Welcome to CS106B!

- Today:
  - Course Overview
  - Where are We Going?
  - Introduction to C++

Course Staff

Instructor: Aubrey Gress
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Head TA: Michael Chang
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The CS106B Section Leaders
The CS106B Course Helpers

Course Website

http://cs106b.stanford.edu

Prerequisites

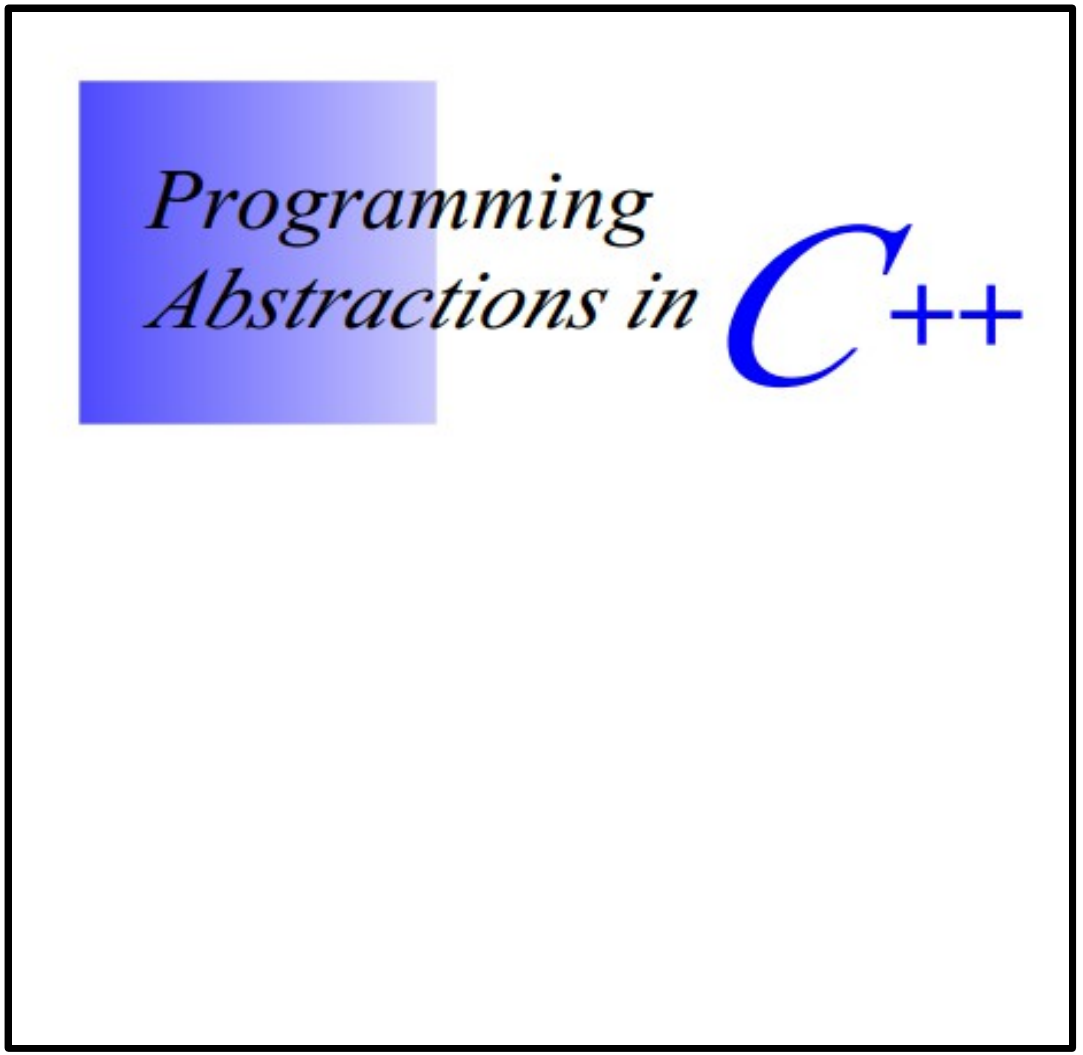
CS106A

(or equivalent)

Background Topics

- We assume you are familiar with:
  - Variables
  - Parameter passing
  - Functions
  - Classes and Objects
  - For/While Loops
  - If/else statements
- Okay if you need to do some background reading
- Most important thing is that you have some experience taking a problem and turning it into code

Required Reading

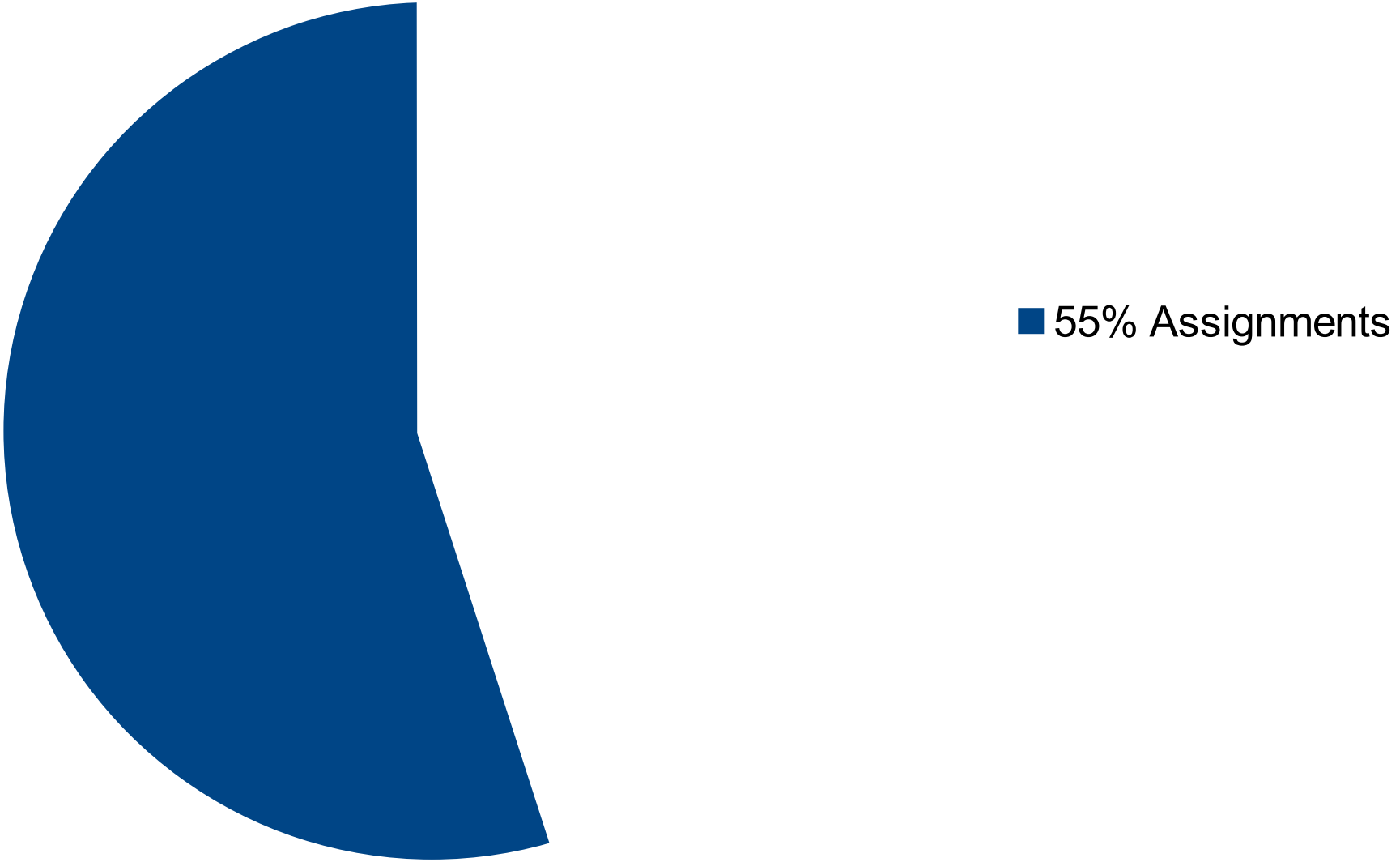


Required Reading

- Hard copies in the book store, electronic copy on the website.
  - Exams this quarter *will not* be open note (more on this in a couple slides).
  - You don't *have* to buy the hard copy, but it is highly recommended.

Grading Policies

Grading Policies



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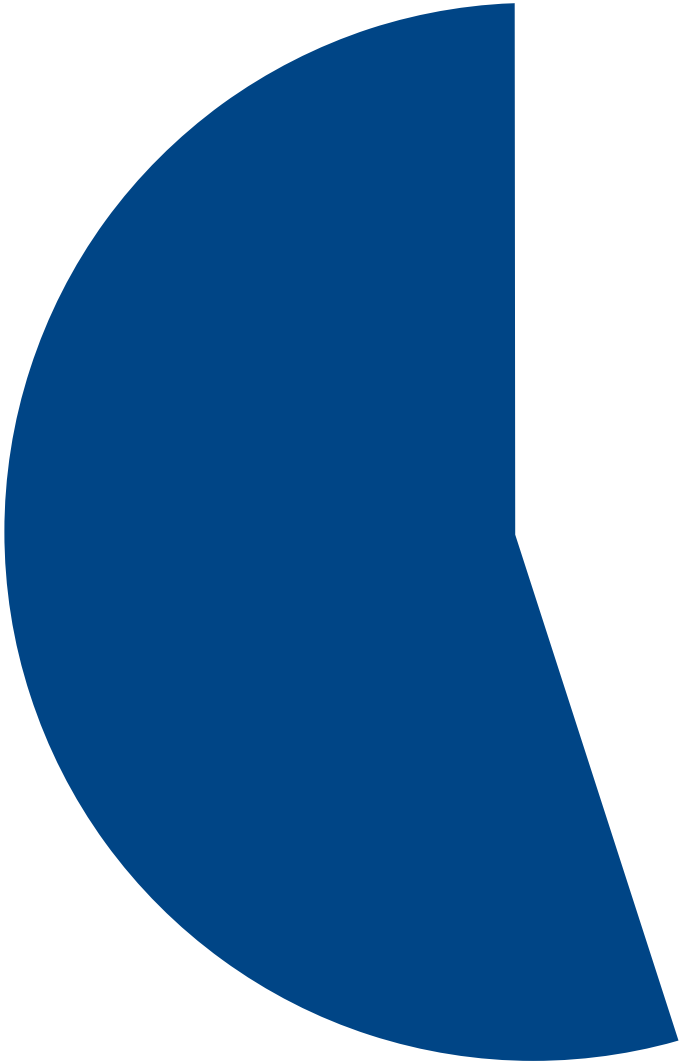
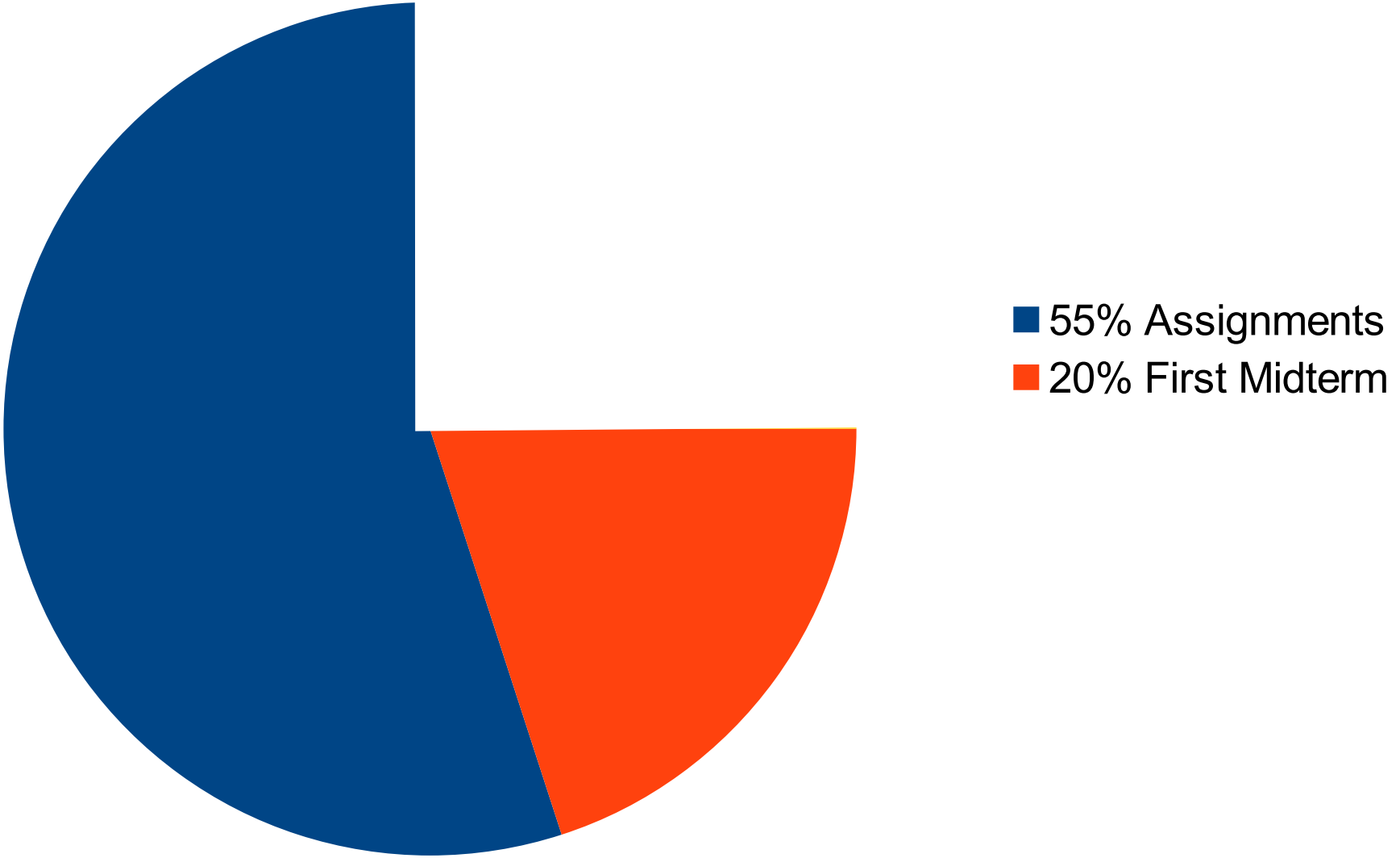


Six Programming Assignments

Grading Policies

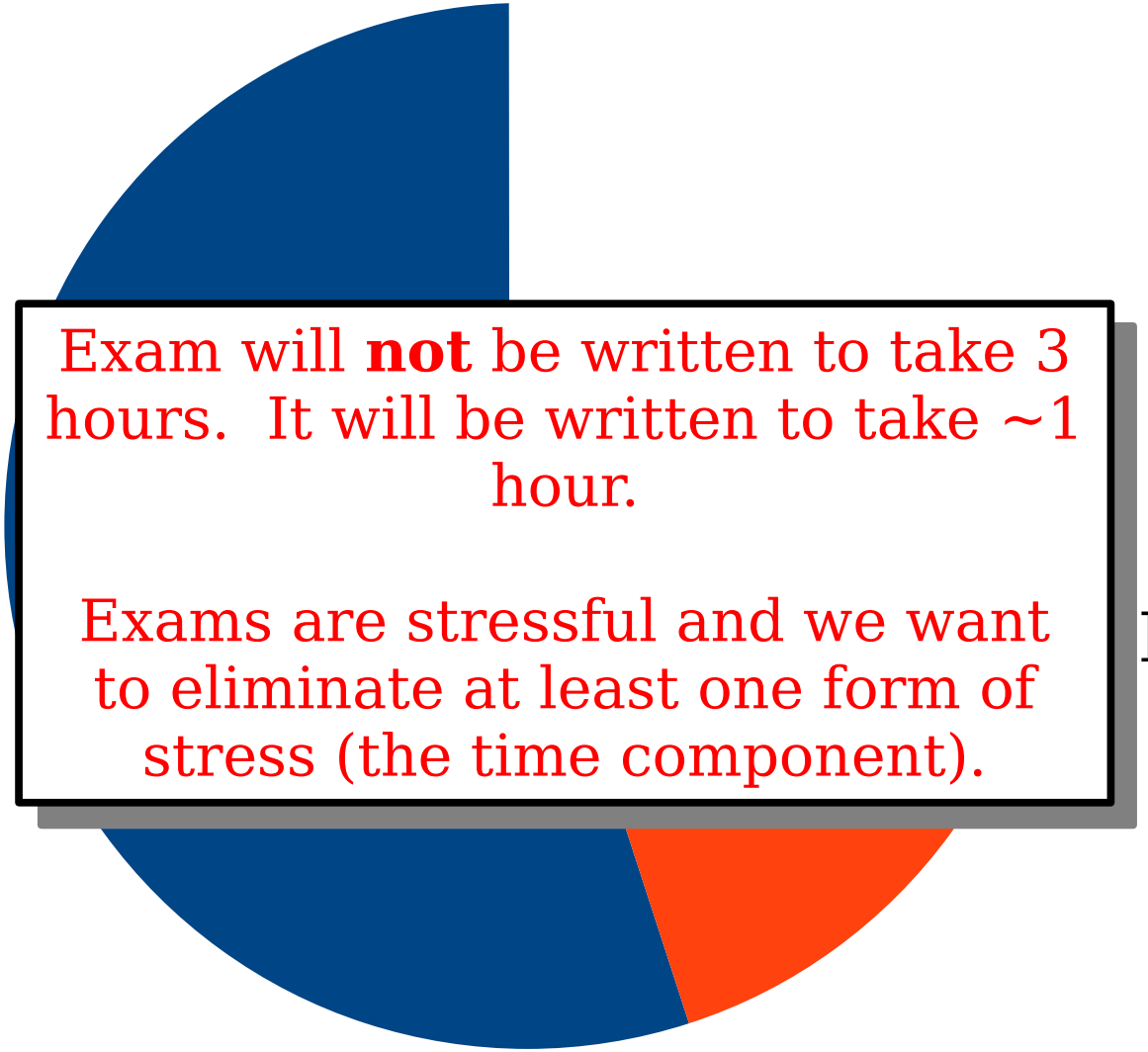


Grading Policies

First Midterm Exam

July 22nd, 7-10pm

Grading Policies



Exam will **not** be written to take 3 hours. It will be written to take ~1 hour.

Exams are stressful and we want to eliminate at least one form of stress (the time component).

First Midterm Exam

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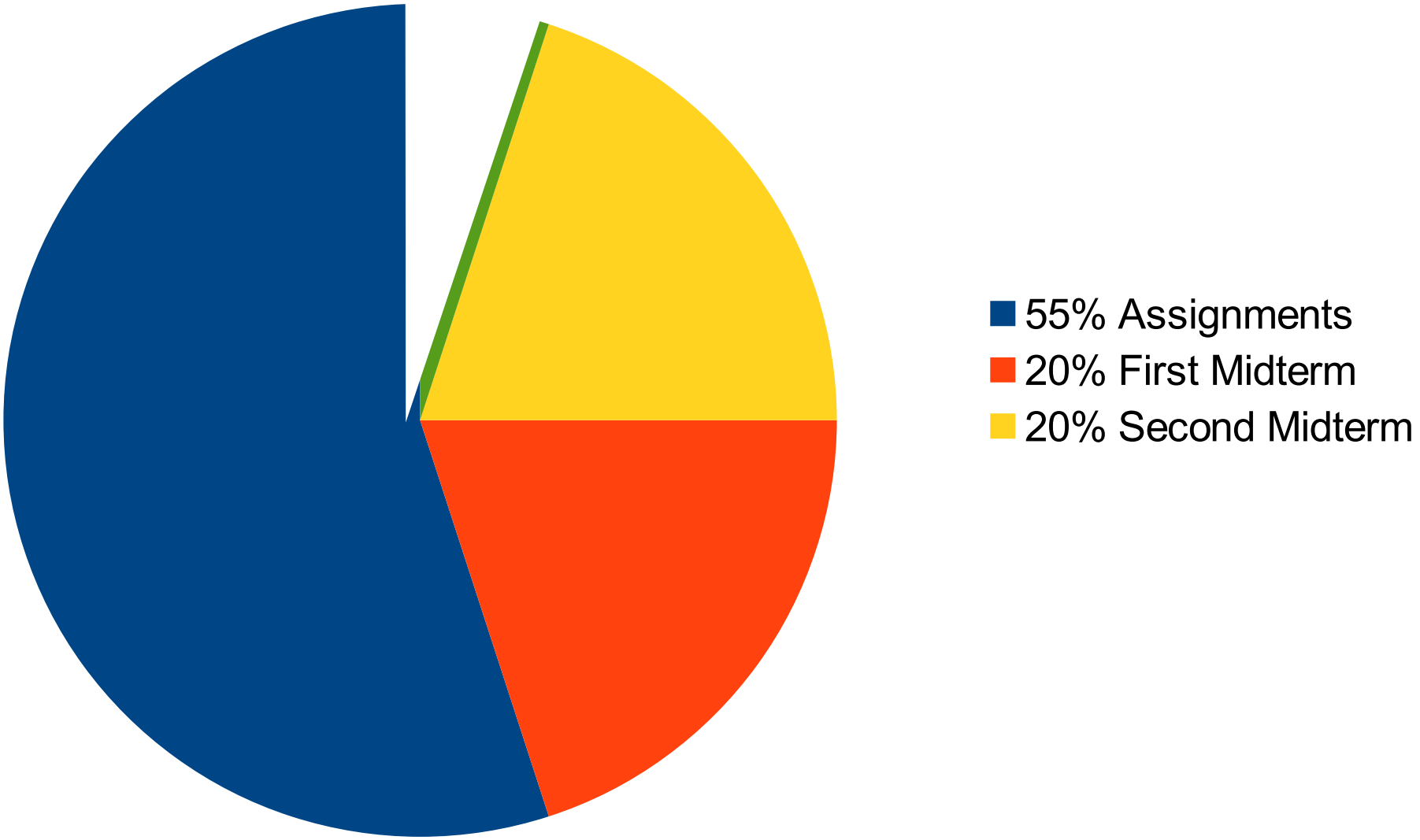

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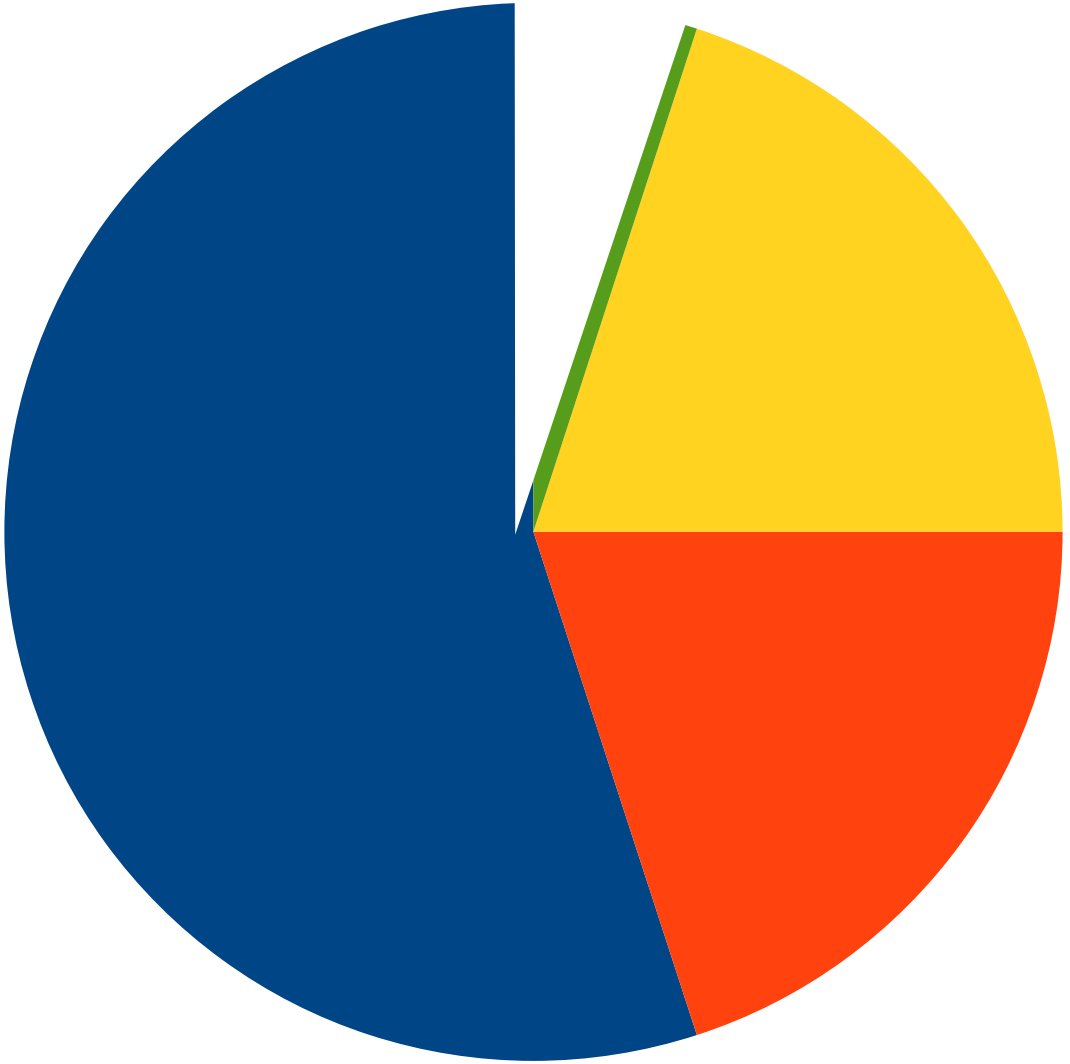

Second Midterm Exam

August 12th, 7-10pm

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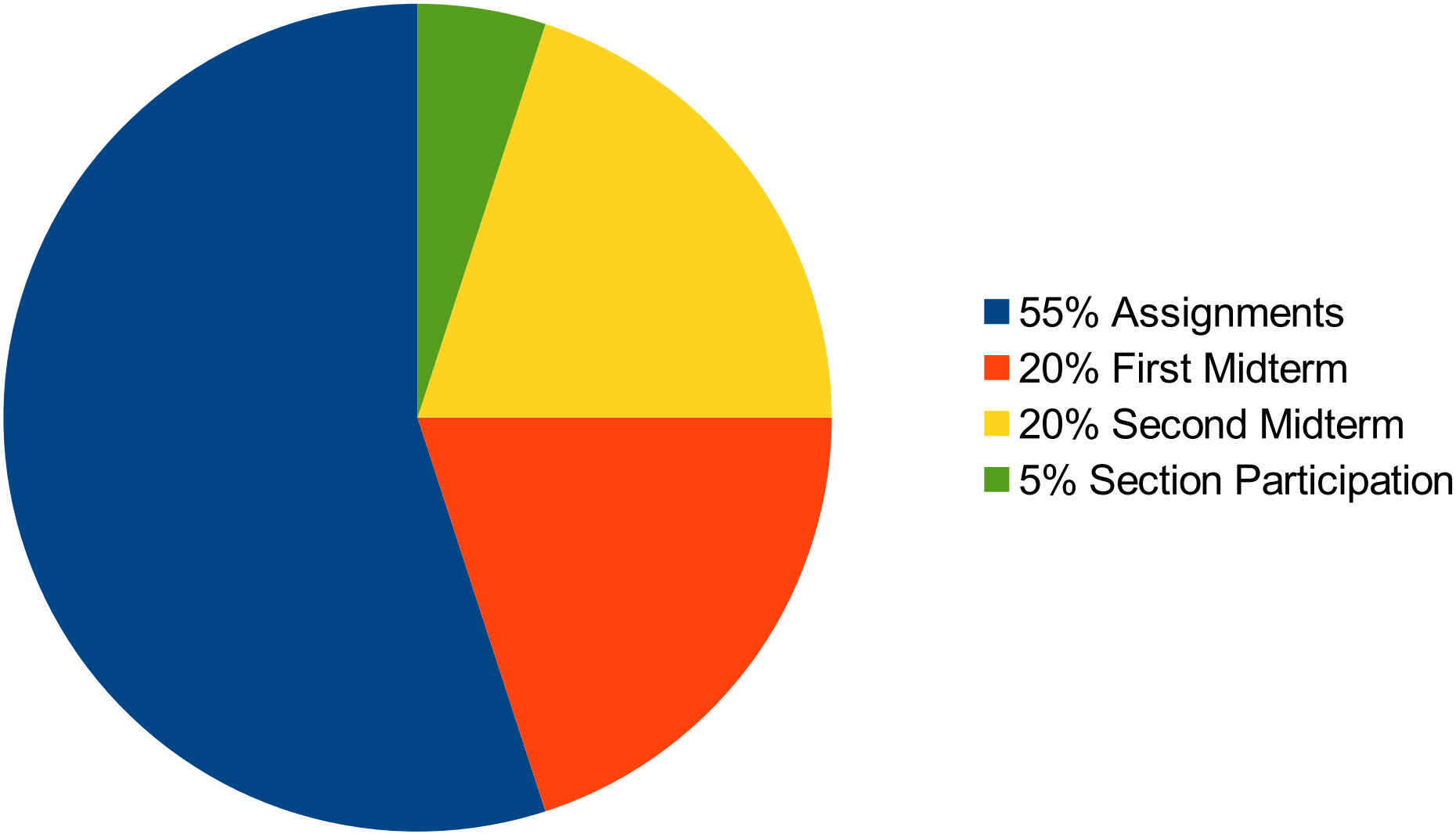

Exams

- Historically exams have been open note. This quarter the exam will **not** be open note
  - Rational: Allows us to ask simpler questions and ask more knowledge based questions.
  - Remember the course is curved.
- Before the first exam I'll cover strategies for studying the exam.

