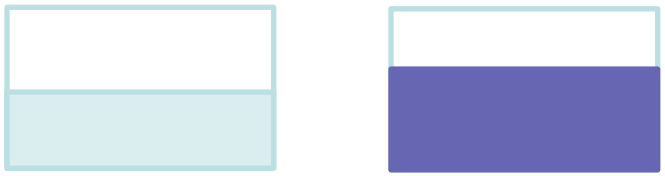
Solutions for High School Prog Contest - 2017

1. Mixing Dino Genes
2. Flipping Eggs
3. Chain Reaction
4. Primetime Investigation
5. In-Out Tour
6. Zipline to Savings
7. Everybody Run! (their code)
8. Clever Girl

1. Mixing Dino Genes

Initialize

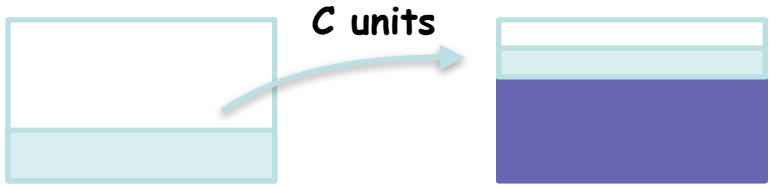
Record amount of Solution A in each dish



Amix = 1 (100% A) Bmix = 0 (0% A)

Initialize

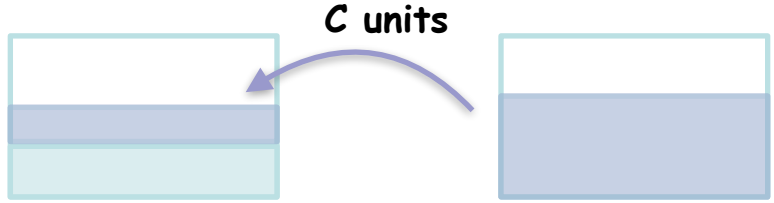
Record amount of Solution A in each dish



New amount of A = Bmix*B+Amix*C
New volume = B+C
New concentration = (Bmix*B+Amix*C)/(B+C)

Initialize

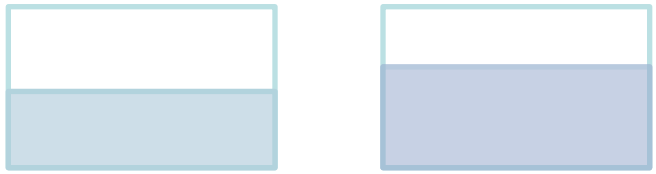
Record amount of Solution A in each dish



New amount of A = Amix*A+Bmix*C
New volume = A+C
New concentration = (Amix*A+Bmin*C)/(A+C)

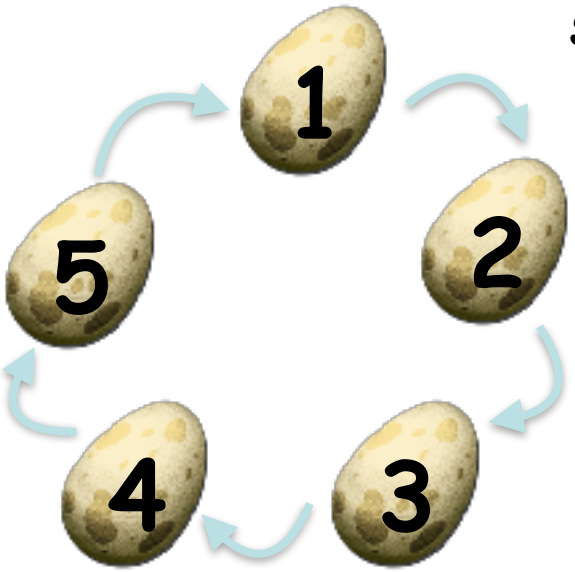
End of iteration 1
(Start of iteration 2)

