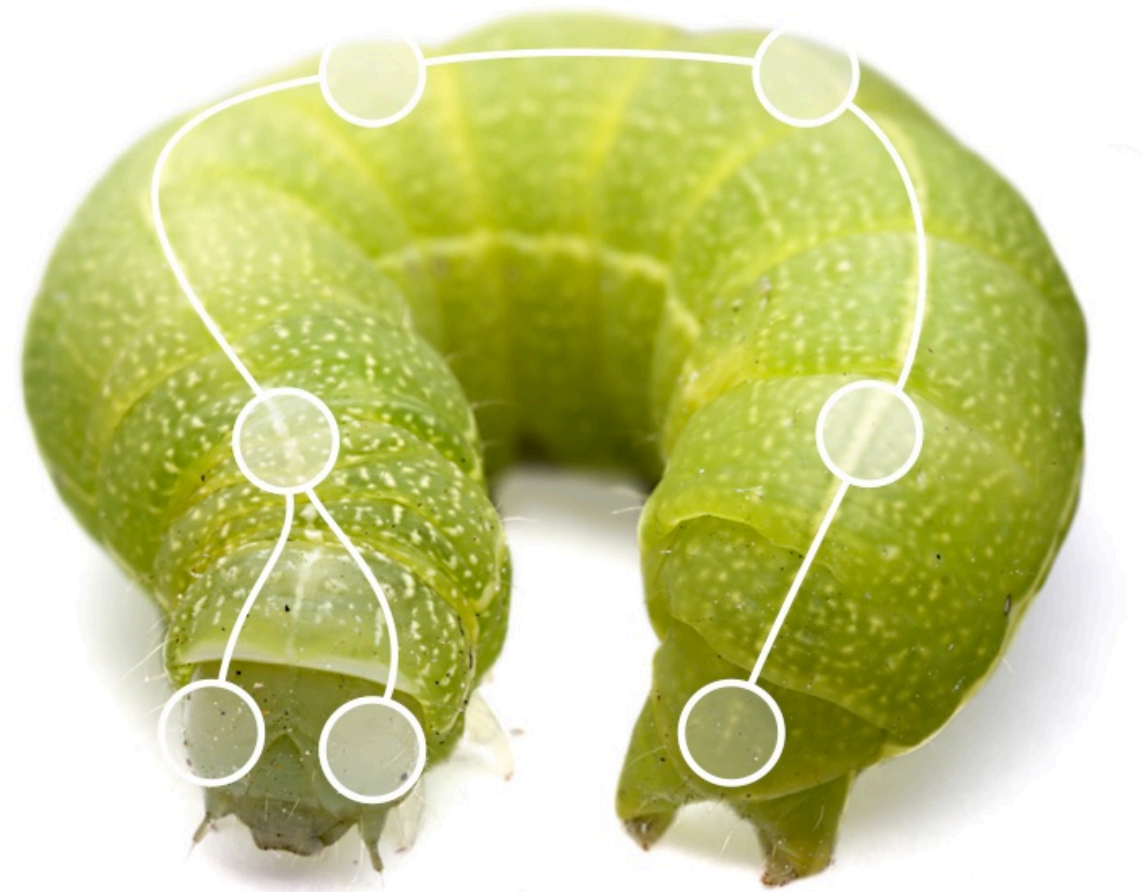
I'll offer $500 for a photograph and/or story highlighting animal subtraction in the grade 2 or 3 classroom.

All students featured must have appropriate consent. All photographs and stories submitted may be used in an updated version of this pdf file and to promote this puzzle elsewhere.

Send submissions to gord@mathpickle.com. Use "$500 Animal Subtraction challenge" as the subject of the email. The winning classroom will be announced the first March 14th that I have at least 10 submissions from different schools. I hope this will be March 14th, 2016.

$500 challenge for anyone

I'll offer $500 for the creation of any insectoid that cannot be solved. Publish the result in a mathematical journal and afterwards contact me at gord@mathpickle.com with subject "$500 Insectoid Challenge". This would solve the Graceful Tree Conjecture - an important unsolved problem in an area of mathematics called Graph Theory. It has been unsolved since 1967 so don't expect to solve it quickly!



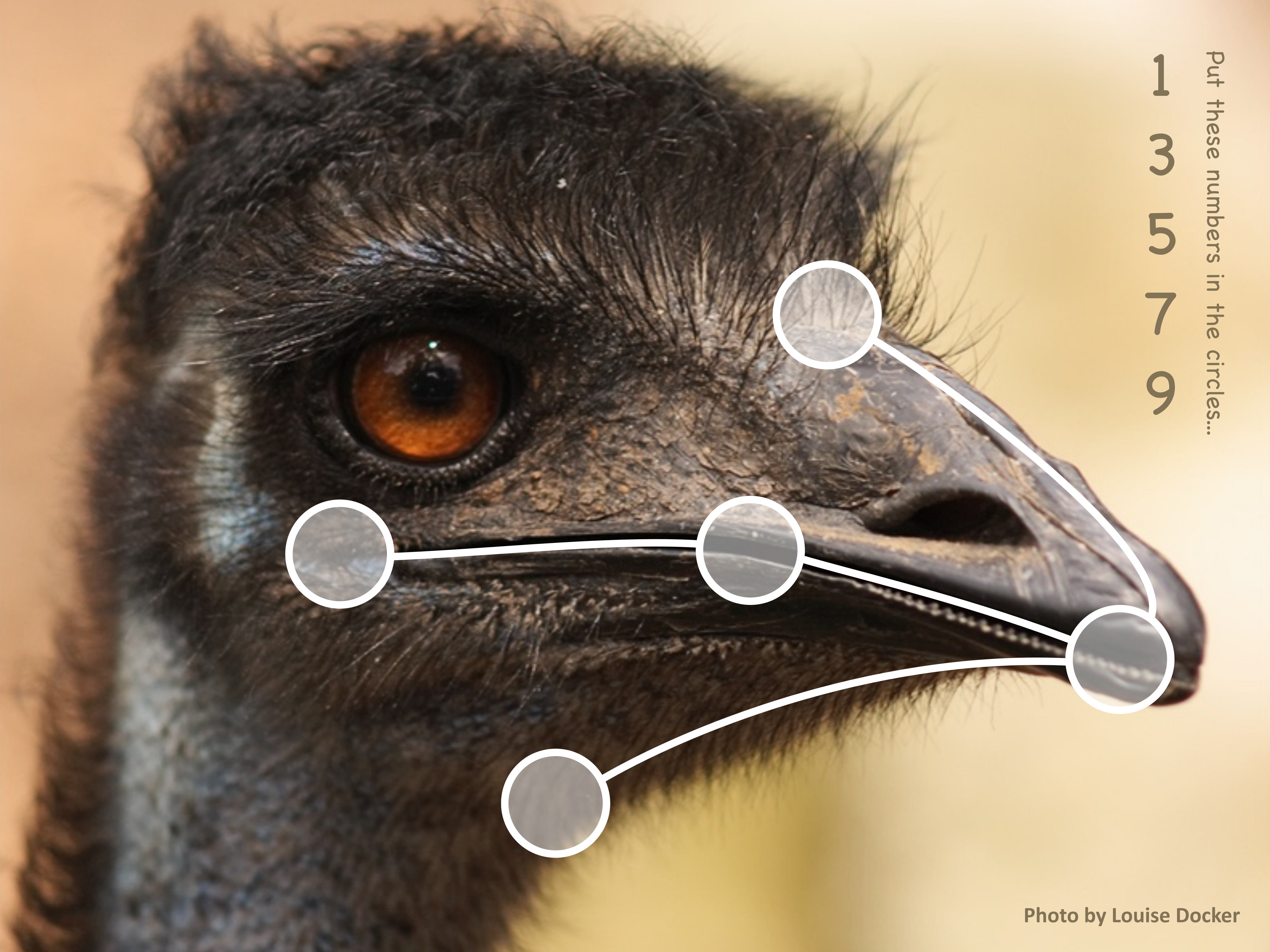
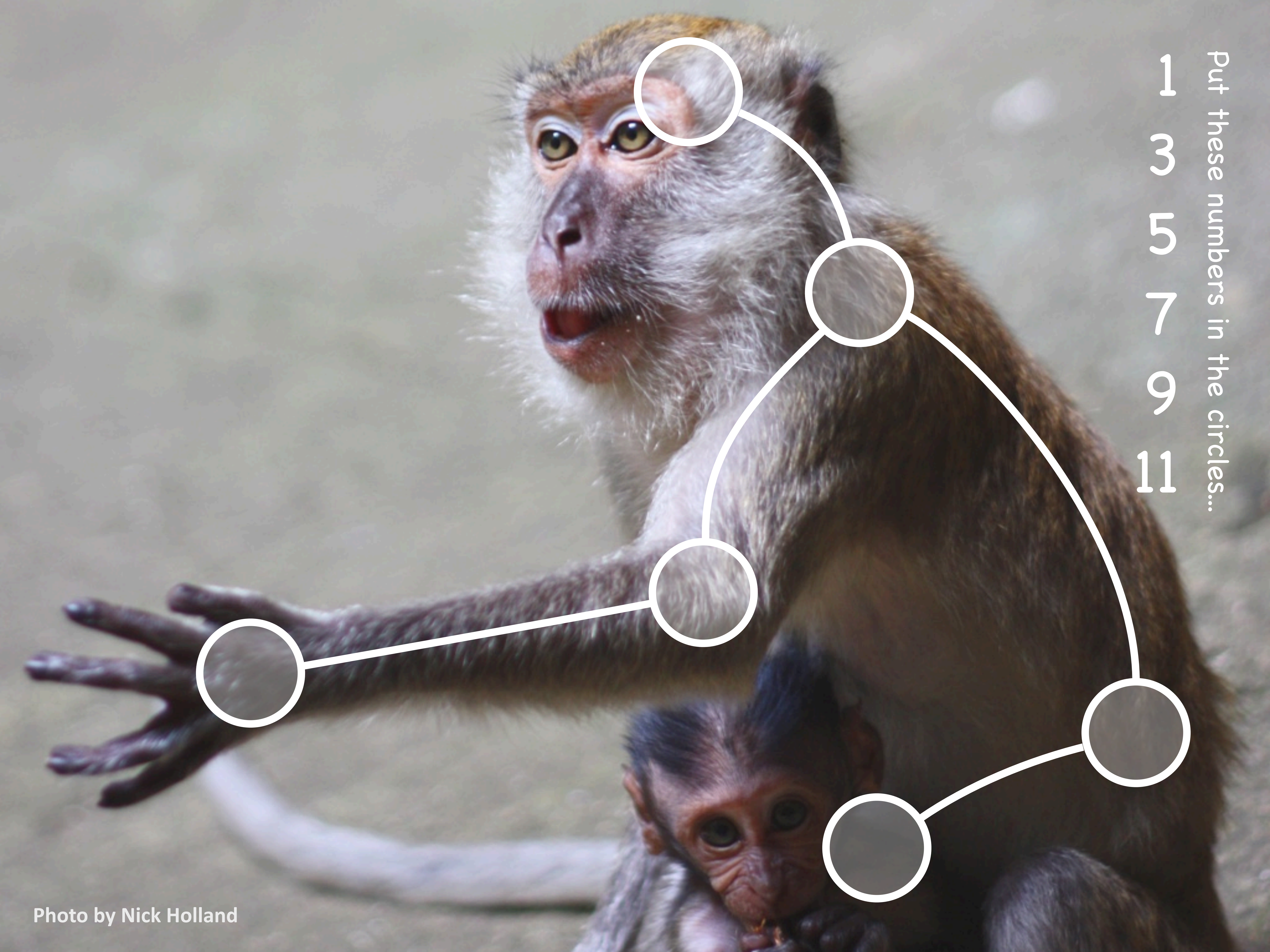