Discussion Sections

- Weekly discussion sections.
- Section attendance is **required** in CS106B.
- Sign up between Thursday, June 27 at 5PM and Sunday, June 30 at 5PM at

  http://cs198.stanford.edu/sectio

- You don't need to (and shouldn't!) sign up for a section on Axess; everything is handled through the above link.

Discussion Sections

- Roughly ~10 students per section
- Get more experience using problem solving techniques from lecture

How Many Units?

How Many Units?

```
int numUnits(bool isGrad, bool wantsFewerUnits) {




}
```

How Many Units?

```
int numUnits(bool isGrad, bool wantsFewerUnits) {
    if (!isGrad) return 5;




}
```

How Many Units?

```
int numUnits(bool isGrad, bool wantsFewerUnits) {
    if (!isGrad) return 5;
    if (!wantsFewerUnits) return 5;



}
```

How Many Units?

```
int numUnits(bool isGrad, bool wantsFewerUnits) {
    if (!isGrad) return 5;
    if (!wantsFewerUnits) return 5;
    if (reallyBusy()) {
       return 3;
    }


}
```

How Many Units?

```
int numUnits(bool isGrad, bool wantsFewerUnits) {
    if (!isGrad) return 5;
    if (!wantsFewerUnits) return 5;
    if (reallyBusy()) {
       return 3;
    } else {
       return 4;
    }
}
```

Getting Help

Getting Help

- LaIR Hours: Run by Section Leaders
  - Sunday – Wednesday, 7PM – 11PM
  - Starts next week.
  - **Great time/place to work on assignments!**
- Mike's Office Hours in Gates 160
  - Tuesday/Wednesday 3PM – 5PM
- Aubrey's Office Hours in Gates 160
  - Monday-Thursday 12PM - 1PM
  - **Or by Appointment!**

What's Next in Computer Science?

Goals for this Course

- **Learn how to model and solve complex problems with computers.**

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- To that end:
  - Explore common abstractions for representing problems.
  - Harness recursion and understand how to think about problems recursively.
  - Quantitatively analyze different approaches for solving problems.

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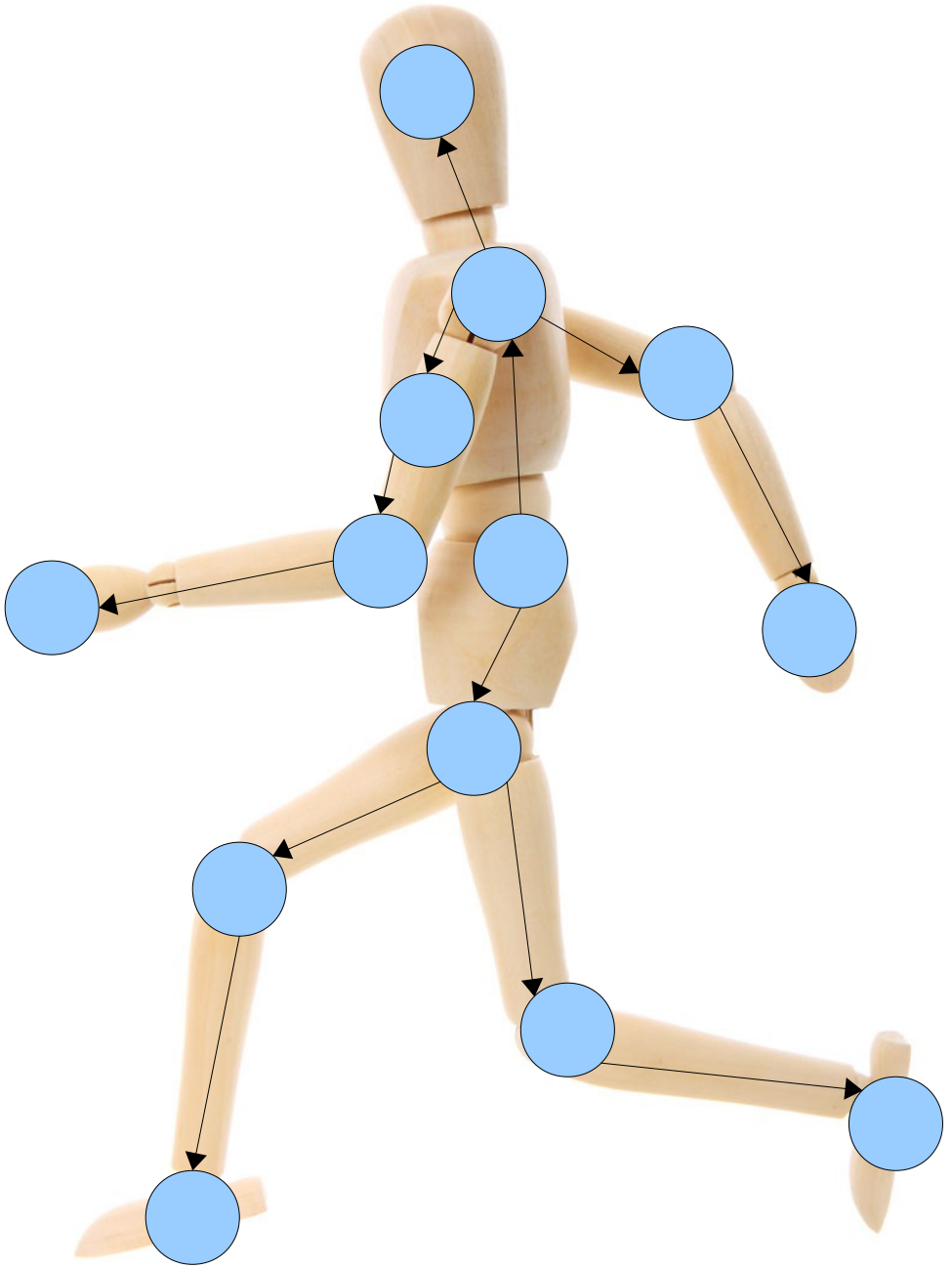

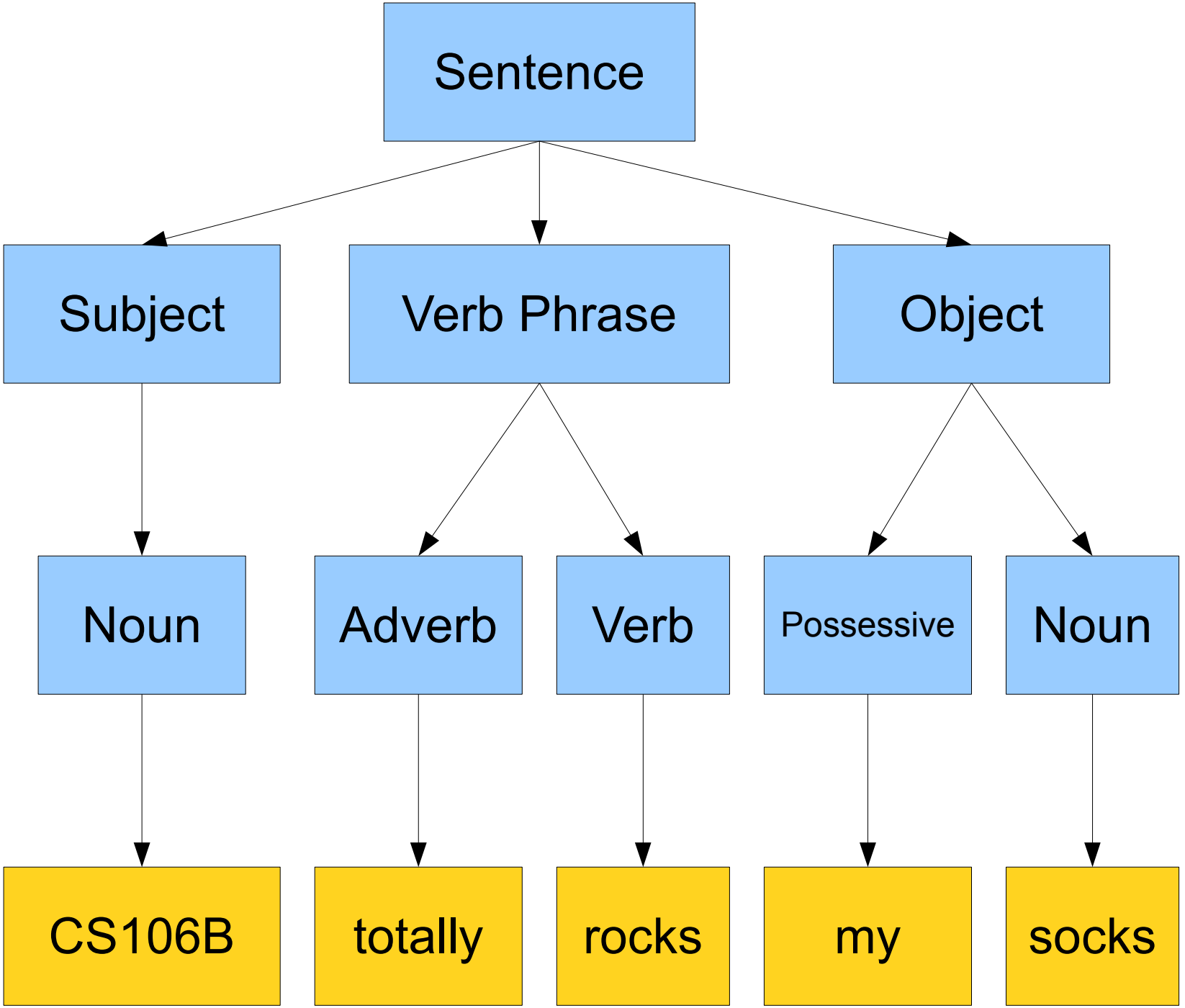
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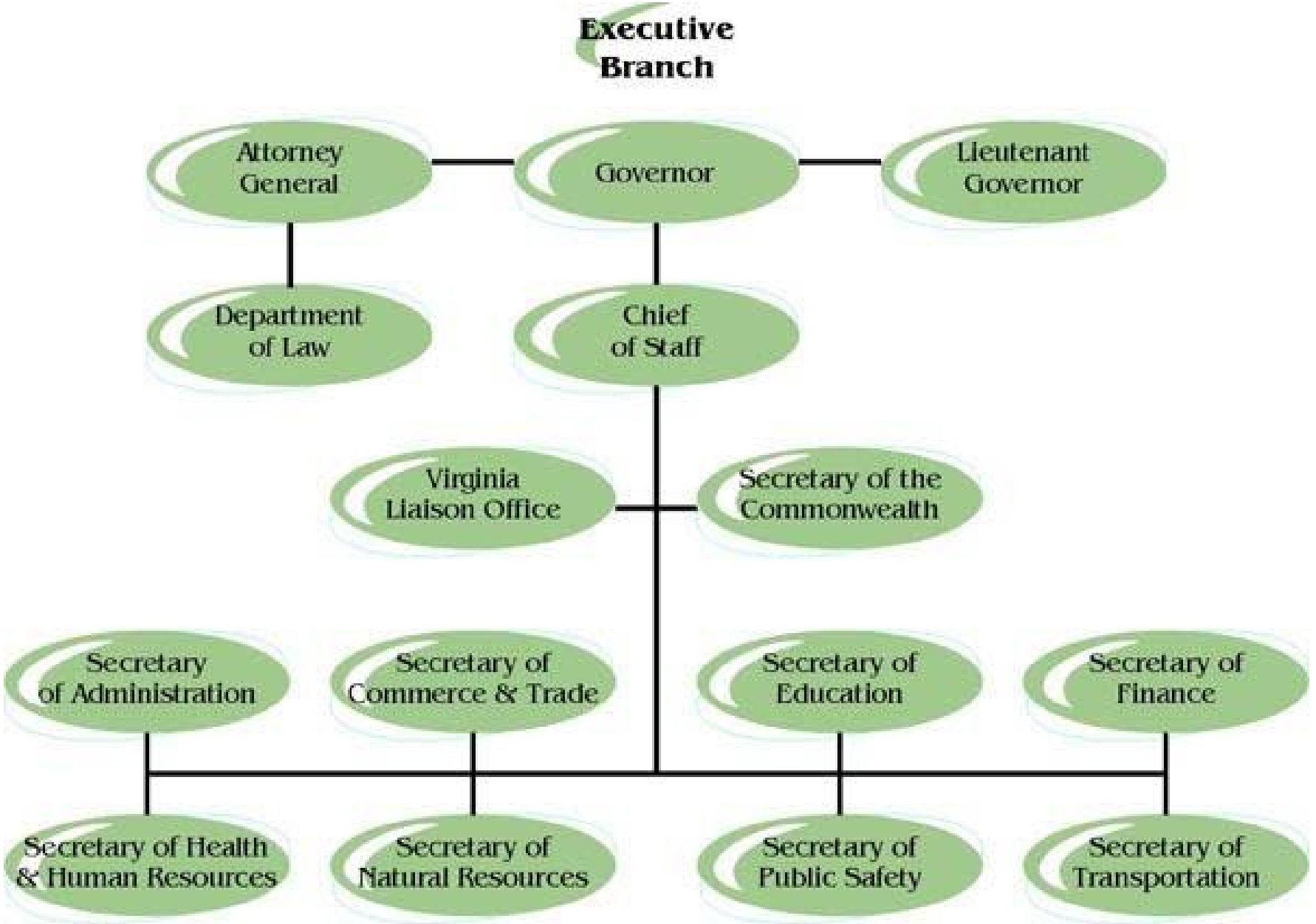

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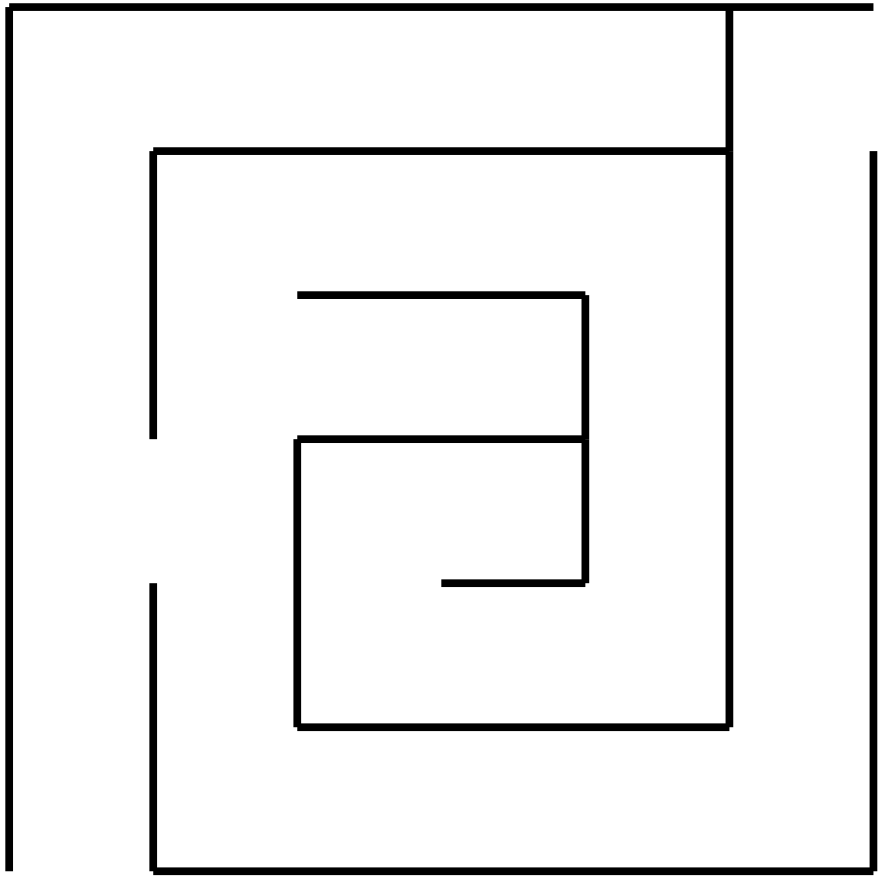

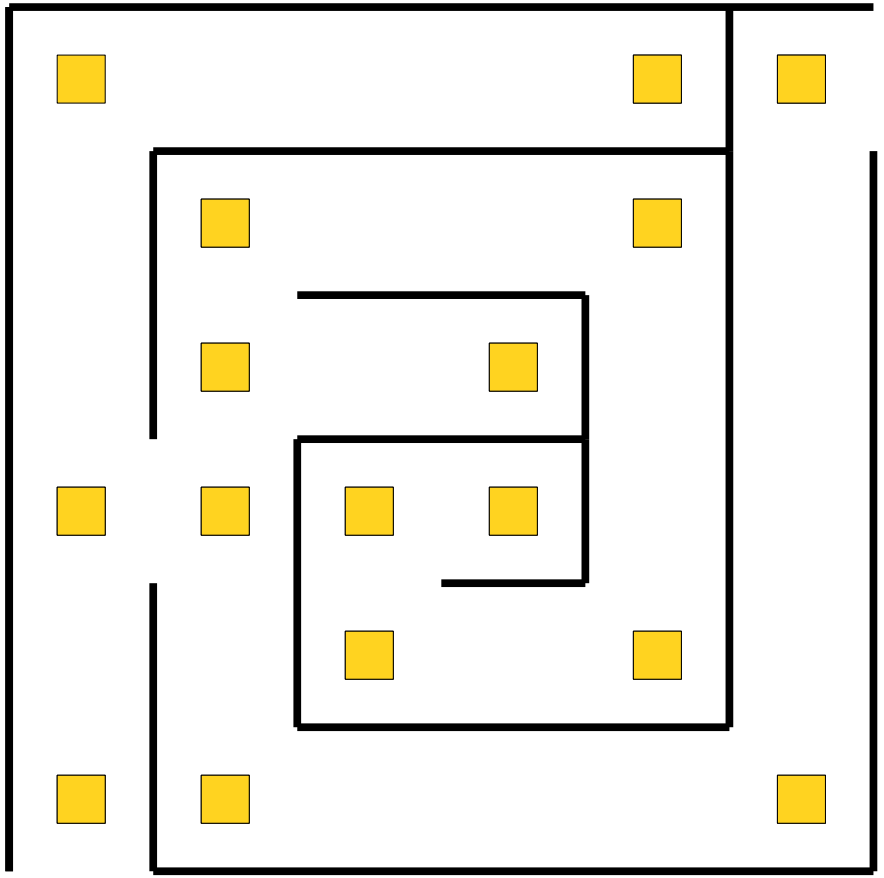

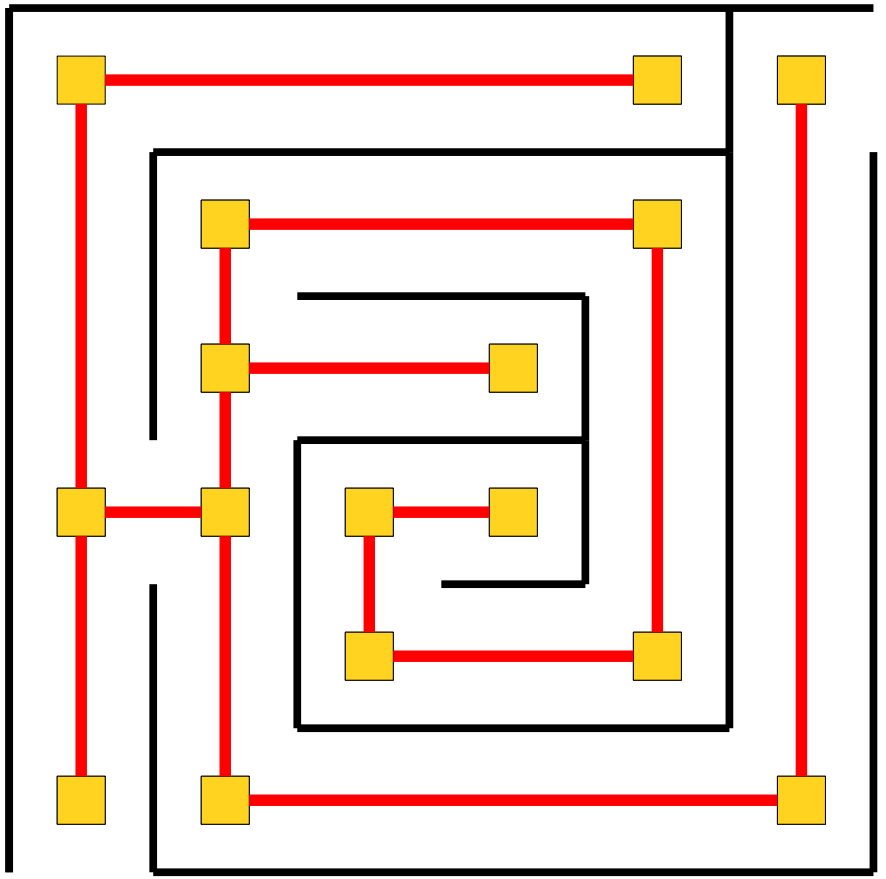

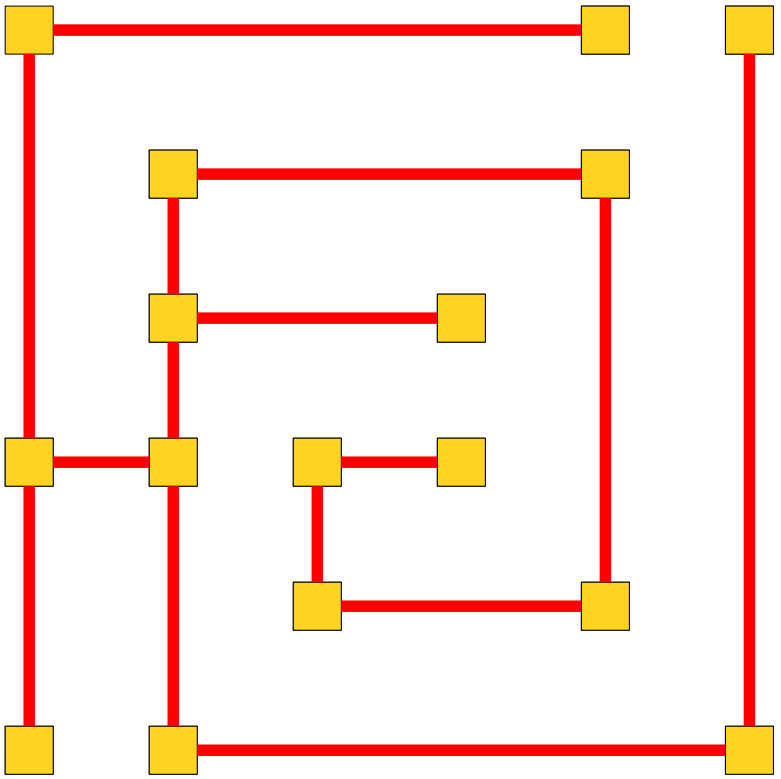

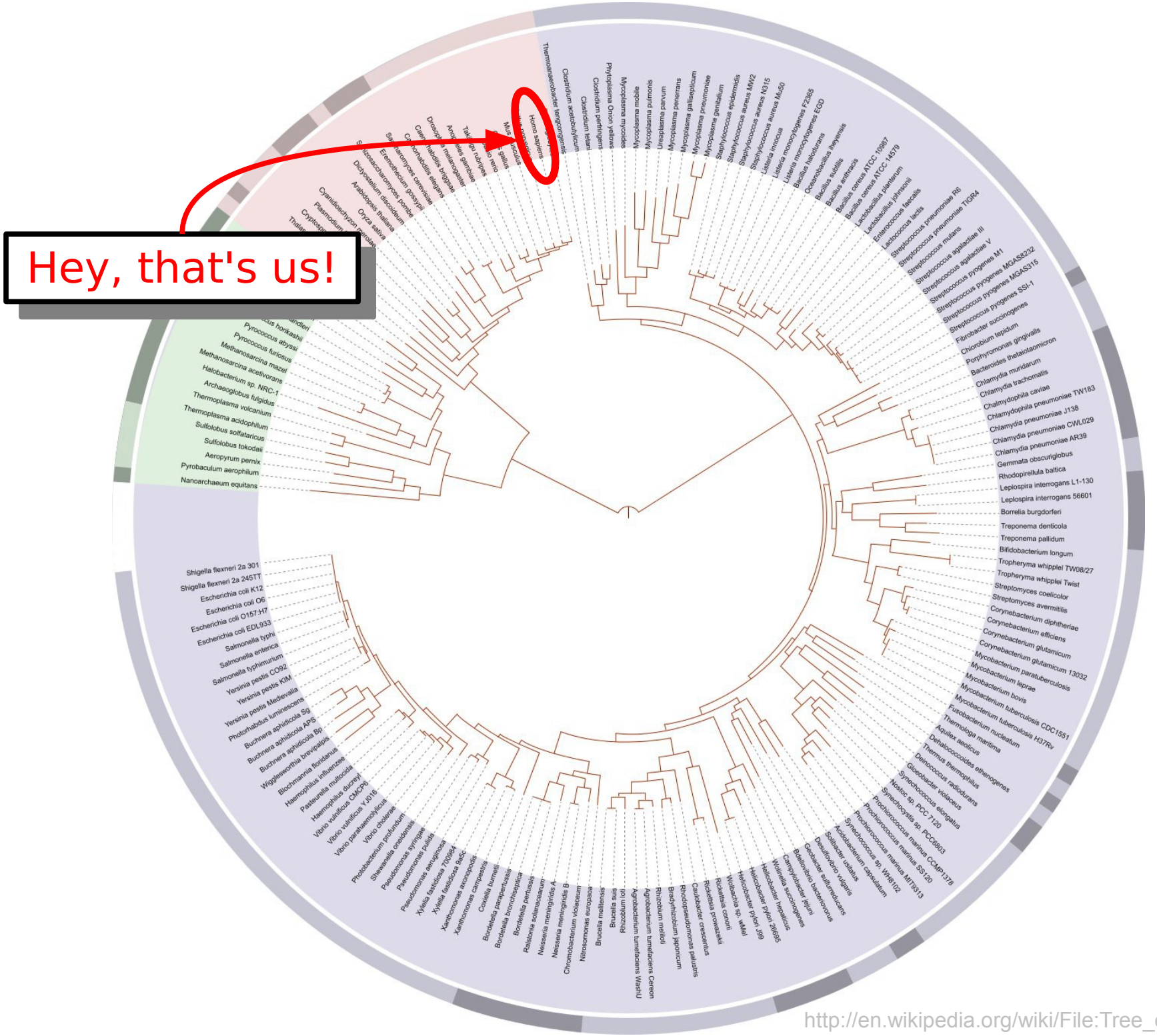

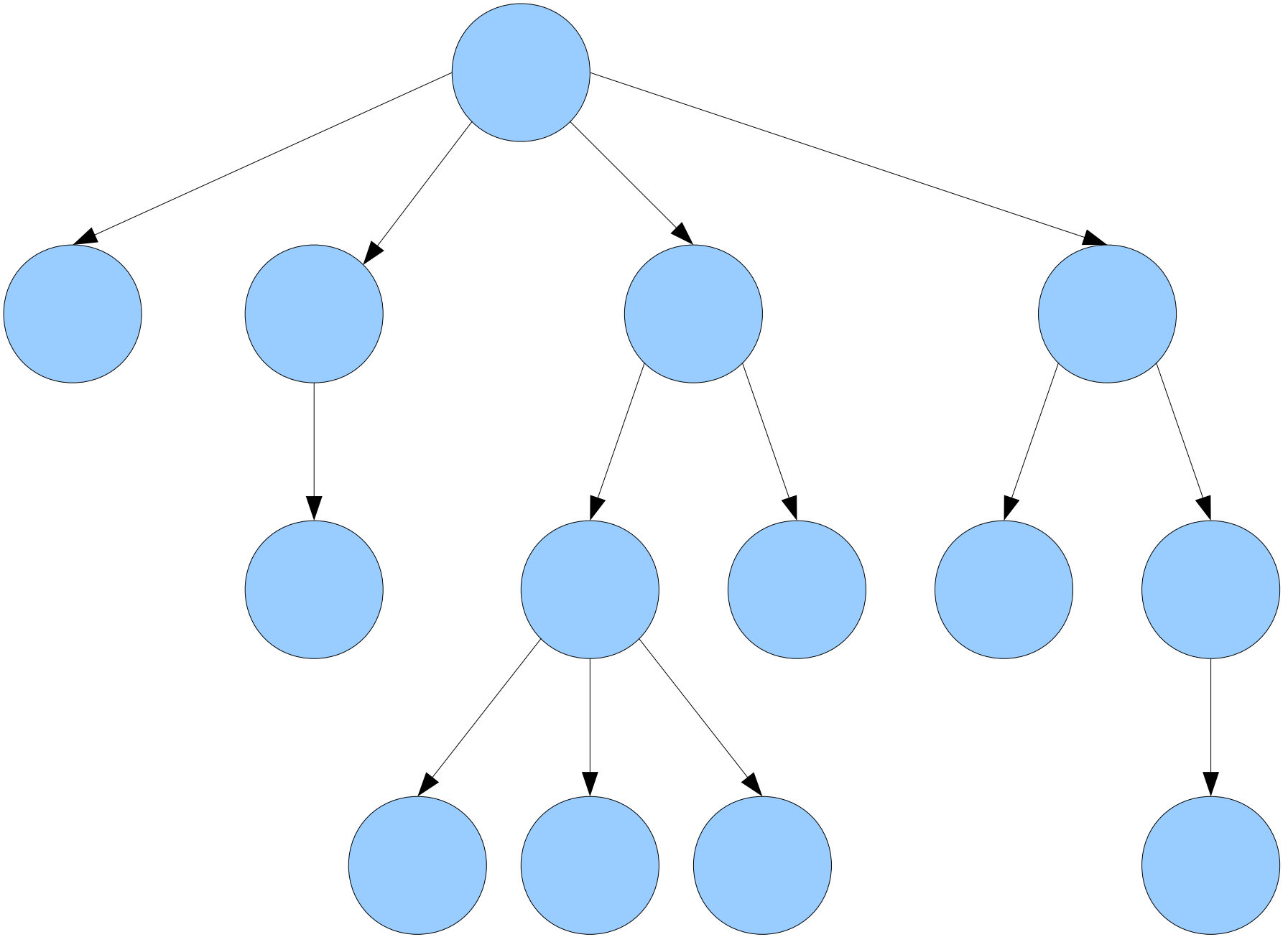

Building a vocabulary of **abstractions** makes it possible to represent and solve a wider class of problems.