Record amount of Solution A in each dish

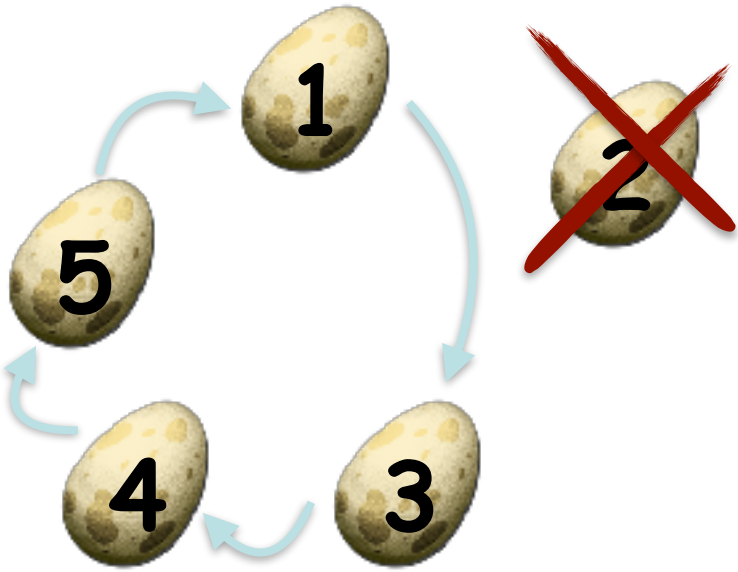


2. Flipping Eggs

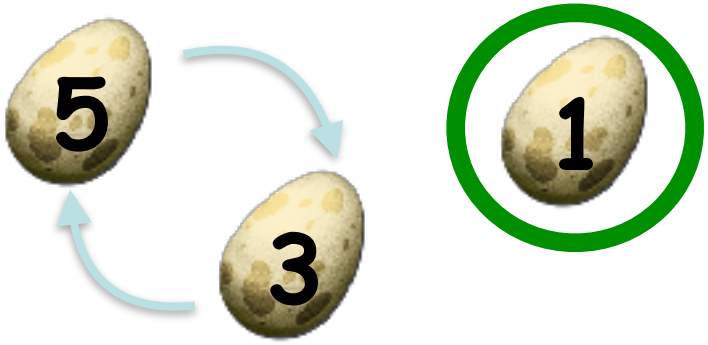
Sample input: 5 2 3



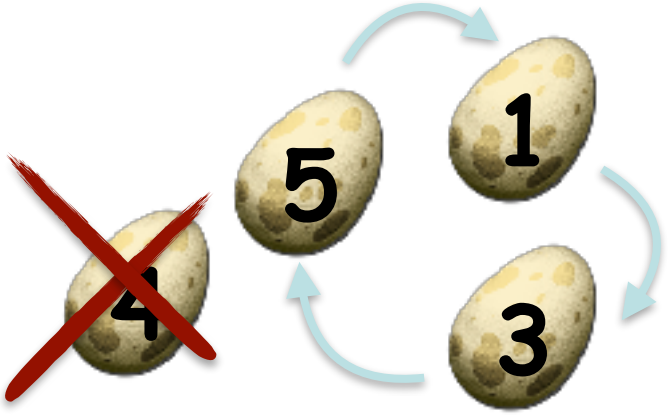
Step 1: make (circular) linked list



Step 2: remove a flipped egg



Step 4: print the first non-flipped egg
…and keep going



Step 3: remove a flipped egg

3. Mixing

Make a list of primes that represents 1

$$2^0\ 3^0\ 5^0\ 7^0\ 11^0\ldots$$

Multiply by first numerator

$$15 = 3^1 5^1$$

update prime factorization →

$$2^0\ 3^1\ 5^1\ 7^0\ 11^0\ldots$$

Divide by first denominator

$$363 = 3^1 11^2$$

update prime factorization →

$$2^0\ 3^0\ 5^1\ 7^0\ 11^{-2}\ldots$$

multiply by second numerator