Photo by Louise Docker

Photo by Mariam Strong


1
3
5
7
9
Put these numbers in the circles...
Photo by Steve Jurvetson


Put these numbers in the circles...
1
3
5
7
9
11
Photo by Nick Holland

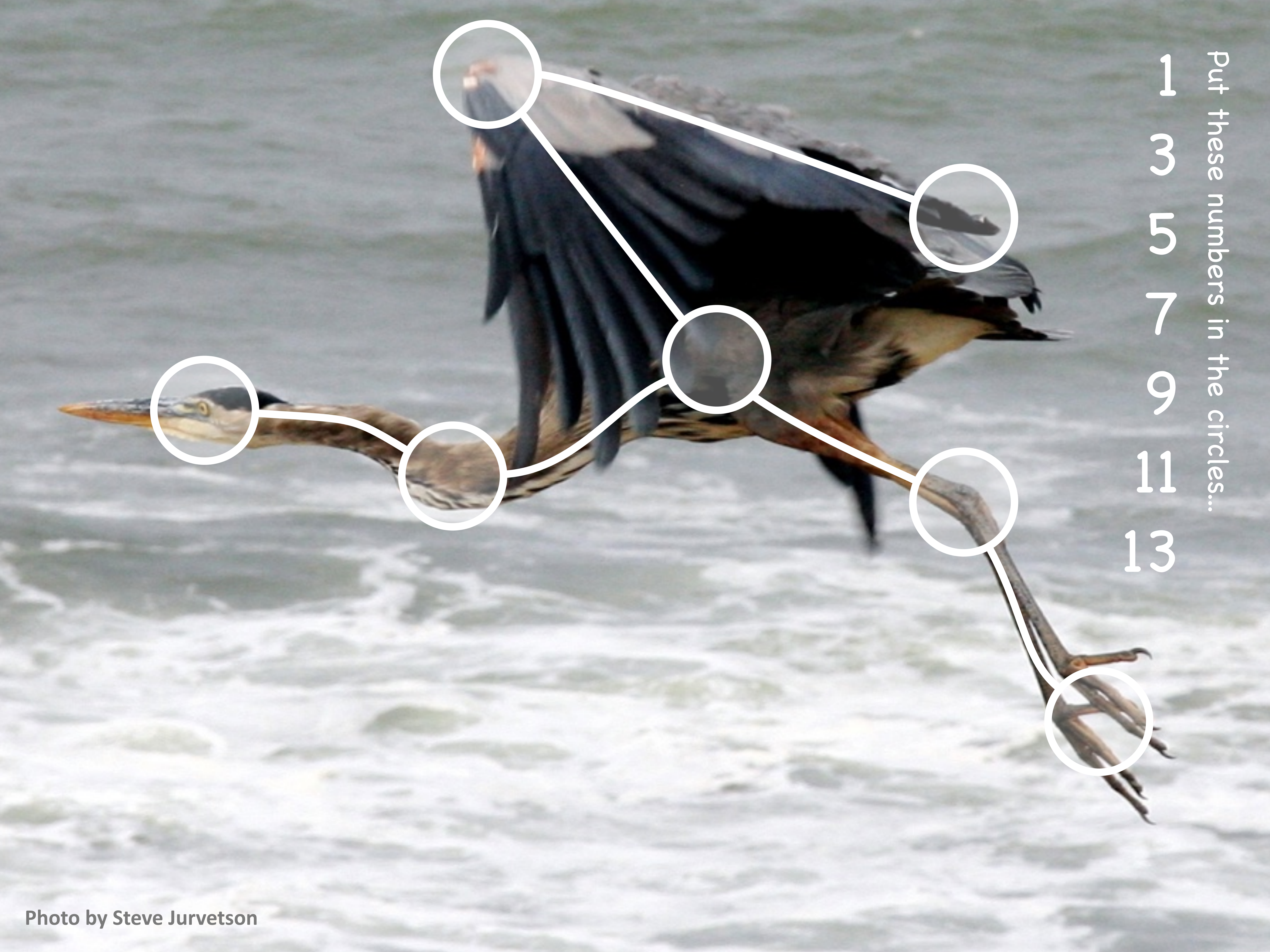


Photo by Steve Jurvetson

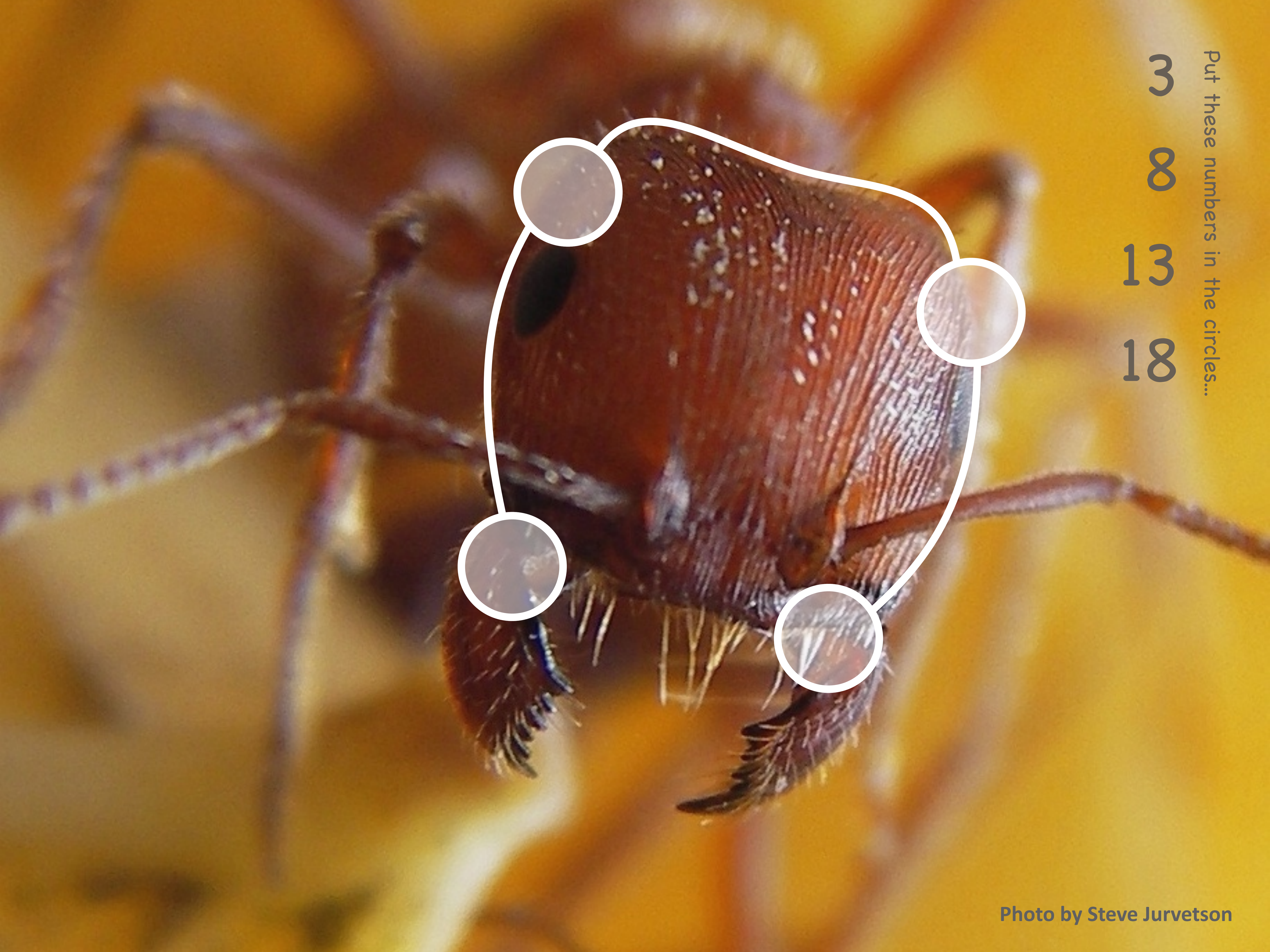
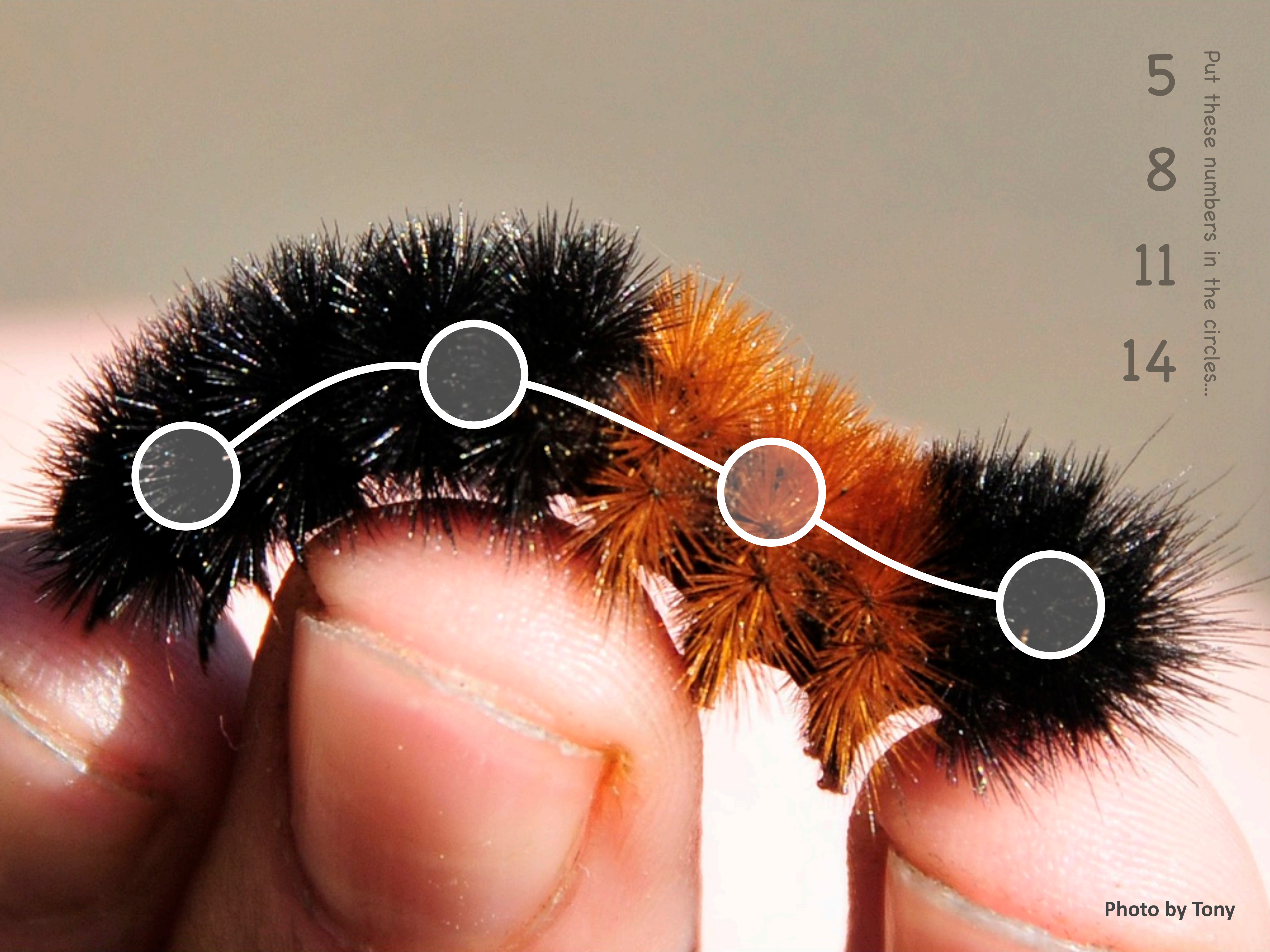


Photo by Steve Jurvetson


5
8
11
14
Put these numbers in the circles...
Photo by Tony


1
4
7
10
13
Put these numbers in the circles...
Photo by Jeffrey Pang

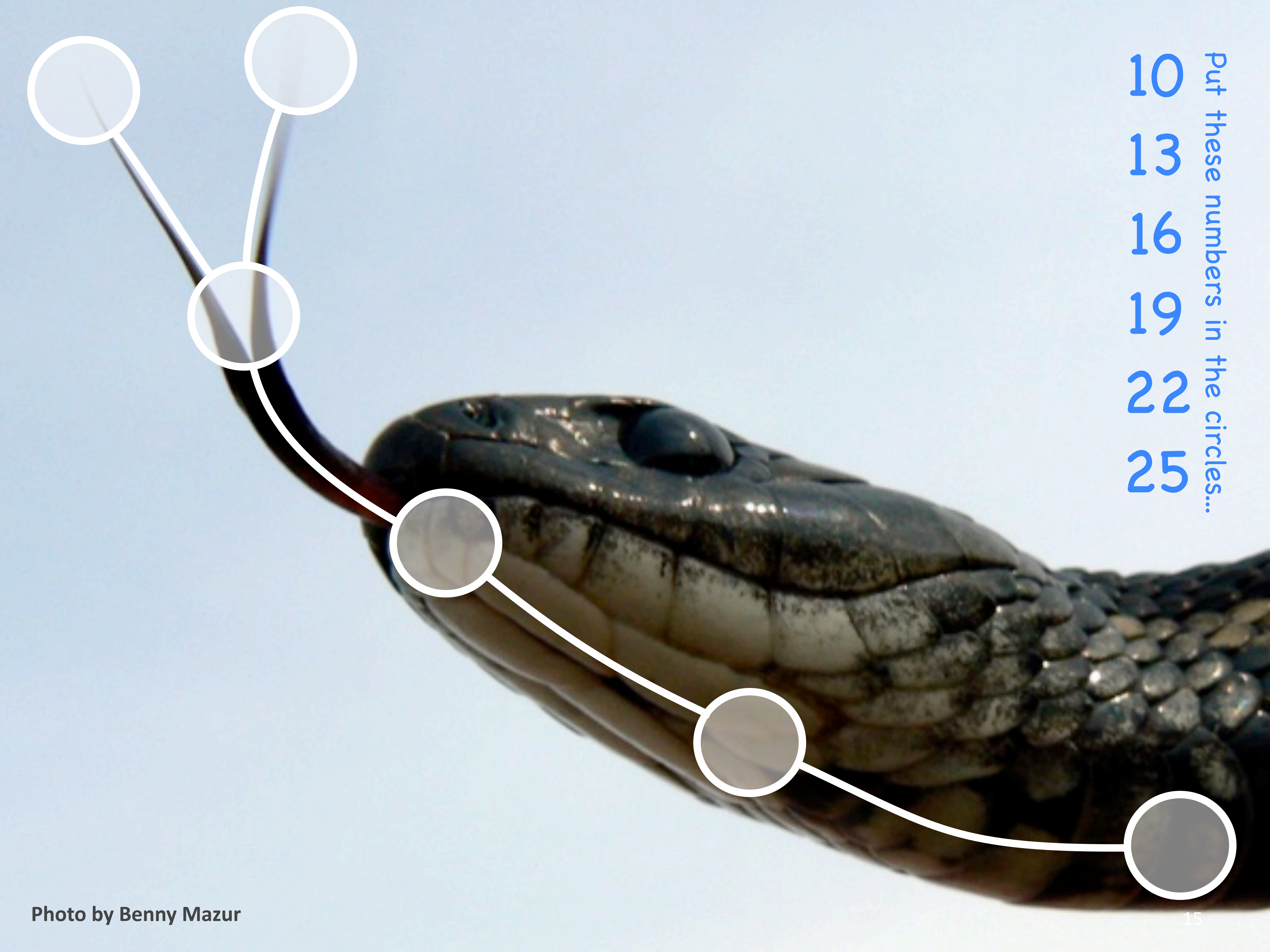
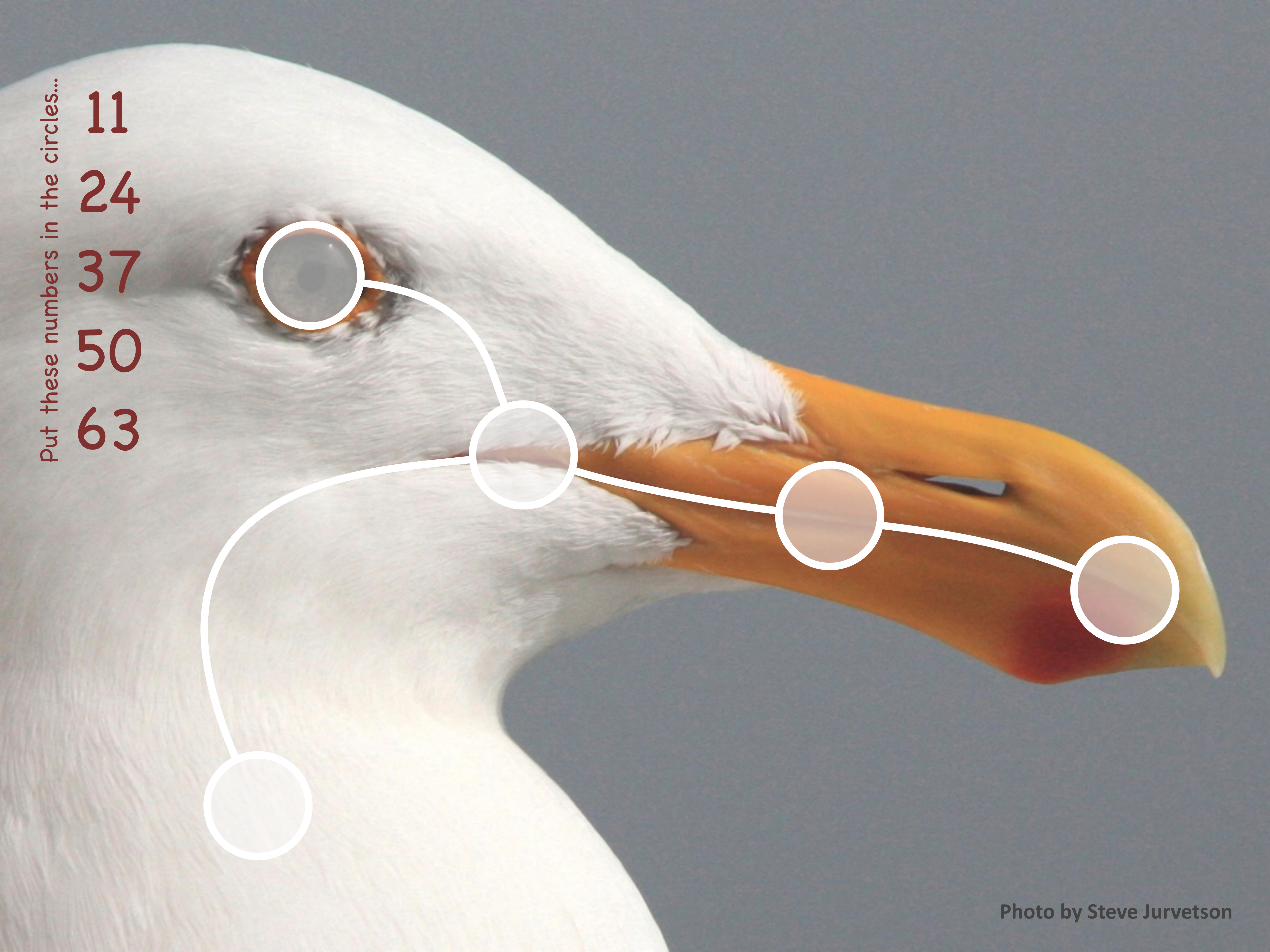
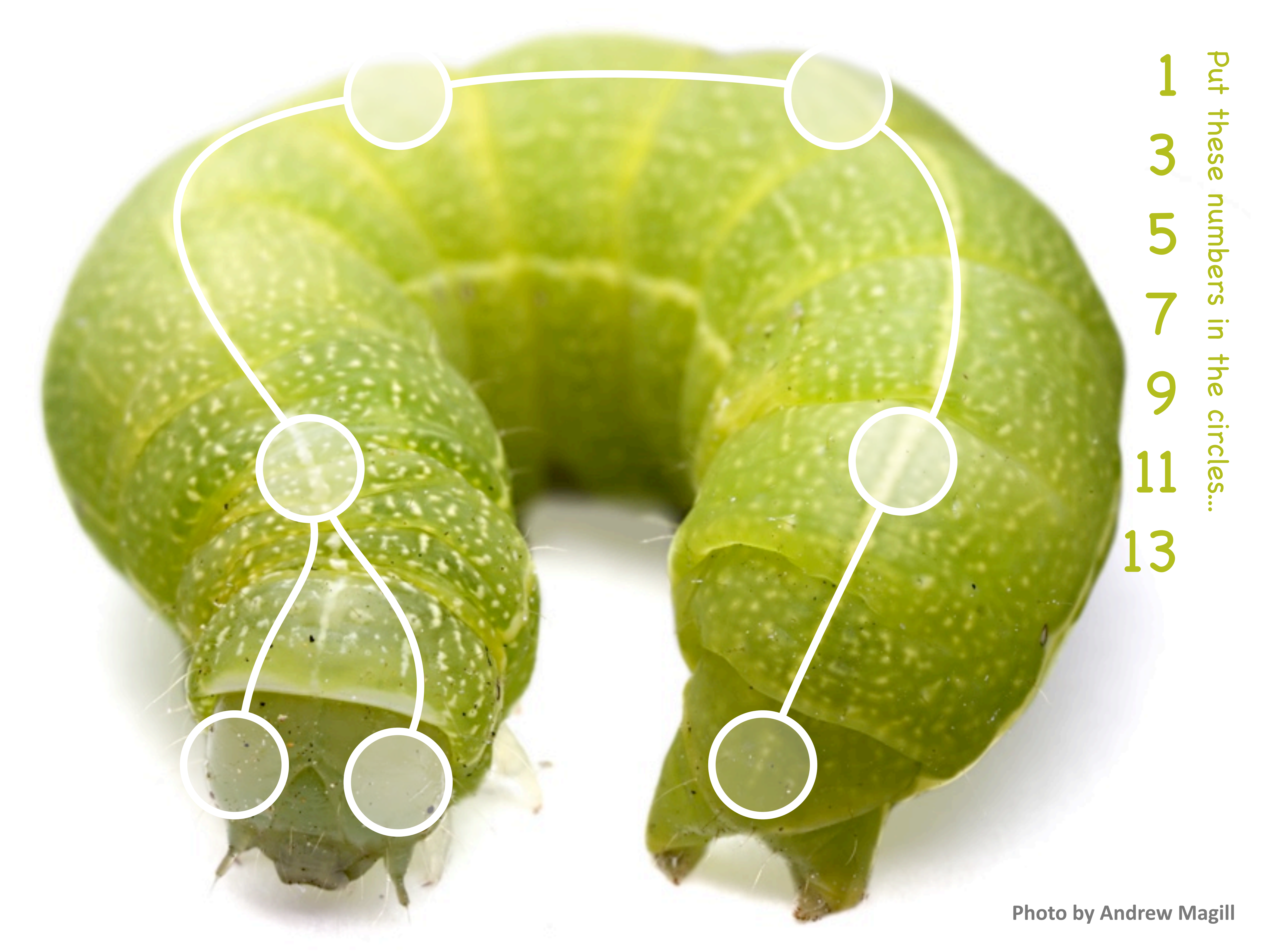


Photo by Benny Mazur


Put these numbers in the circles...
11
24
37
50
63
Photo by Steve Jurvetson


1
3
5
7
9
11
13
Put these numbers in the circles...
Photo by Andrew Magill

Put these numbers in the circles...