Goals for this Course

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Recursion: Fibonacci Numbers

- Fibonacci Numbers
  - 0, 1, 1, 2, 3, 5, 8, 13, 21, ...
  - Defined *recursively*:

$$fib(n) = \begin{cases} n & \text{if } n = 0 \text{ or } 1 \\ fib(n\text{-}1) + fib(n\text{-}2) & \text{otherwise} \end{cases}$$

- What would this look like in code?

Recursion: Fibonacci Numbers

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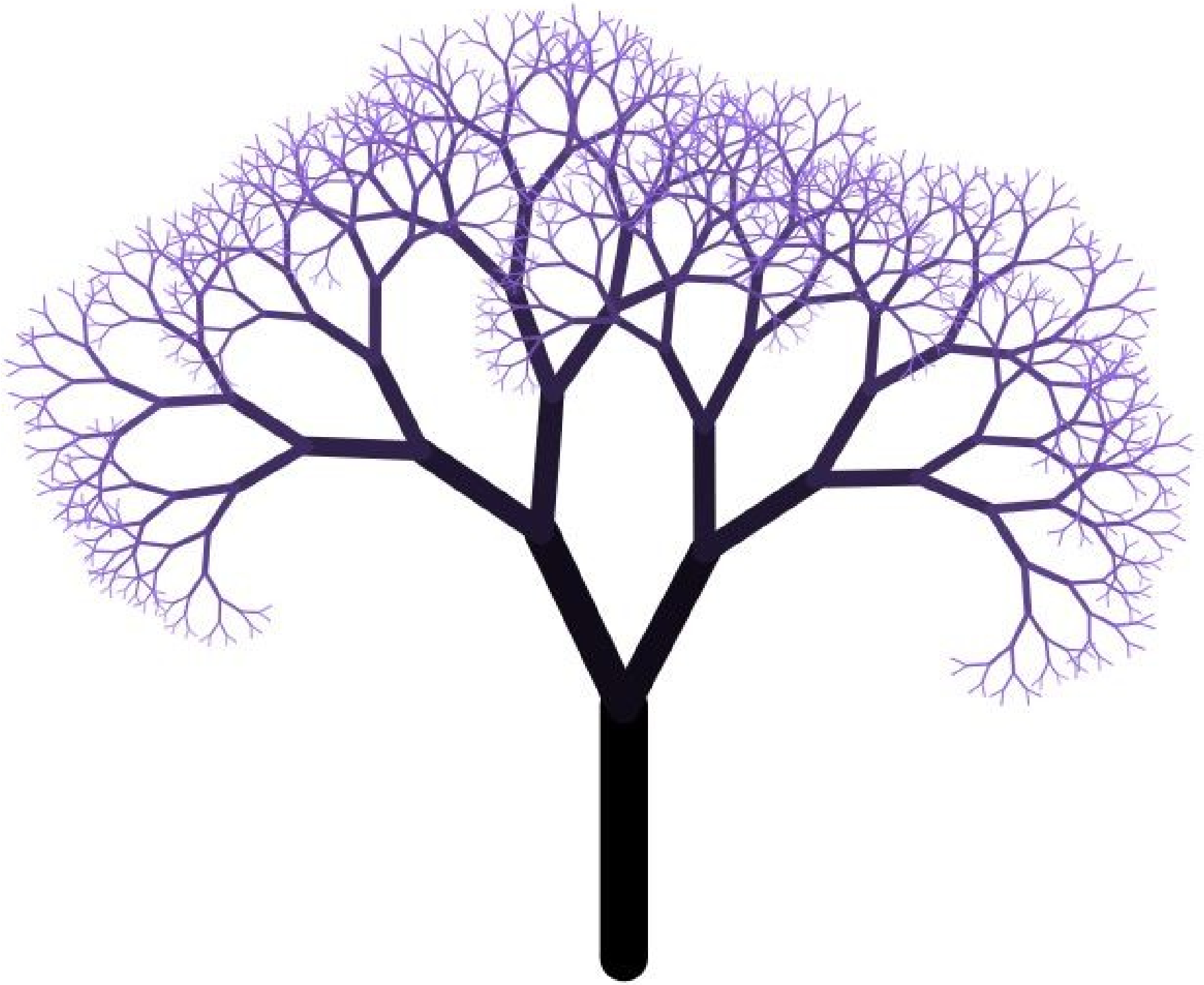
$$fib(n) = \begin{cases} n & \text{if } n = 0 \text{ or } 1 \\ fib(n\text{-}1) + fib(n\text{-}2) & \text{otherwise} \end{cases}$$

- What would this look like in code?
- It's okay if this is hard to think about! It is for most people when they see it for the first (and second and third) time.



http://www.marketoracle.co.uk/images/2010/Oct/fractal-tree2.jpg

A **recursive solution** is a solution that is defined in terms of “smaller” instances of itself.

Thinking recursively allows you to solve an enormous class of problems cleanly and concisely.

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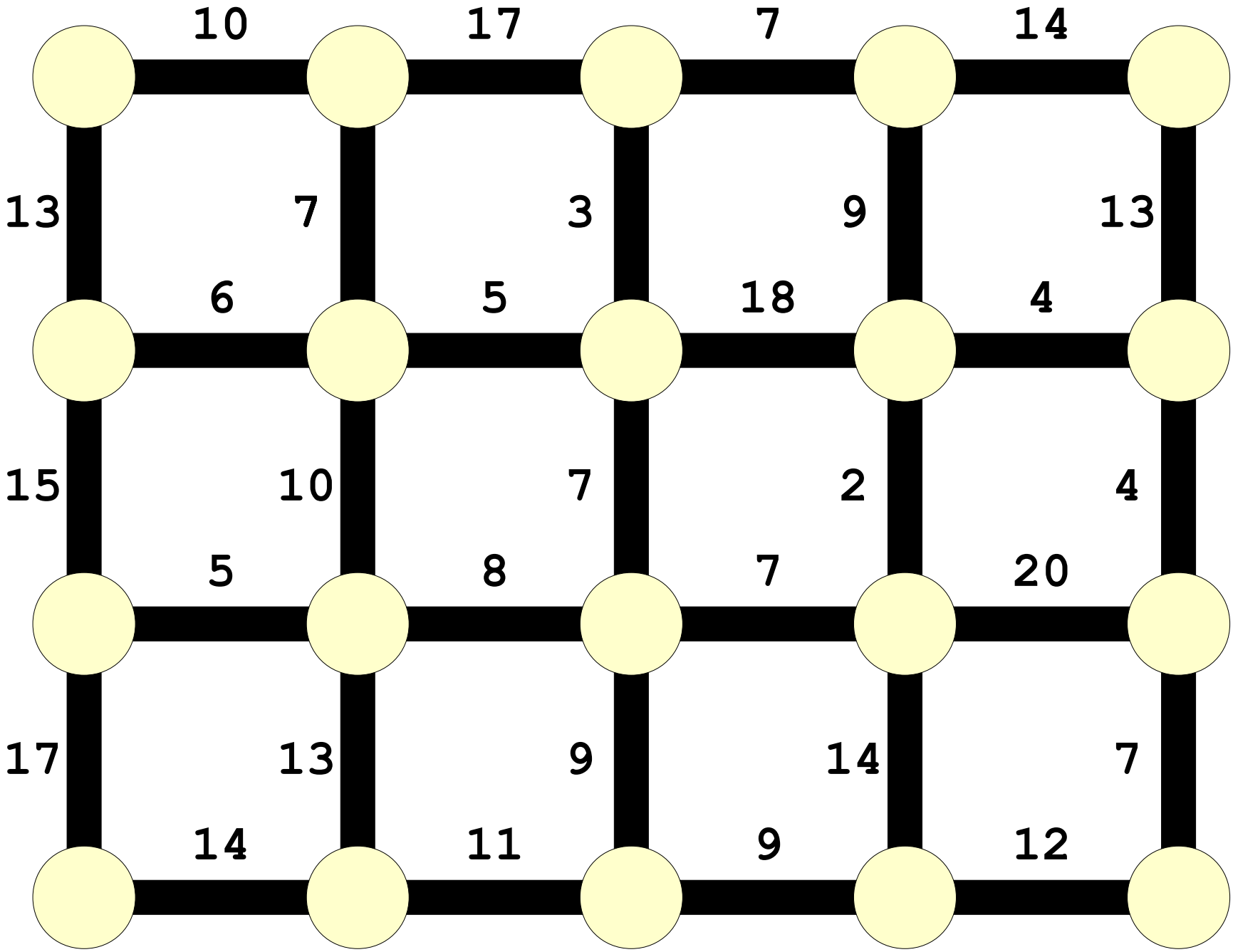
What makes an algorithm “fast” or “slow”?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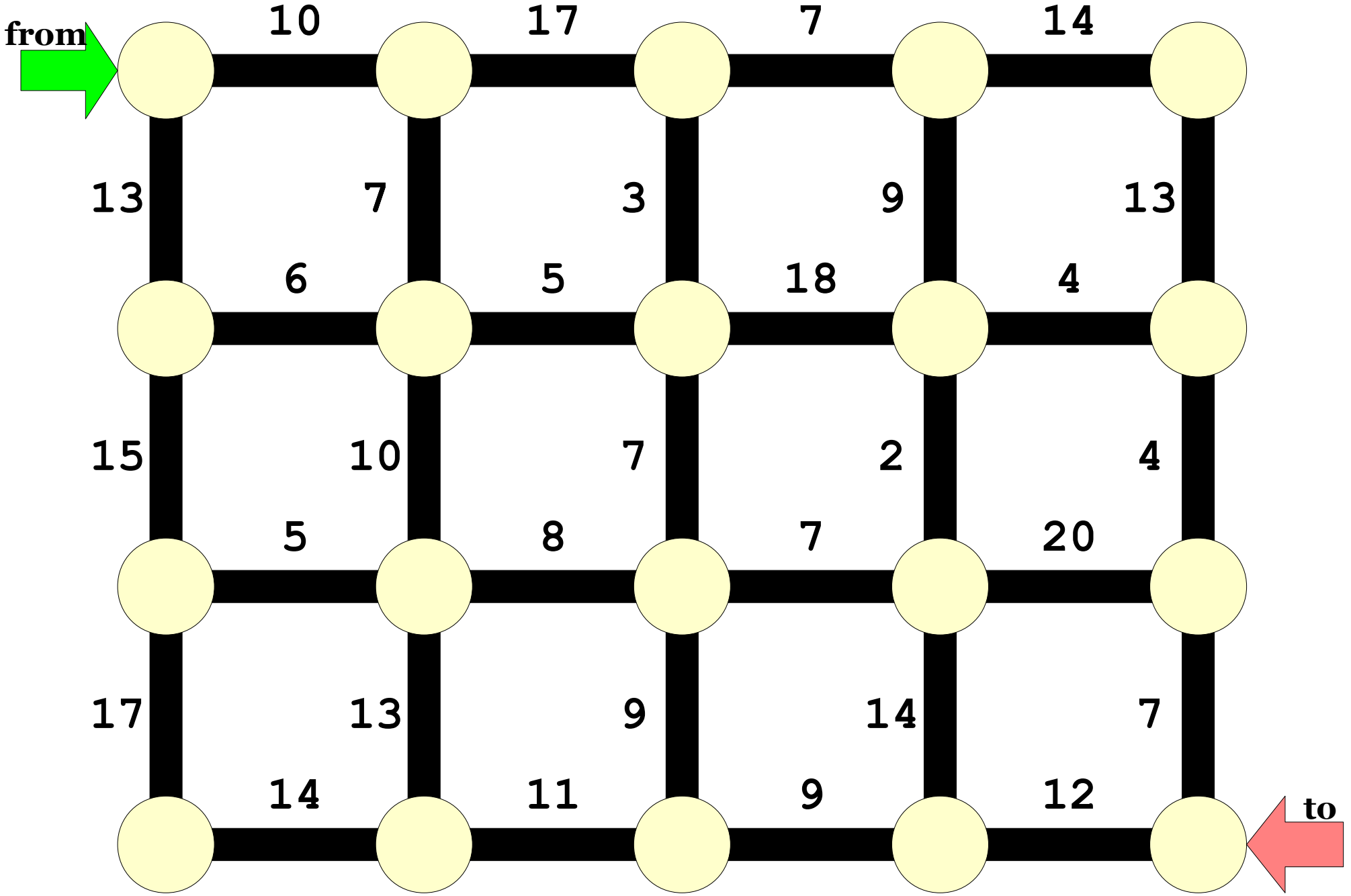
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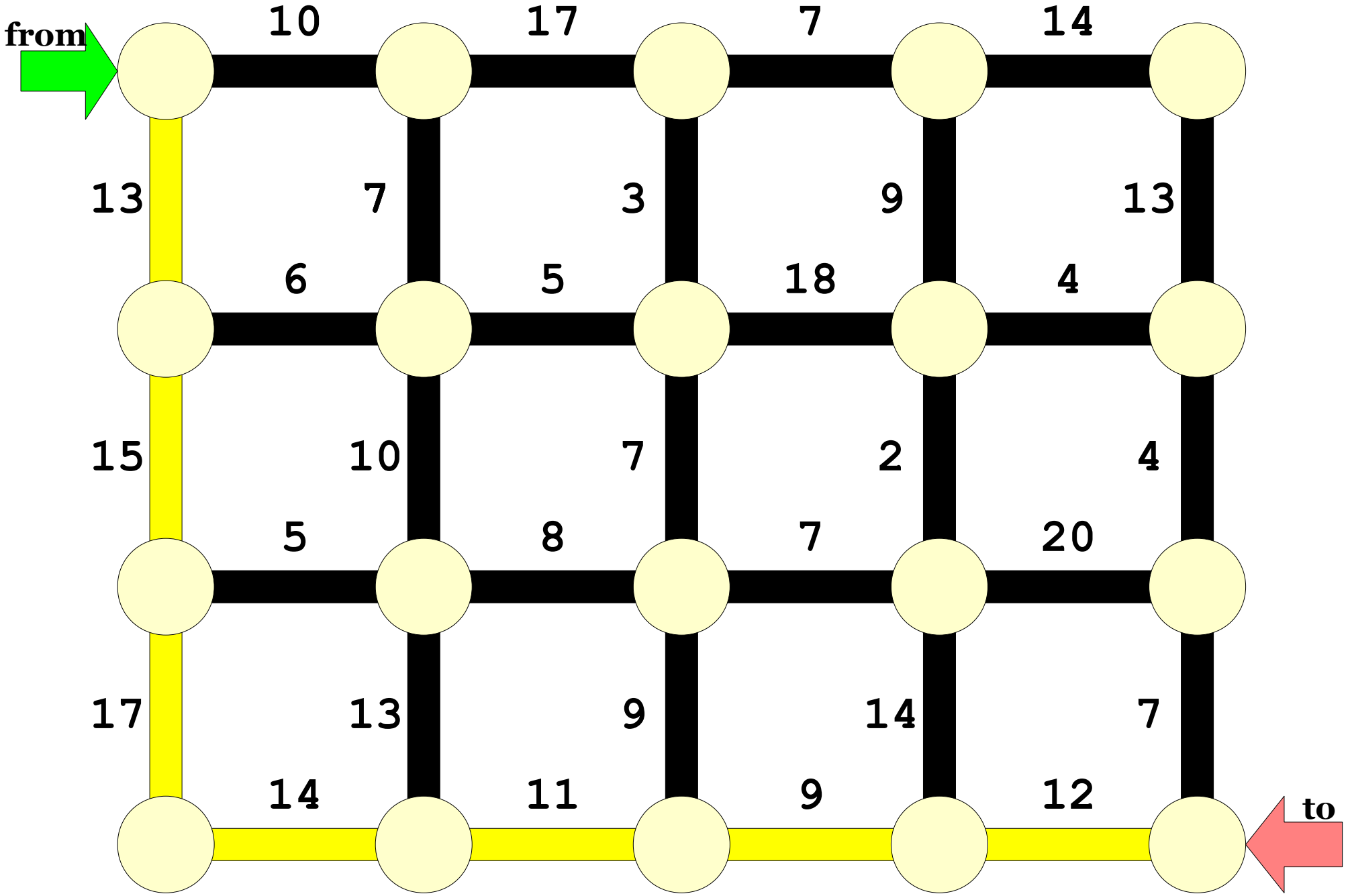
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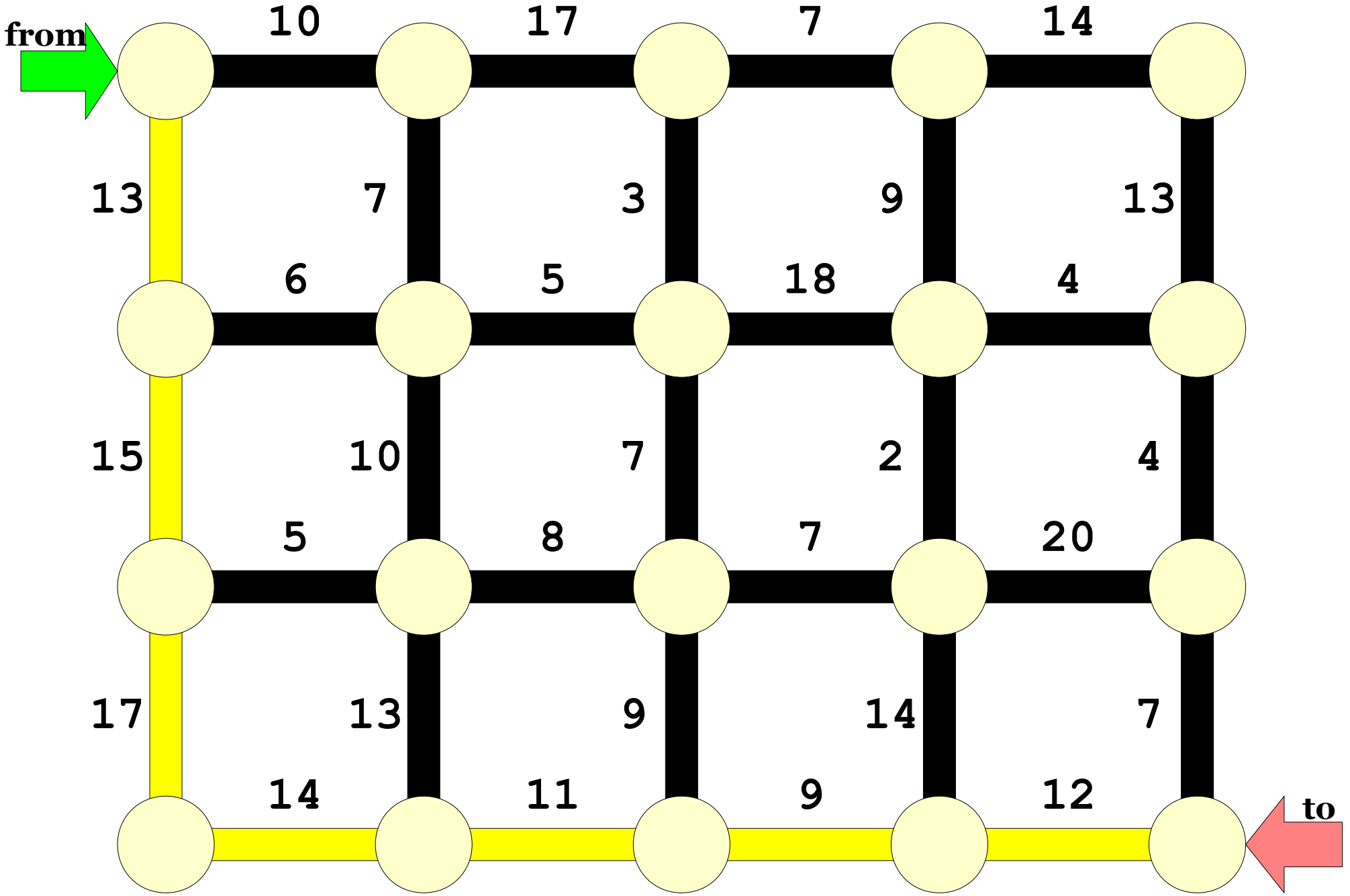
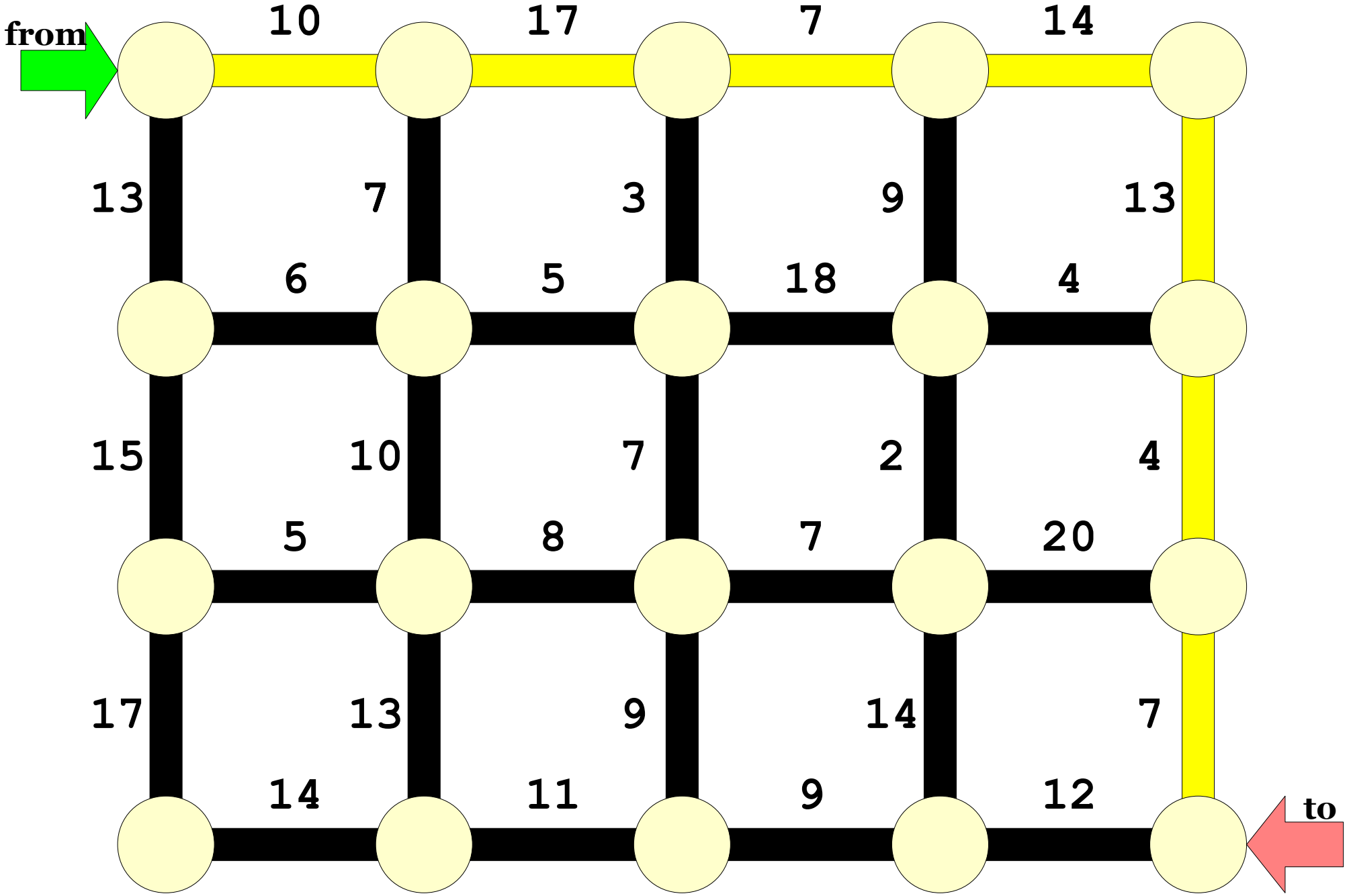


Travel Time: 13 + 15 + 17 + 14 + 11 + 9 + 12 = **91**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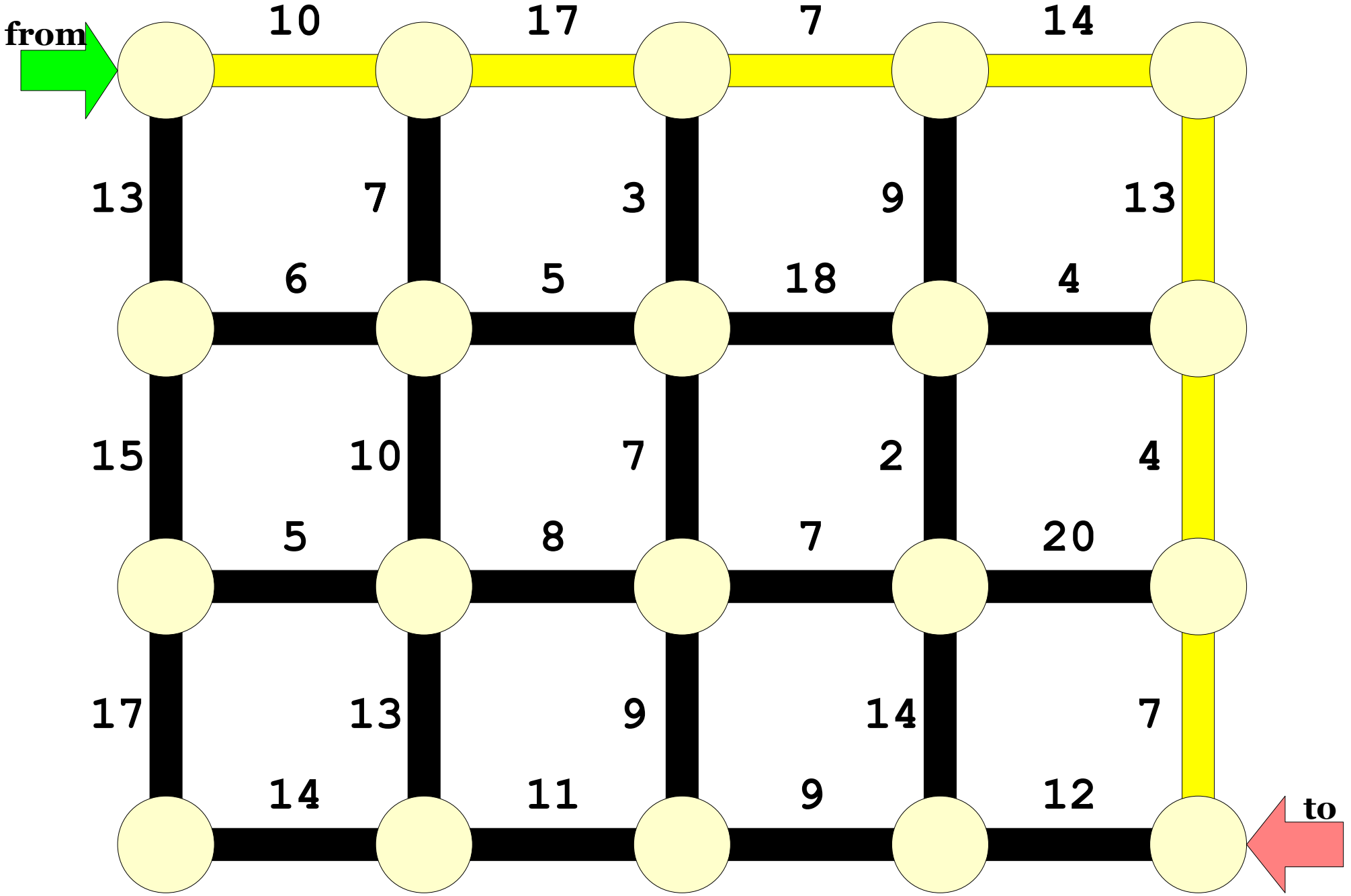
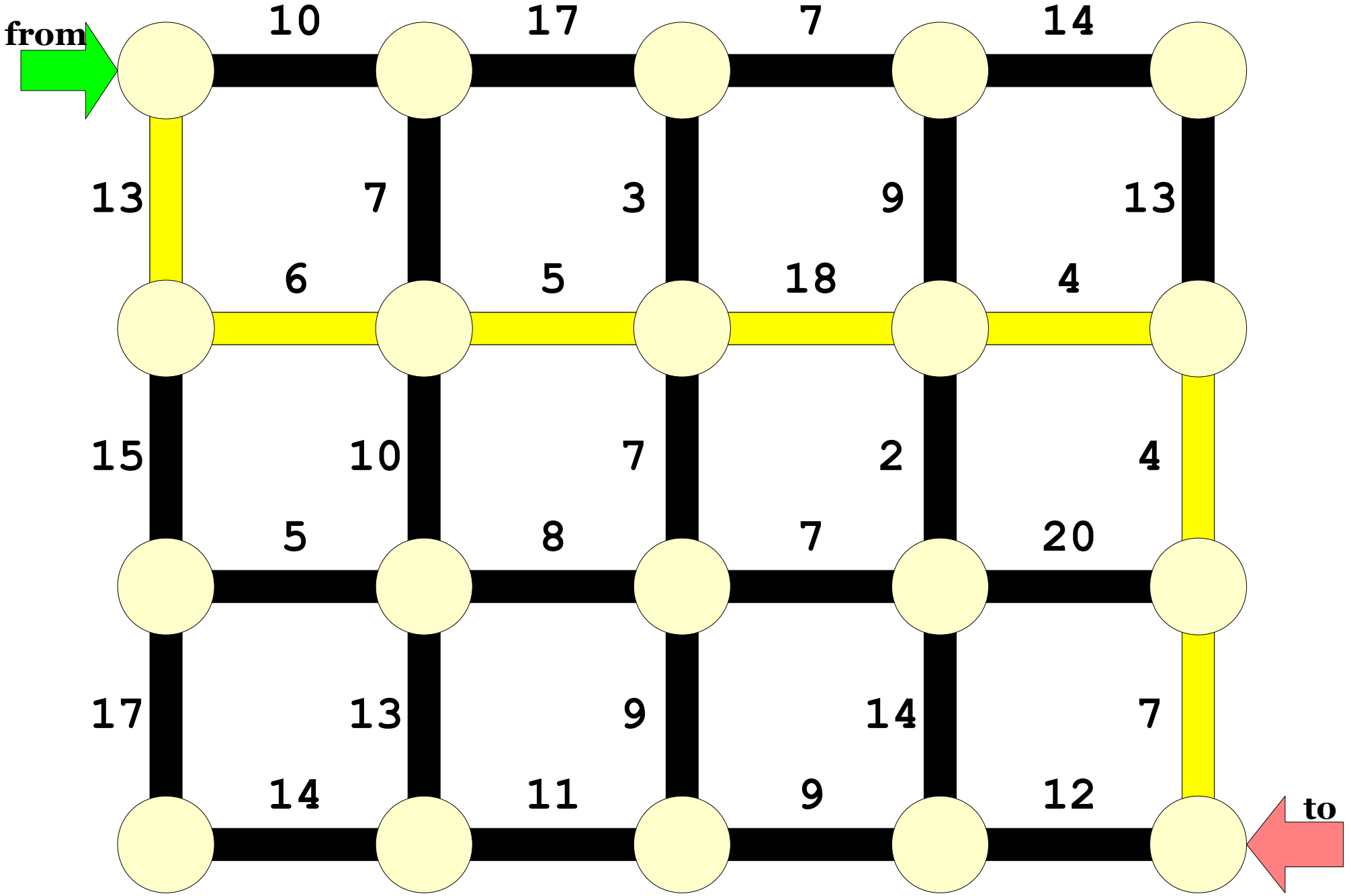