$$44 = 2^2 11^1$$

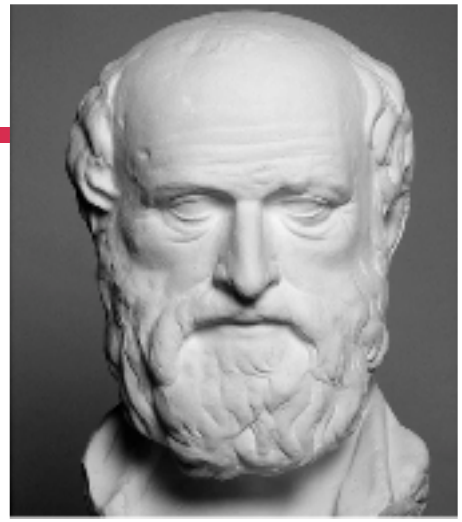
update prime factorization →

$$2^2\ 3^0\ 5^1\ 7^0\ 11^{-1}\ldots$$

keep going…

How to find primes? Described in the next problem

4. Primetime



But how do we find primes?

Sieve of Eratosthenes

Allocate list of booleans for all ints between 1 and (largest integer)/2

2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21…

Remove all multiples of two

2 3 ~~4~~ 5 ~~6~~ 7 ~~8~~ 9 ~~10~~ 11 ~~12~~ 13 ~~14~~ 15 ~~16~~ 17 ~~18~~ 19 ~~20~~ 21…

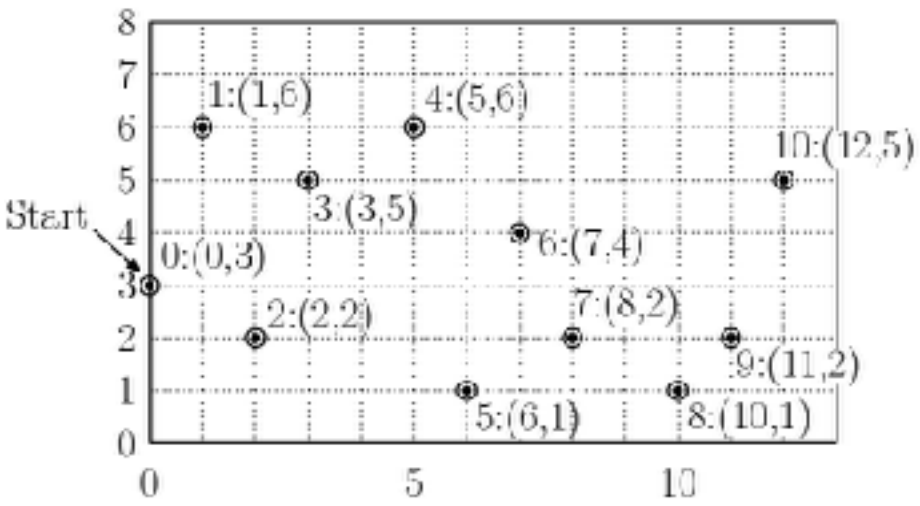
Remove all multiples of three

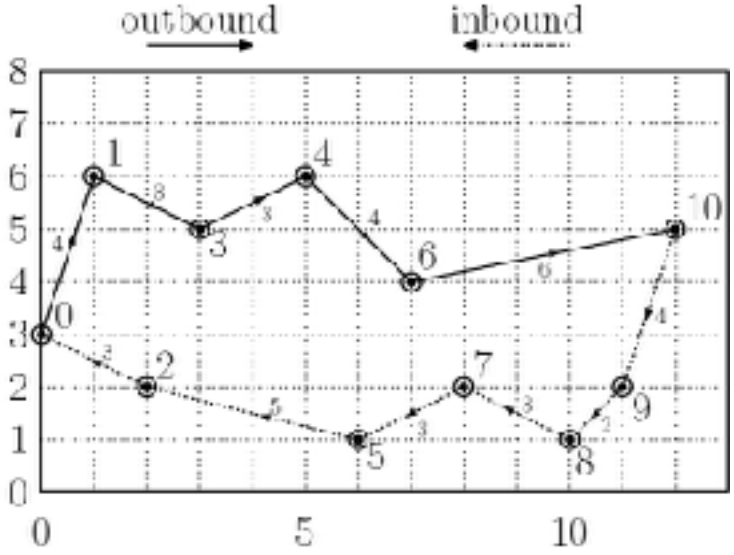
2 3 ~~4~~ 5 ~~6~~ 7 ~~8~~ 9 ~~10~~ 11 ~~12~~ 13 ~~14~~ 15 ~~16~~ 17 ~~18~~ 19 ~~20~~ ~~21~~…