10

18

26

34

42

50

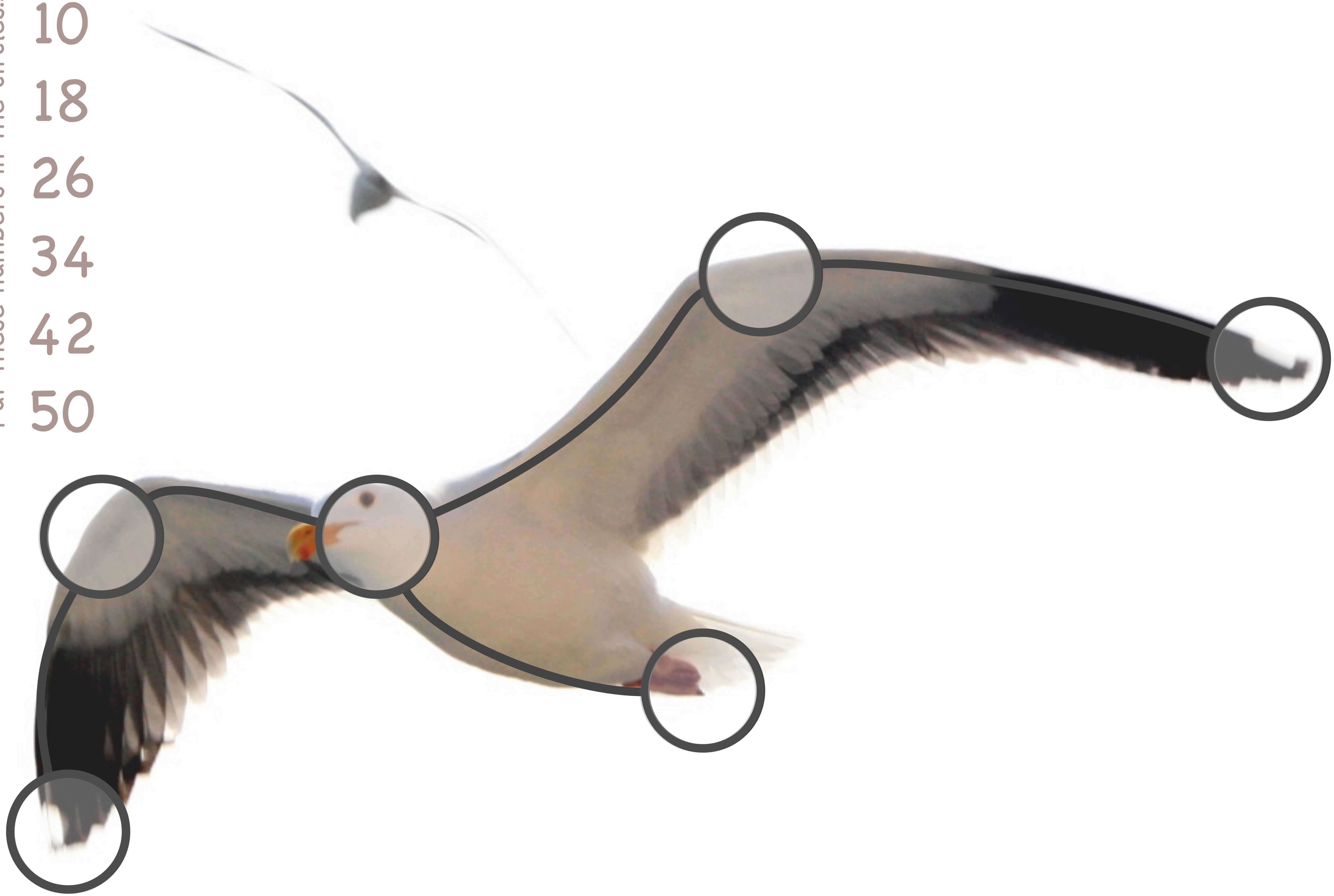


Photo by Steve Jurvetson


1
3
5
7
9
11
13
15
Photo by Louise Docker

Photo by Axel Rouvin

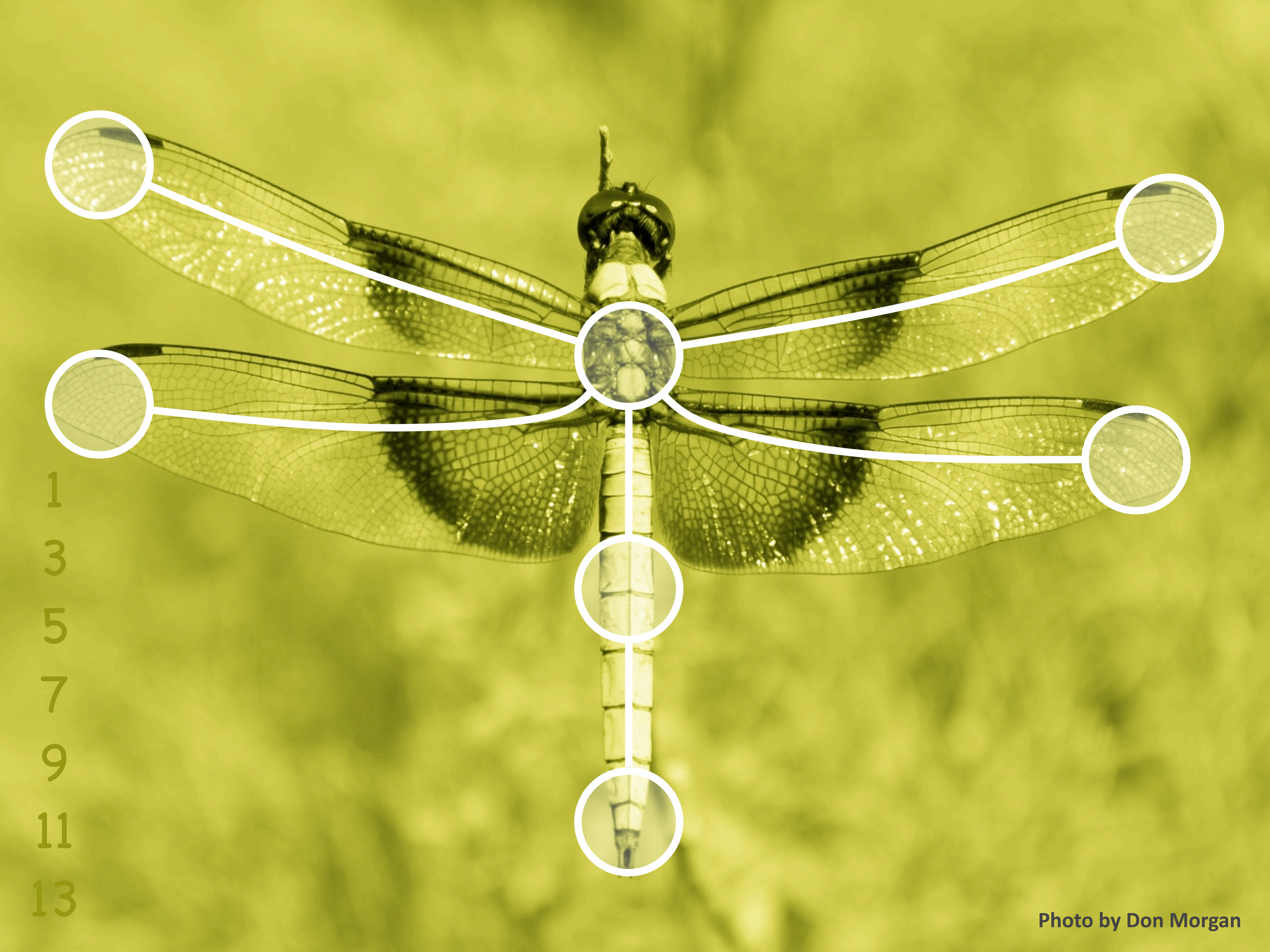
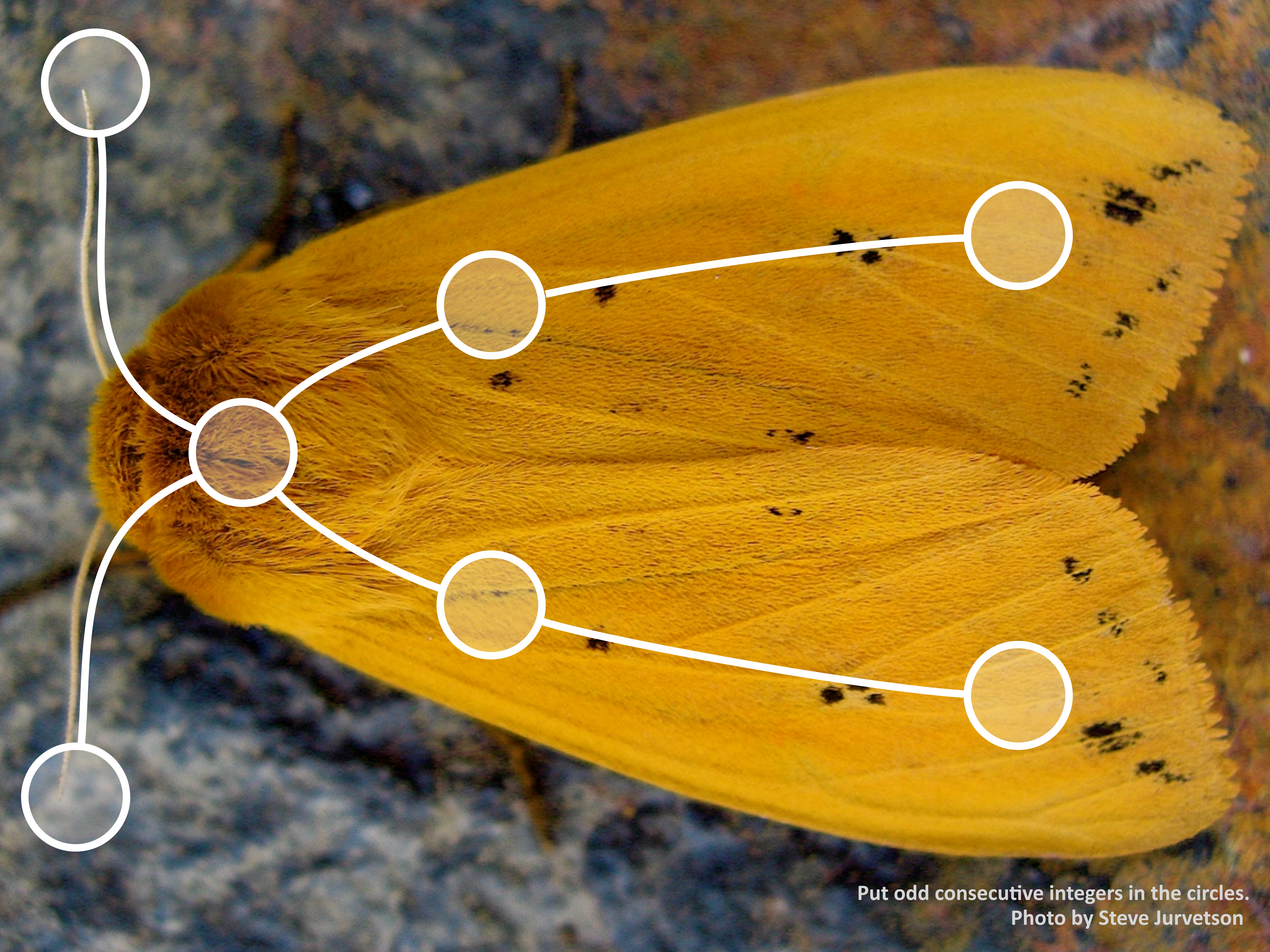
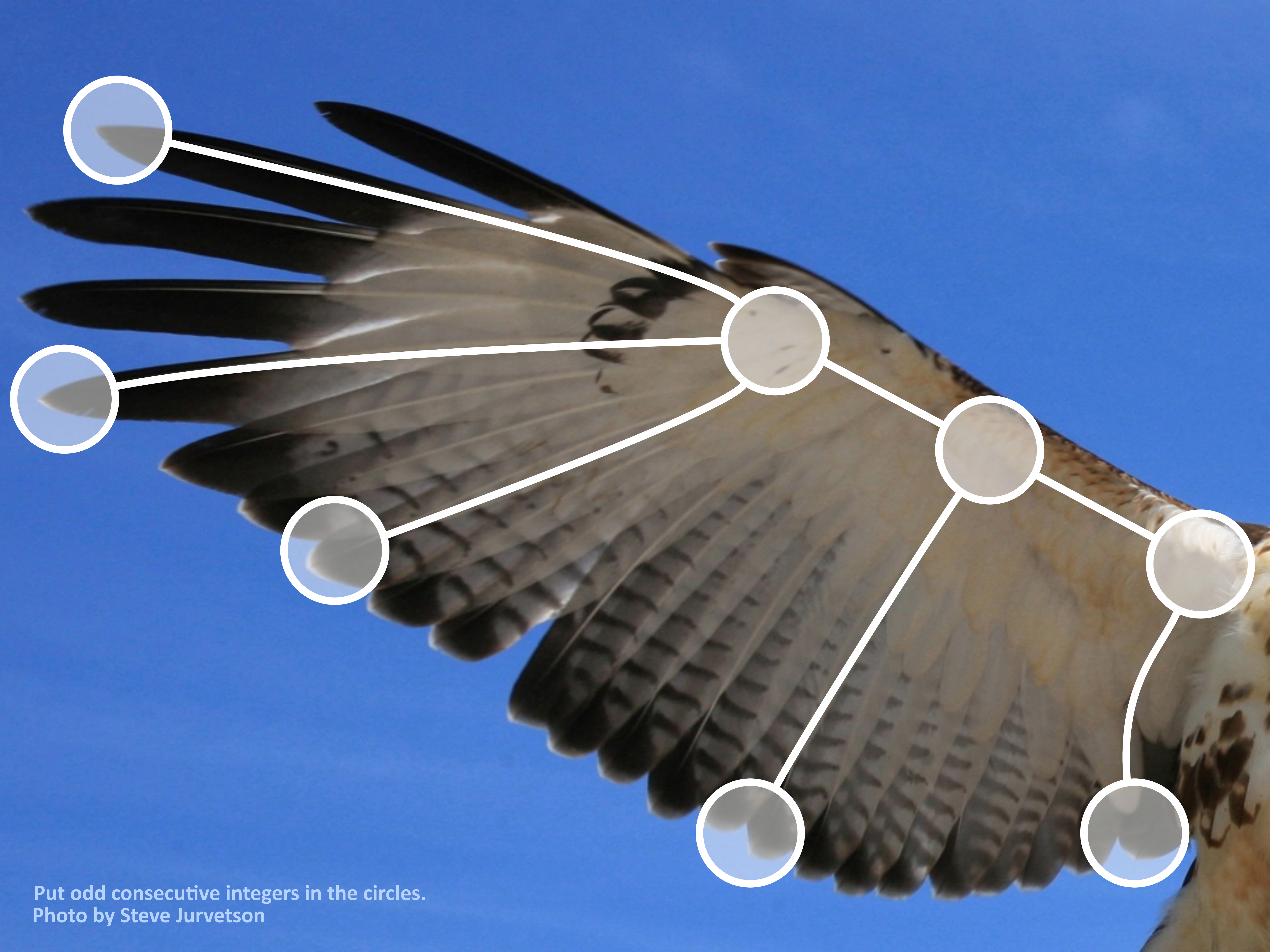
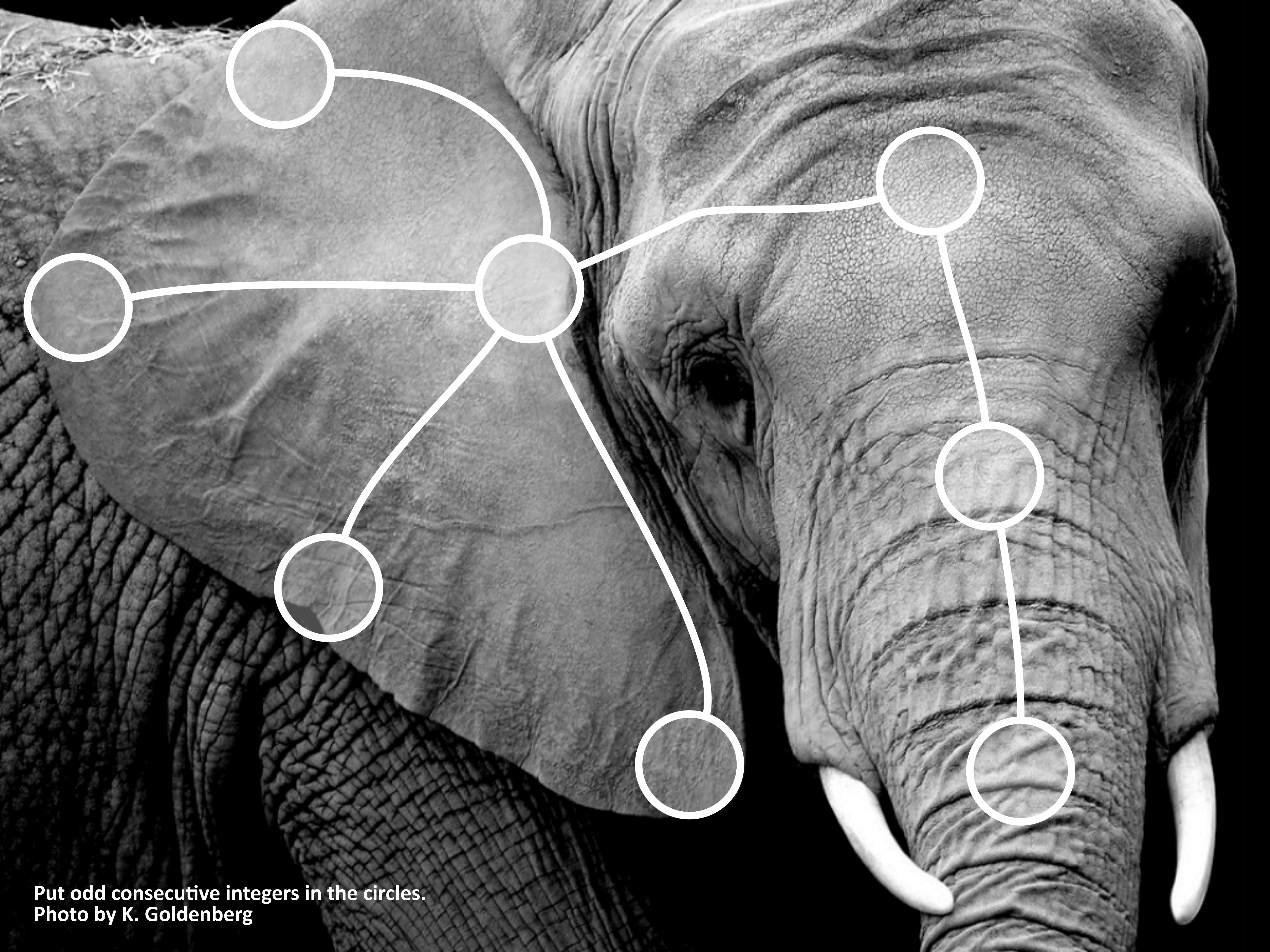