Travel Time: 10 + 17 + 7 + 14 + 13 + 4 + 7 = **72**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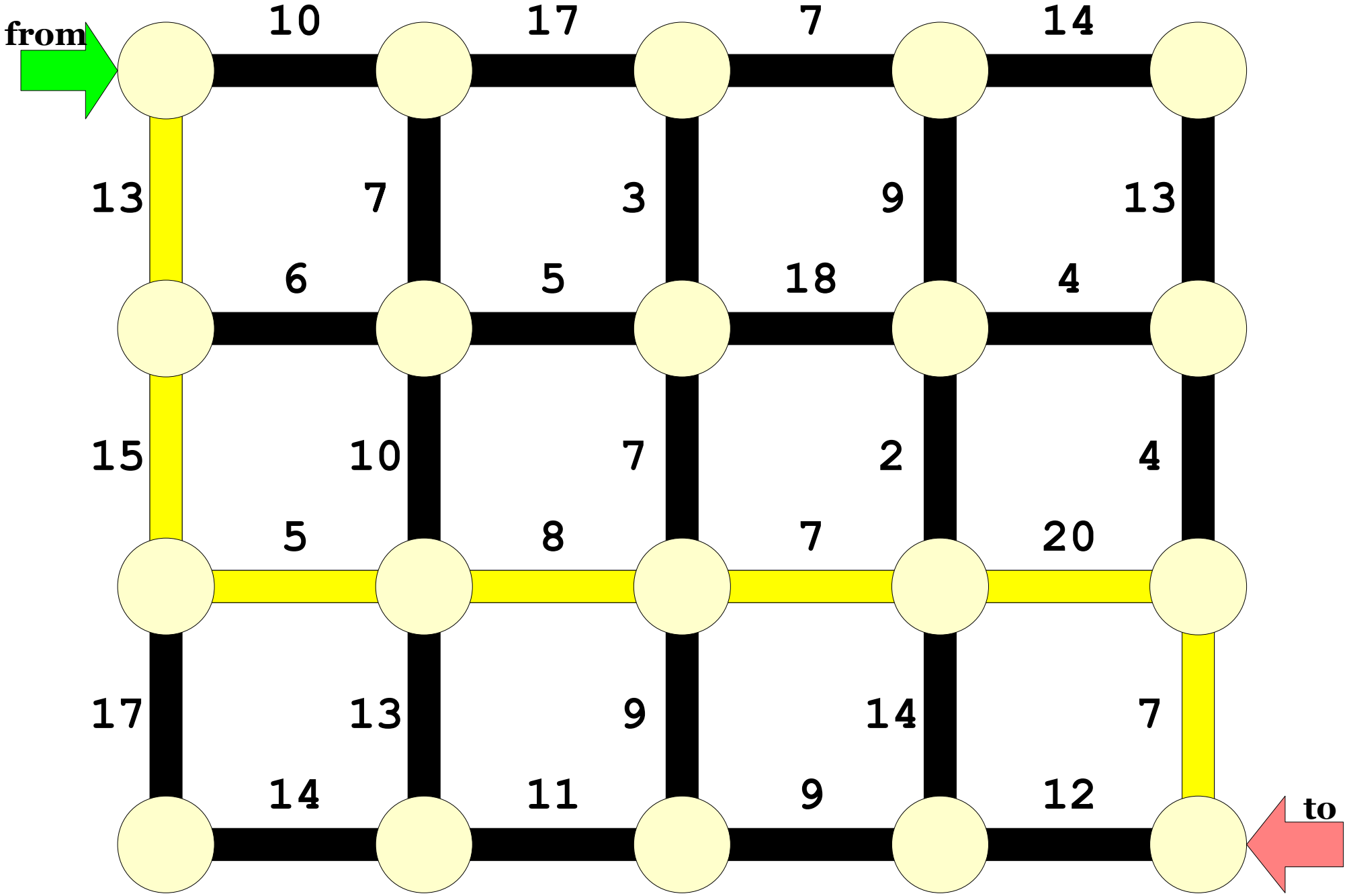
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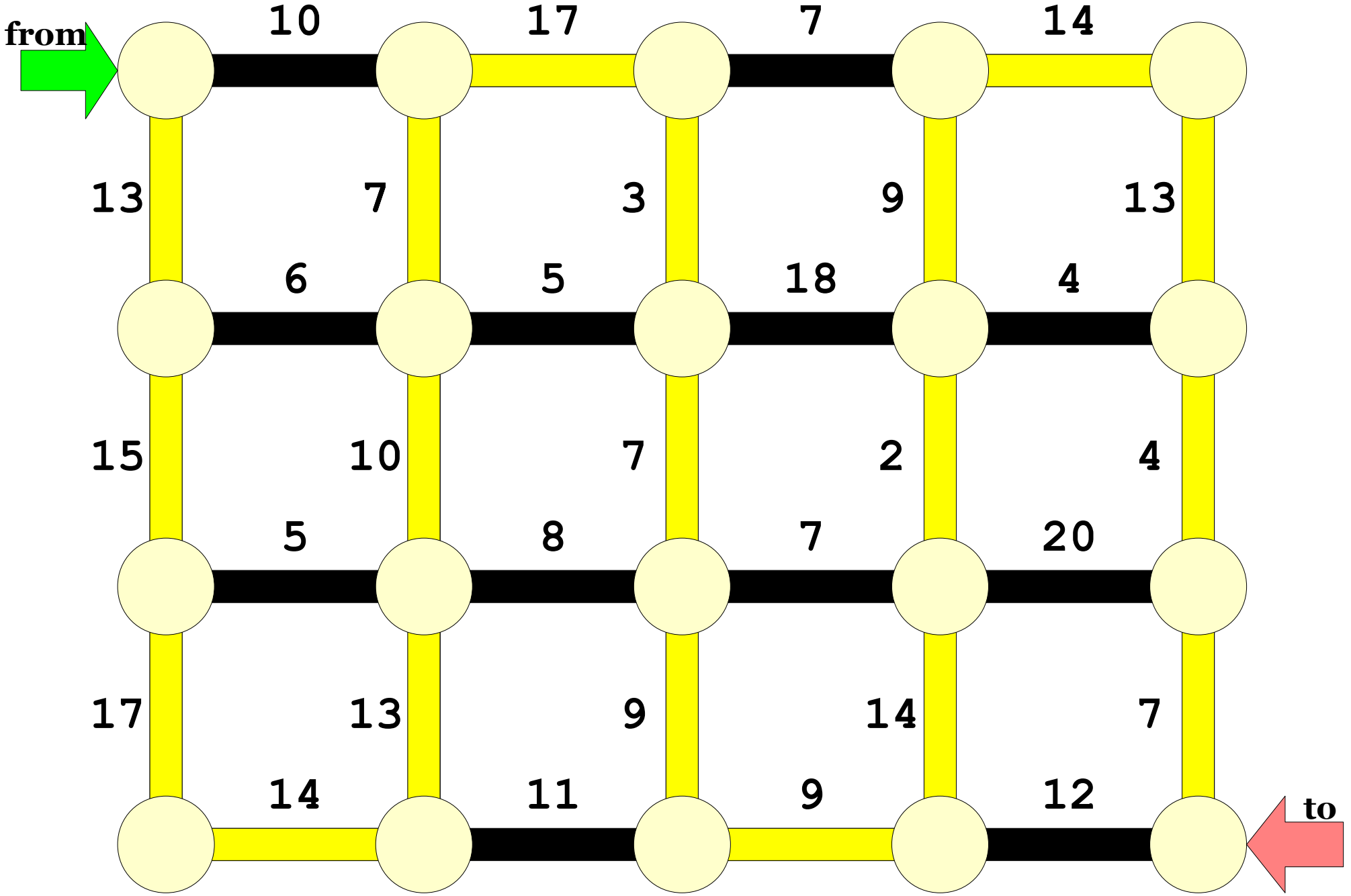
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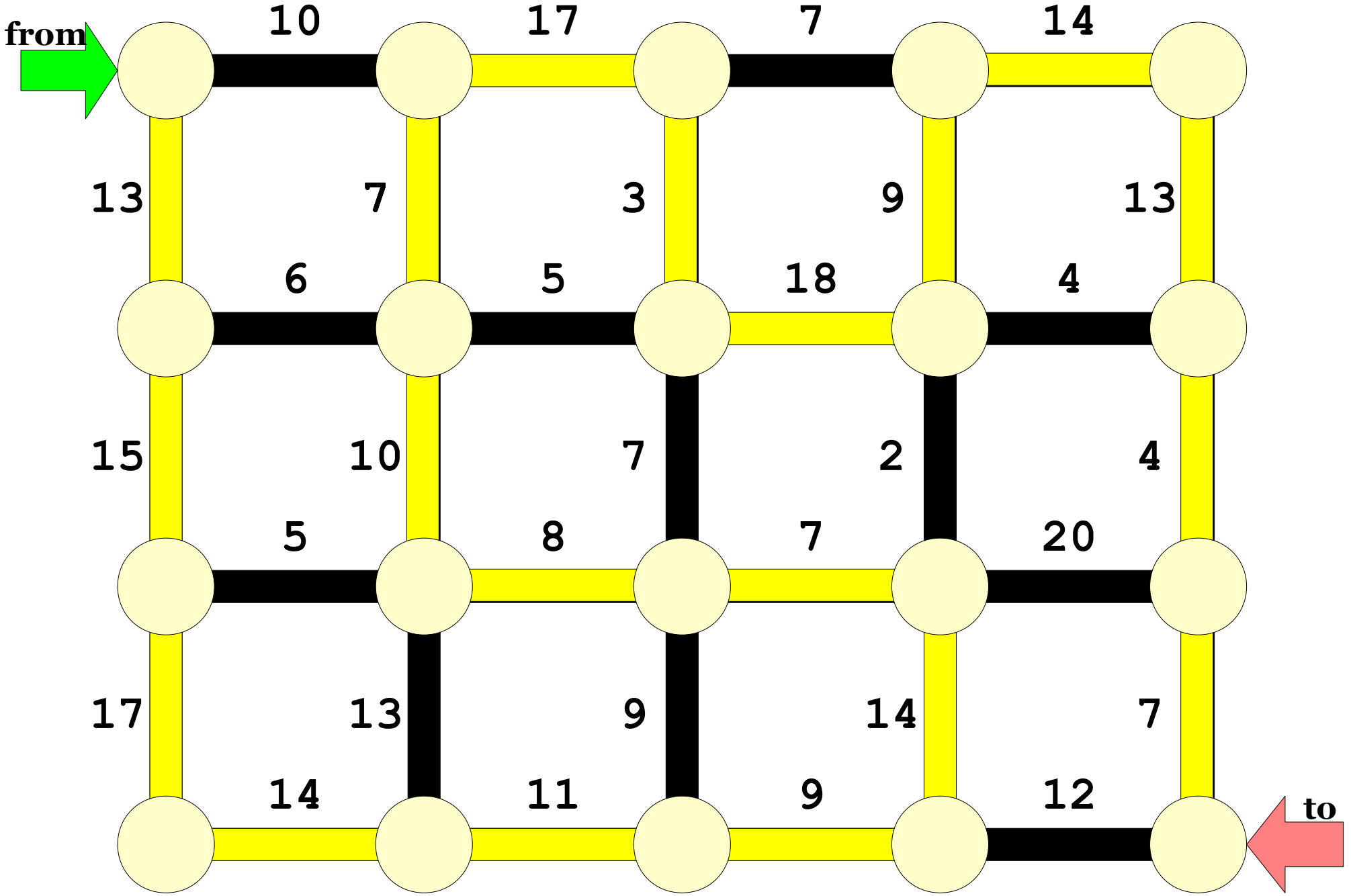
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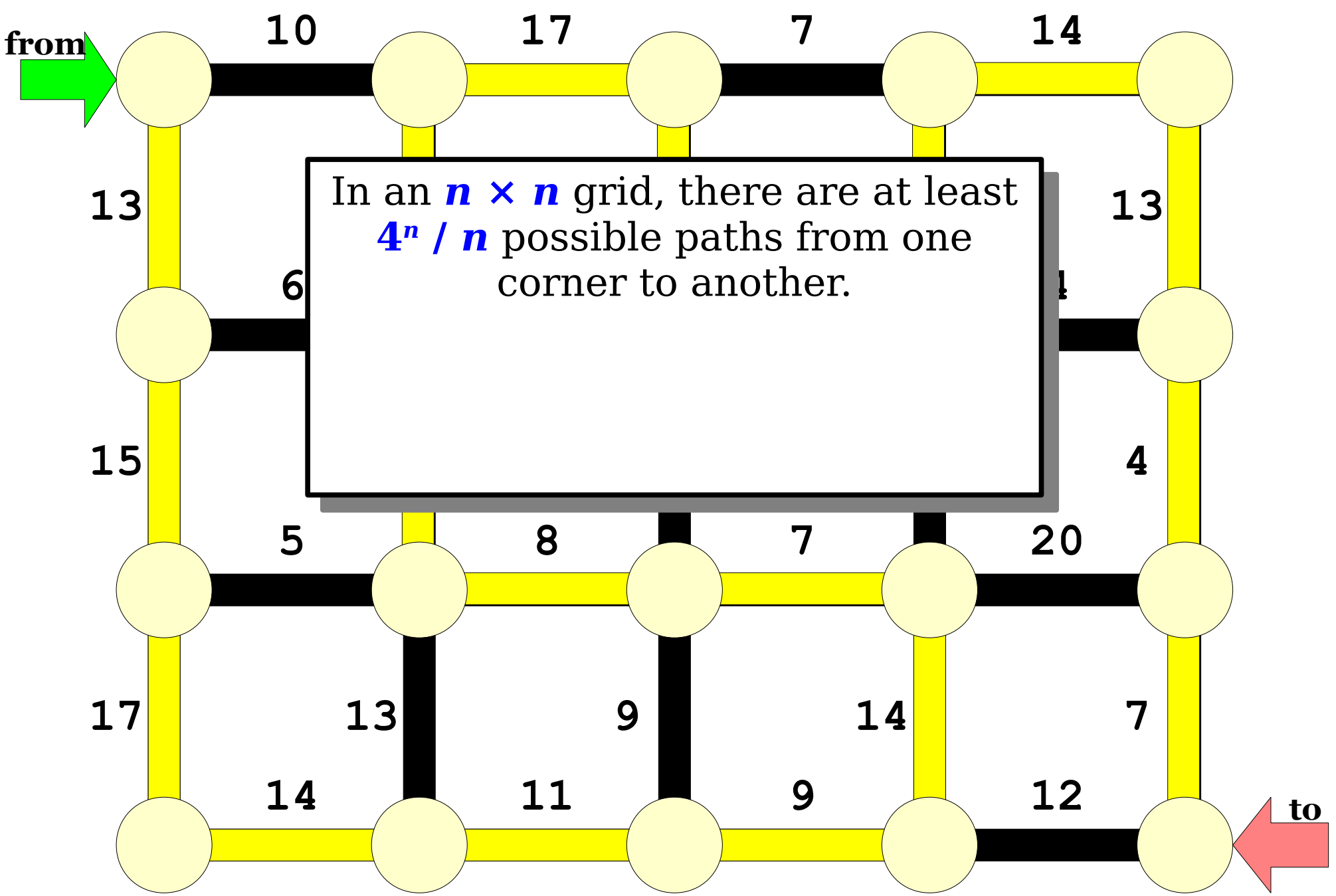
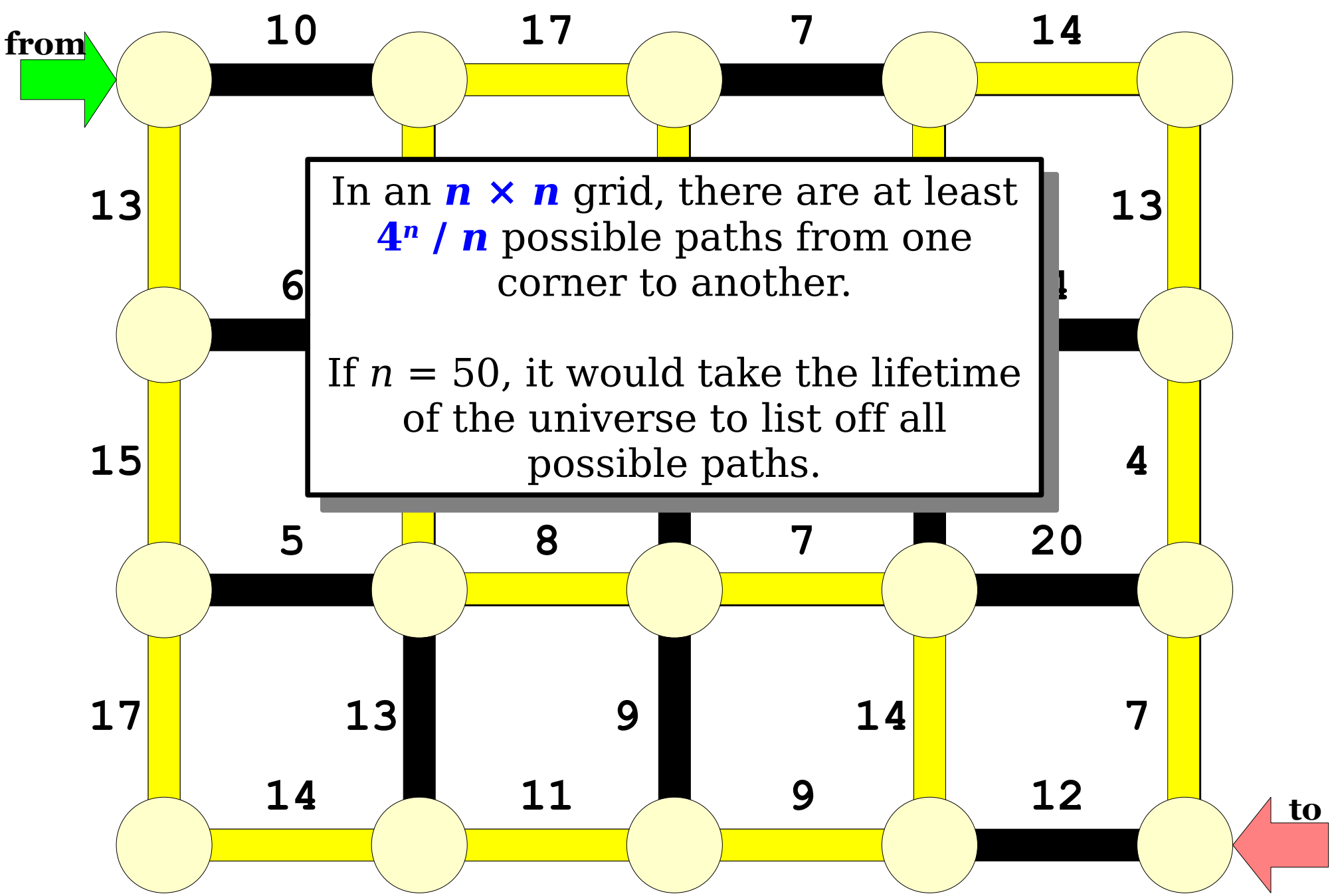