remove all multiples of 5…
keep going…

5. In-Out Tour

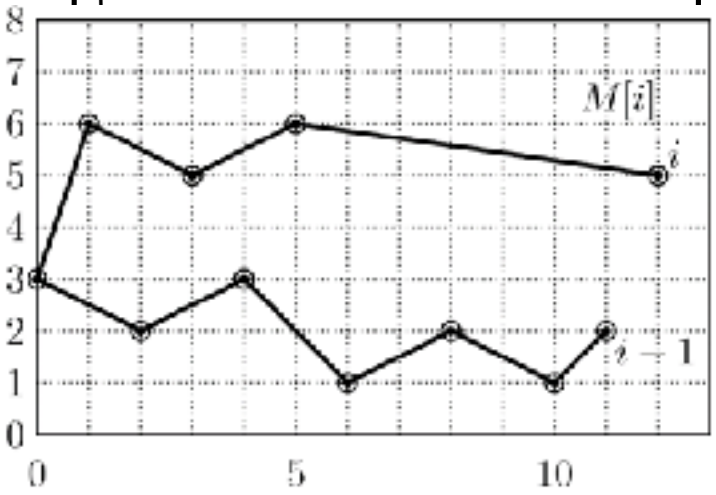
Problem: Given a **start point** p_0 and a set of n **points** p_1 to p_n, compute the shortest tour that visits all the points, subject to the conditions that the tour starts and ends at p_0, visits all points, and has two parts, left-to-right (**outbound**) and right-to-