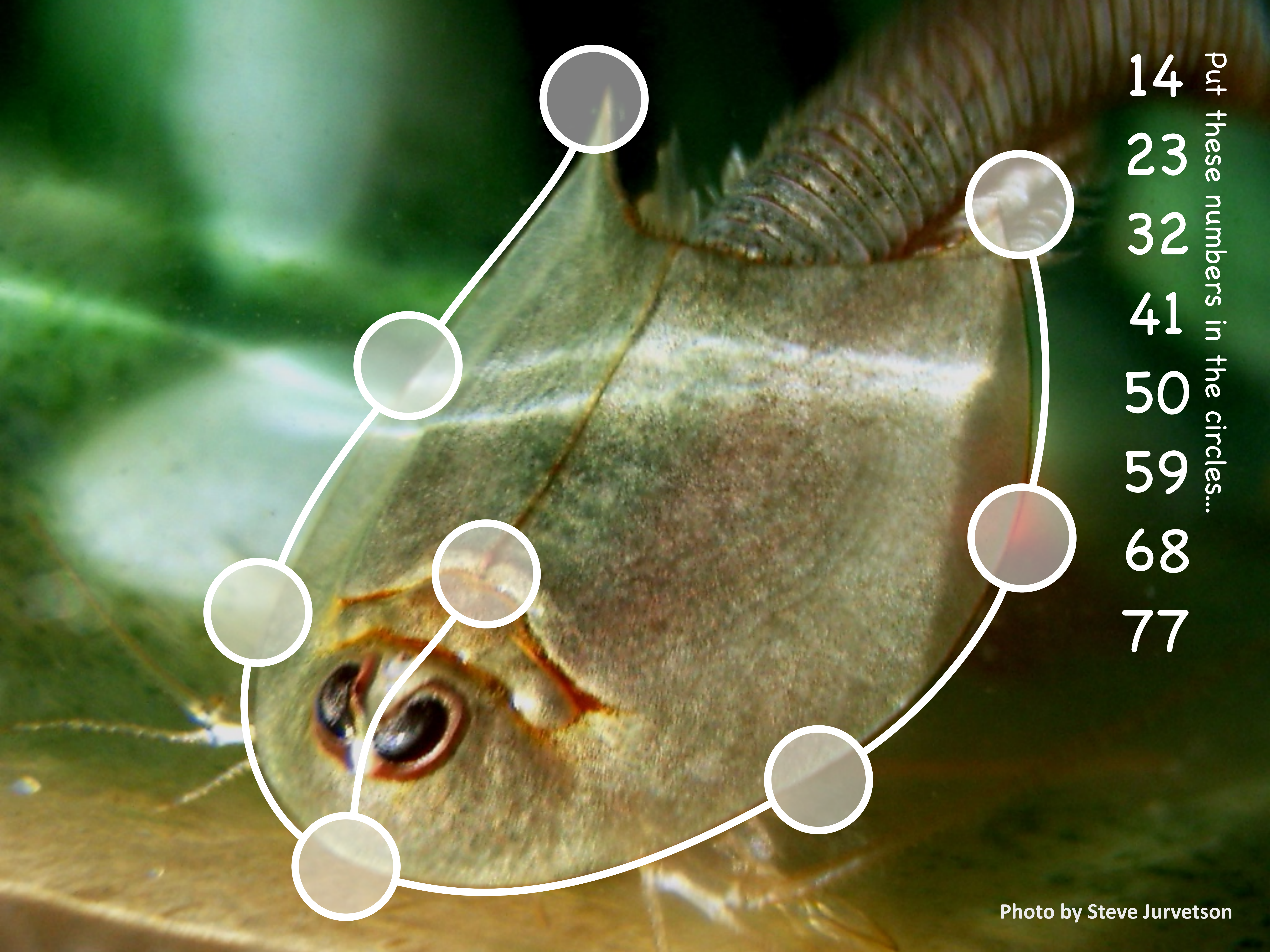
Photo by Don Morgan

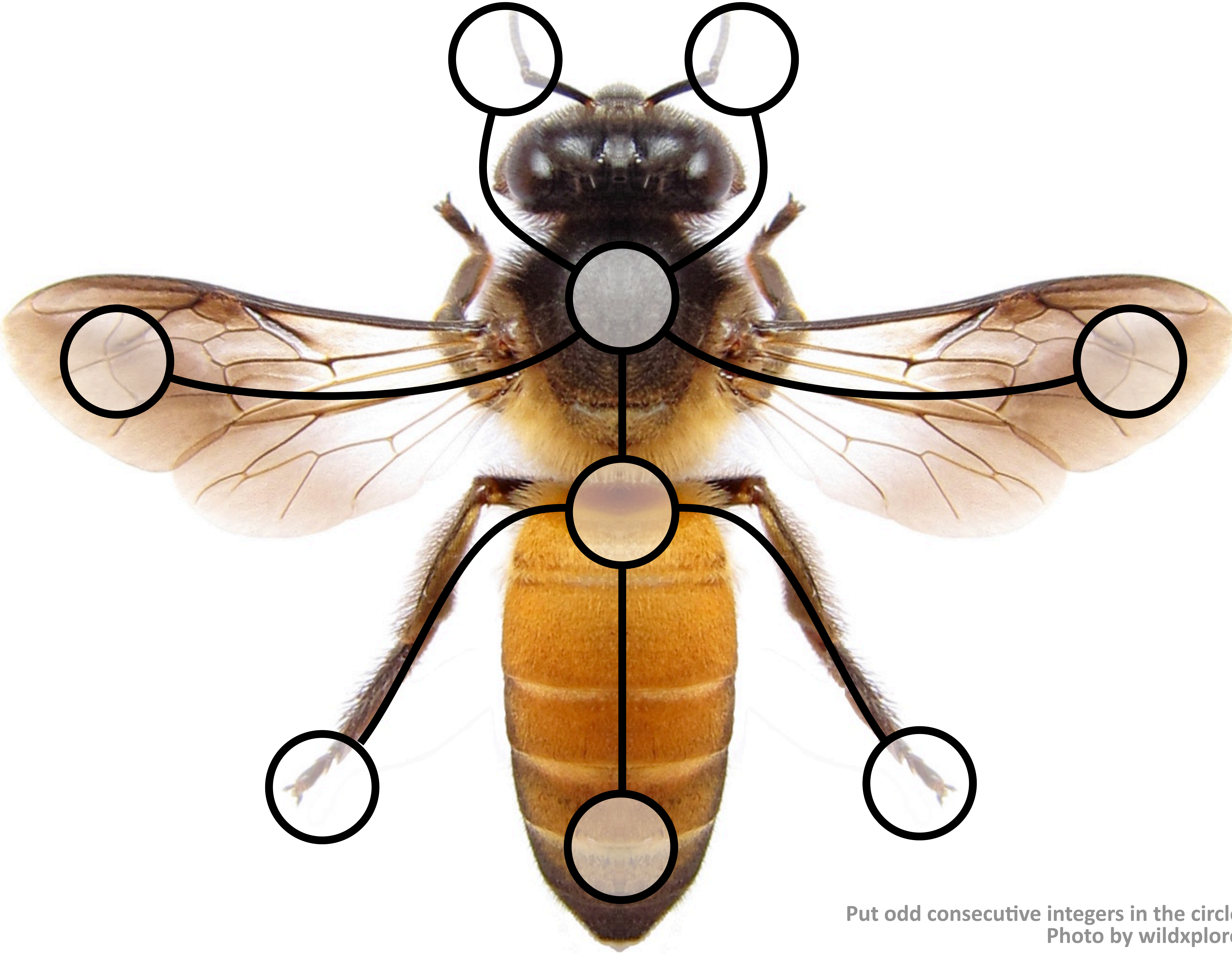

Put odd consecutive integers in the circles.
Photo by Steve Jurvetson


Put odd consecutive integers in the circles.
Photo by Steve Jurvetson

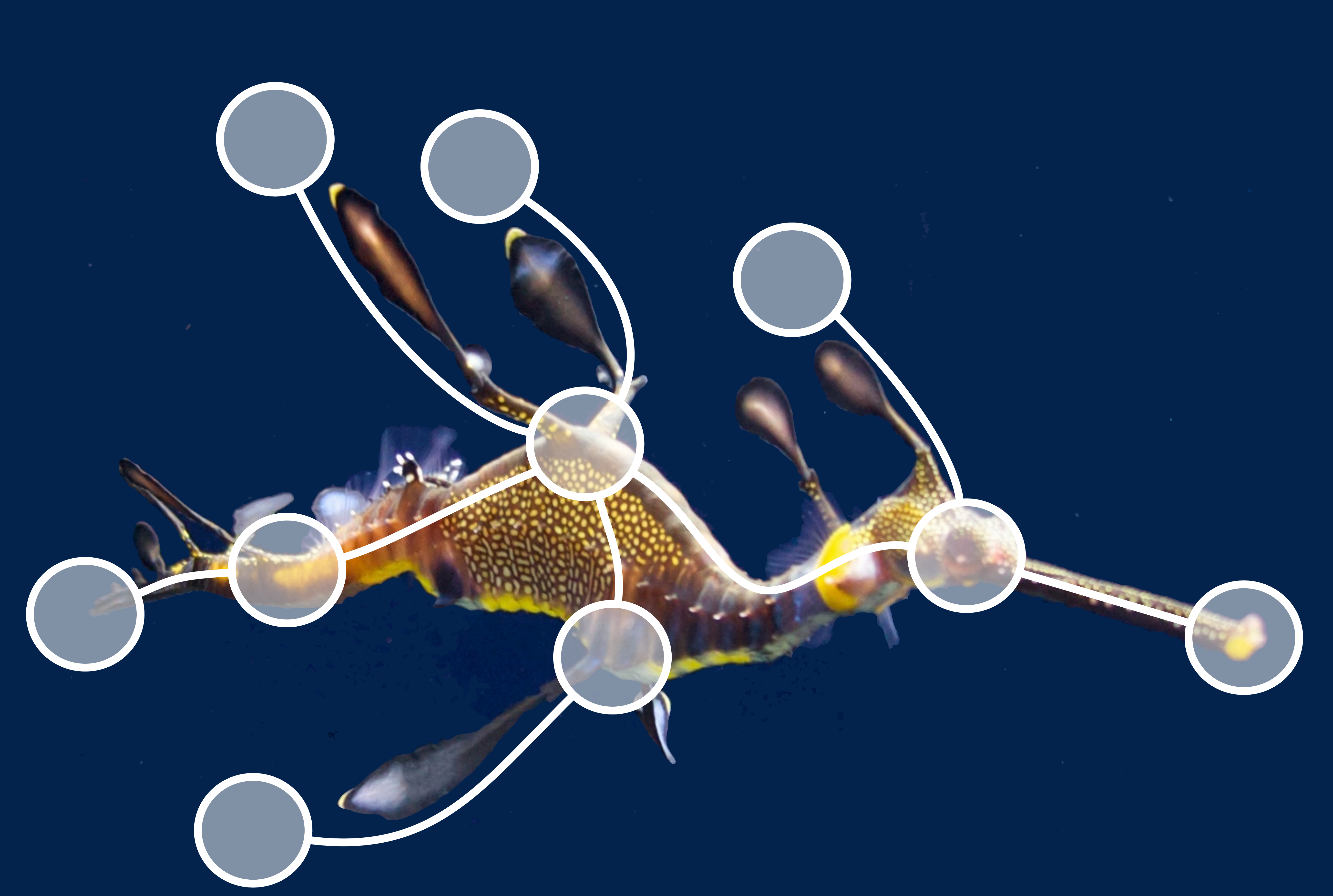

Put odd consecutive integers in the circles.
Photo by Steve Jurvetson


Put odd consecutive integers in the circles.
Photo by K. Goldenberg


14
23
32
41
50
59
68
77
Put these numbers in the circles...
Photo by Steve Jurvetson



Put odd consecutive integers in the circles.
Photo by wildxplorer



Put odd consecutive integers in the circles.
Photo by Jay Galvin

Animal Subtraction

Things to think about
(Meta puzzles and Proofs)

Question:

All animals solved so far have n circles and n-1 connecting lines. The nasty fish on the next page has 9 circles and 9 connecting lines. Is it possible to solve? (Dunkleosteus terrelli is an extinct 4 ton predatory fish)

Question:

The puzzles on pages 30-38 have loops. Put odd consecutive integers into the circles and figure out which are possible and which are impossible to solve.

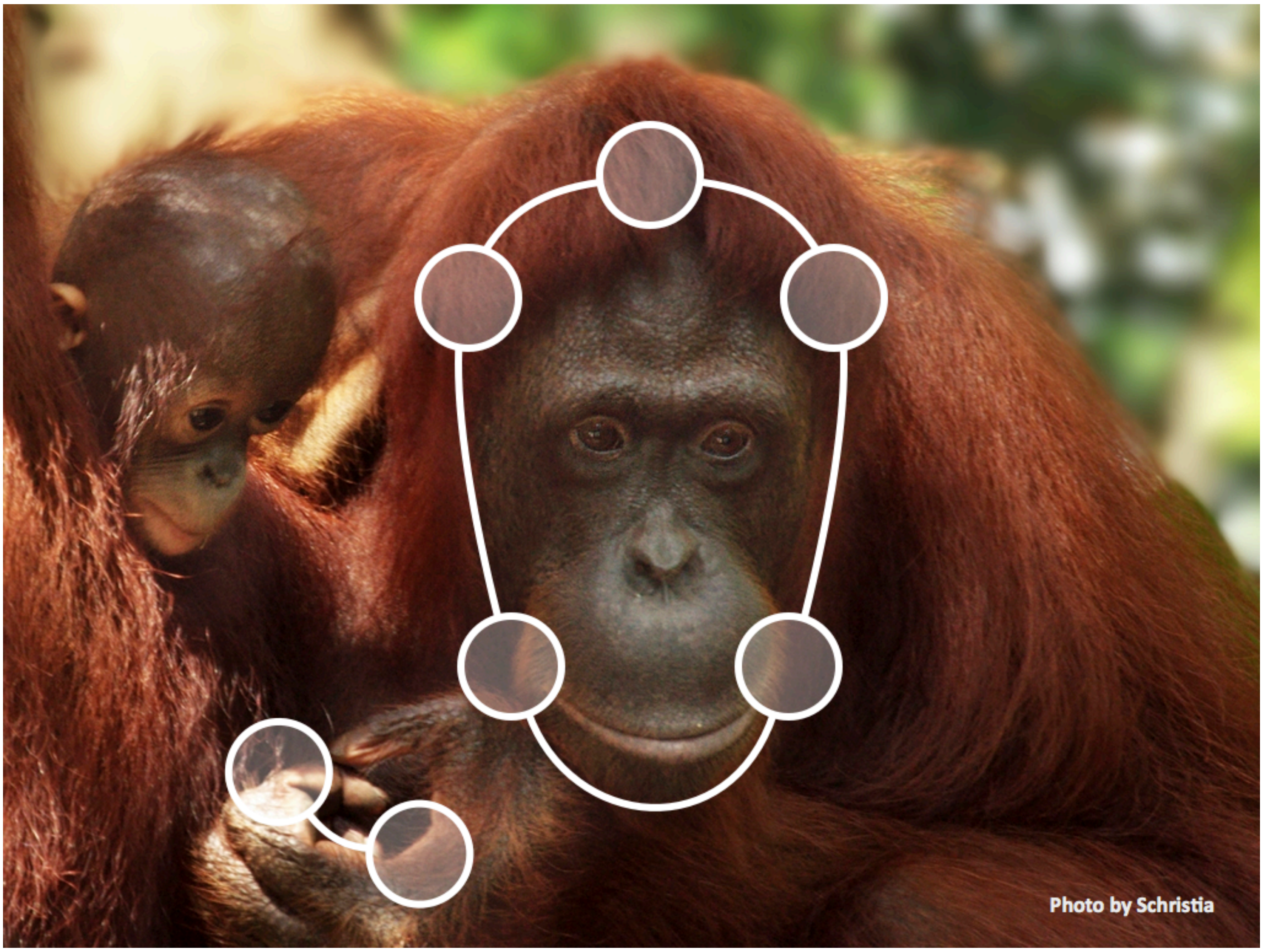
Question:

How many patterns are there with 7 circles and 6 connecting lines - and no loop ?