In an $n \times n$ grid, there are at least $4^n / n$ possible paths from one corner to another.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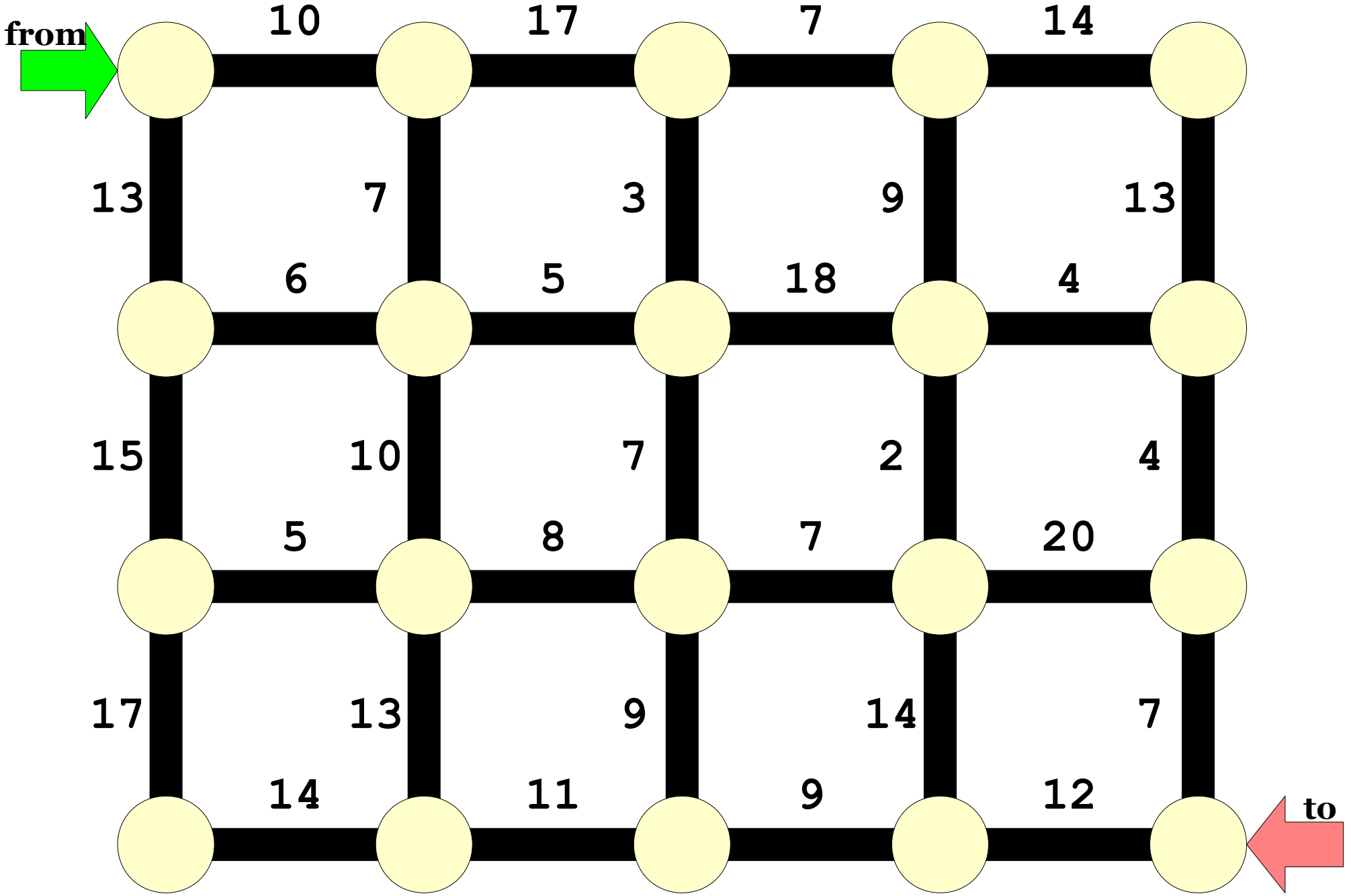
In an $n \times n$ grid, there are at least $4^n / n$ possible paths from one corner to another.
If $n = 50$, it would take the lifetime of the universe to list off all possible paths.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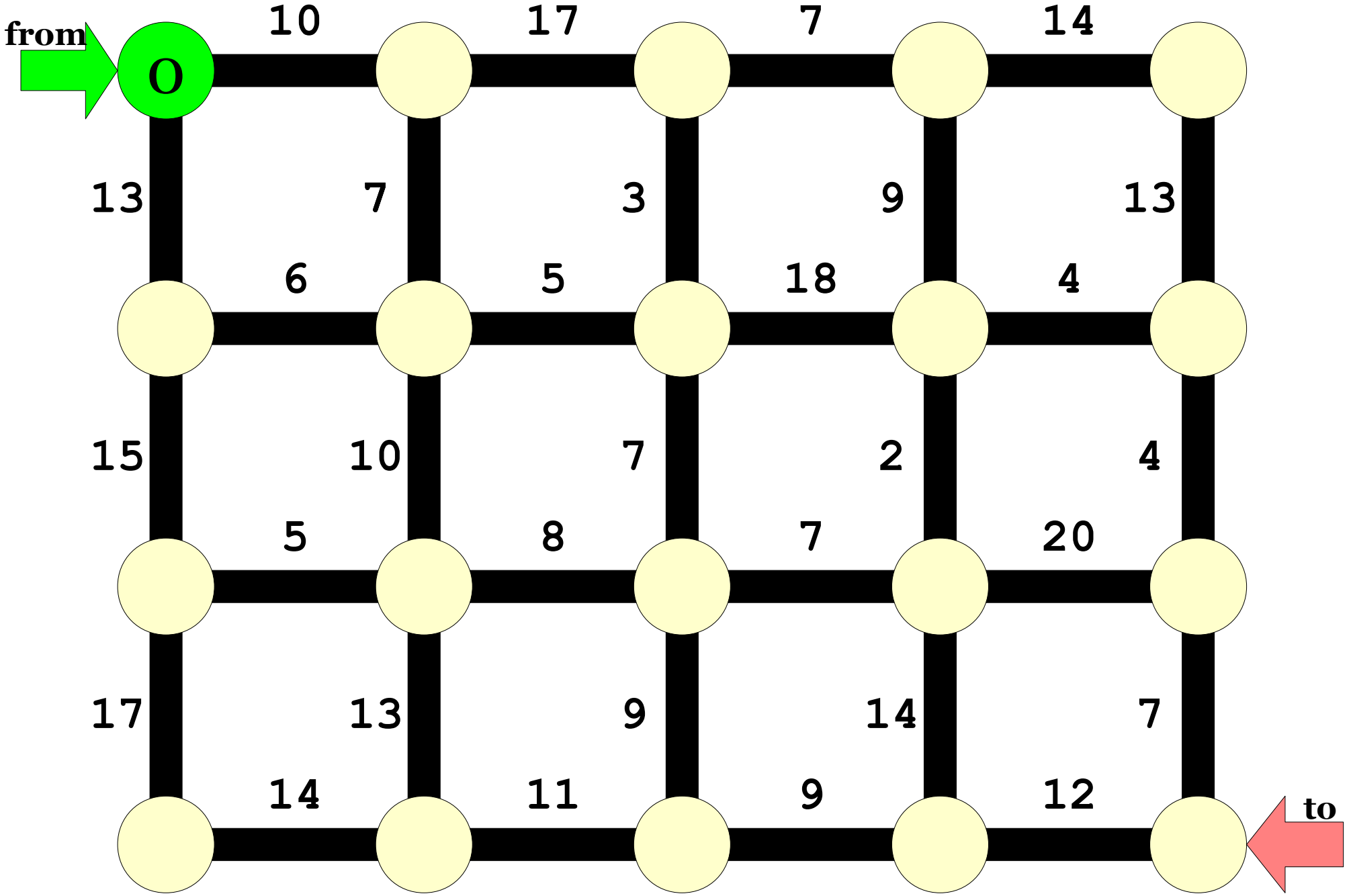
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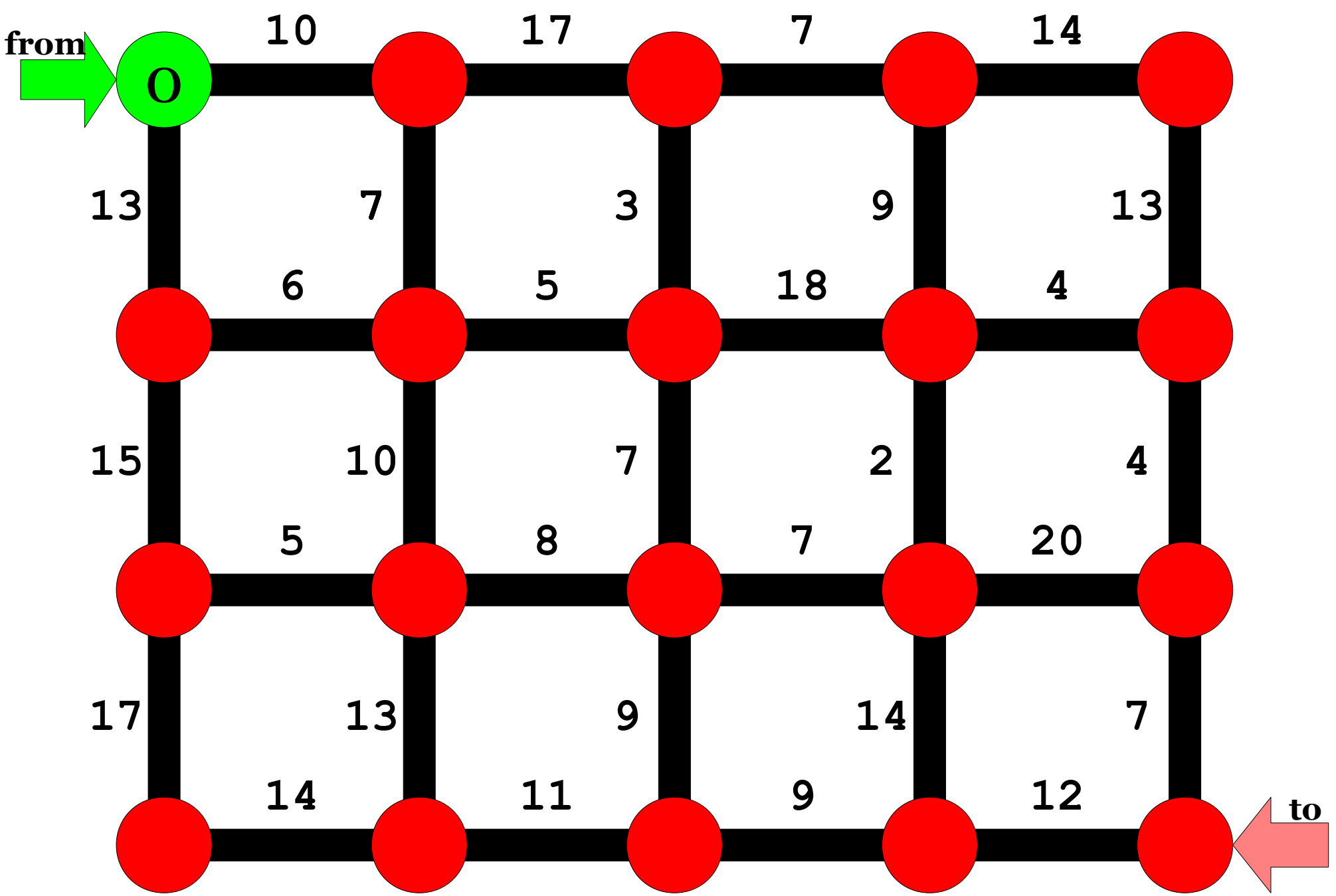
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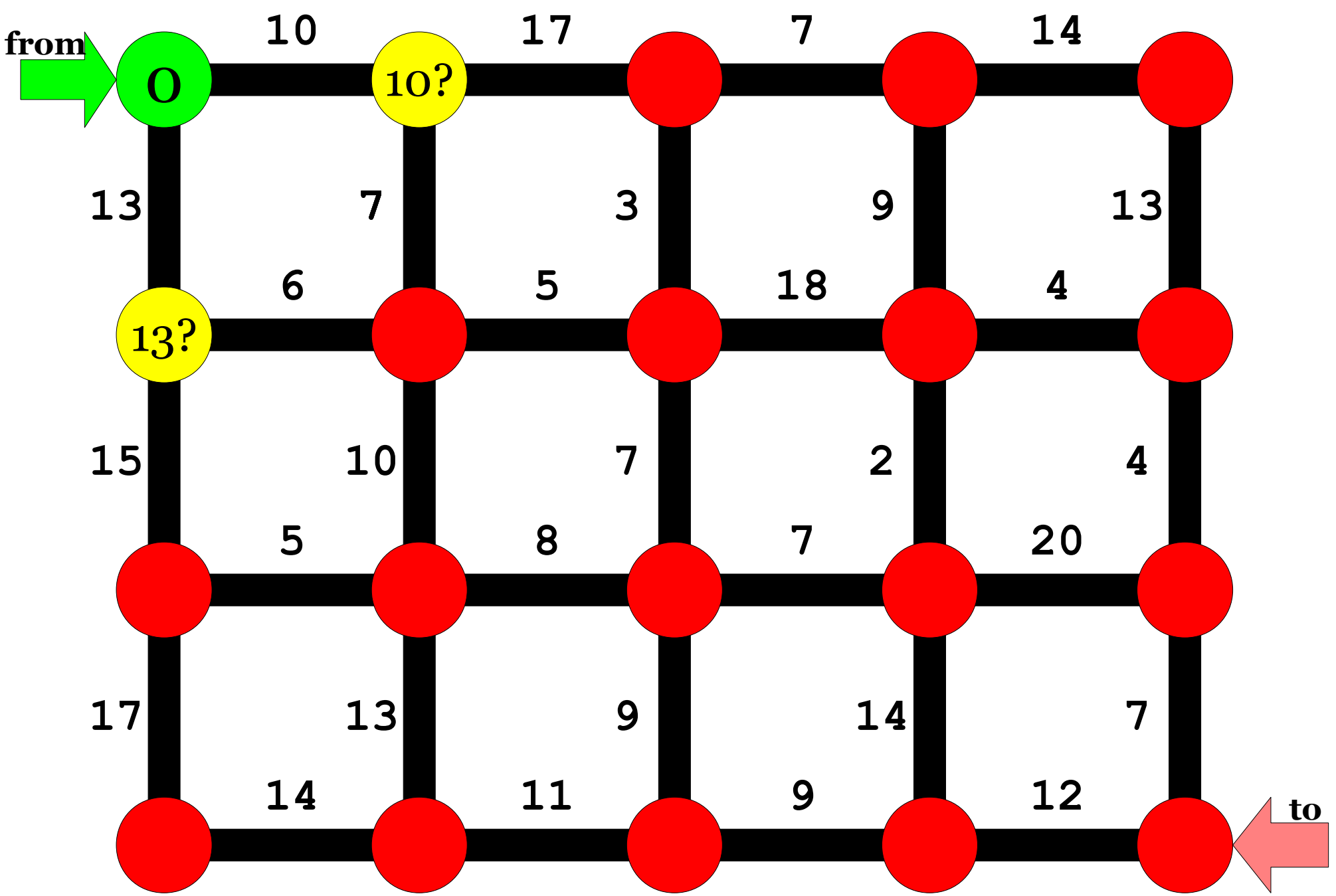
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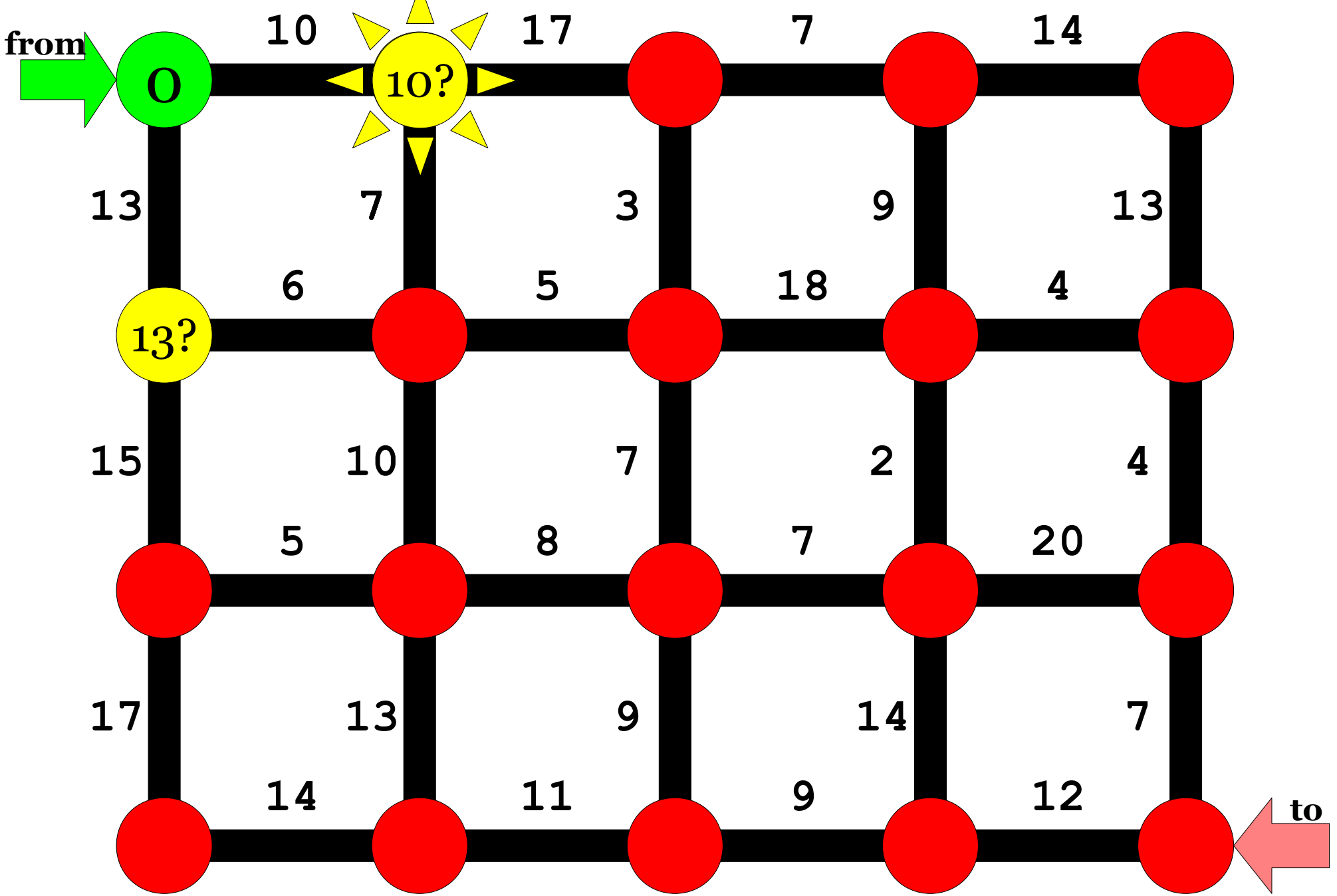
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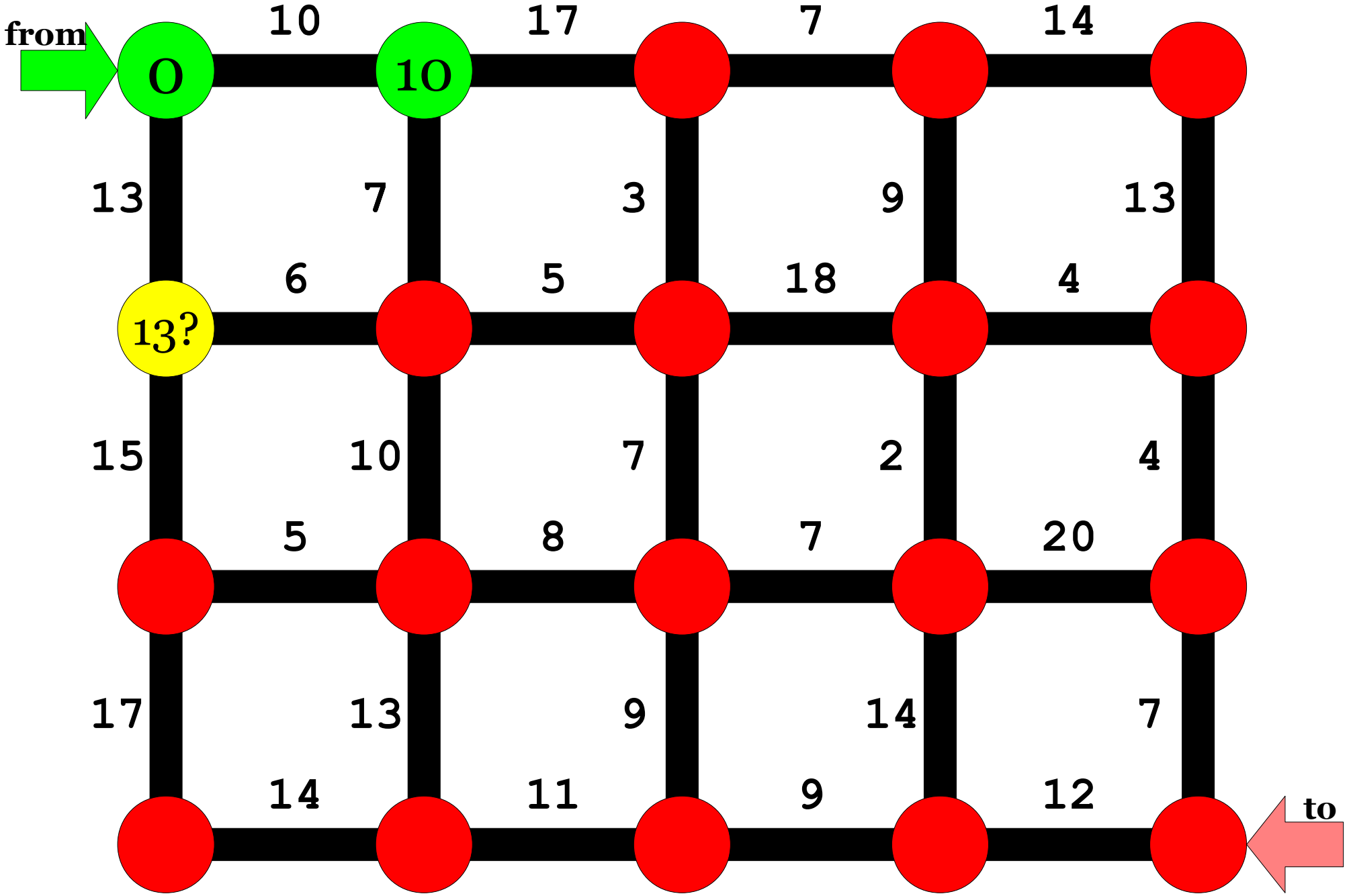