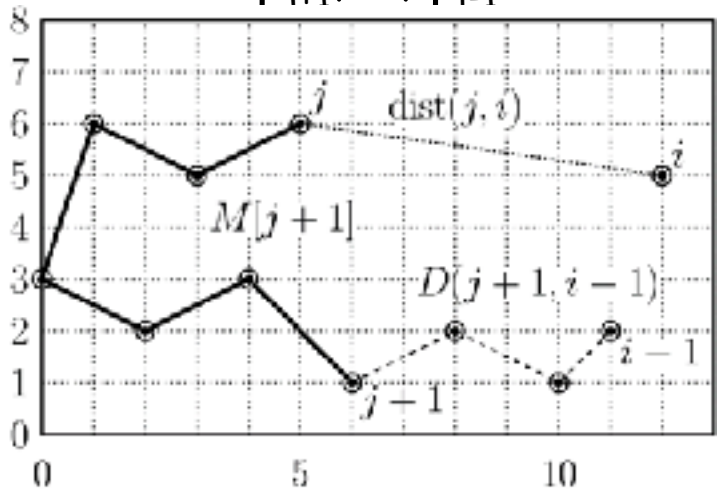




5. In-Out Tour (Solution sketch)

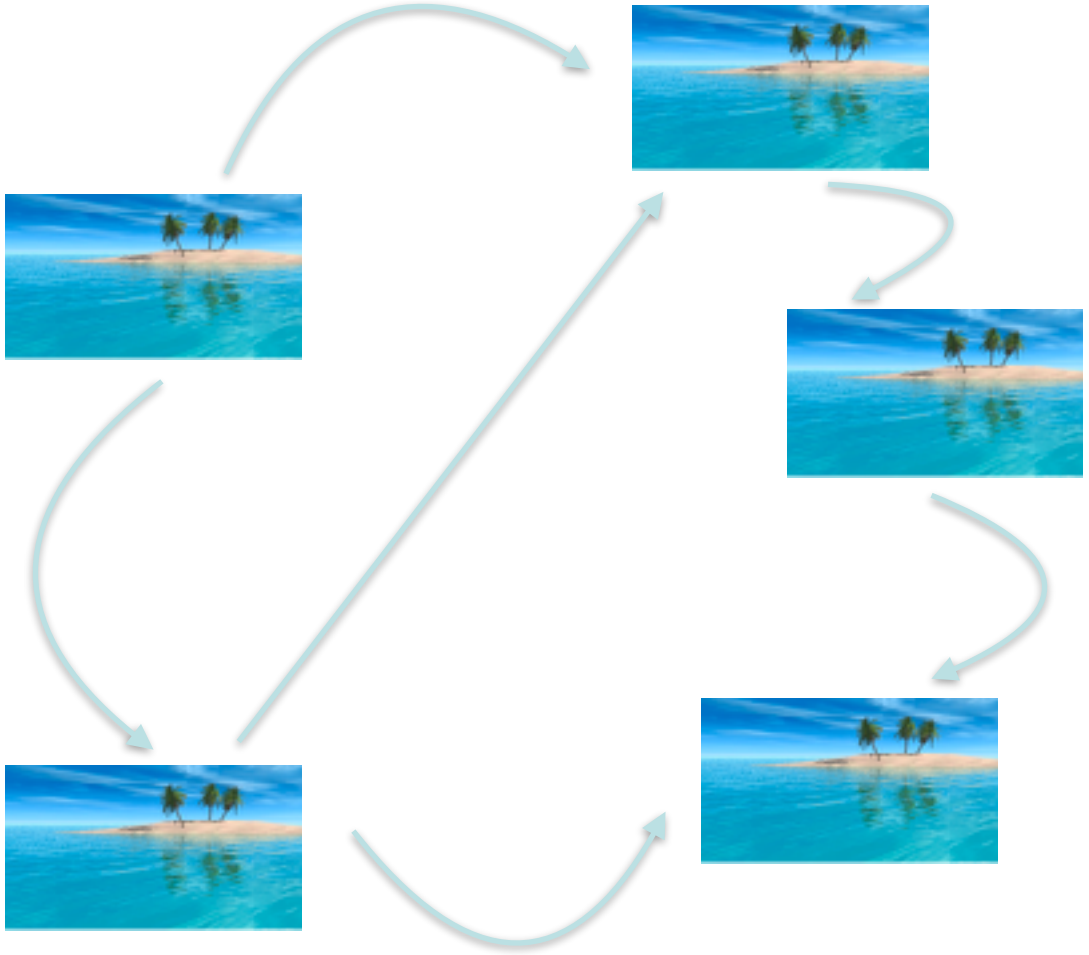
- Let **dist(j,i)** be the **direct distance** from p_j to p_i.
- Let **D(j,i)** be the **total length** of the path from p_j, p_{j+1}, …, p_i.
- Let **M[i]** = the minimum length of two paths from p_0, one ending at p_i and the other at p_{i-1} (see figure below).
- Define M[i] **recursively** by "guessing" the last point p_j just prior to p_i. The other side of the path must visit p_{i+1}, …, p_{i-1}. Thus:





6. Ziplines

Make directed graph



…then, find largest STRONGLY CONNECTED COMPONENT (standard algorithm)

7. Everybody run

Divide 70 by 7

Write 70 = 7x, find the binary representation of x

Step 1: approximate x by largest power of 2

$$70 > 7*8 = 7*2^3$$

Step 2: calculate remainder

$$70 - 56 = 14$$

Step 3: divide remainder by largest power of 2

$$14 = 7*2$$

Step 4: combine quotients to get solution

$$8+2 = 10$$

Thanks!

Questions?