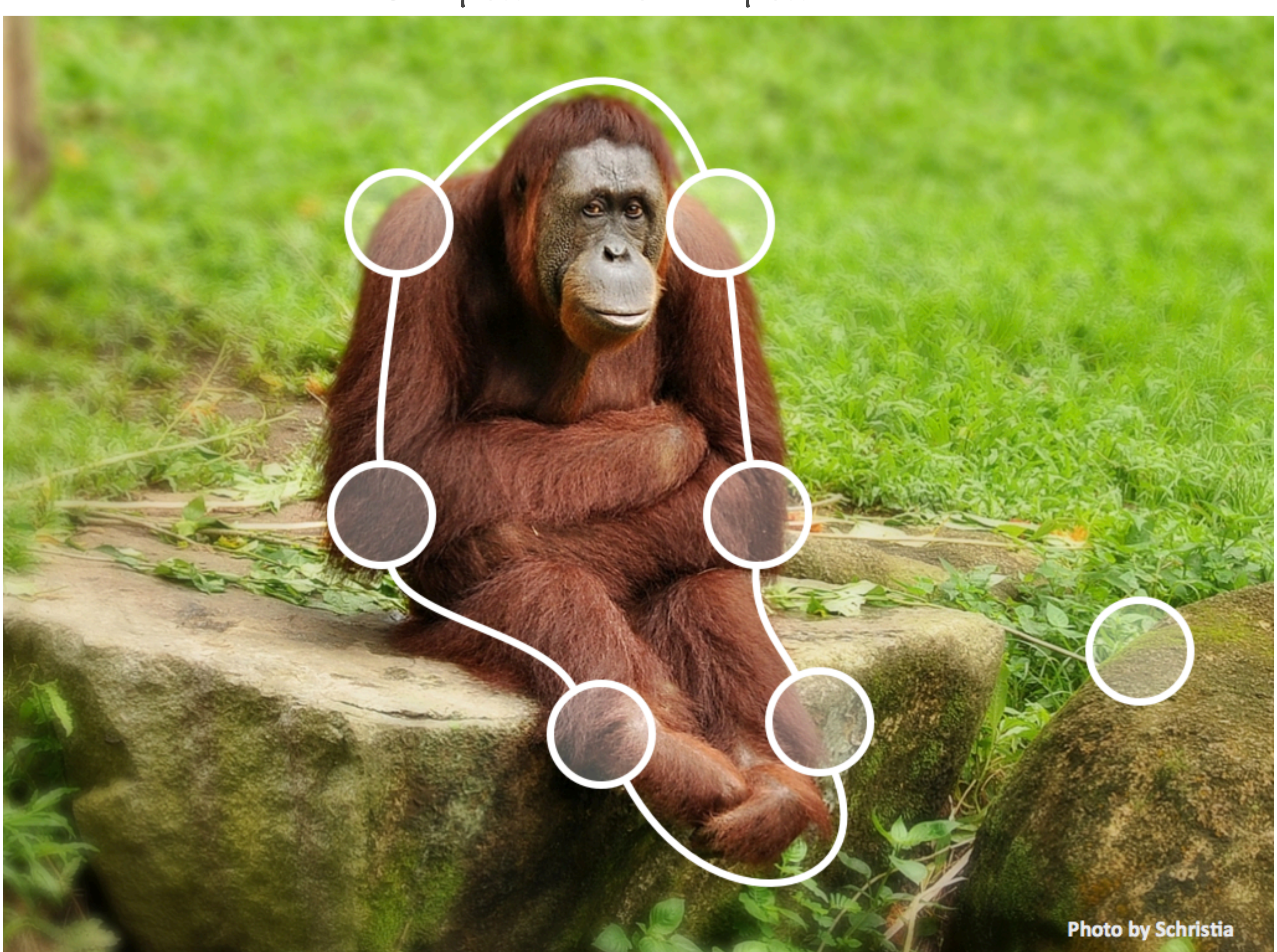
How many of these are solvable?

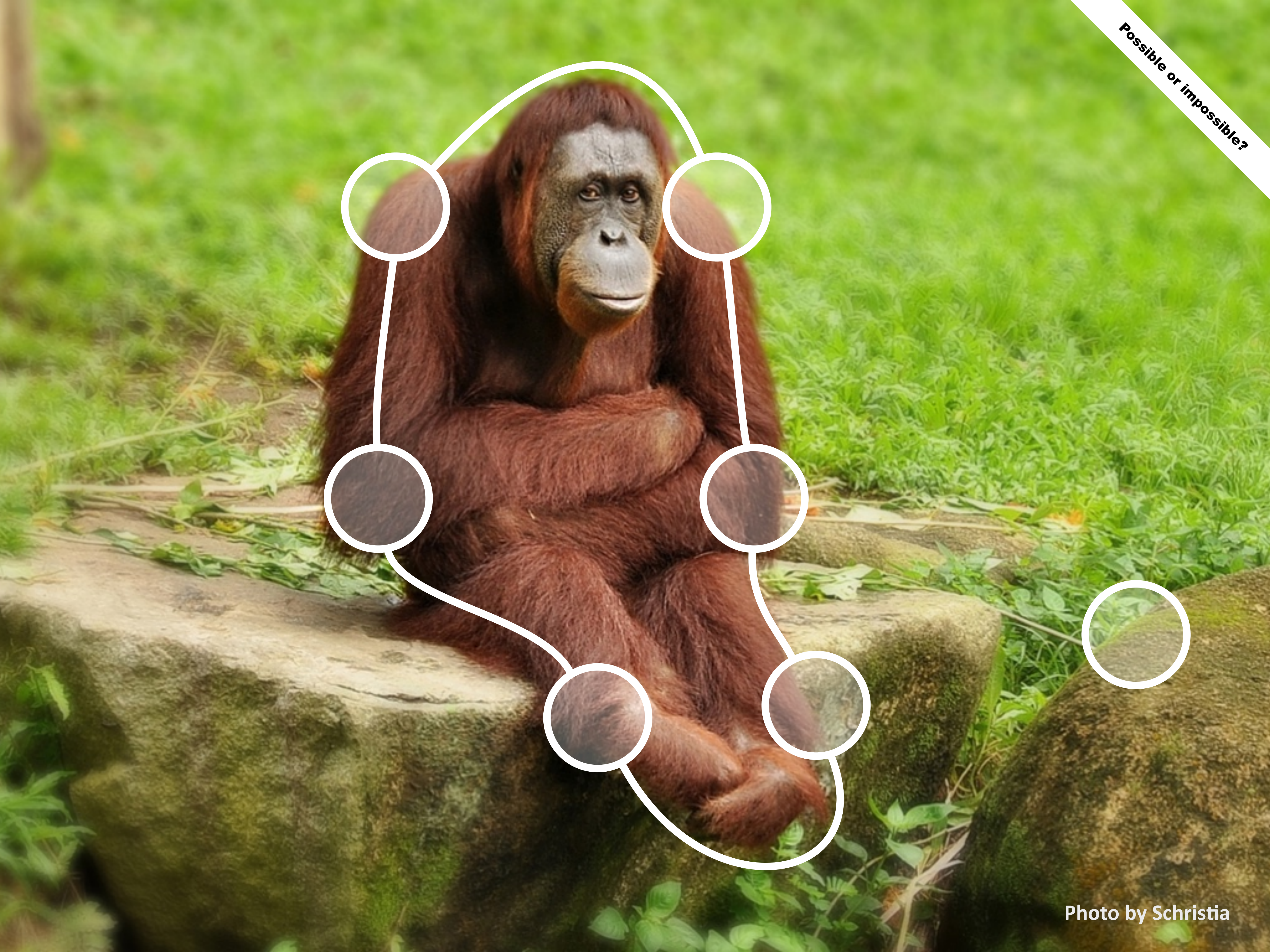
How many patterns are there with 7 circles and 6 connecting lines - and and at least one loop ?

How many of these are solvable?