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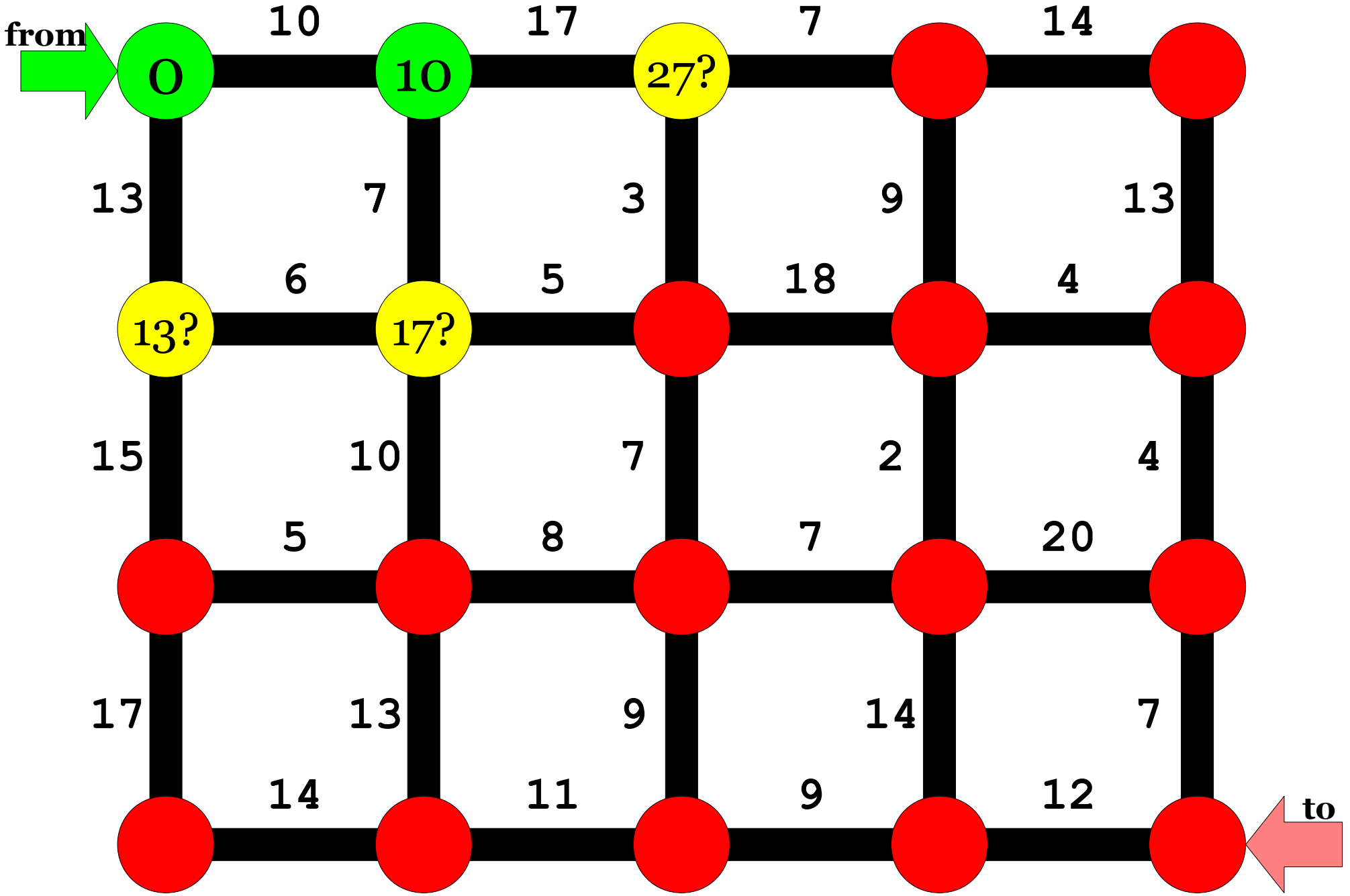
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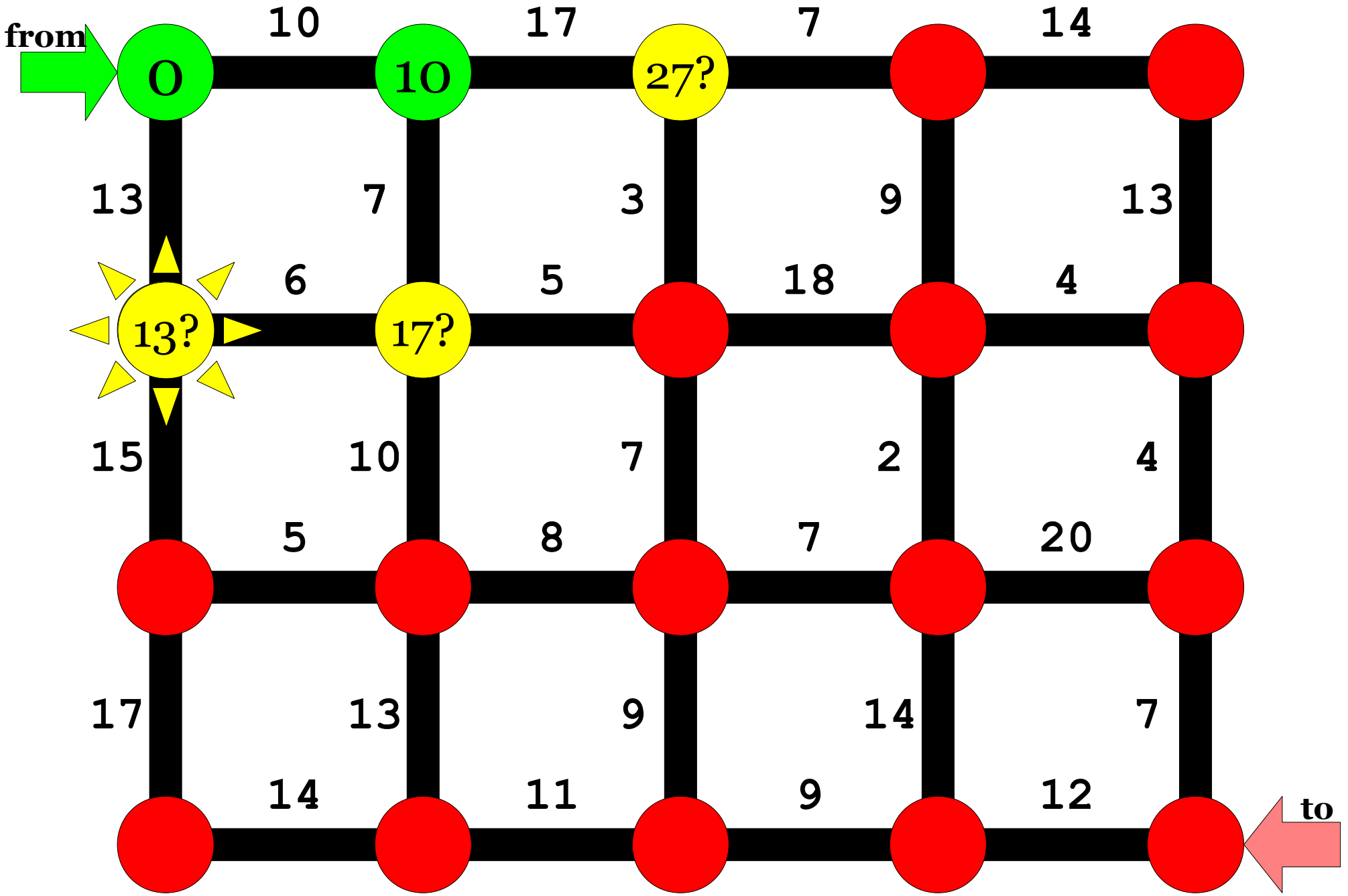
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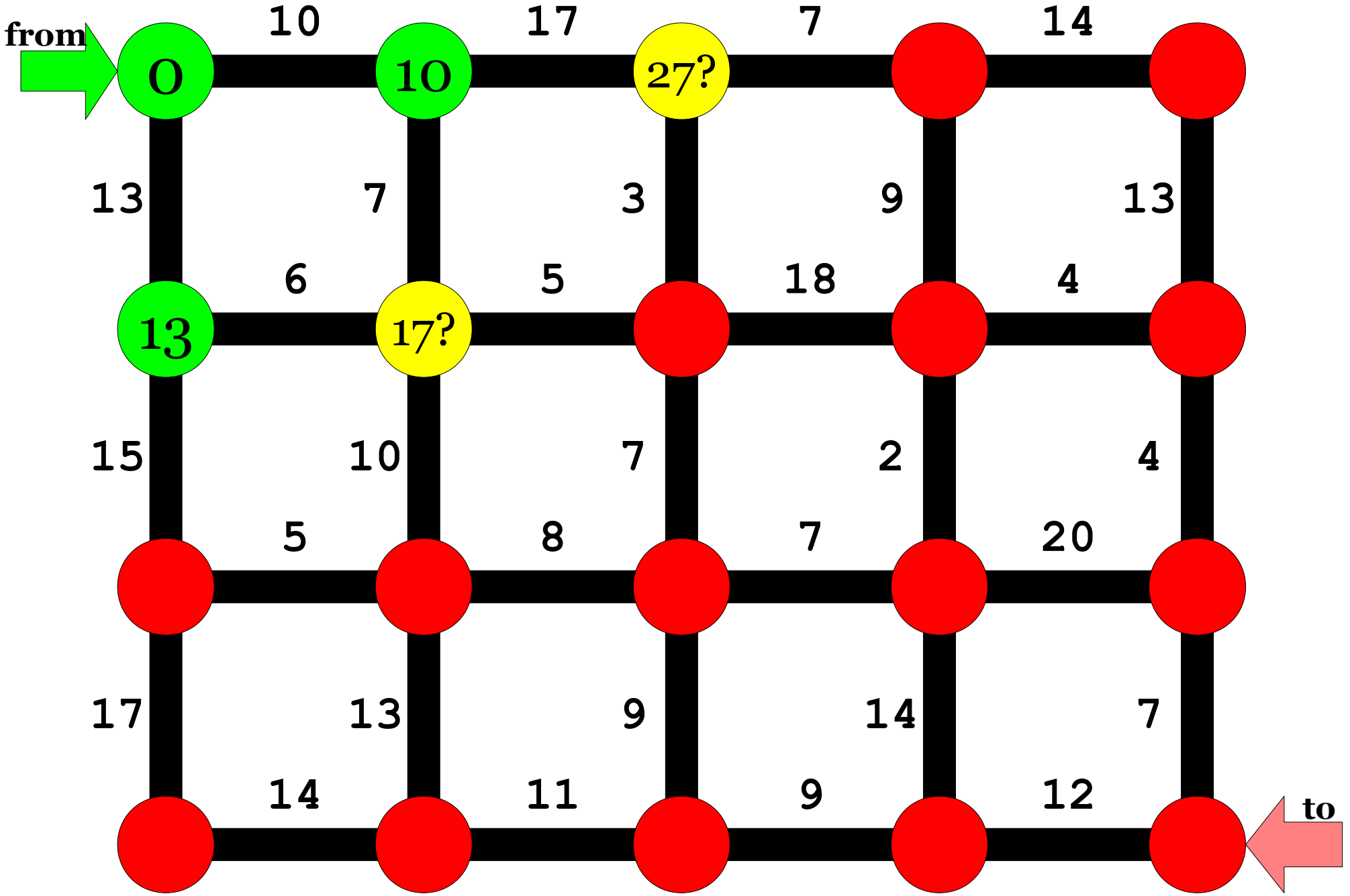
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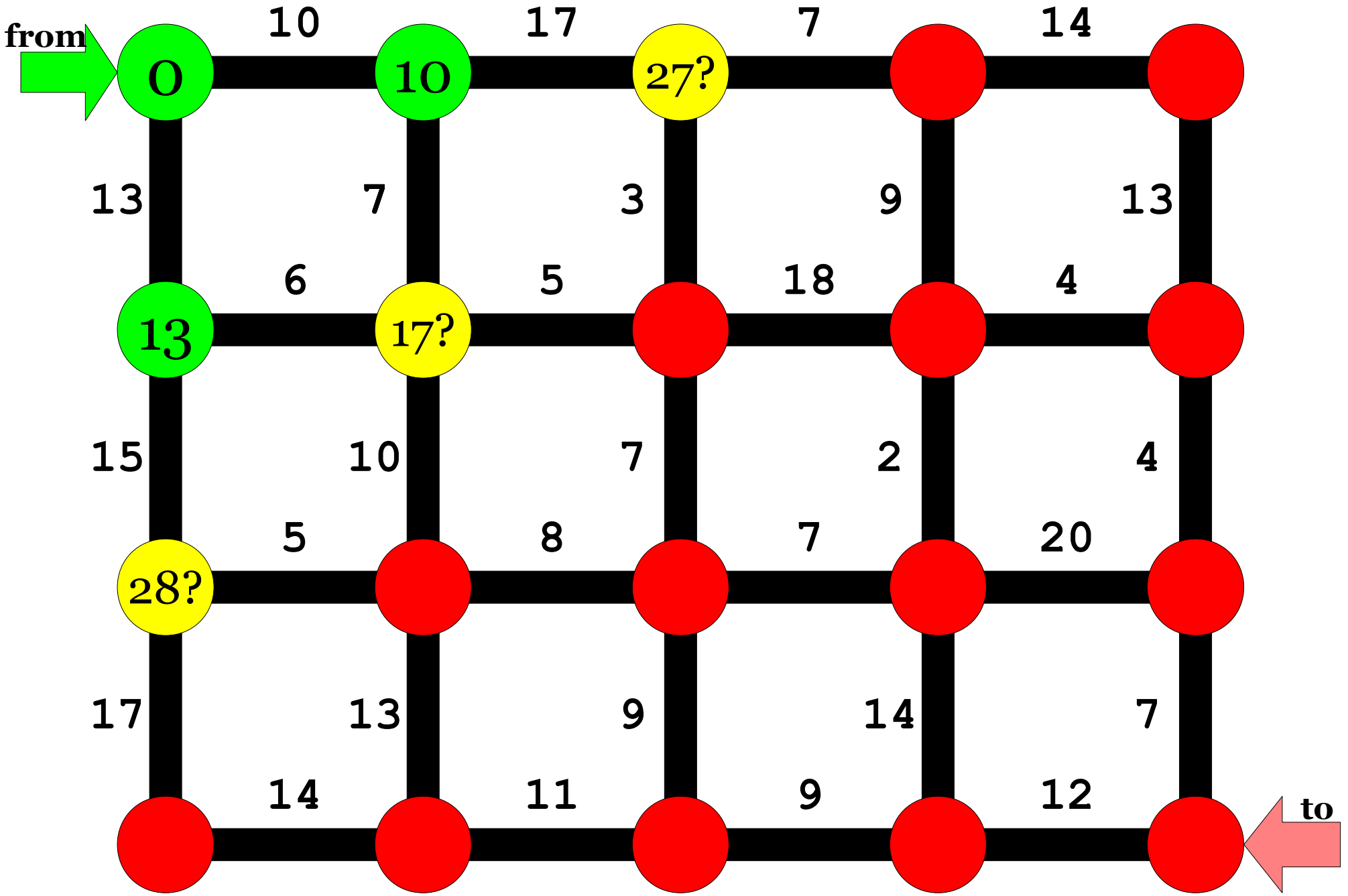
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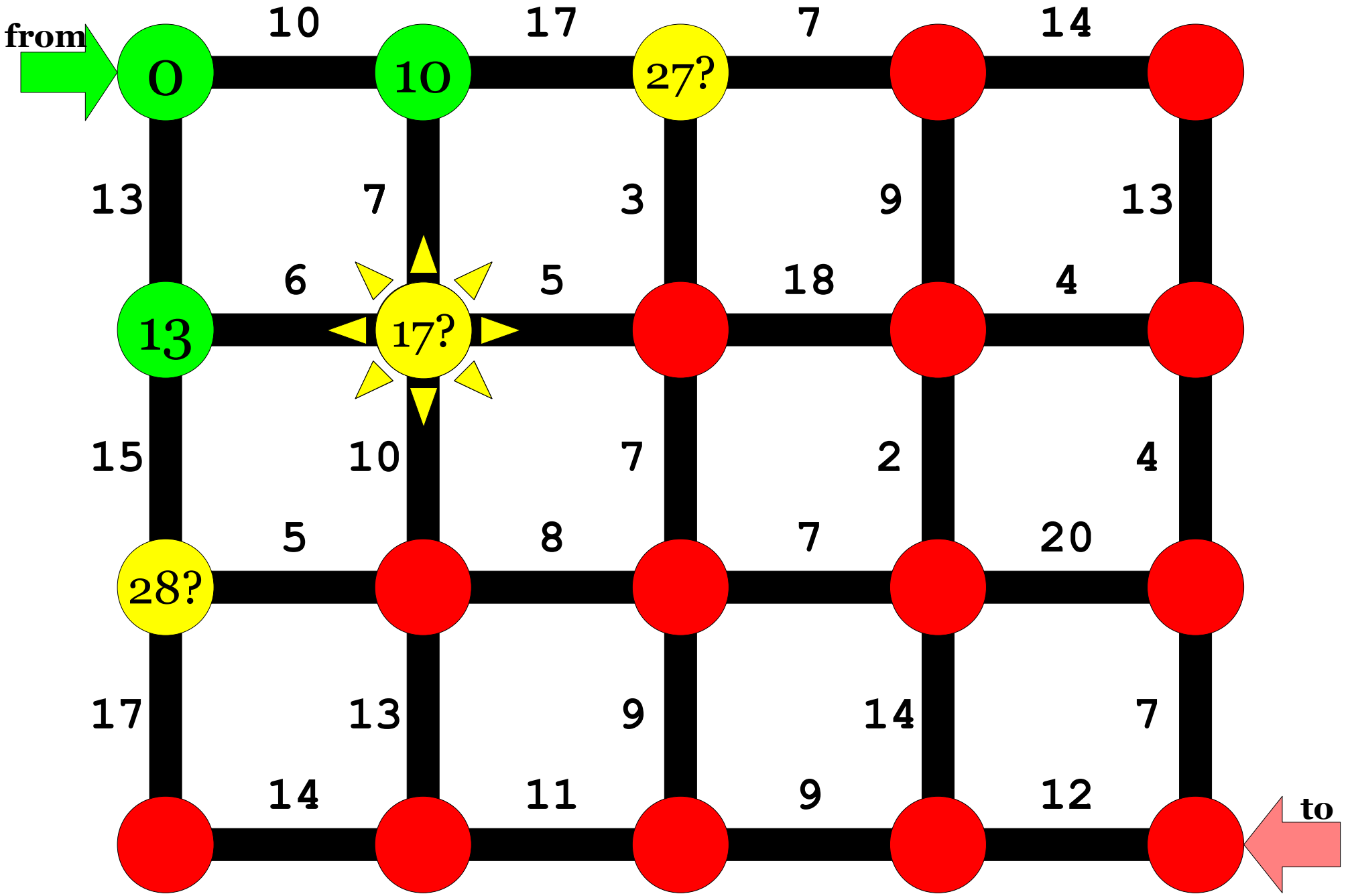
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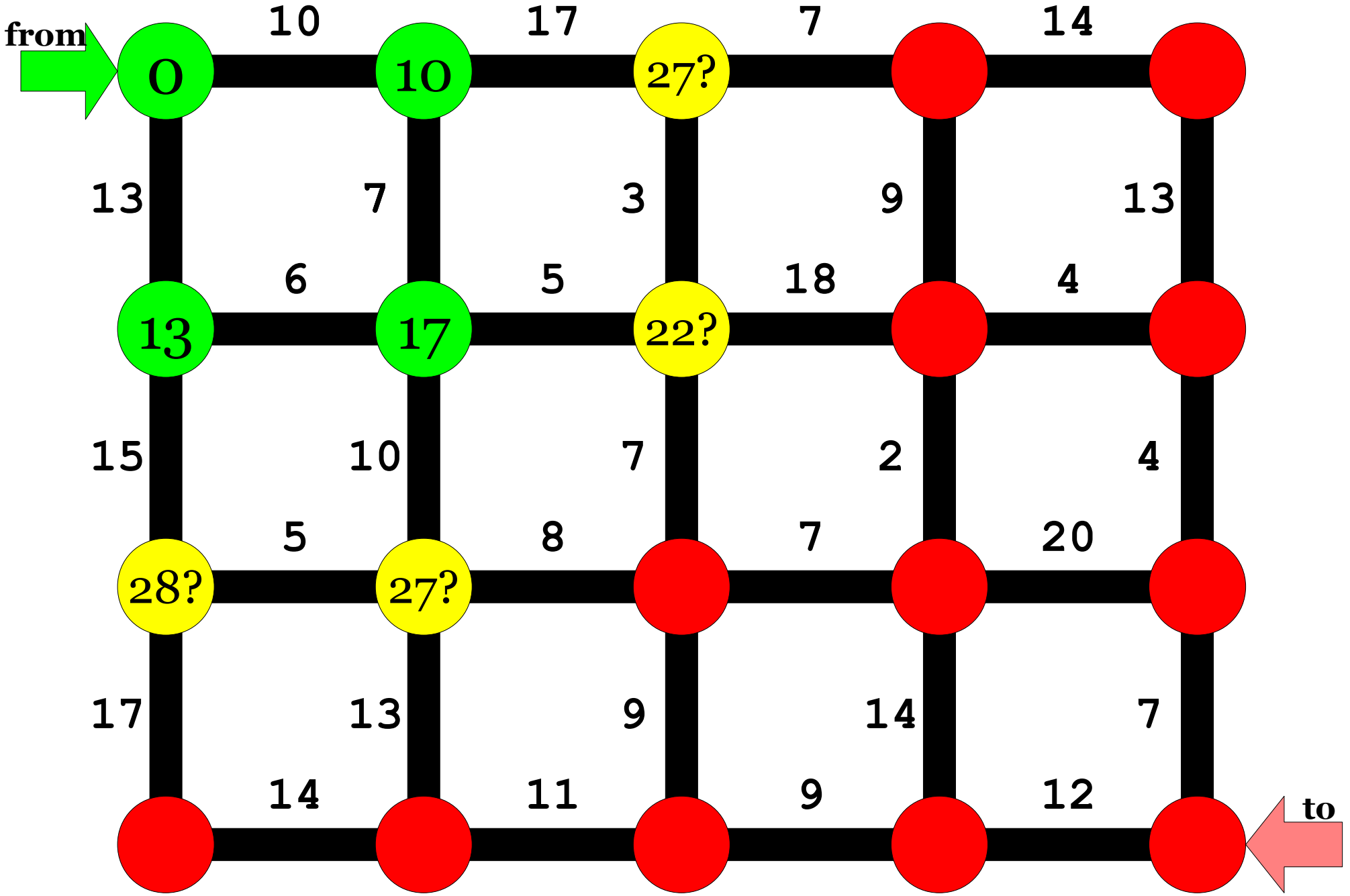
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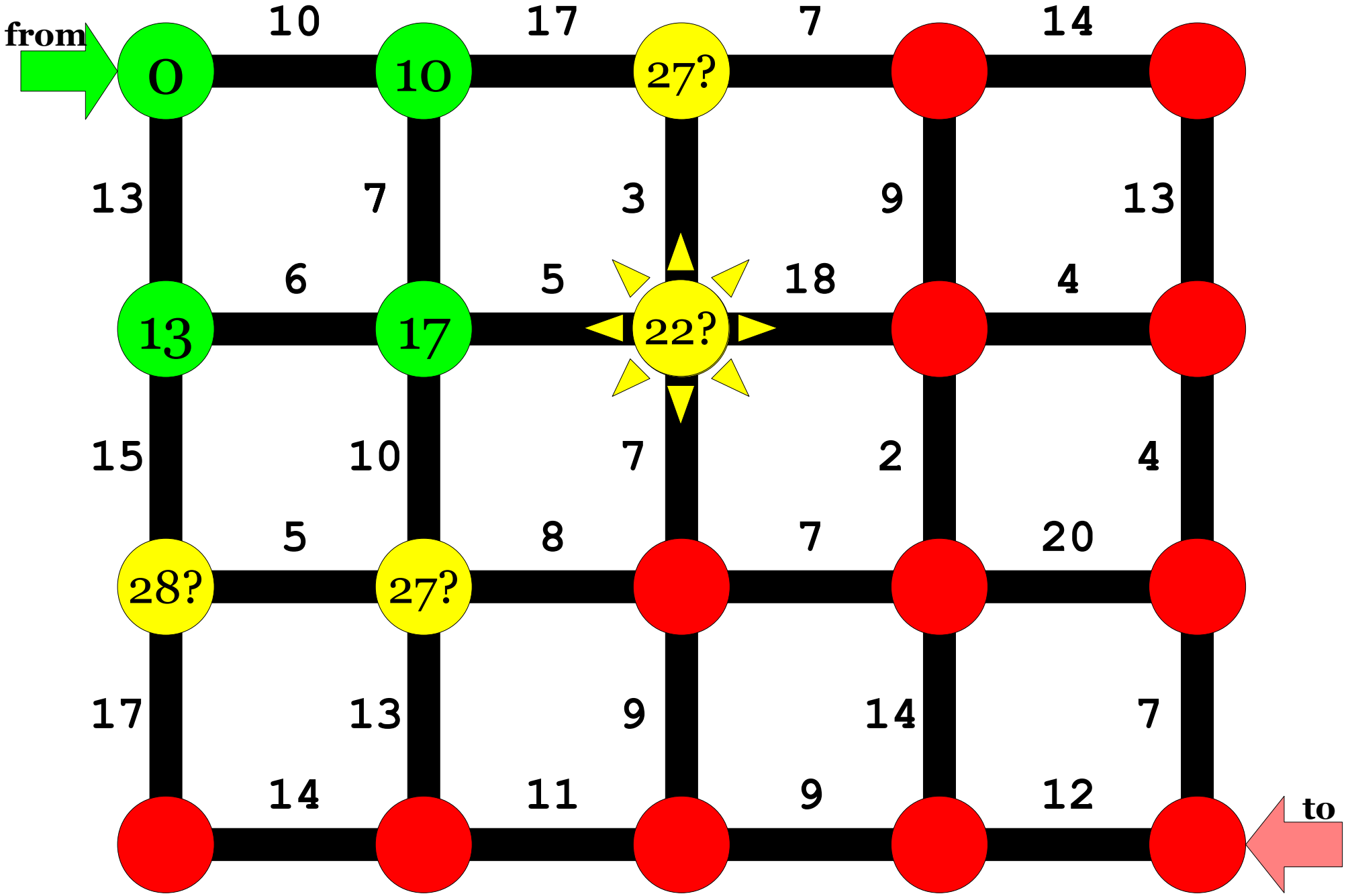
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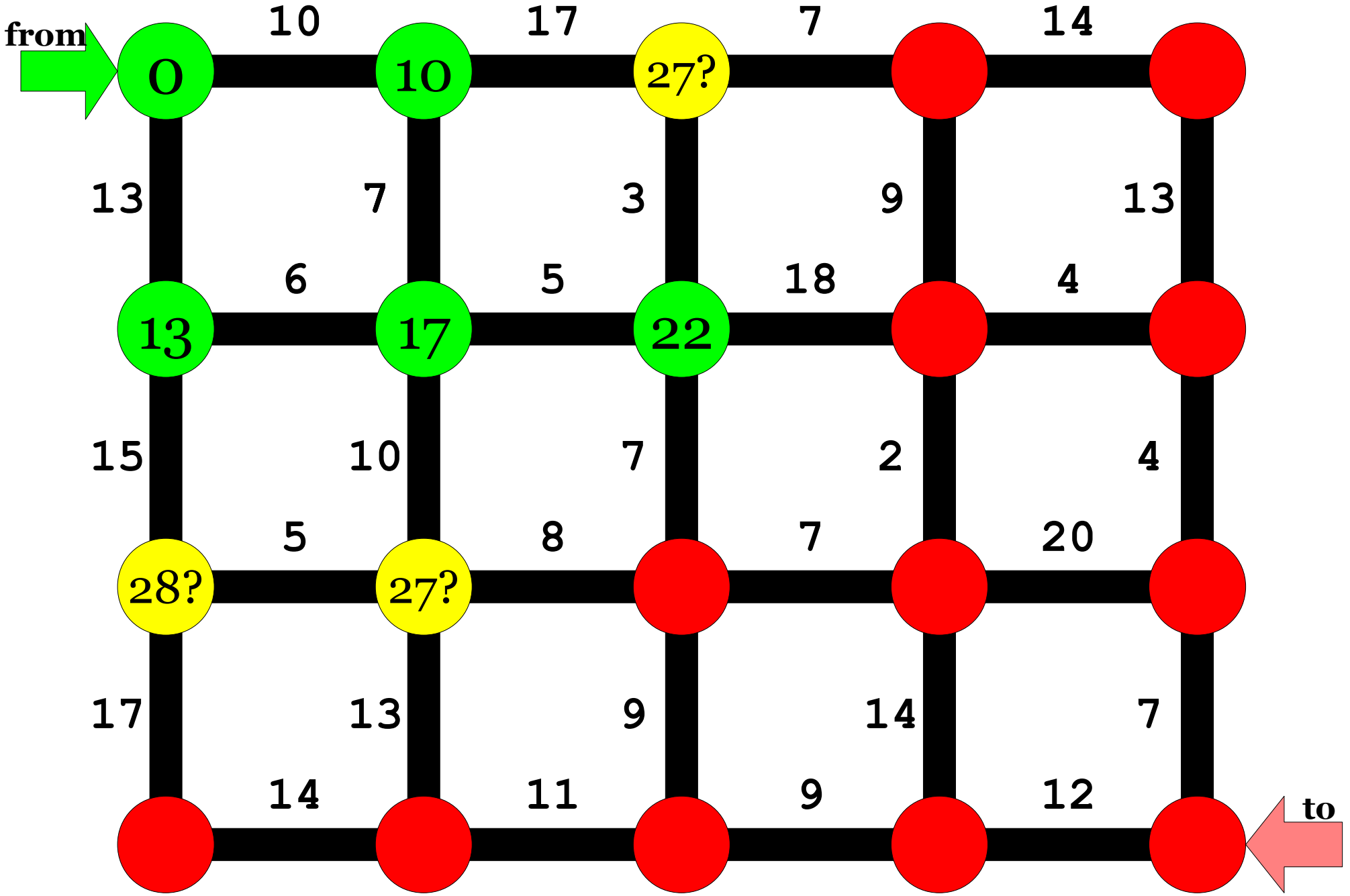
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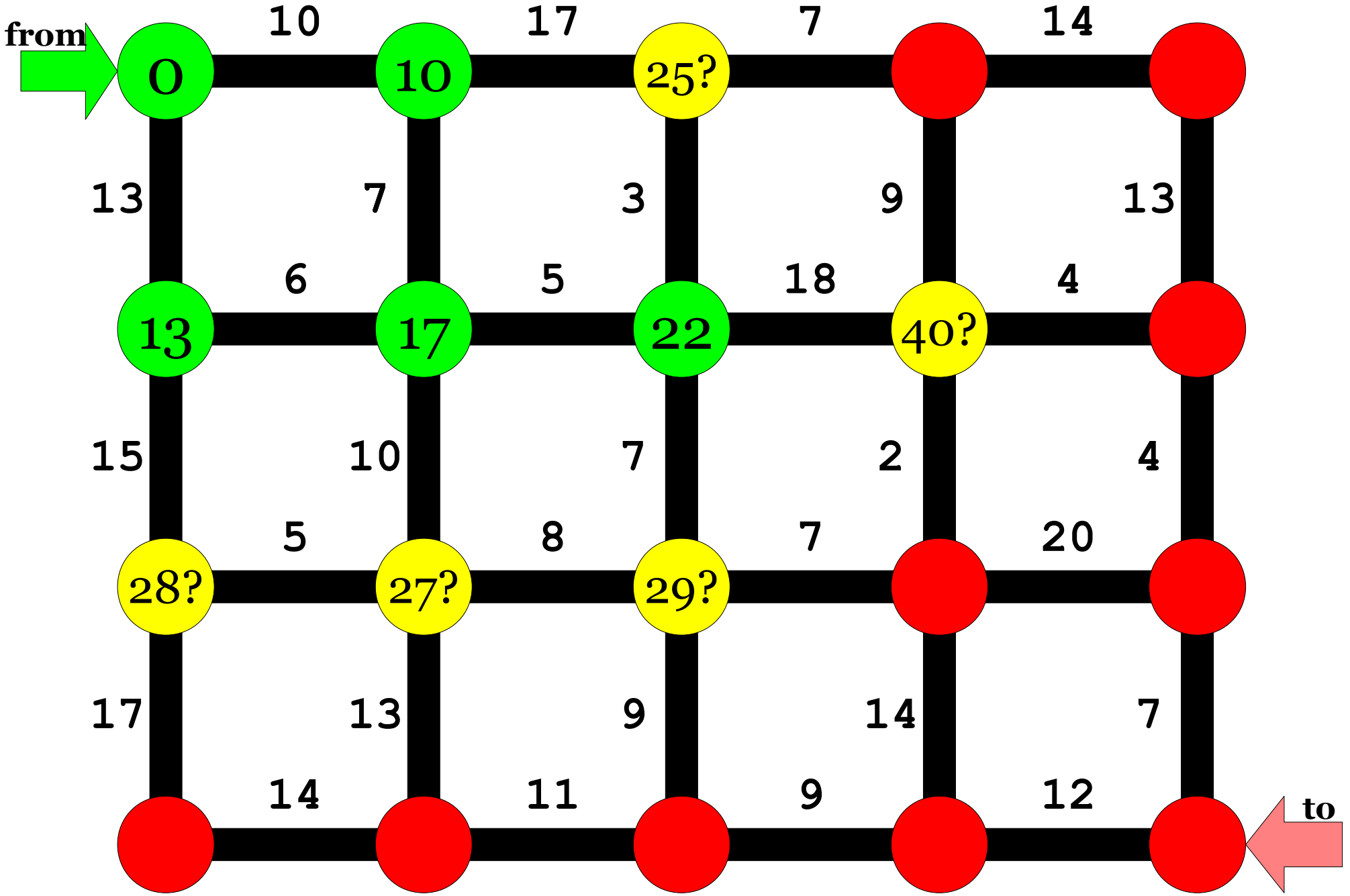