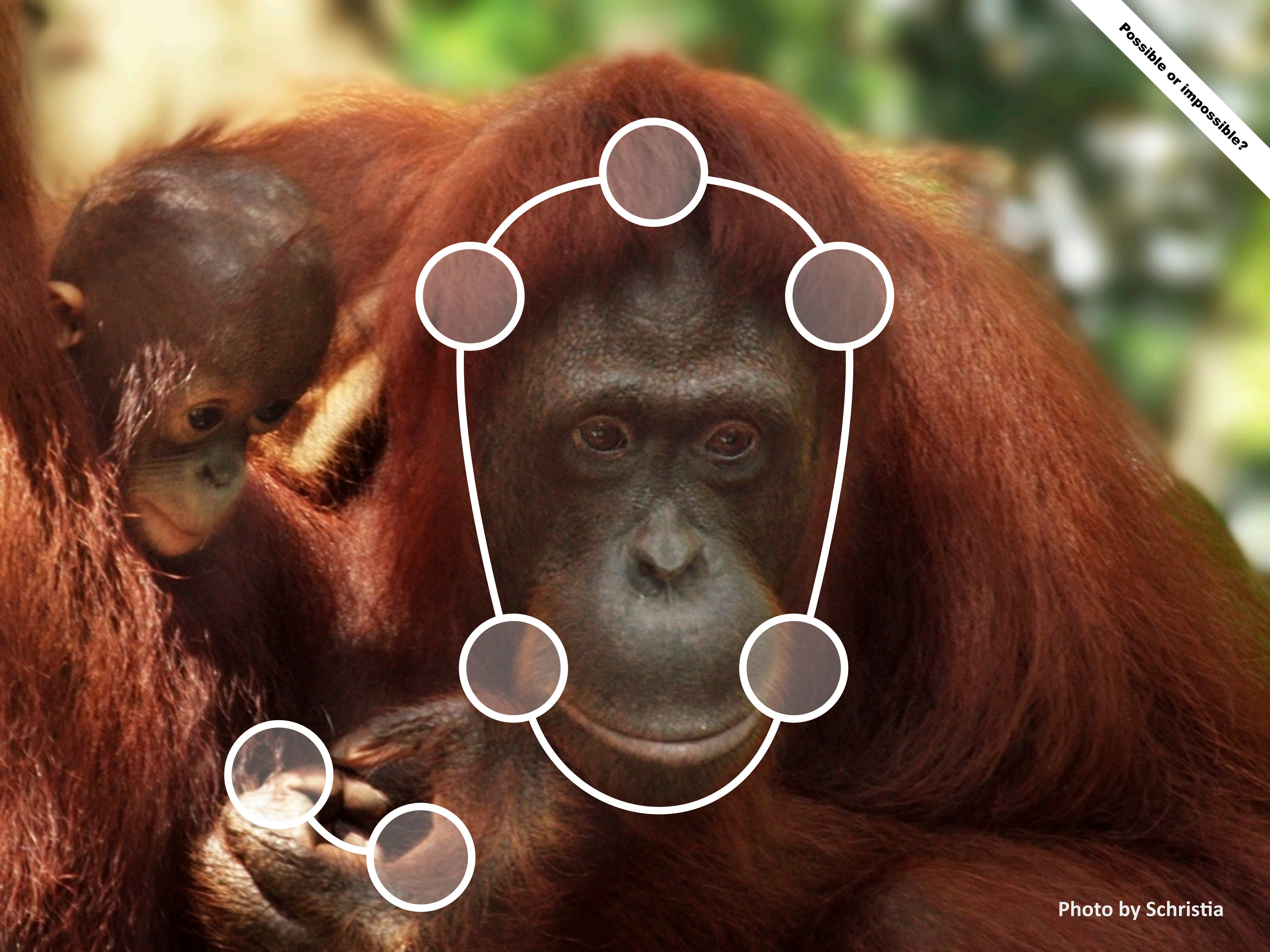


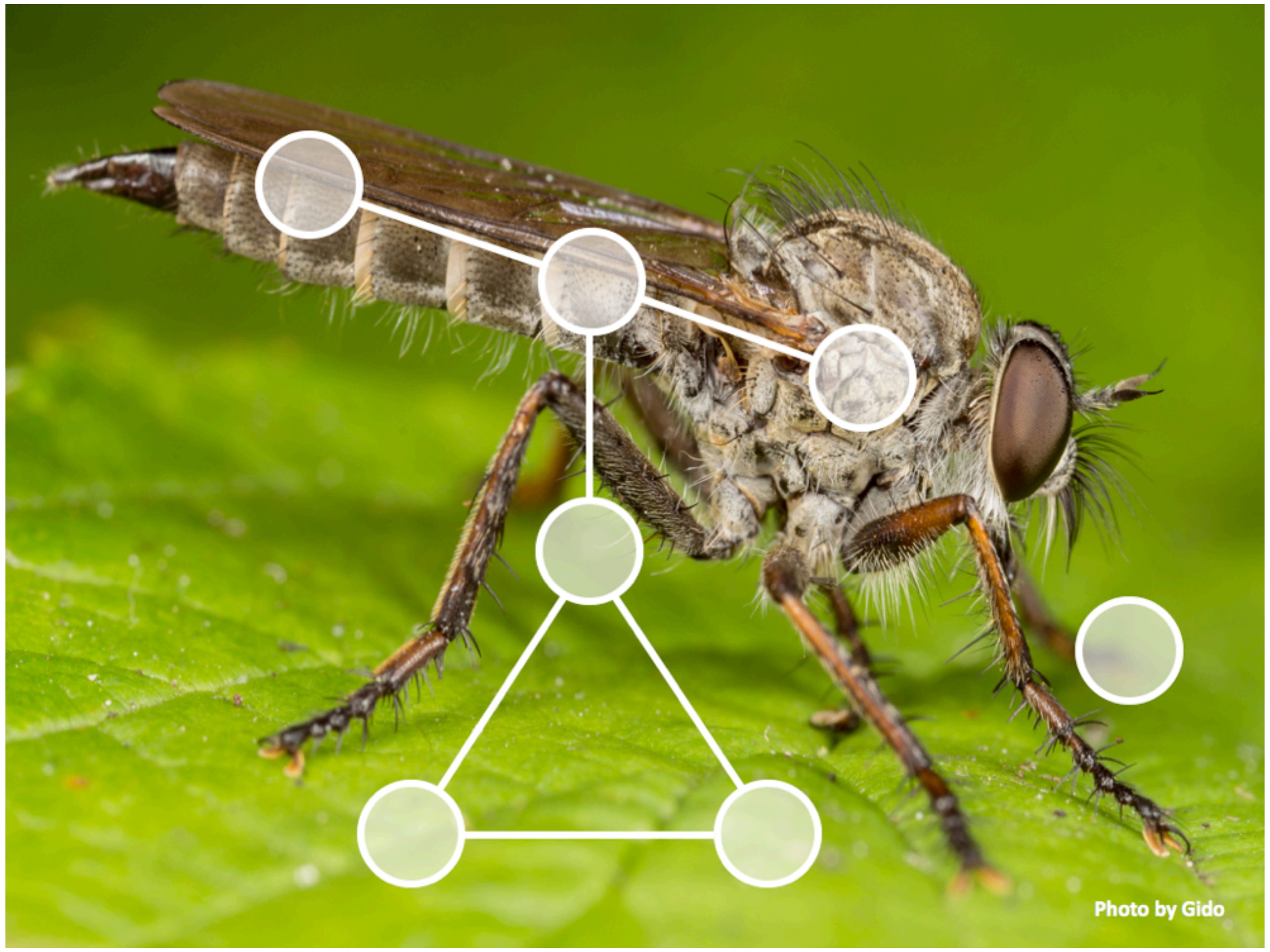
One possible… one impossible…



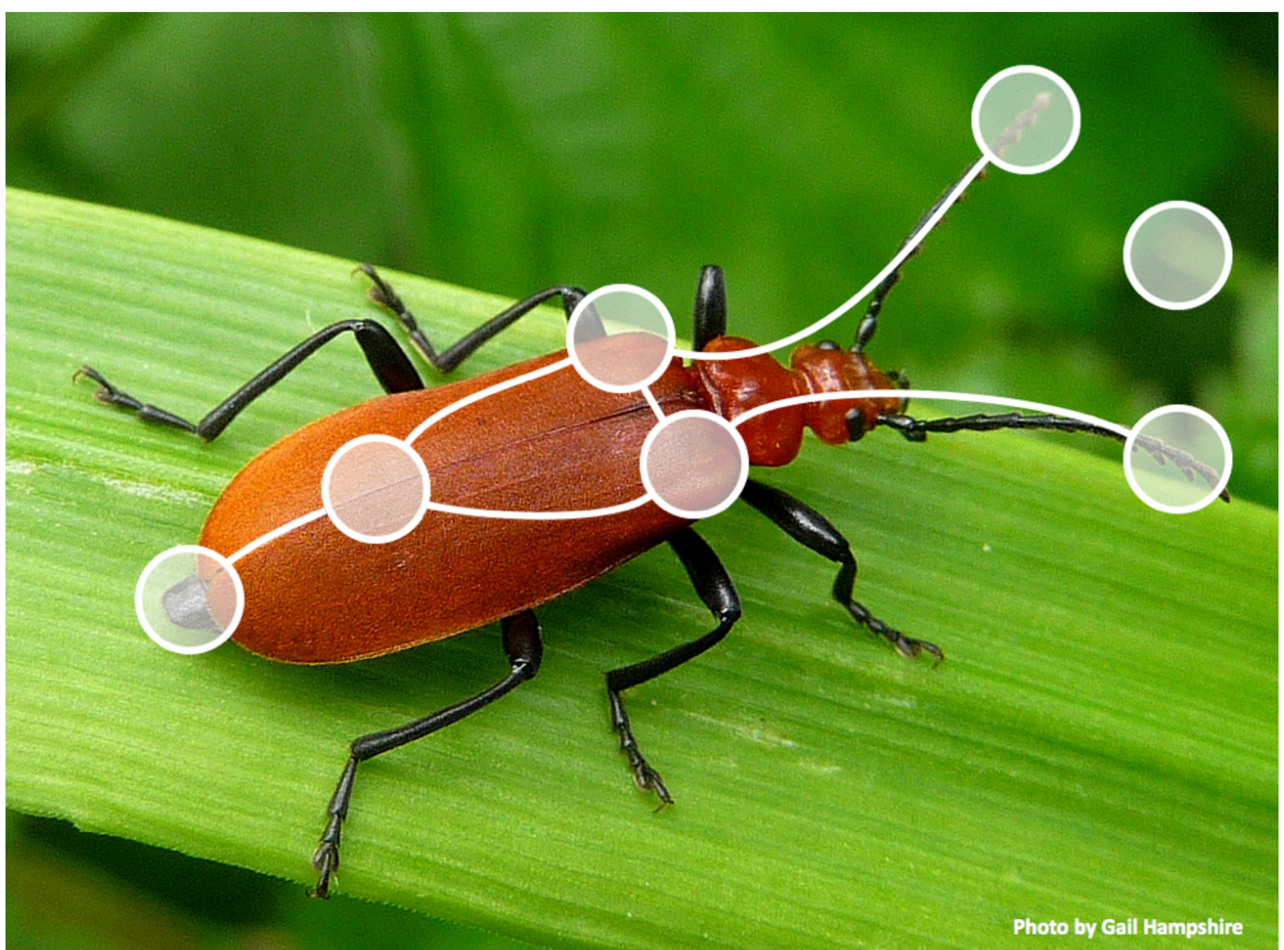


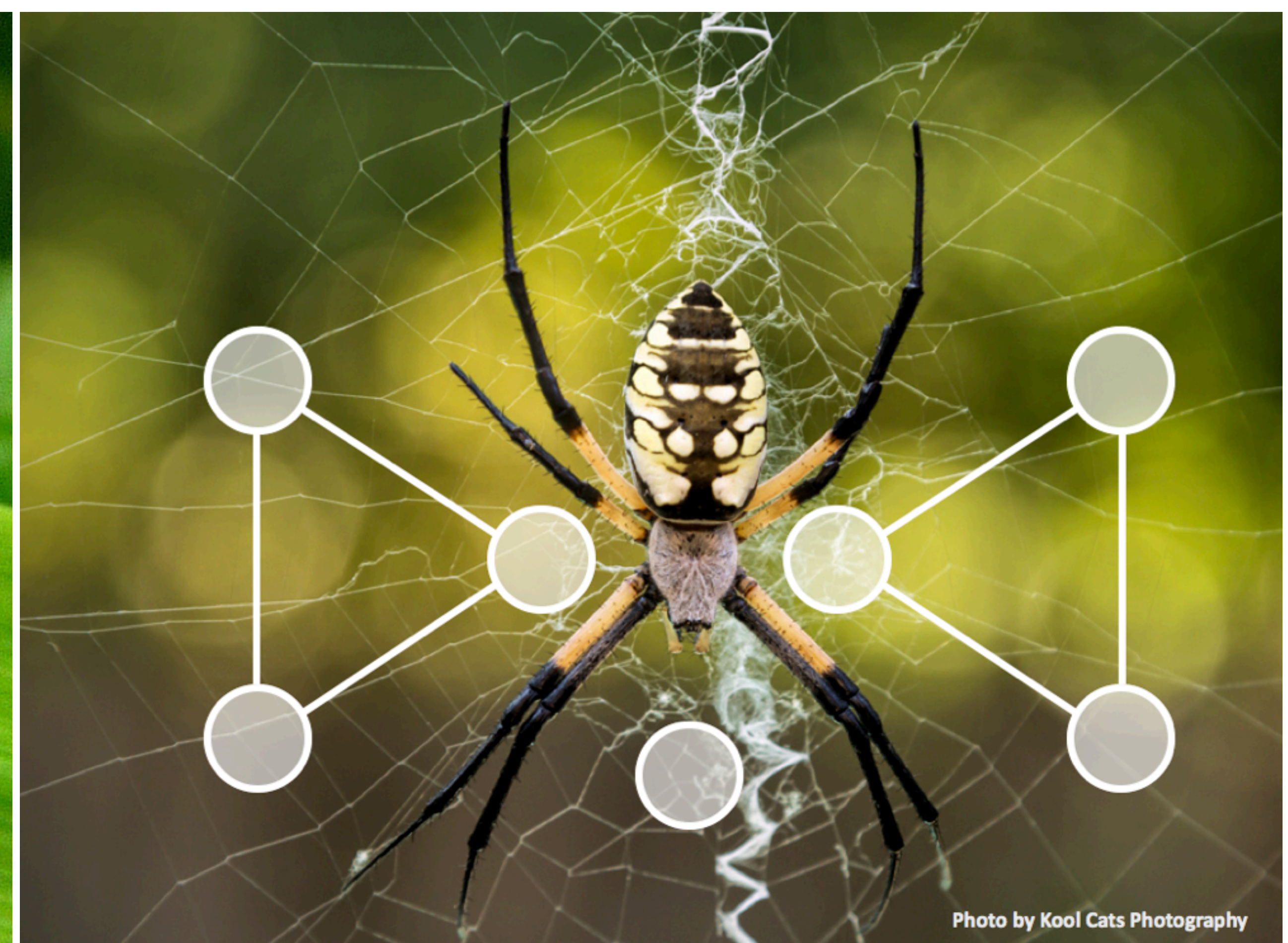
Possible or impossible?
Photo by Schristia


Possible or impossible?
Photo by Schristia

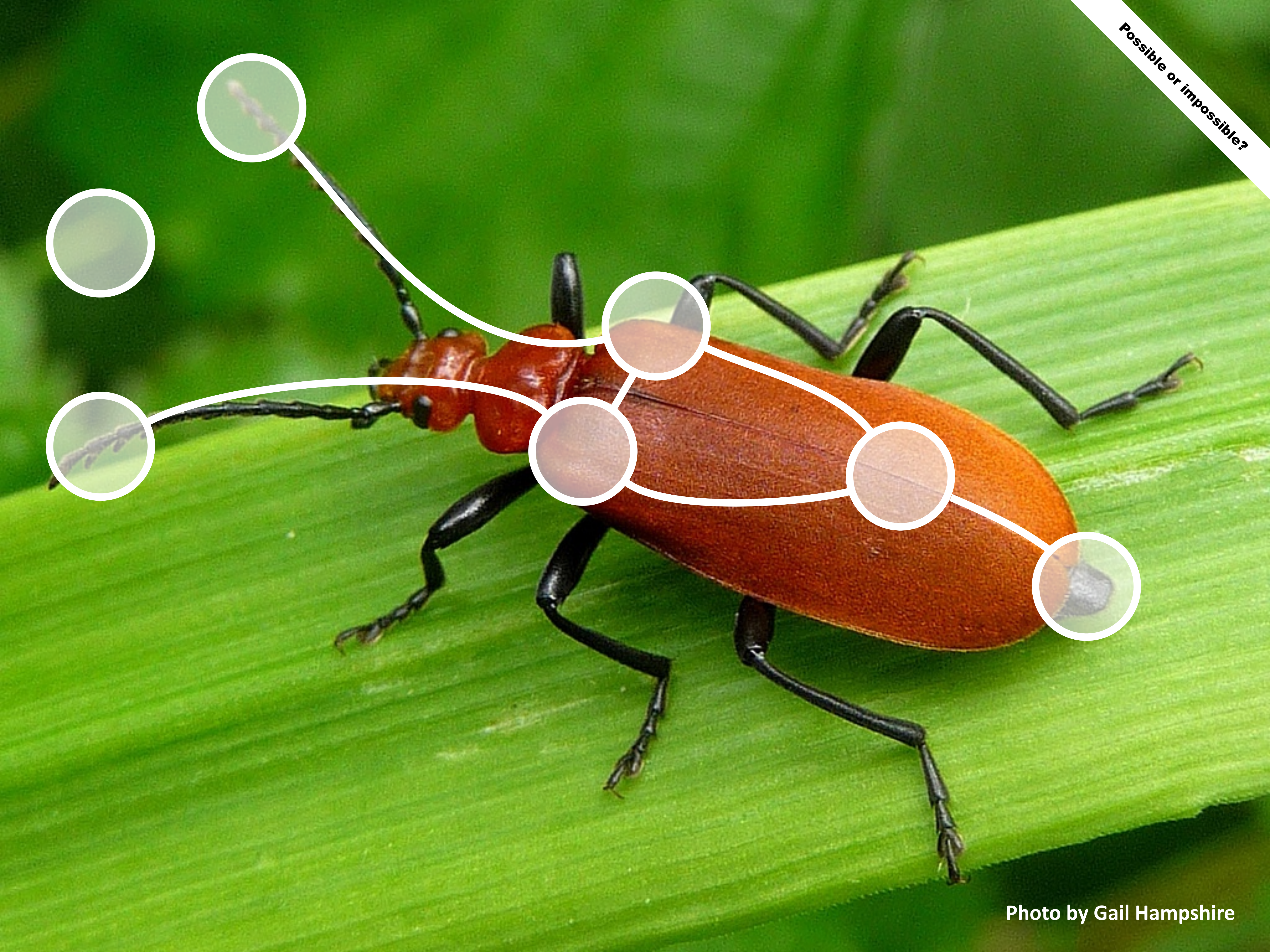


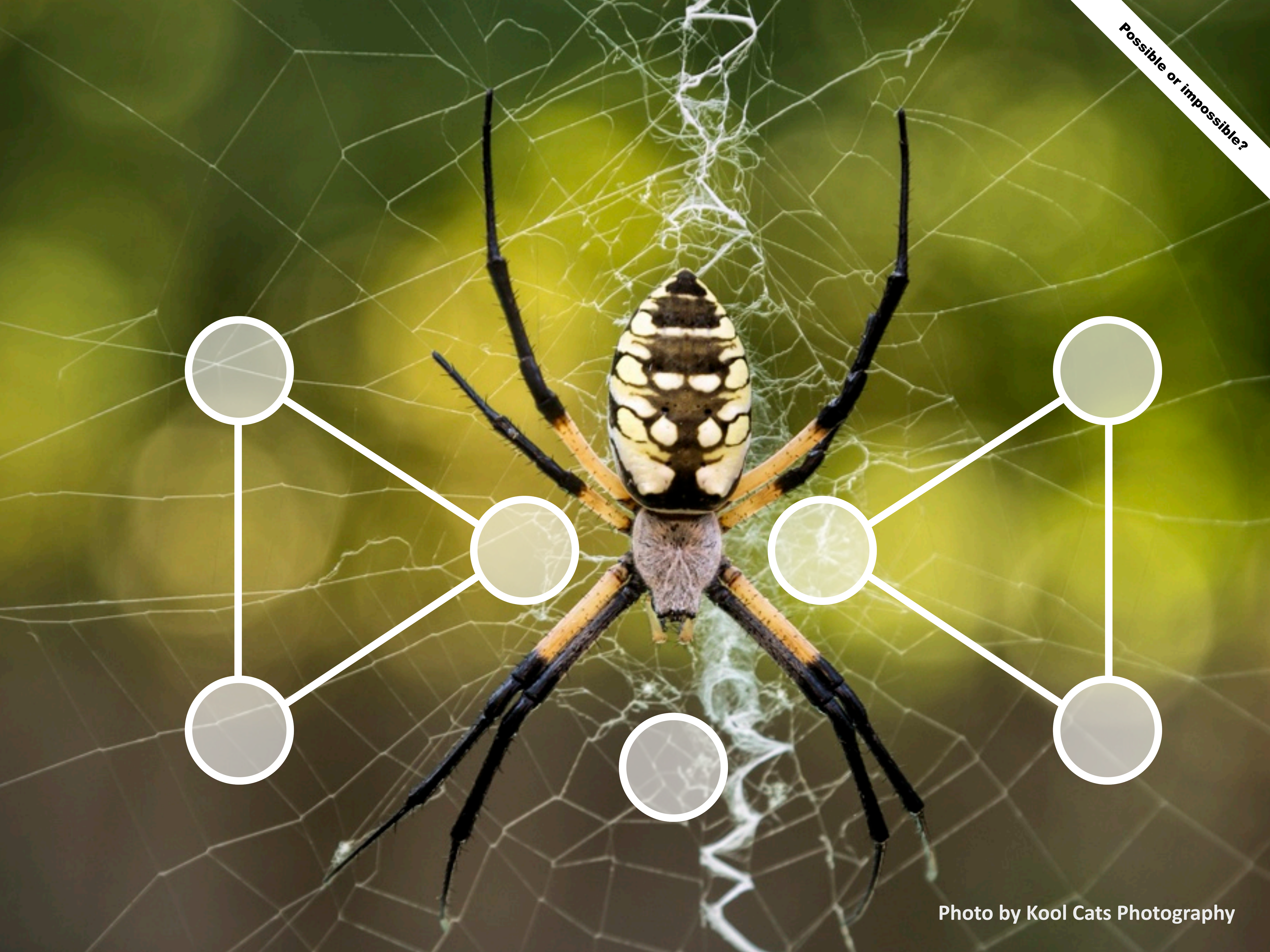
Two possible… two impossible…

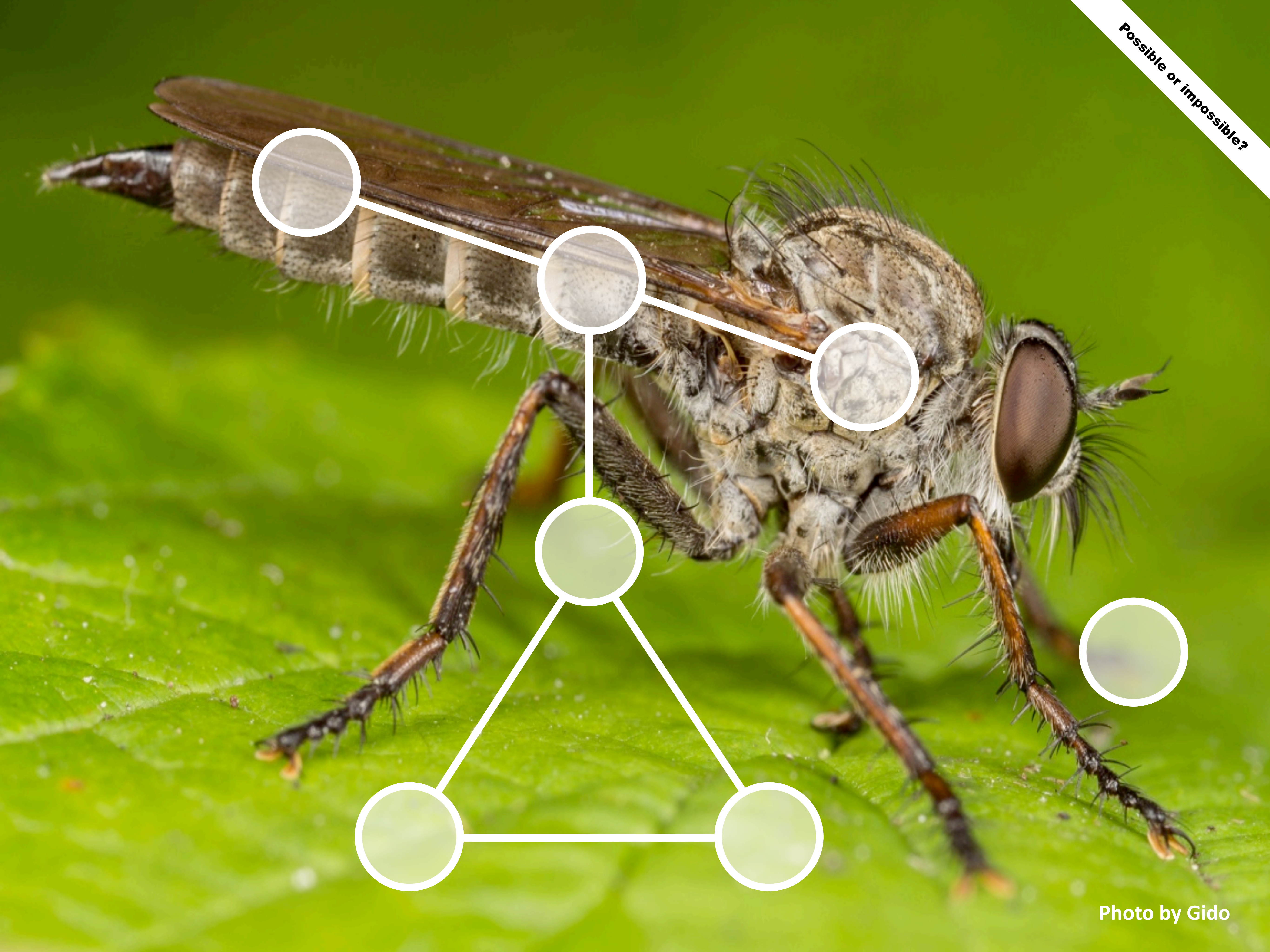


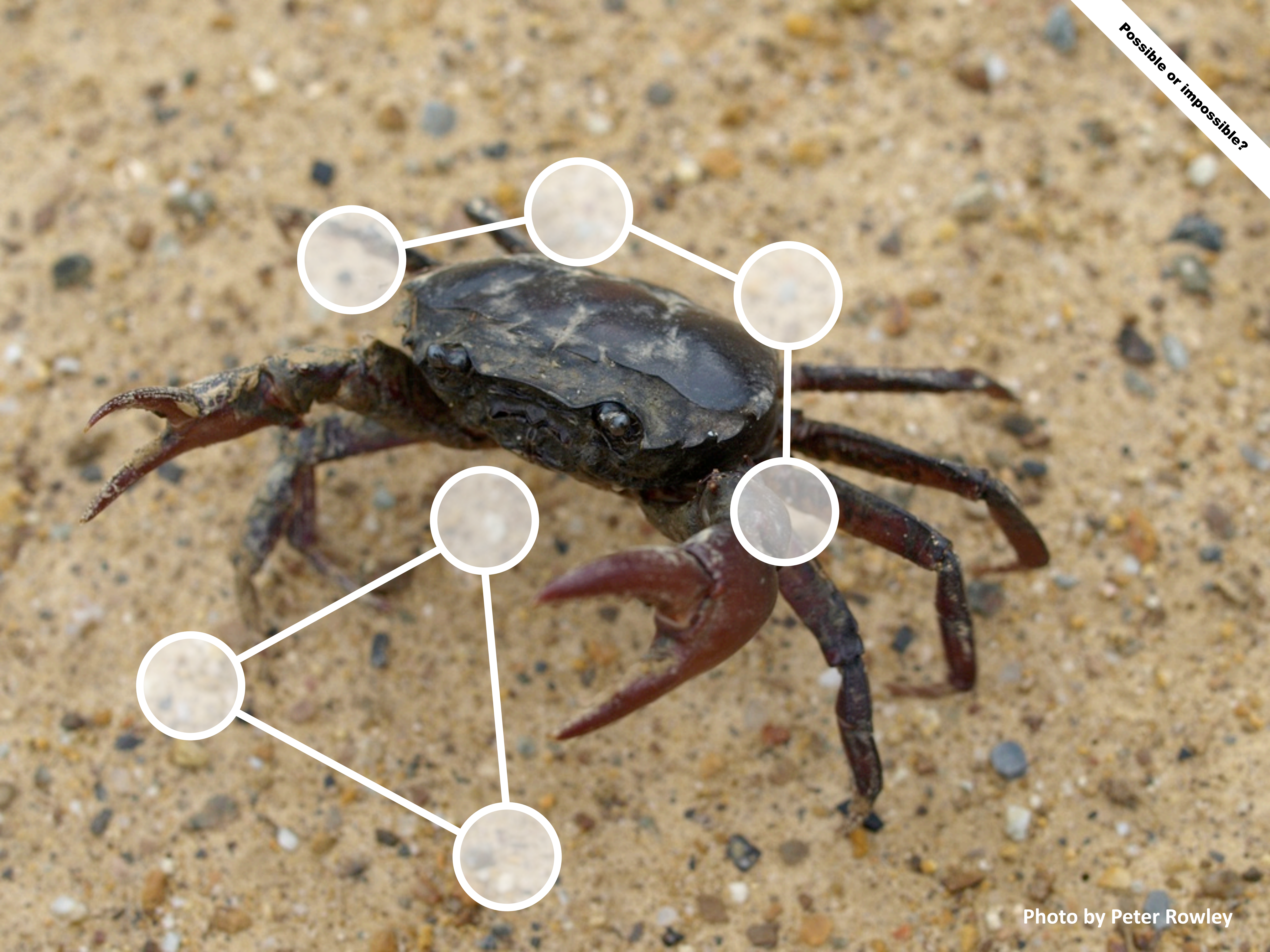


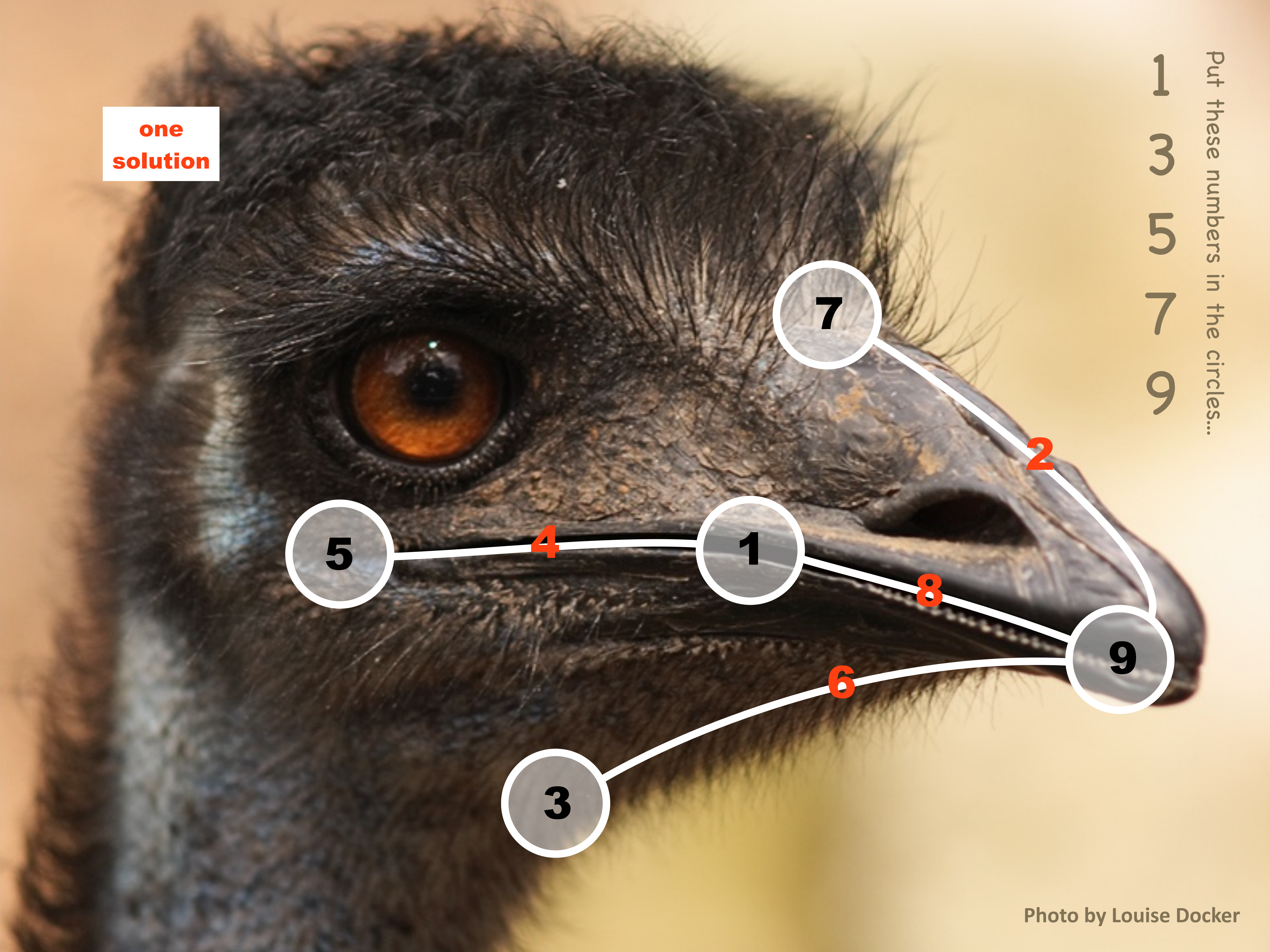

Possible or impossible?
Photo by Clint Budd

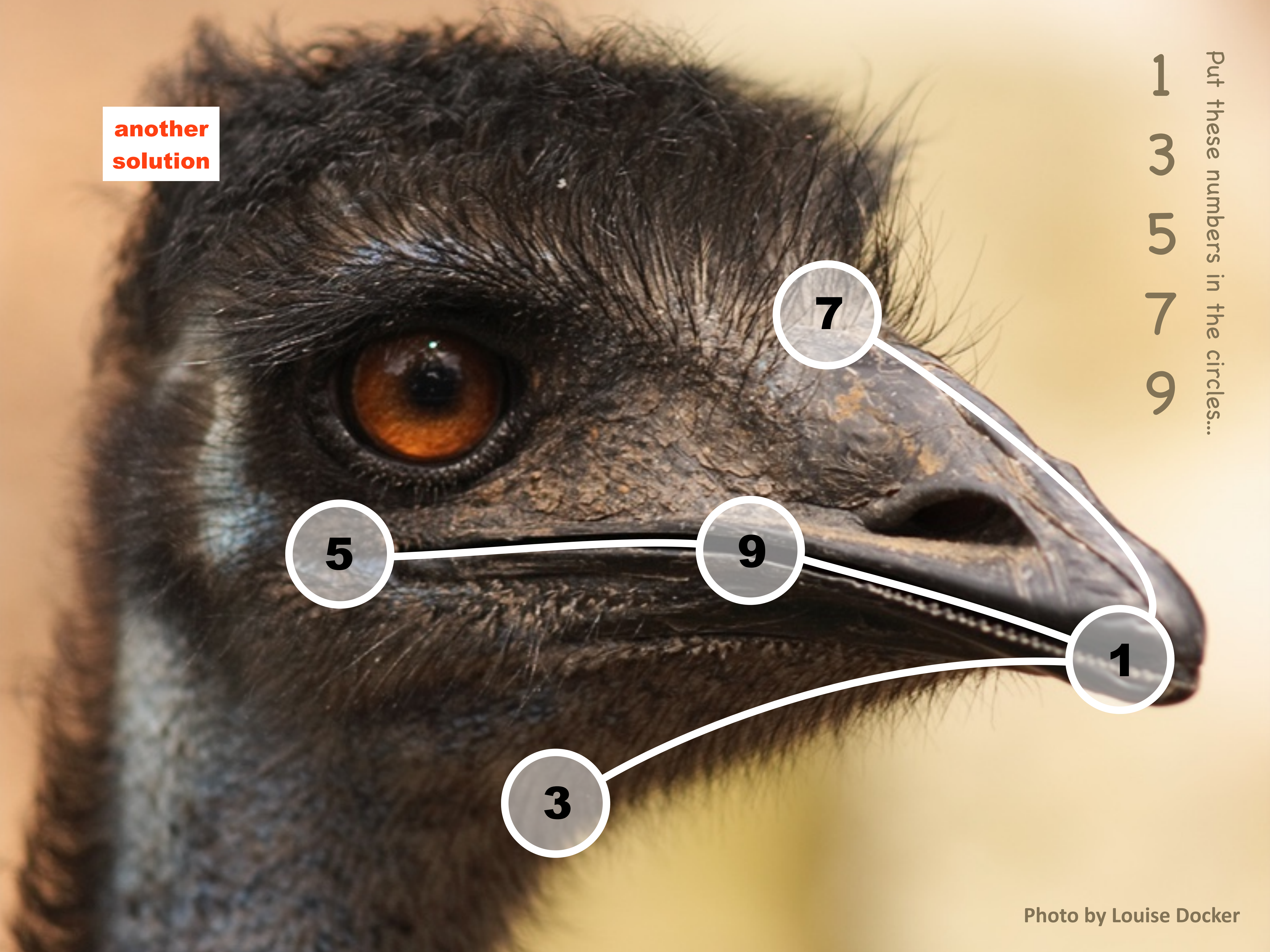

Possible or impossible?
Photo by Gail Hampshire


Possible or impossible?
Photo by Kool Cats Photography


Possible or impossible?
Photo by Gido


Possible or impossible?
Photo by Peter Rowley

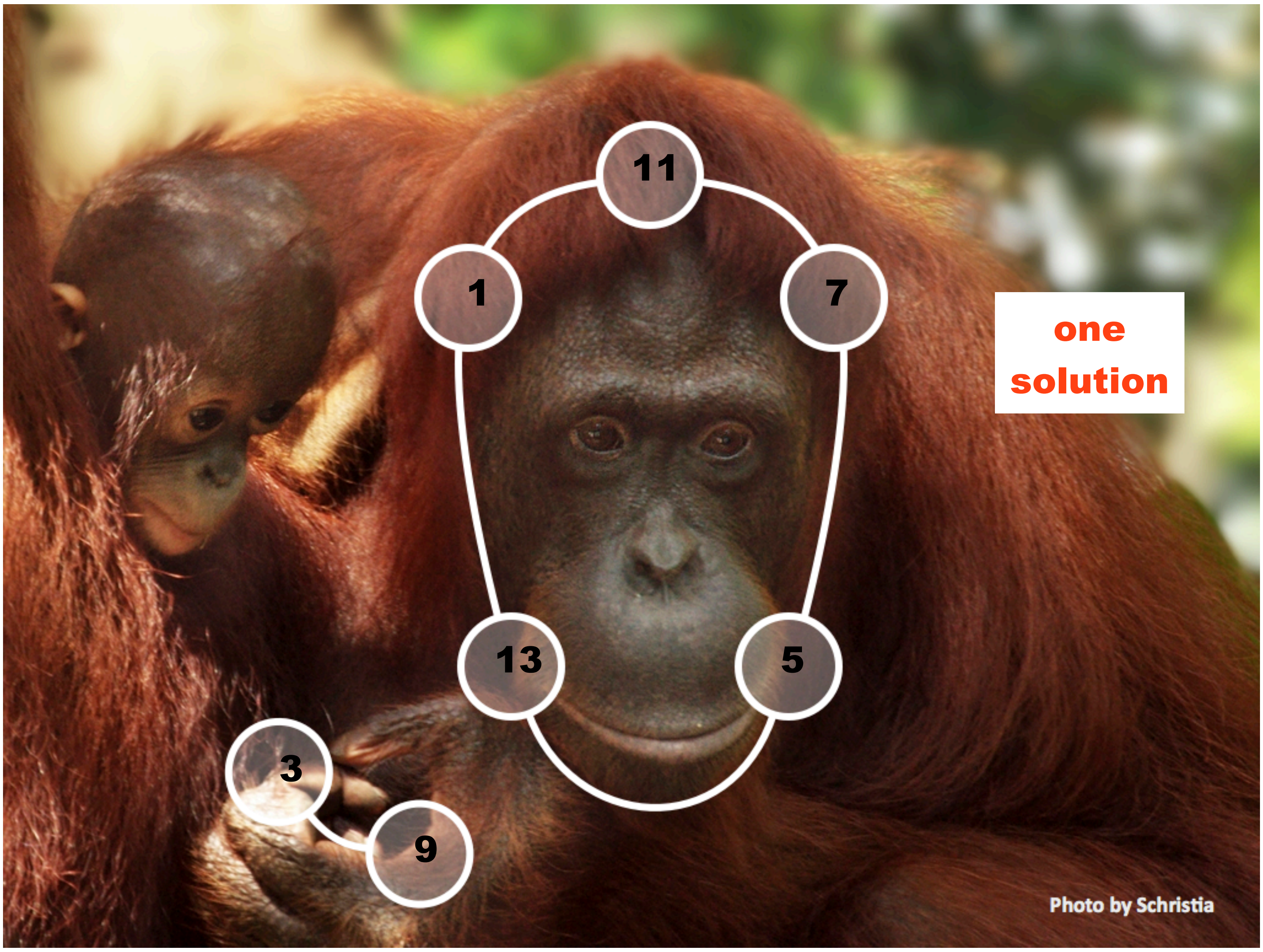

one solution
Put these numbers in the circles...
1
3
5
7
9
7
2
5
4
1
8
9
6
3
Photo by Louise Docker



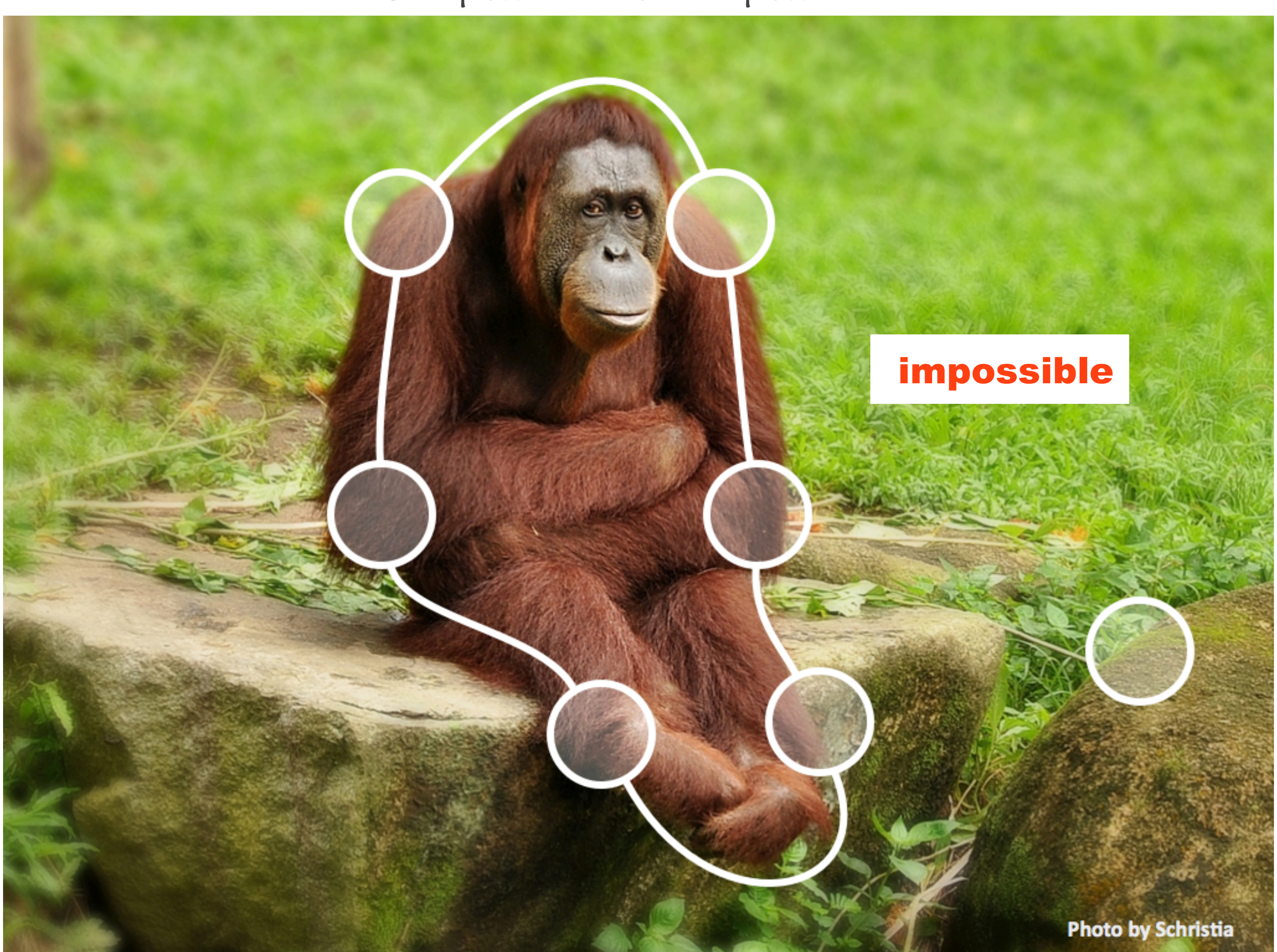
another solution
7
5
9
1
3
1
3
5
7
9
Put these numbers in the circles...
Photo by Louise Docker