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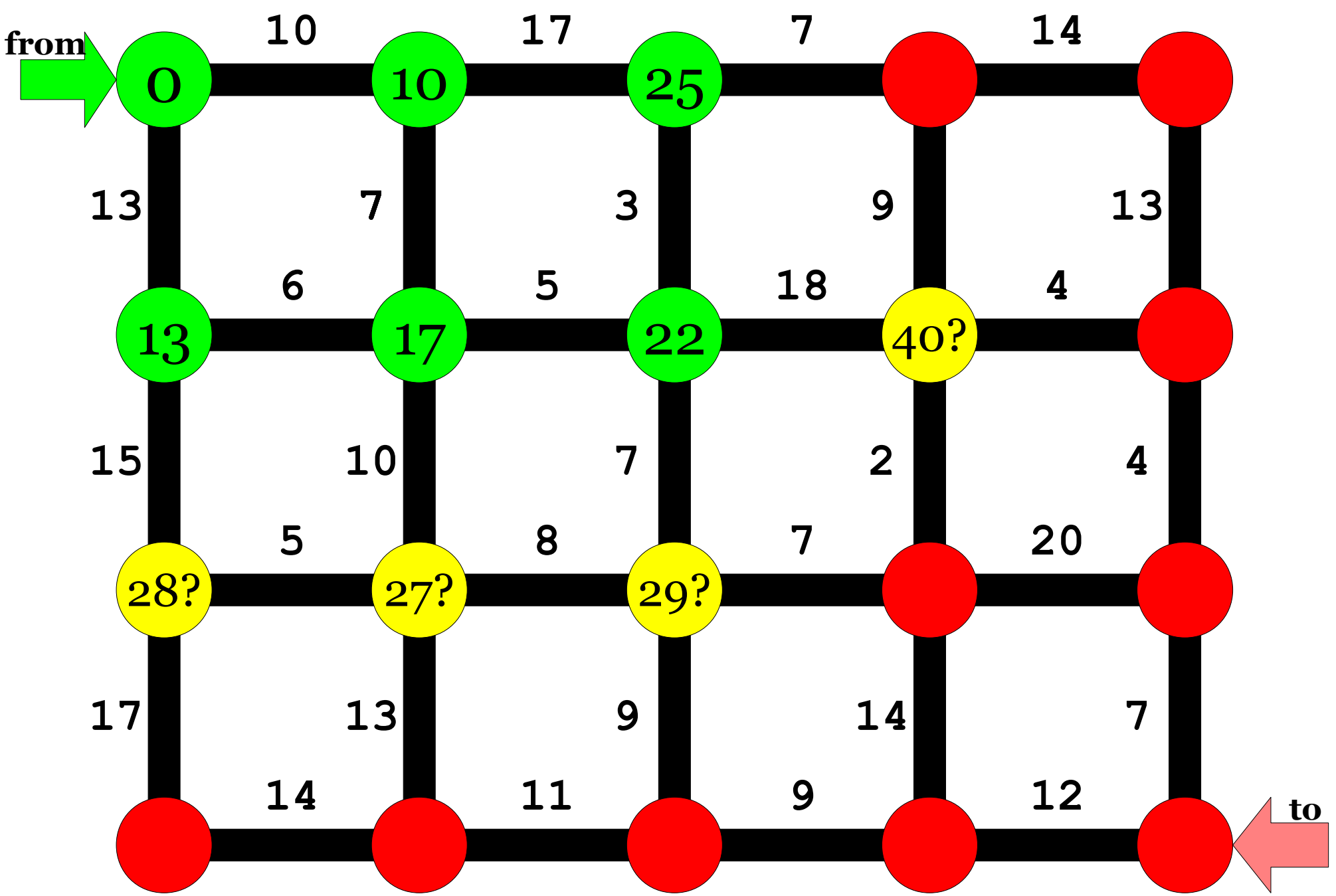
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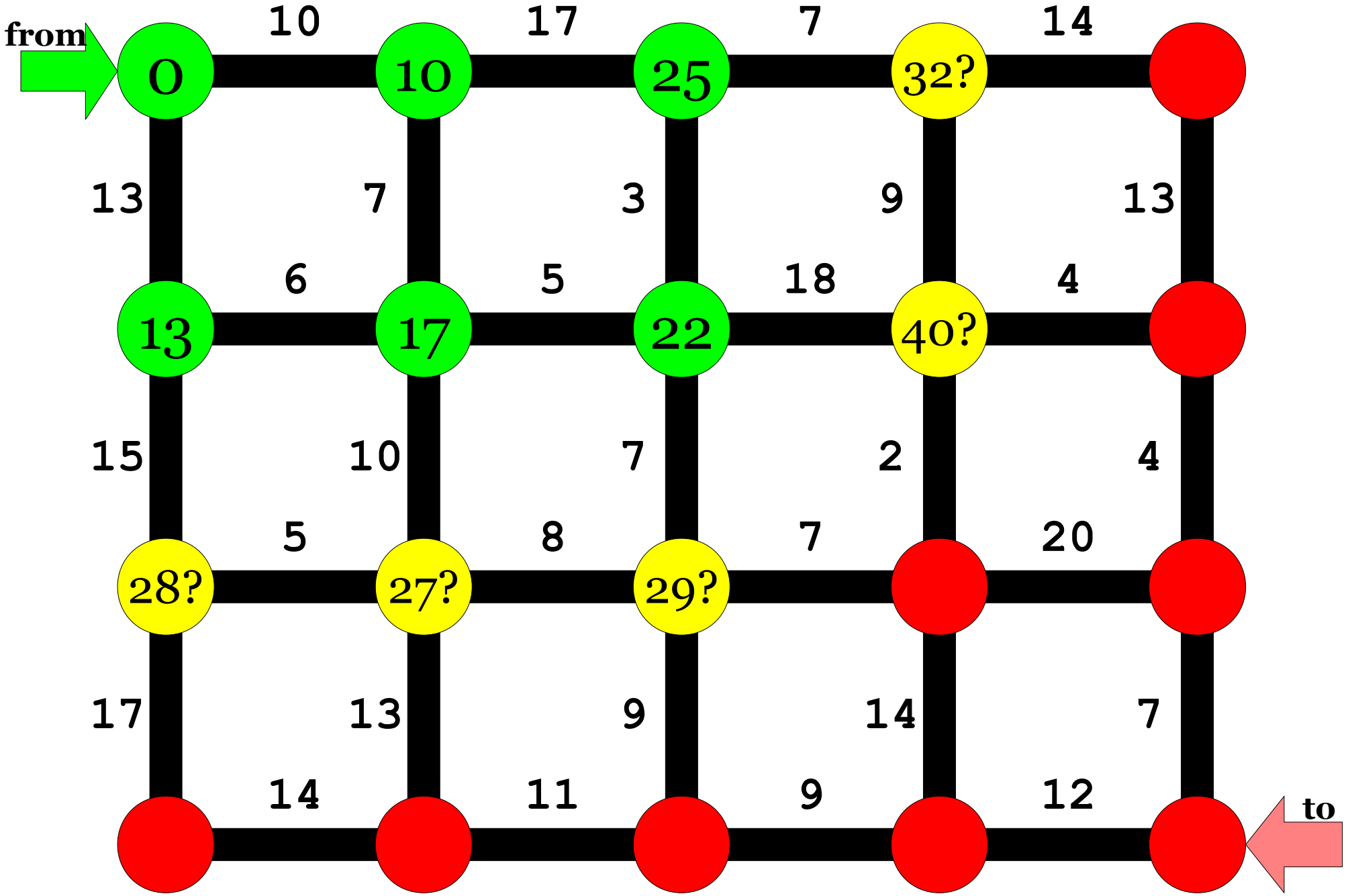
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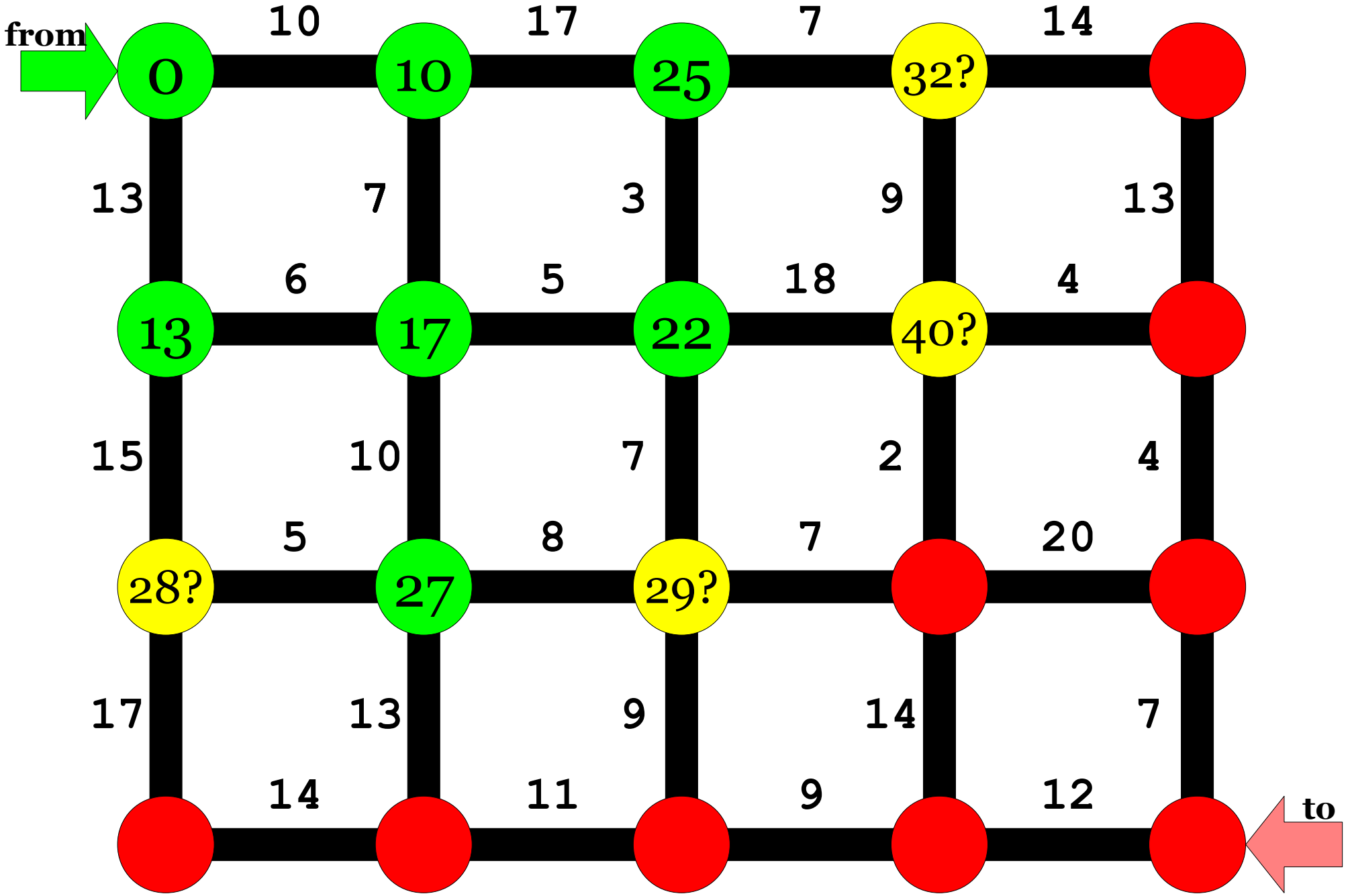
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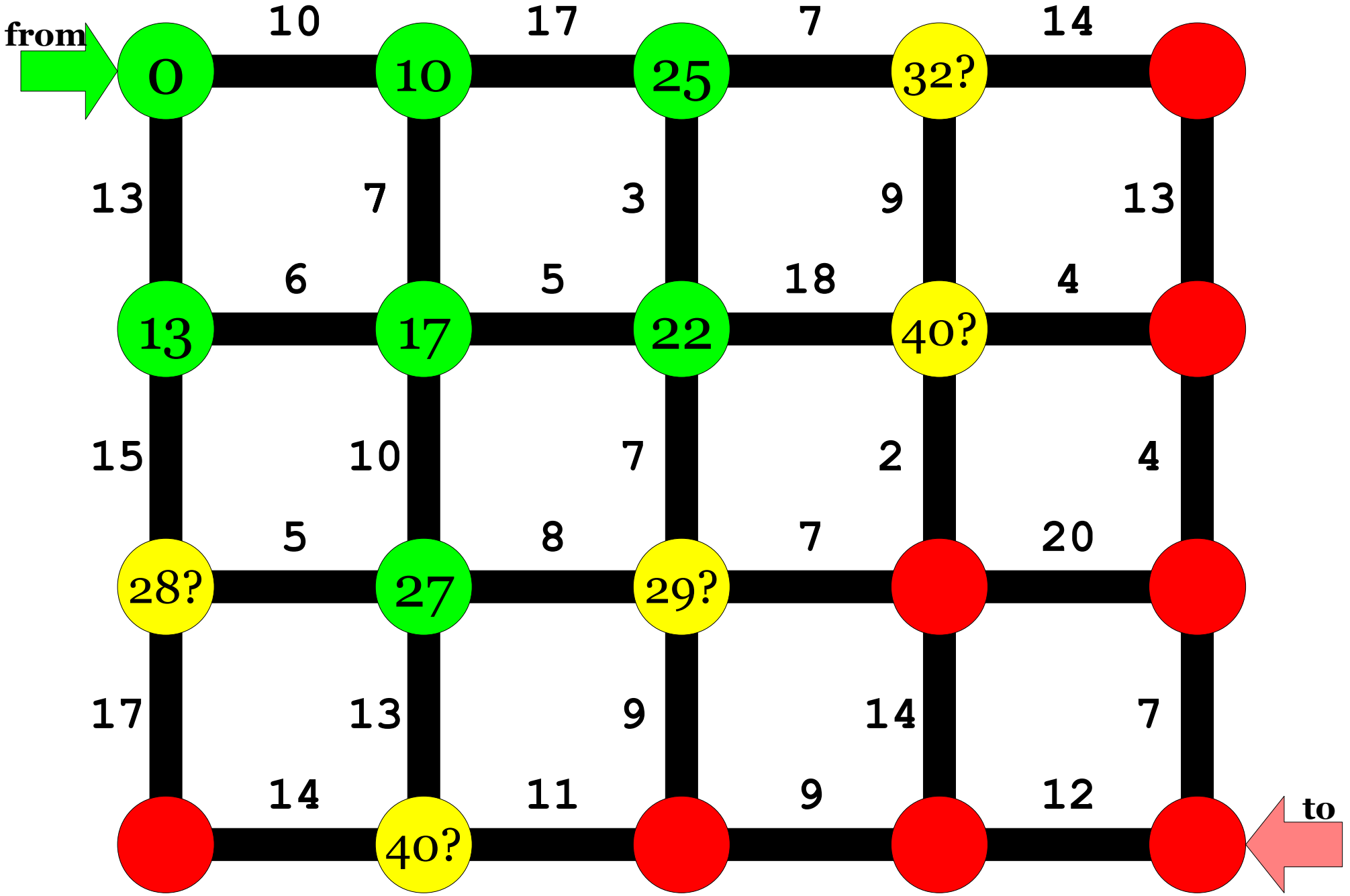
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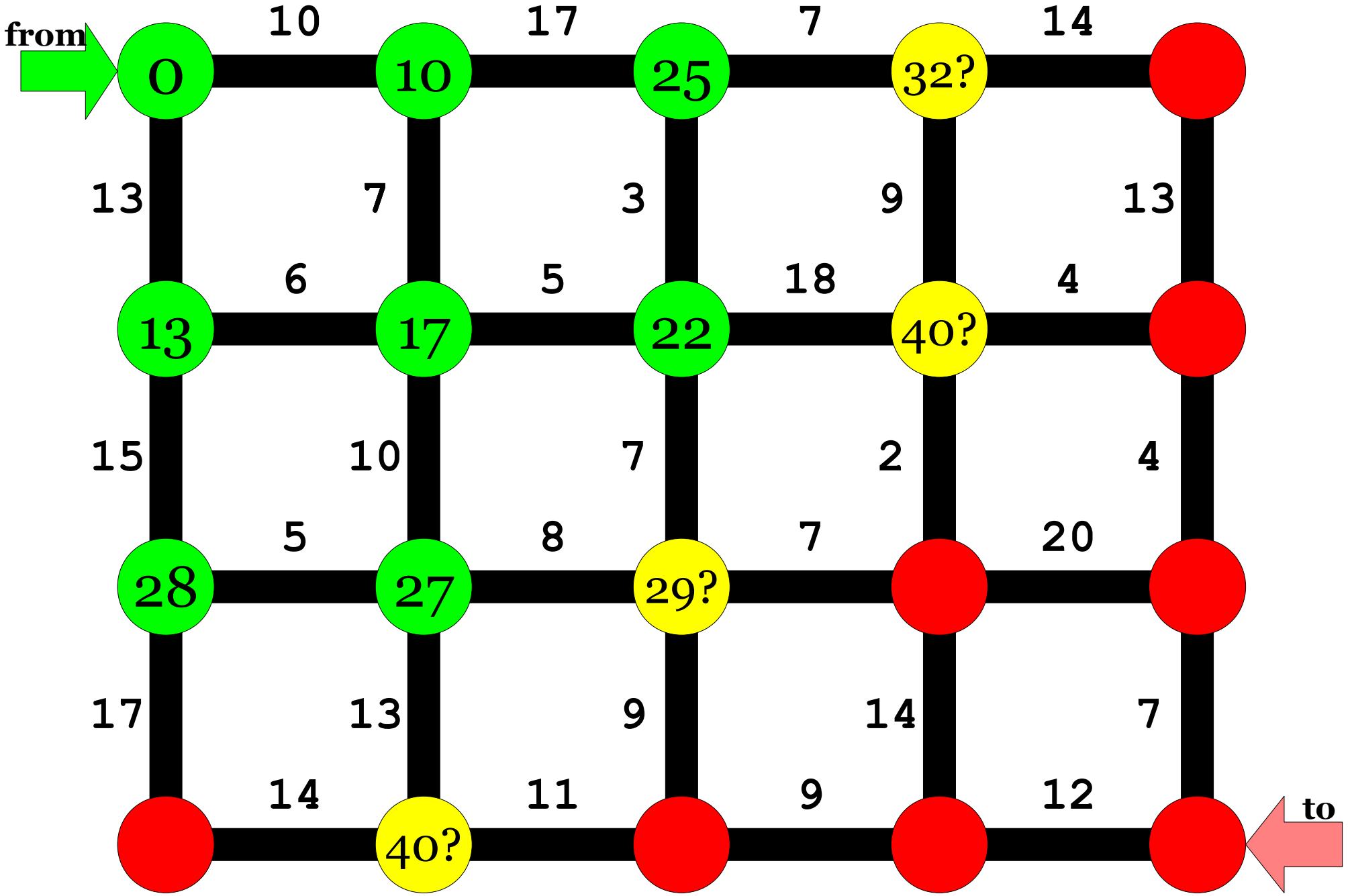
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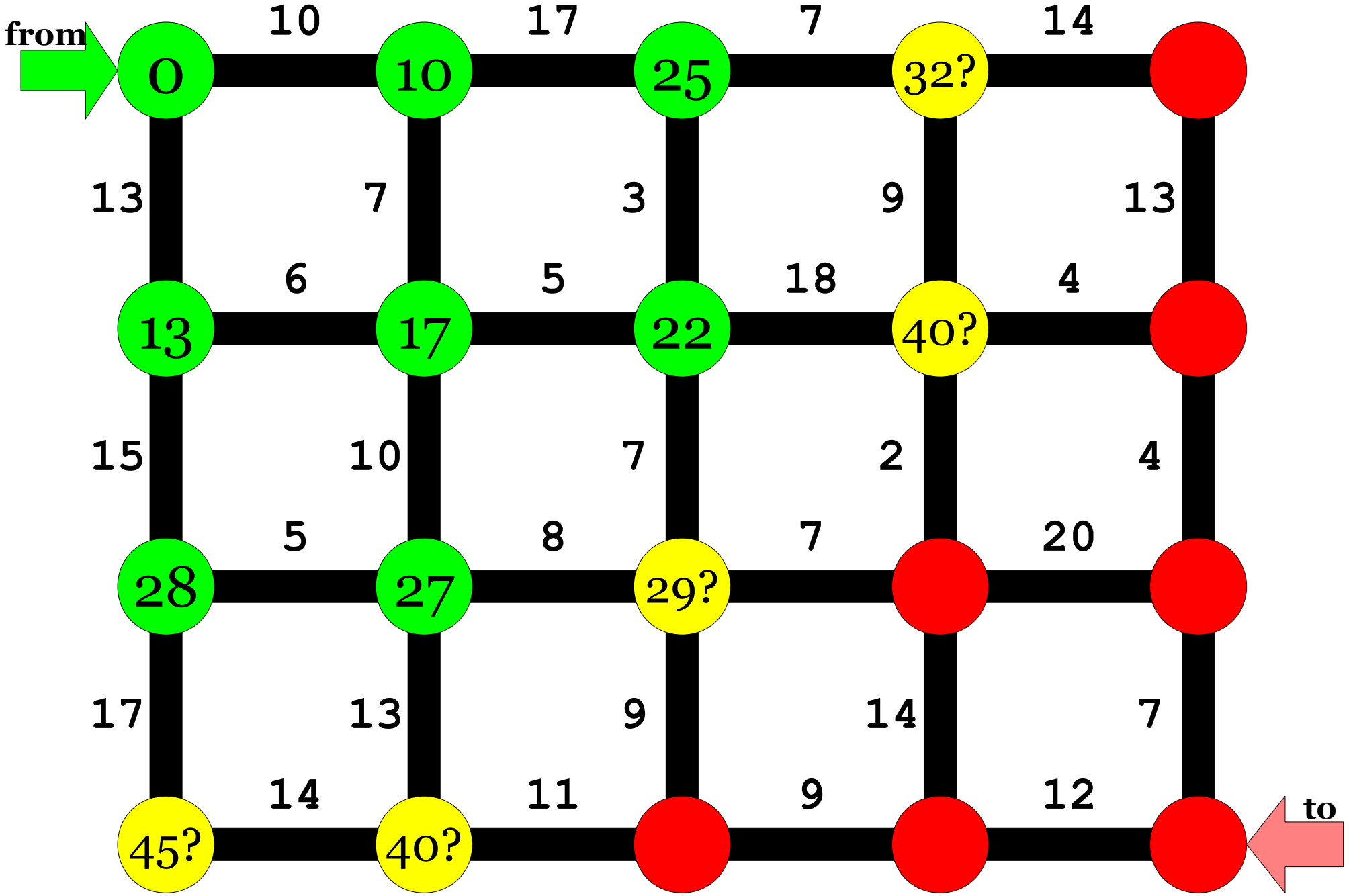
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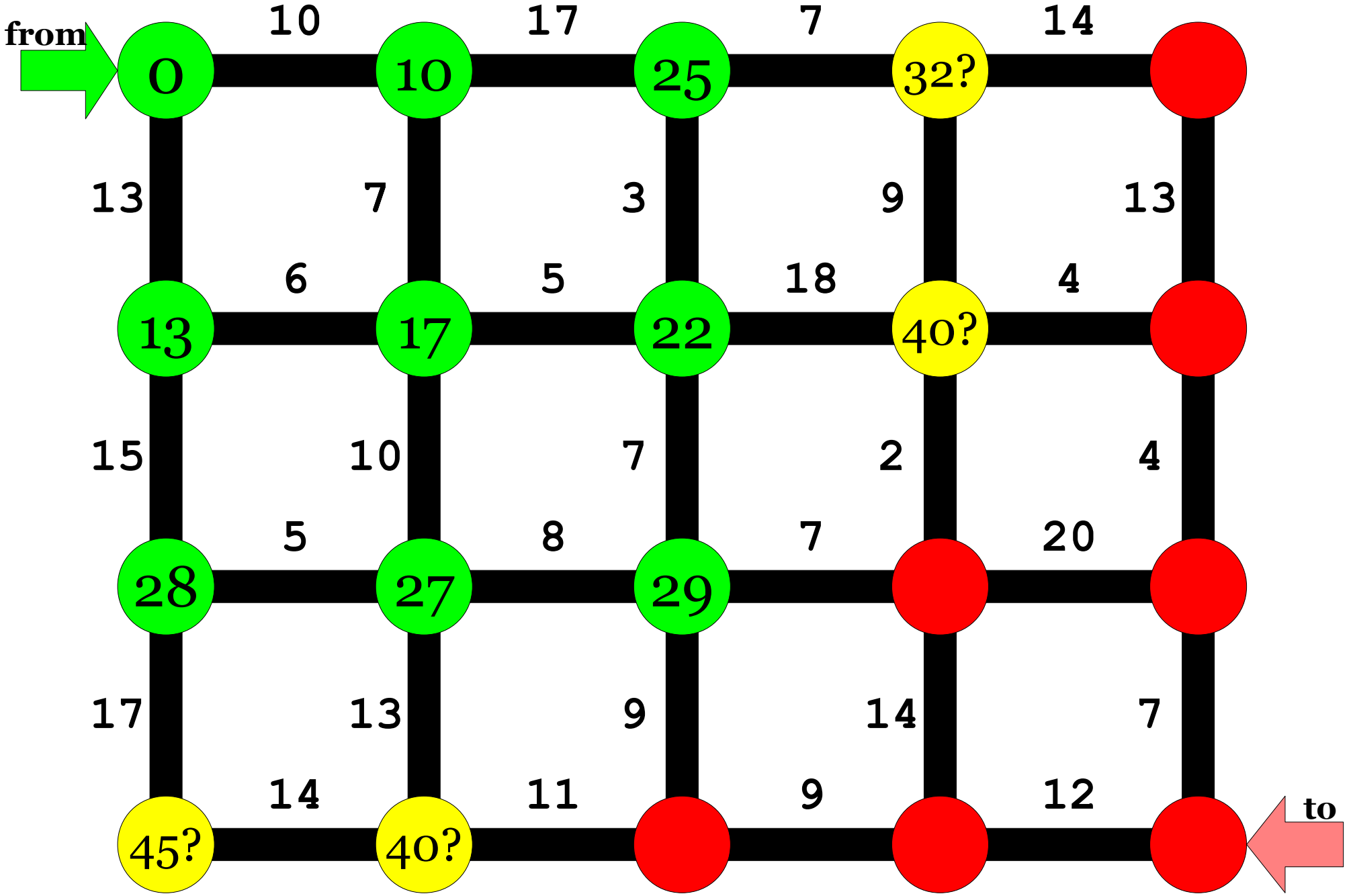
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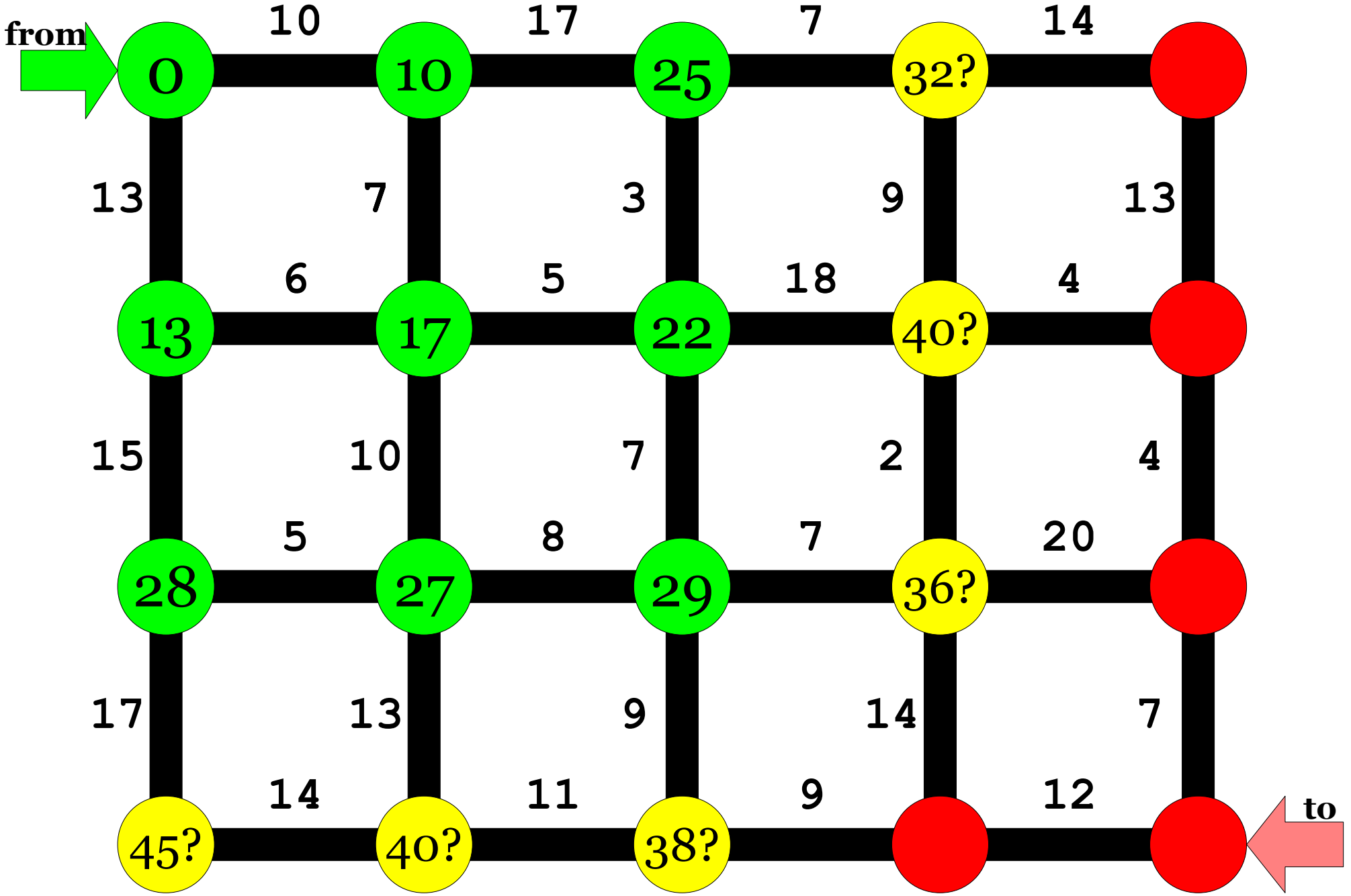
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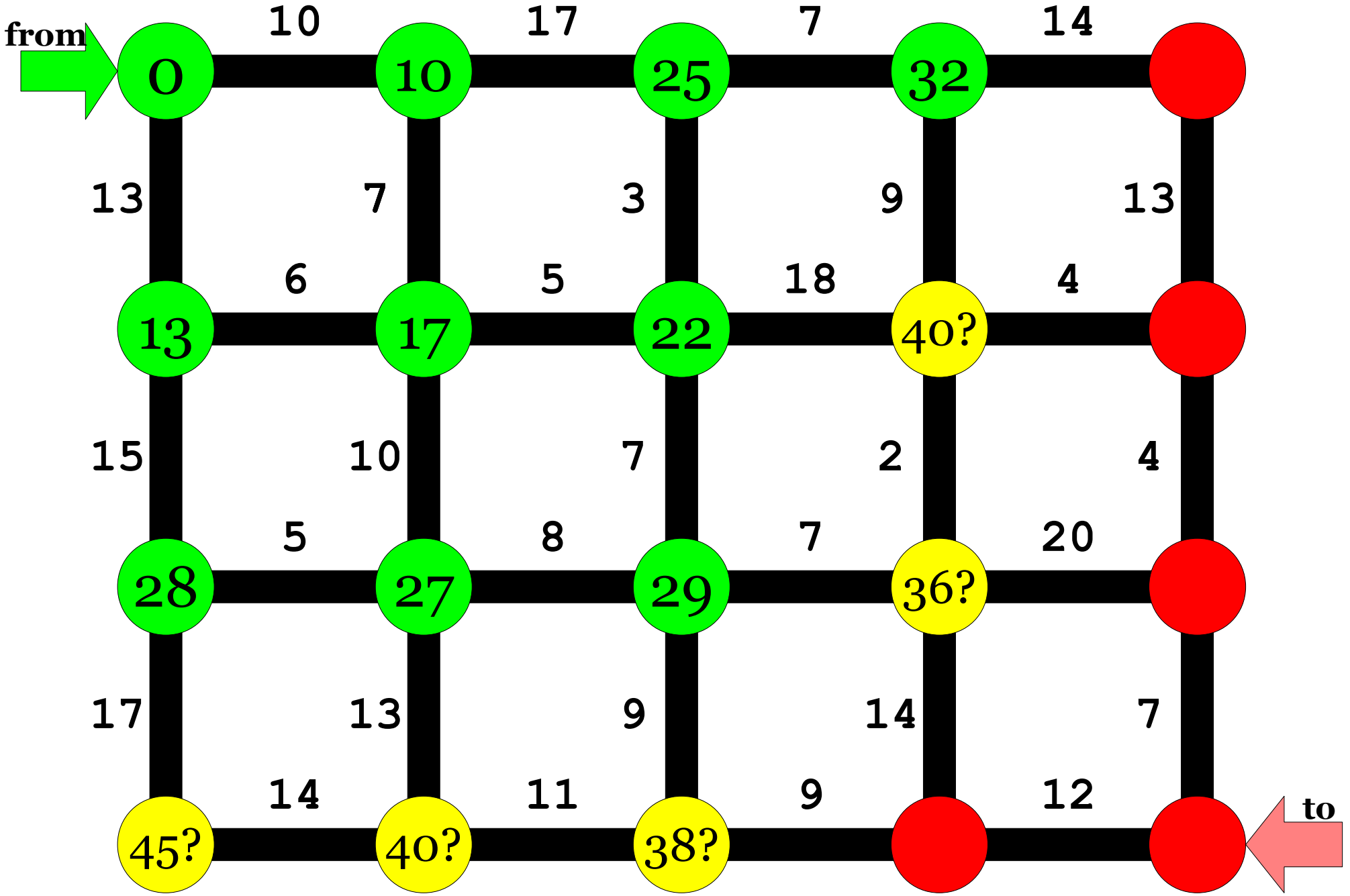