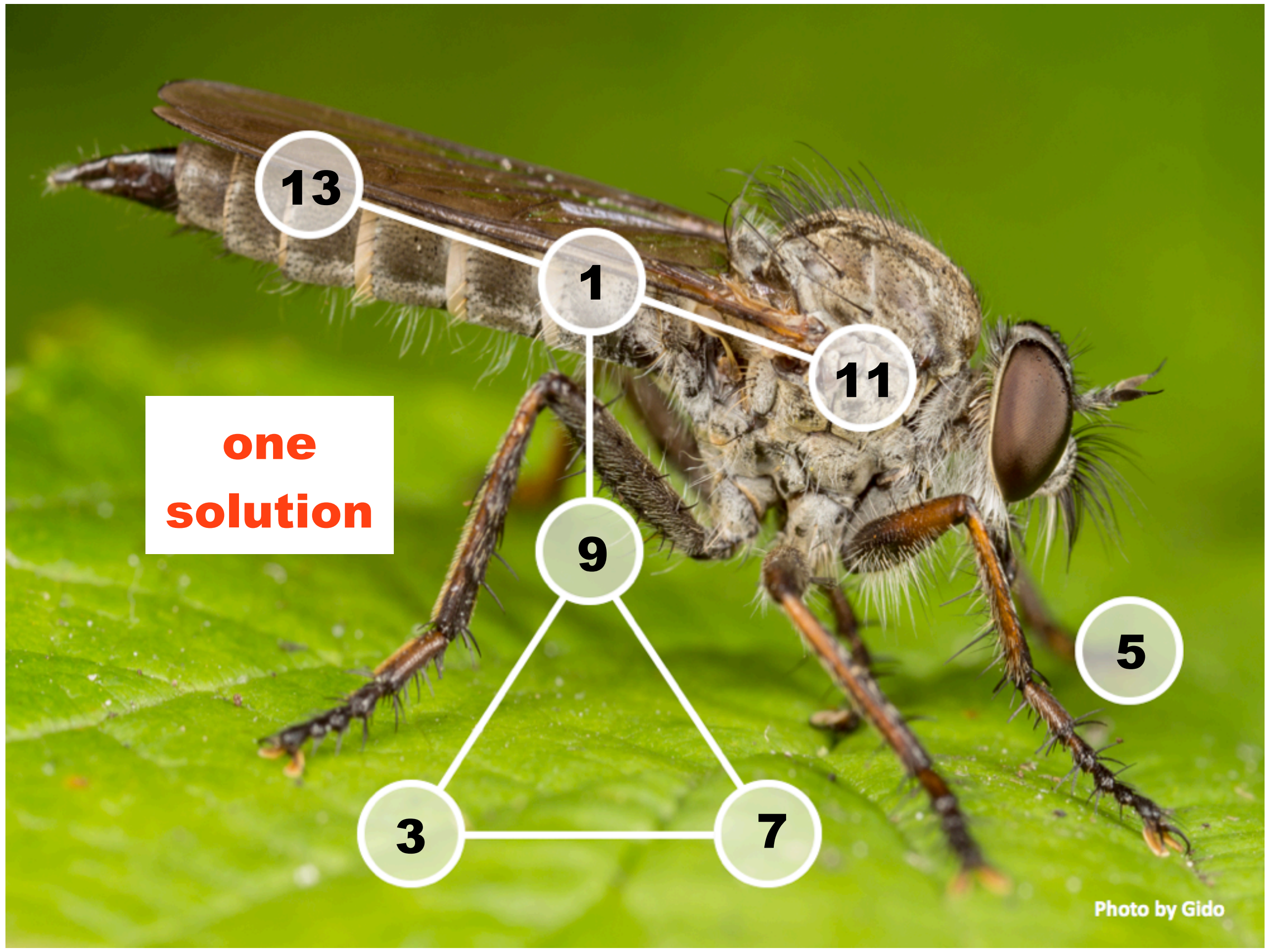

1
17
3
15
5
13
7
11
9
one solution
Photo by Axel Rouvin


17
1
15
3
13
5
11
7
9
another
solution
Photo by Axel Rouvin

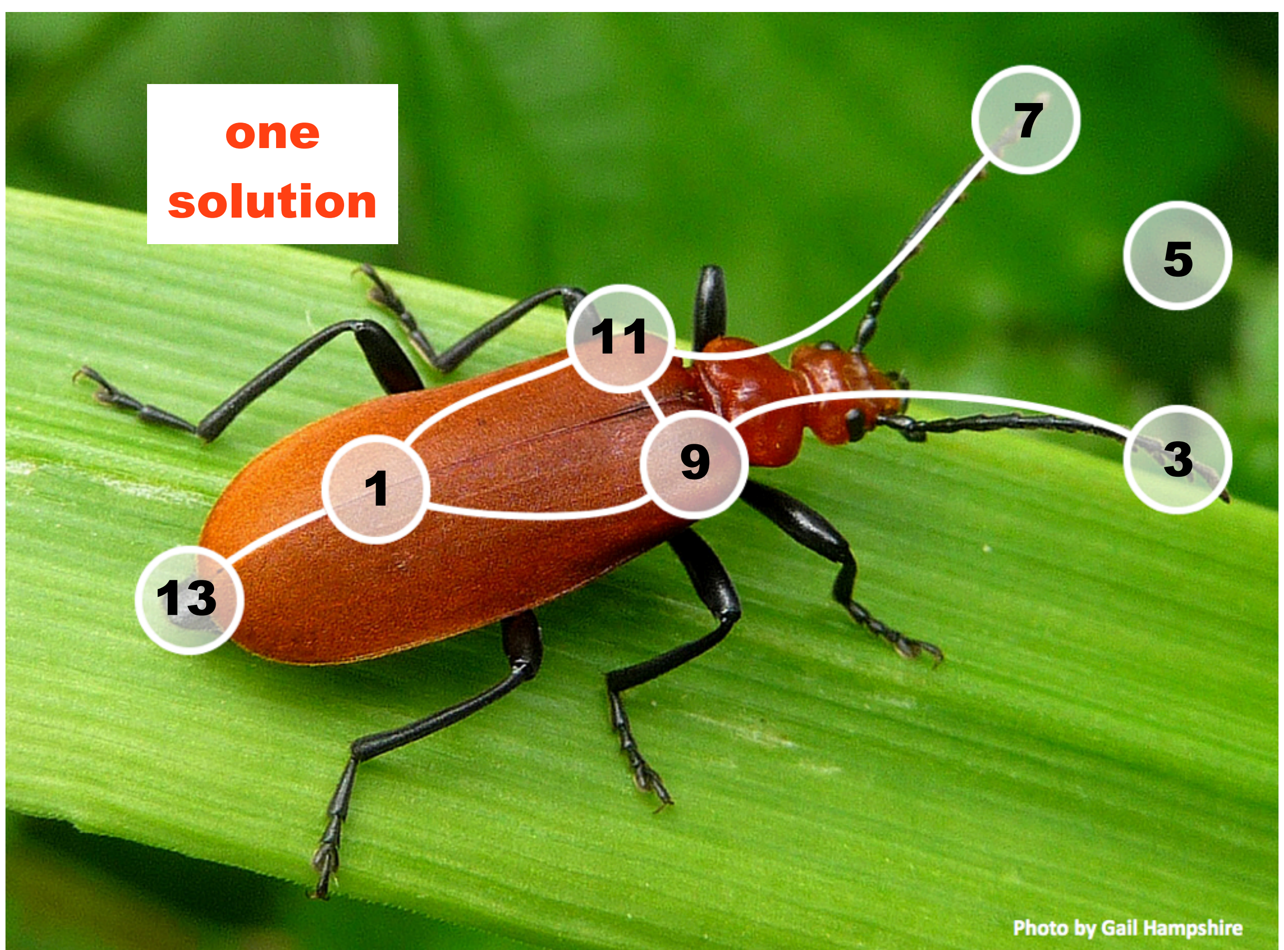


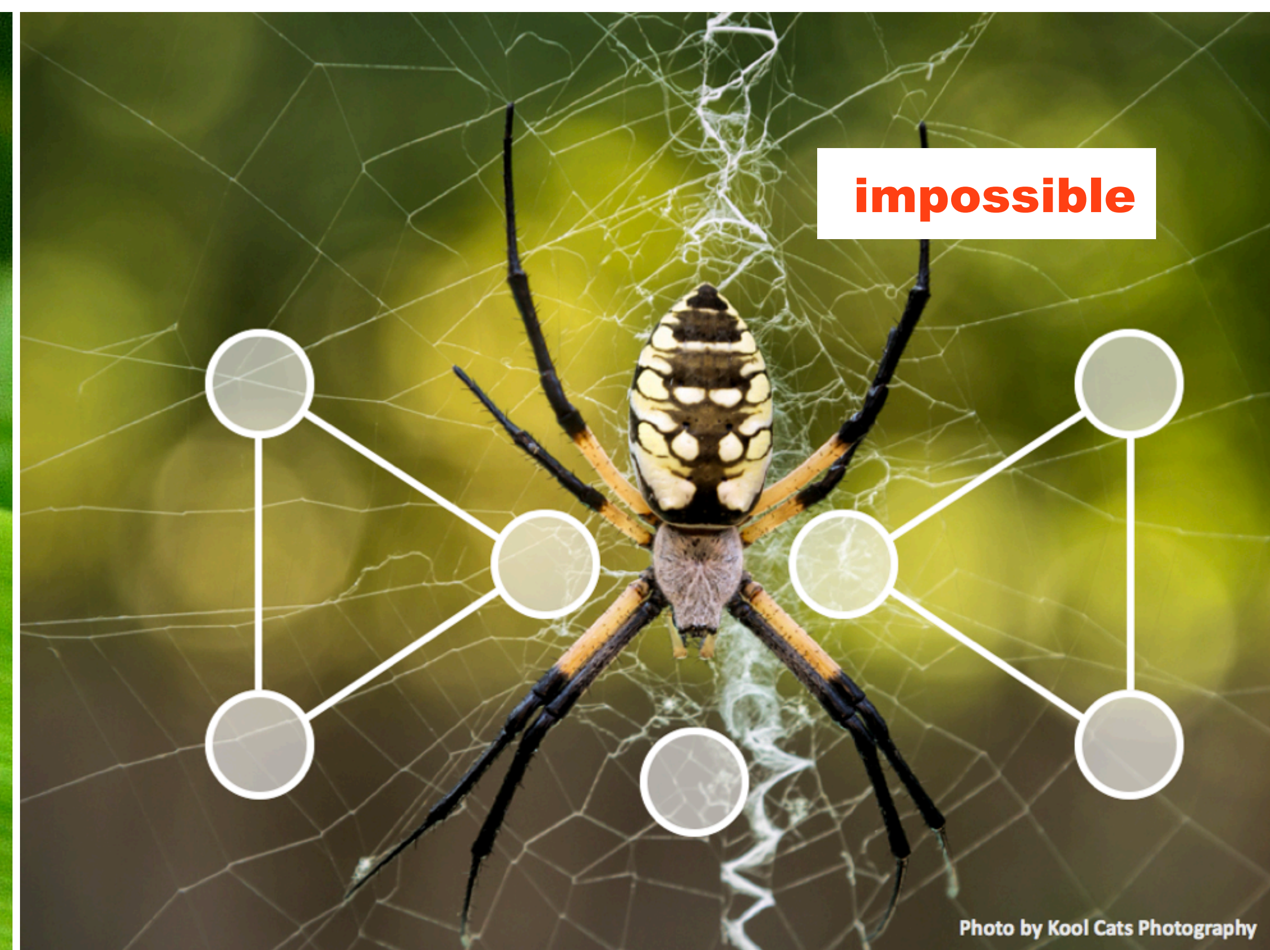
One possible… one impossible…

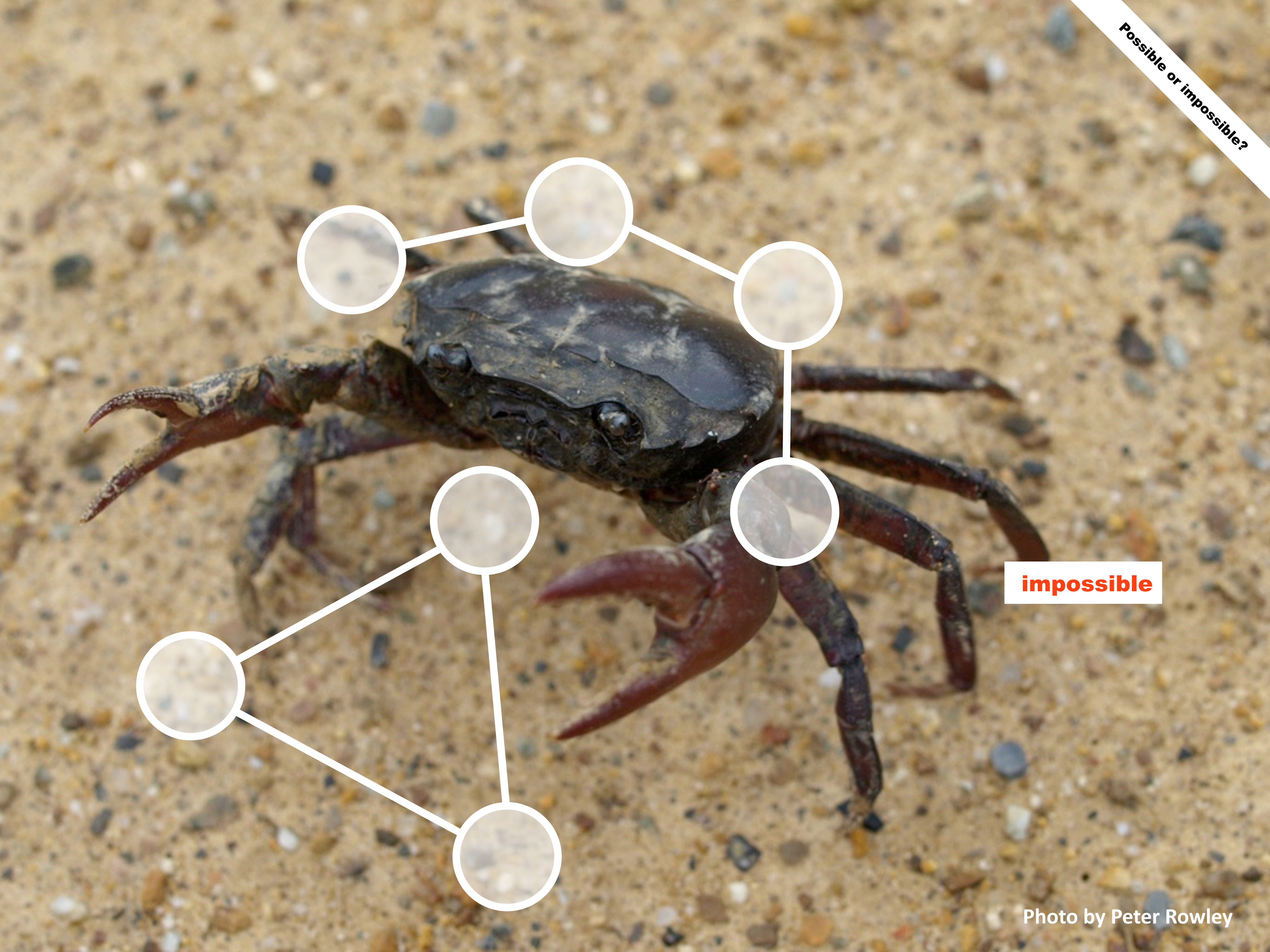




Two possible… two impossible…






Possible or impossible?
impossible
Photo by Peter Rowley

Animal Subtraction

Things to think about
(Meta puzzles and Proofs)

Question:

All animals solved so far have n circles and n-1 connecting lines. The nasty fish on the next page has 9 circles and 9 connecting lines. Is it possible to solve? (Dunkleosteus terrelli is an extinct 4 ton predatory fish)

No - this is not possible! There are only 8 even numbers between 1 and 17. You would need 9 numbers to make this loop. (This is called the pigeon hole strategy.)

Question:

How many patterns are there with 7 circles and 6 connecting lines - and no loop ? 11

How many of these are solvable? 11

How many patterns are there with 7 circles and 6 connecting lines - and and at least one loop ? 30

How many of these are solvable? 25

Question:

The puzzles on pages 30-38 have loops. Put odd consecutive integers into the circles and figure out which are possible and which are impossible to solve.

solutions are on pages 43-45

Photo by Penelope Else


Photo by banspy

Photo by Jeff Kubina

Photo by Nick Holland

Photo by Creative Tools

Put Your Students in a Pickle!

I'm a father of two elementary school children, a mathematician, and designer of puzzles and board games. Students call me Dr. Pickle. There is nothing I enjoy more than stumping students and having them stump me.

I founded MathPickle.com in 2010 to inject new ideas into the classroom. MathPickle's primary objective is to get thirteen curricular unsolved problems into classrooms worldwide - one for each grade K-12. A conference in November 2013 established the thirteen unsolved problems. To aid with the dissemination of these awesome problems, MathPickle is looking at setting up a $1,000,000 reward for each - the prize money to be split between the person who solves the problem and their most inspirational K-12 educator.

MathPickle is also developing a range of curricular puzzles like the ones you'll find at TpT. These help teachers them with their number one challenge:

"How to engage the spectrum of student ability?"

Whenever an elementary school teacher wants to teach addition, she will invariably face 20% of students who already know how to add and another 20% who are struggling with last year's curriculum. How can she engage the top students without losing the bottom students? How can she engage the bottom students without boring the top students?

One solution: Parents of top students often ask that their child be allowed to accelerate through the curriculum. This exacerbates the problem for future teachers, and sets up a failure-impoverished education experience for the bright student.

A wiser approach is to use curricular puzzles, games and mini-competitions to simultaneously teach curriculum to the students who need it, and to deflect top students into tough problem solving activities. This is never time wasted, because problem solving is the primary reason we teach mathematics.

The experience of mathematics should be profound and beautiful. Too much of the regular K-12 mathematics experience is trite and true. Children deserve tough, beautiful puzzles.

Gordon Hamilton
MMath, PhD