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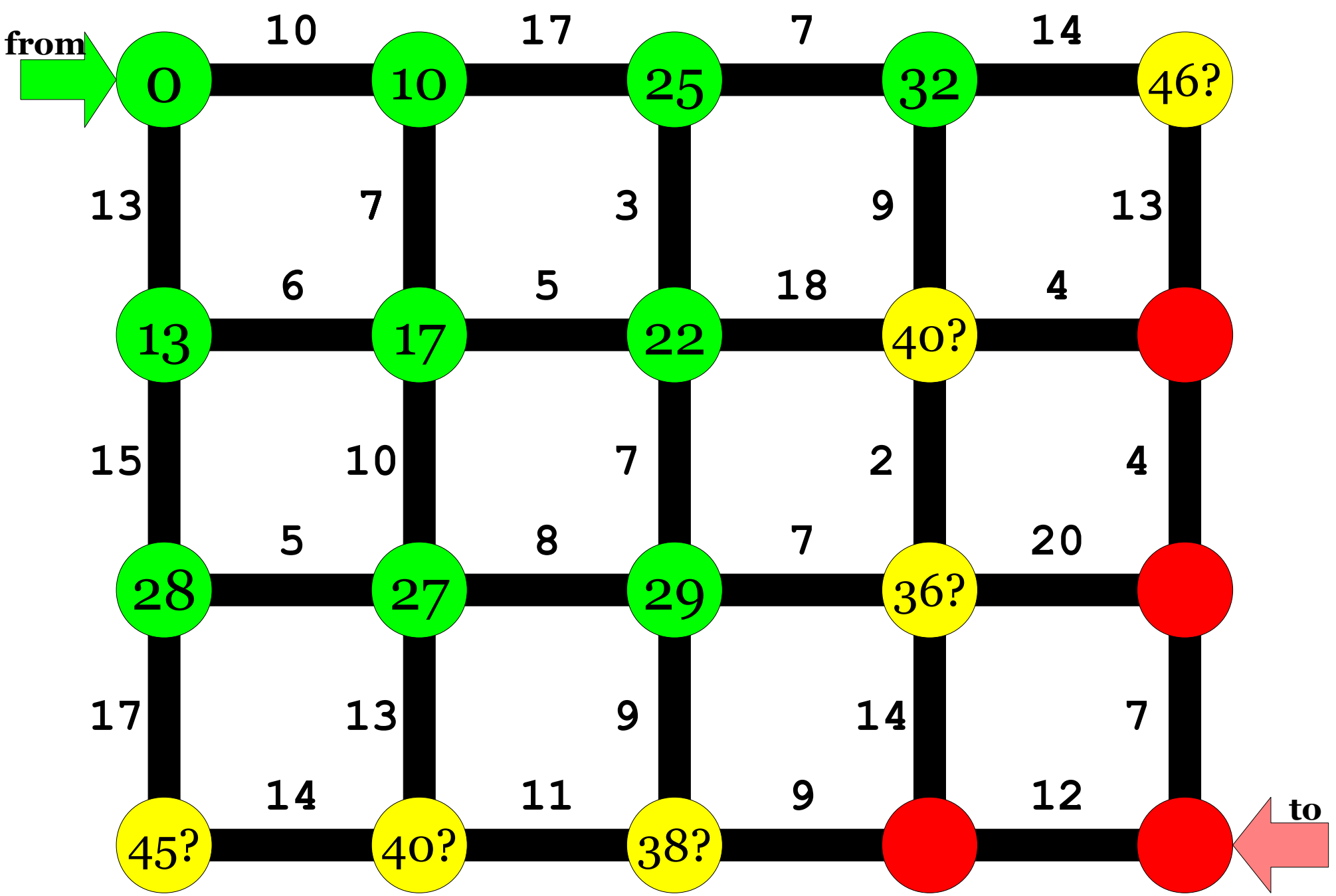
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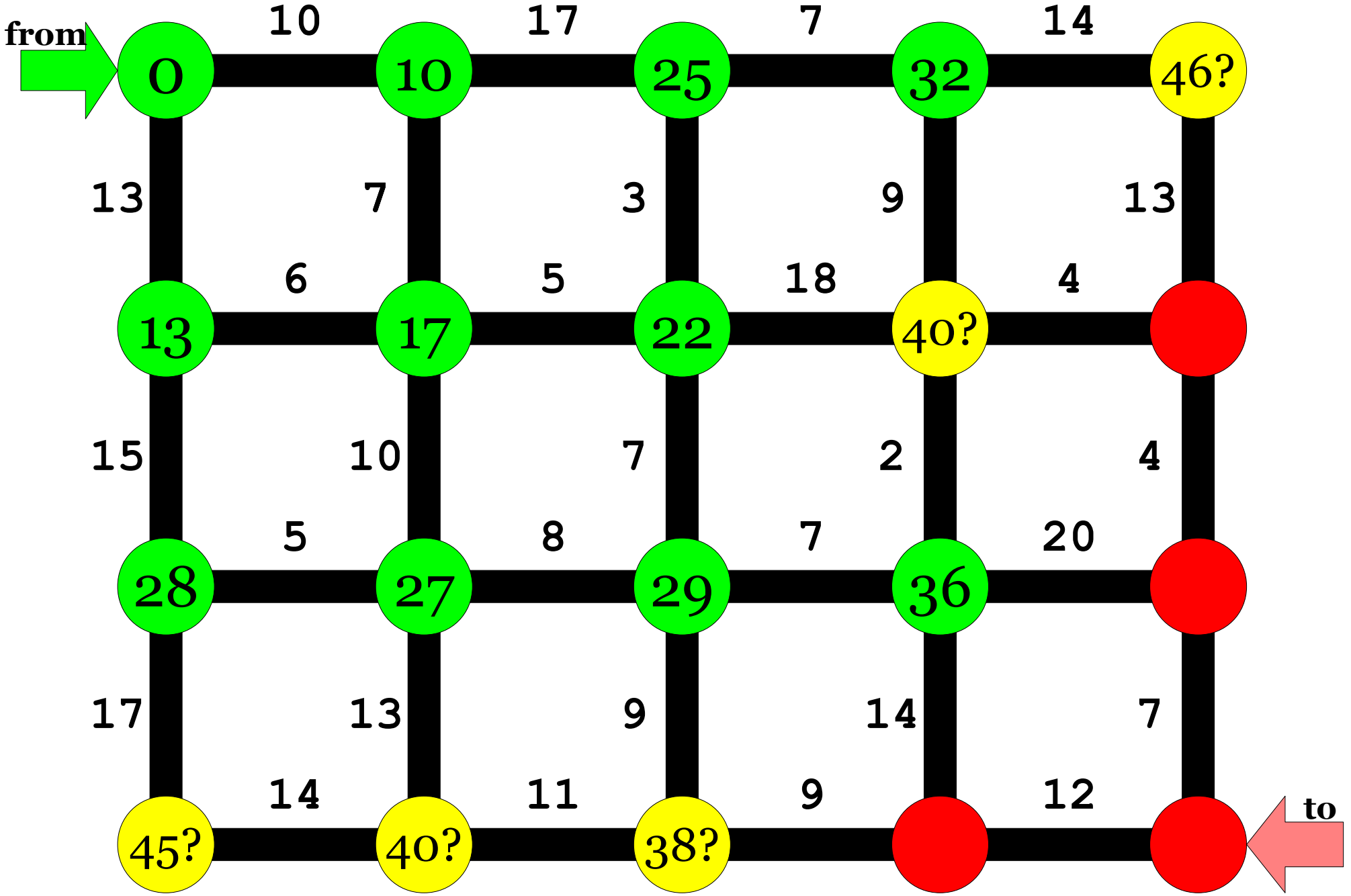
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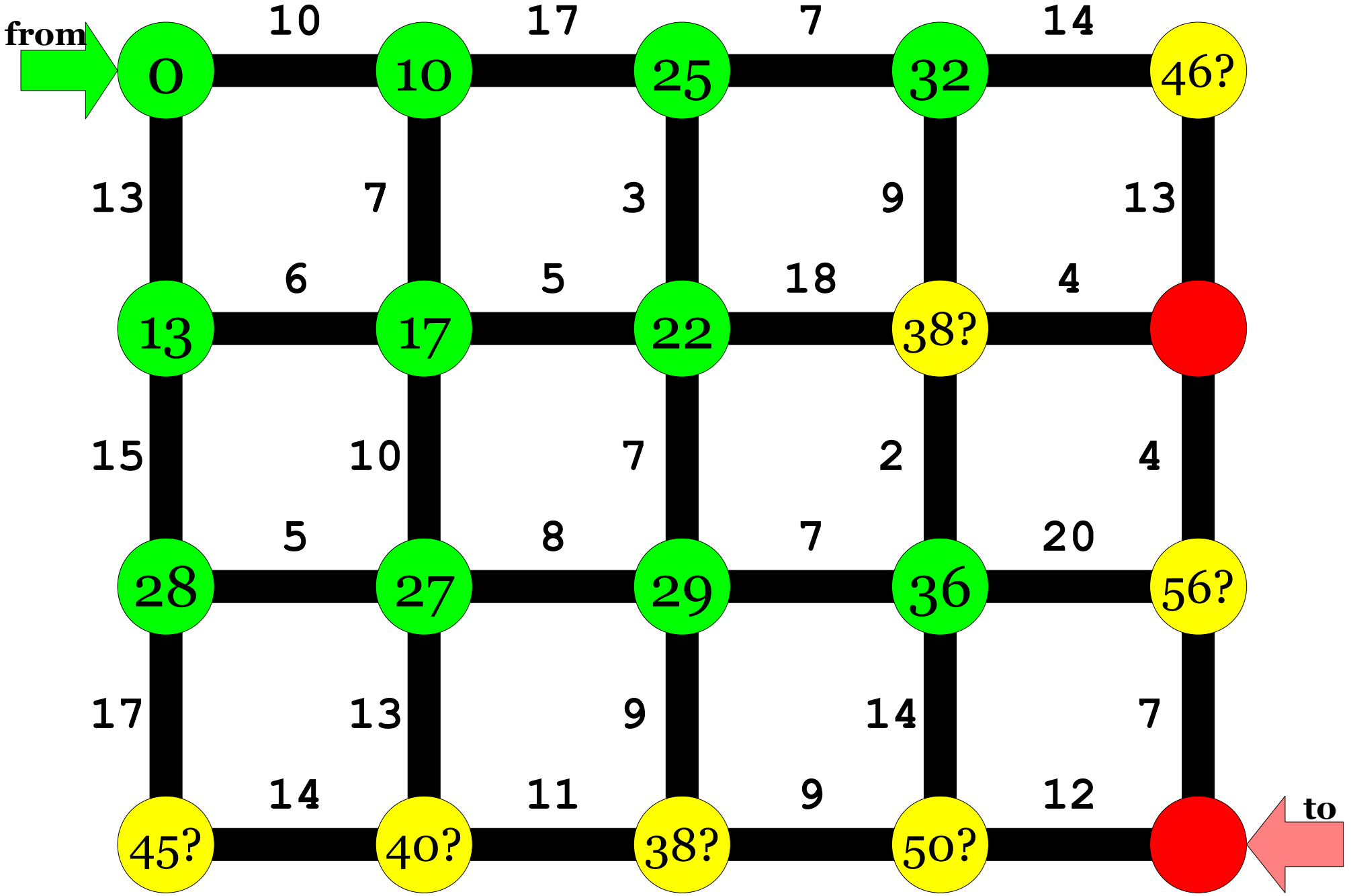
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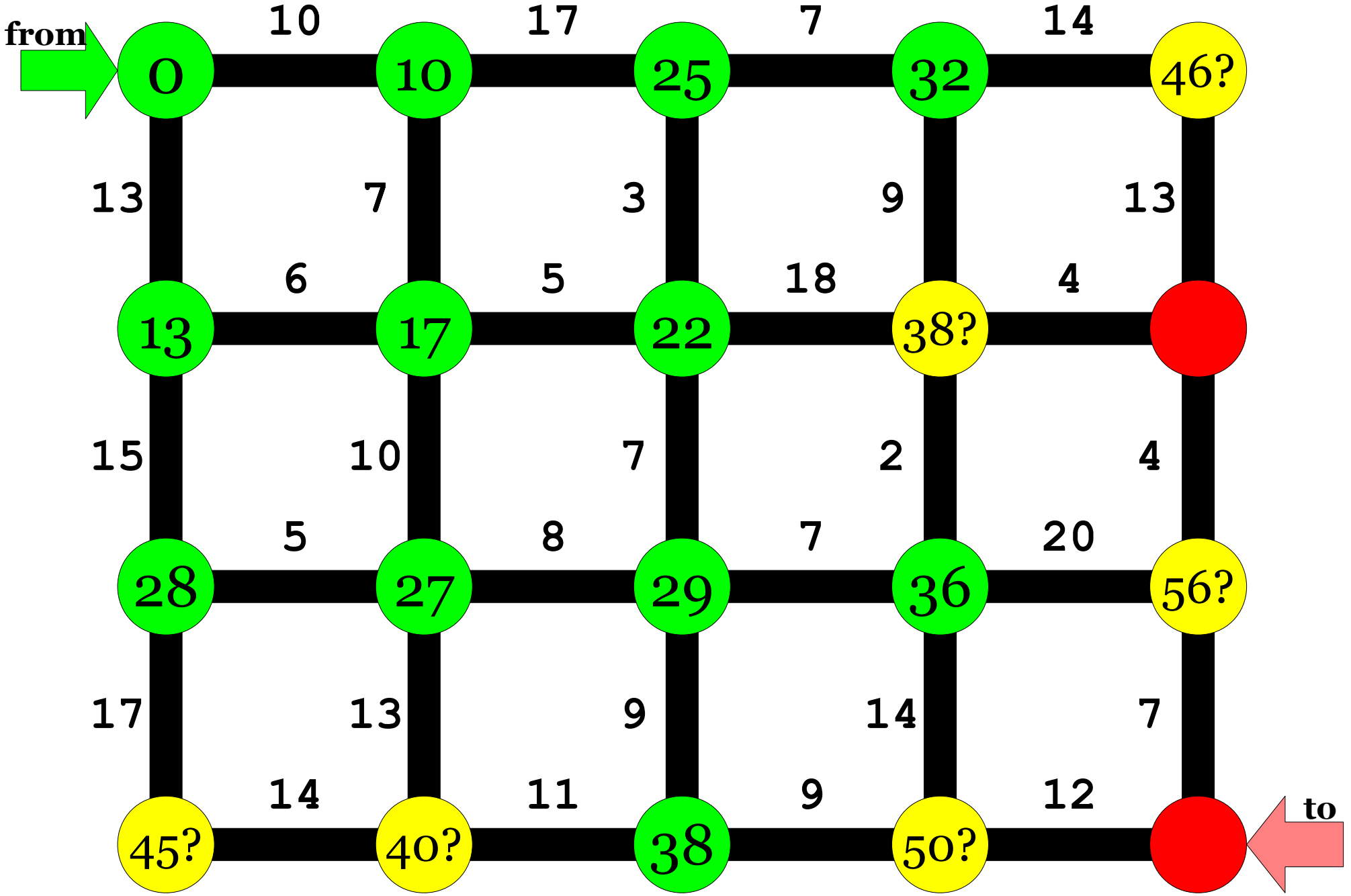
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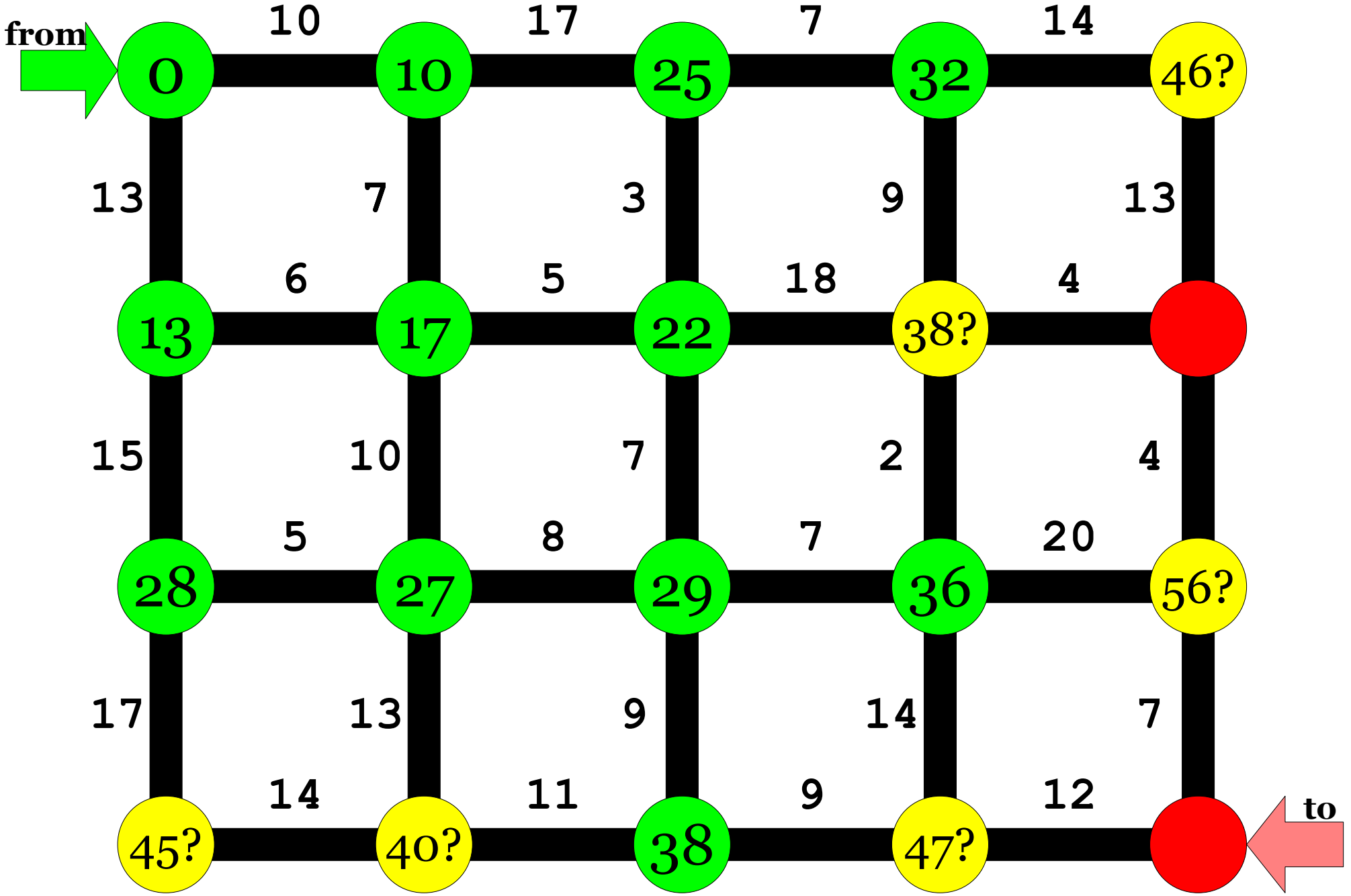
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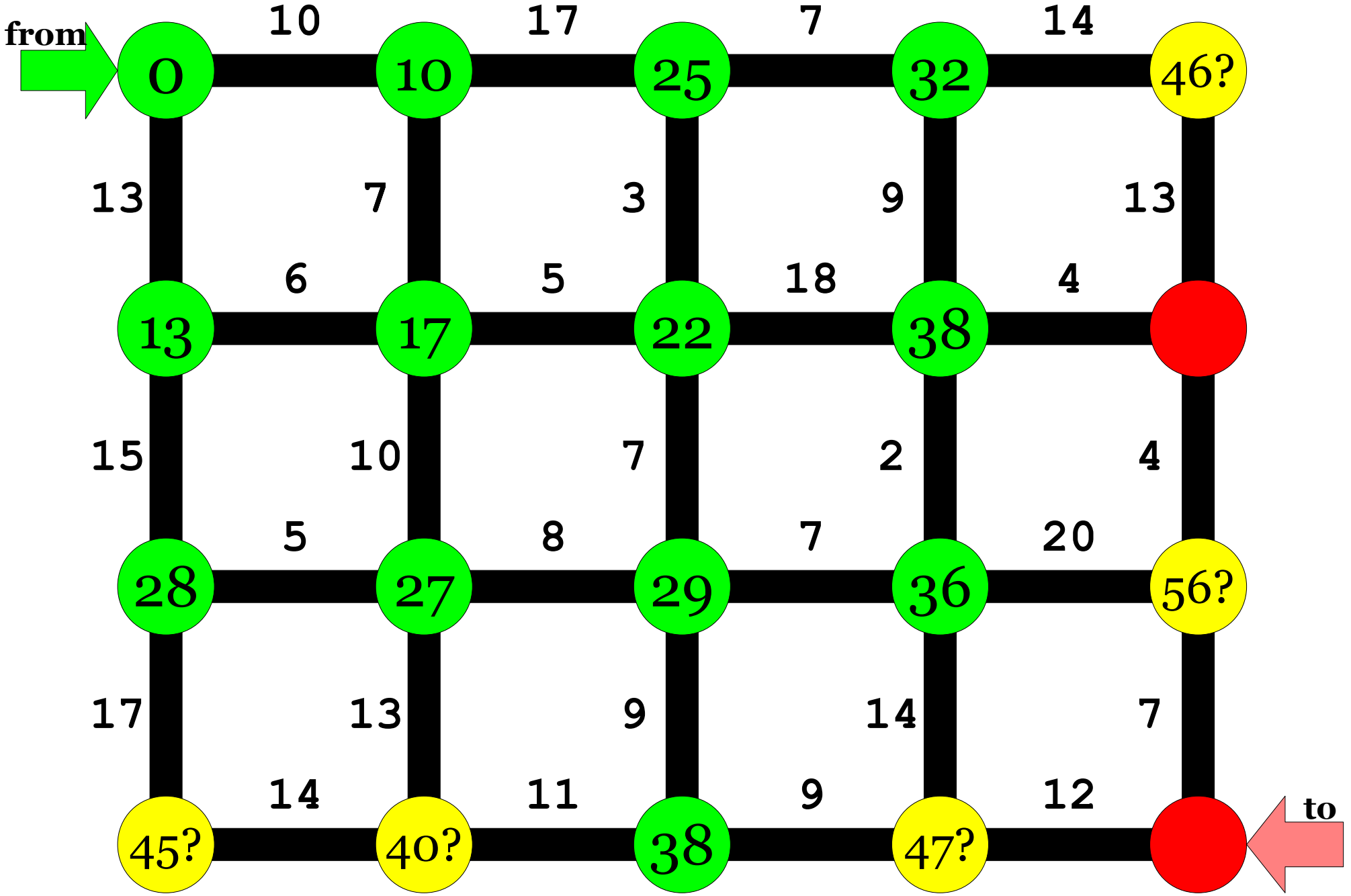
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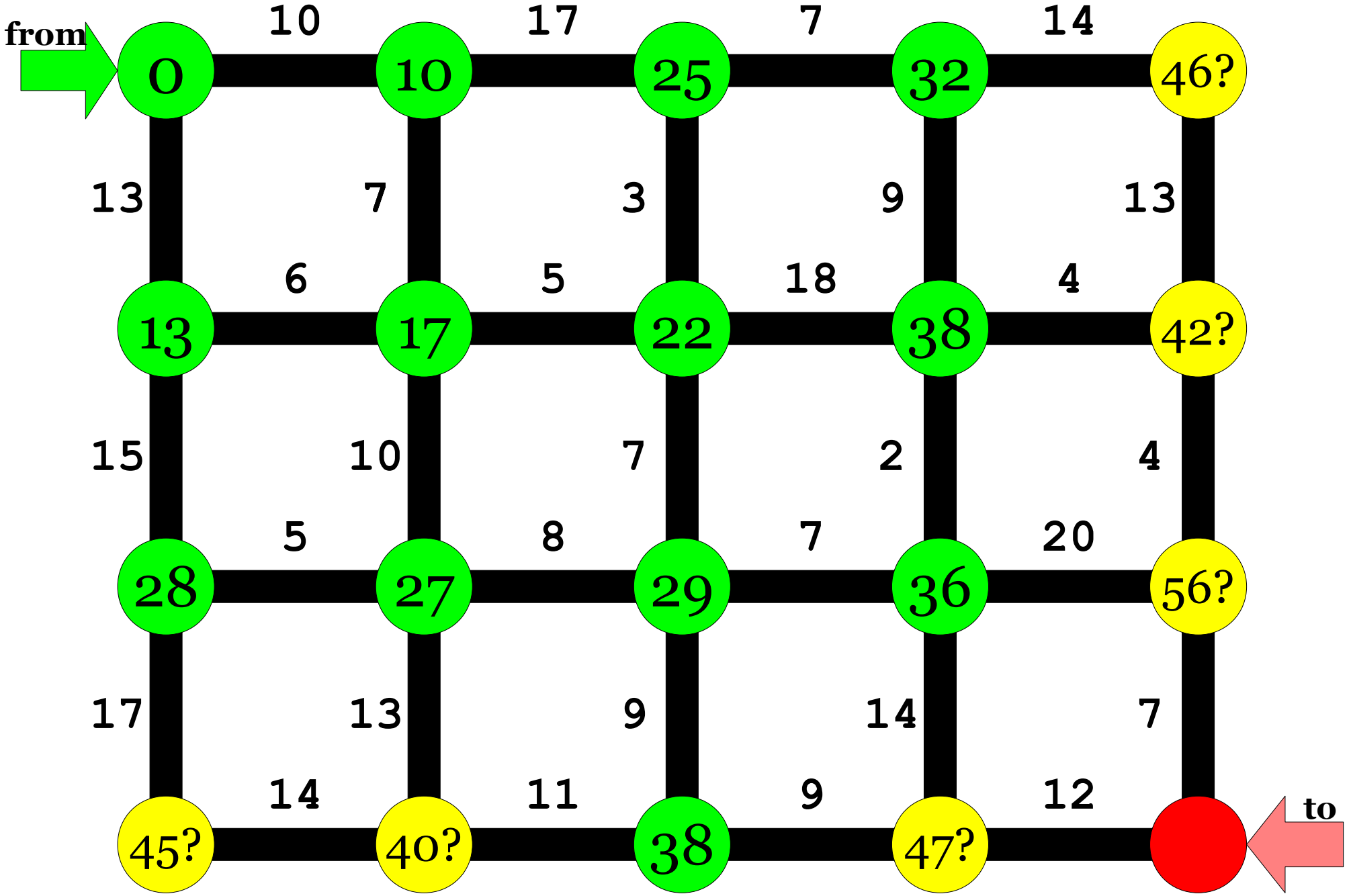
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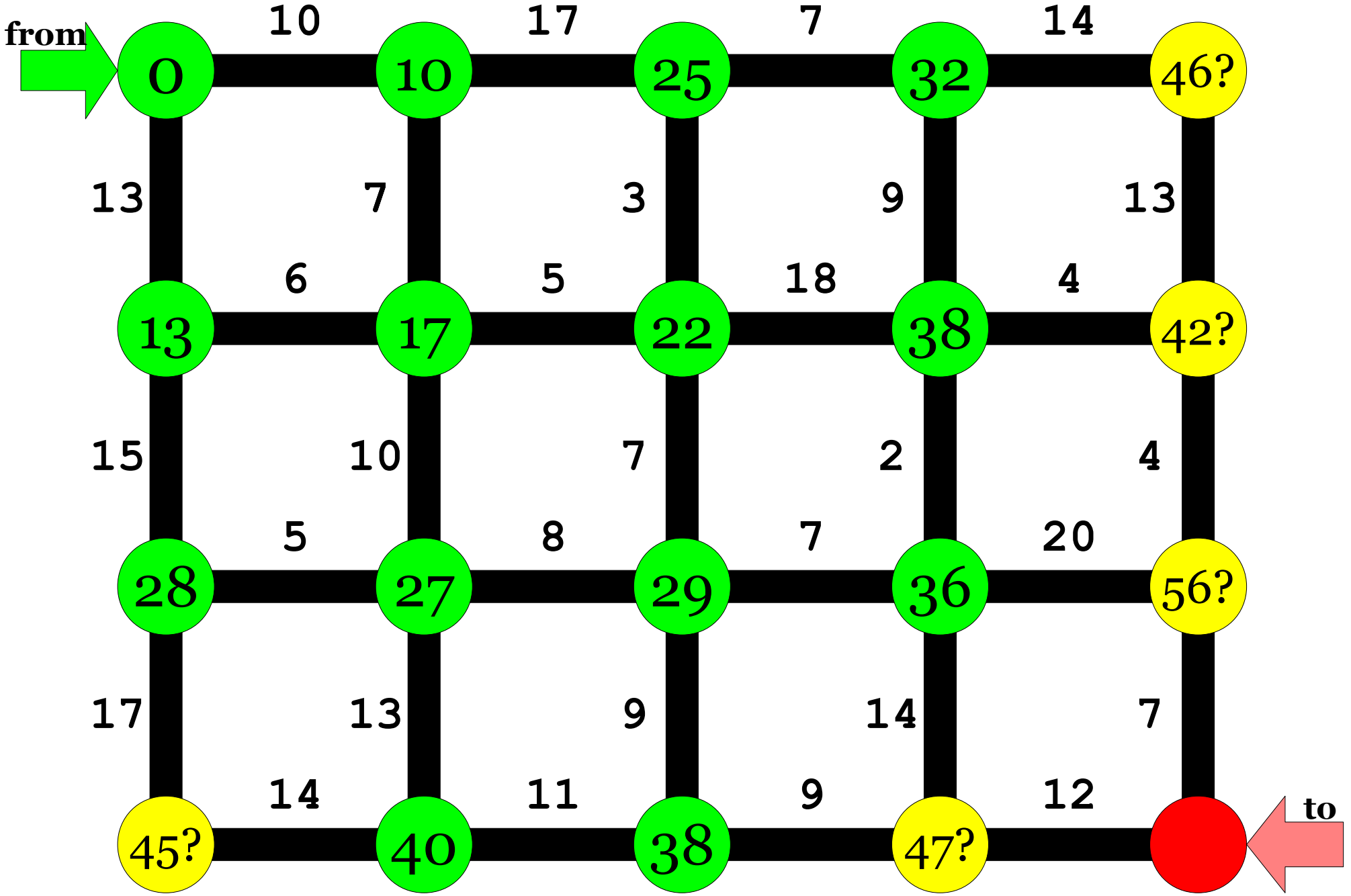
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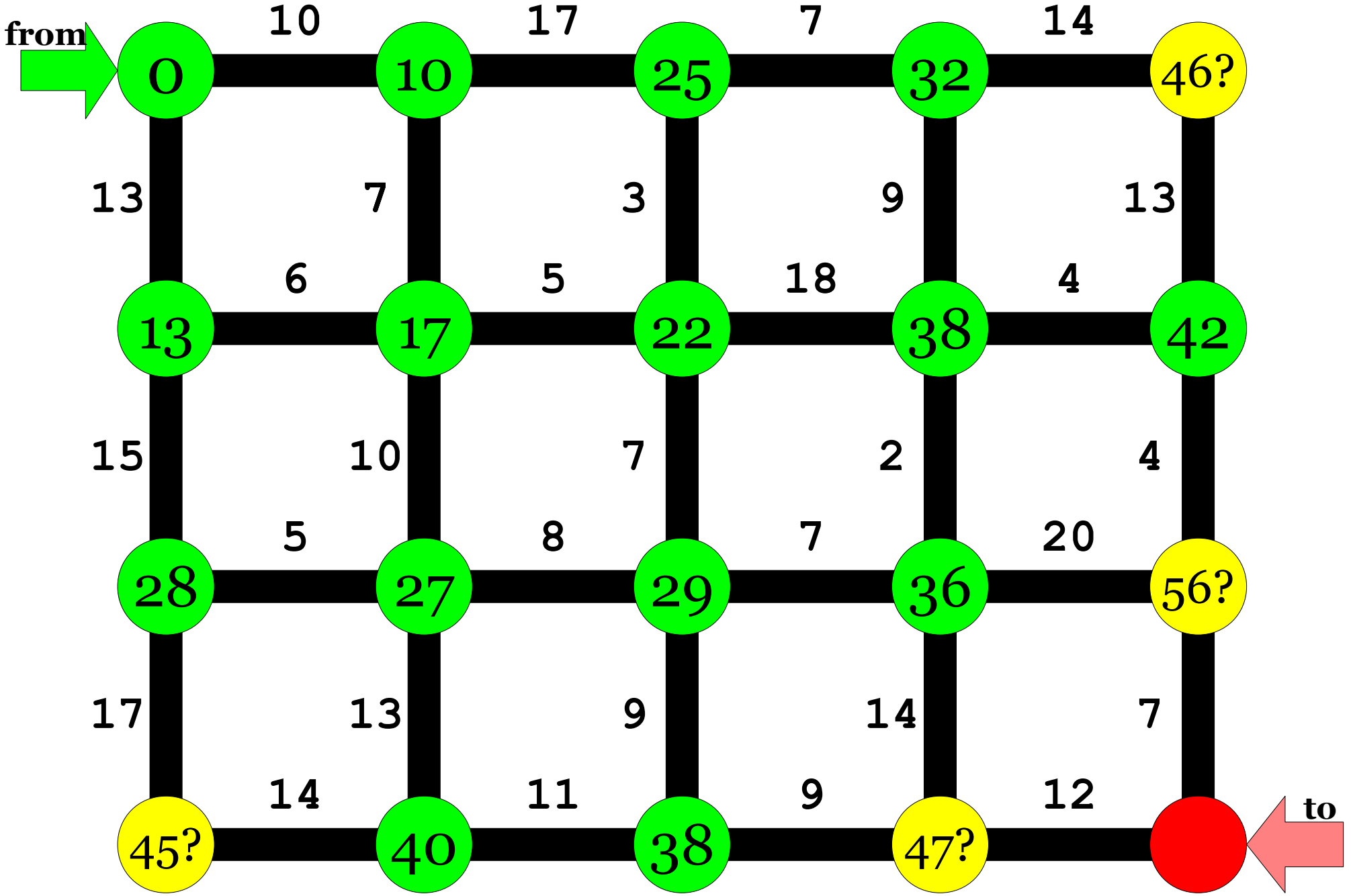
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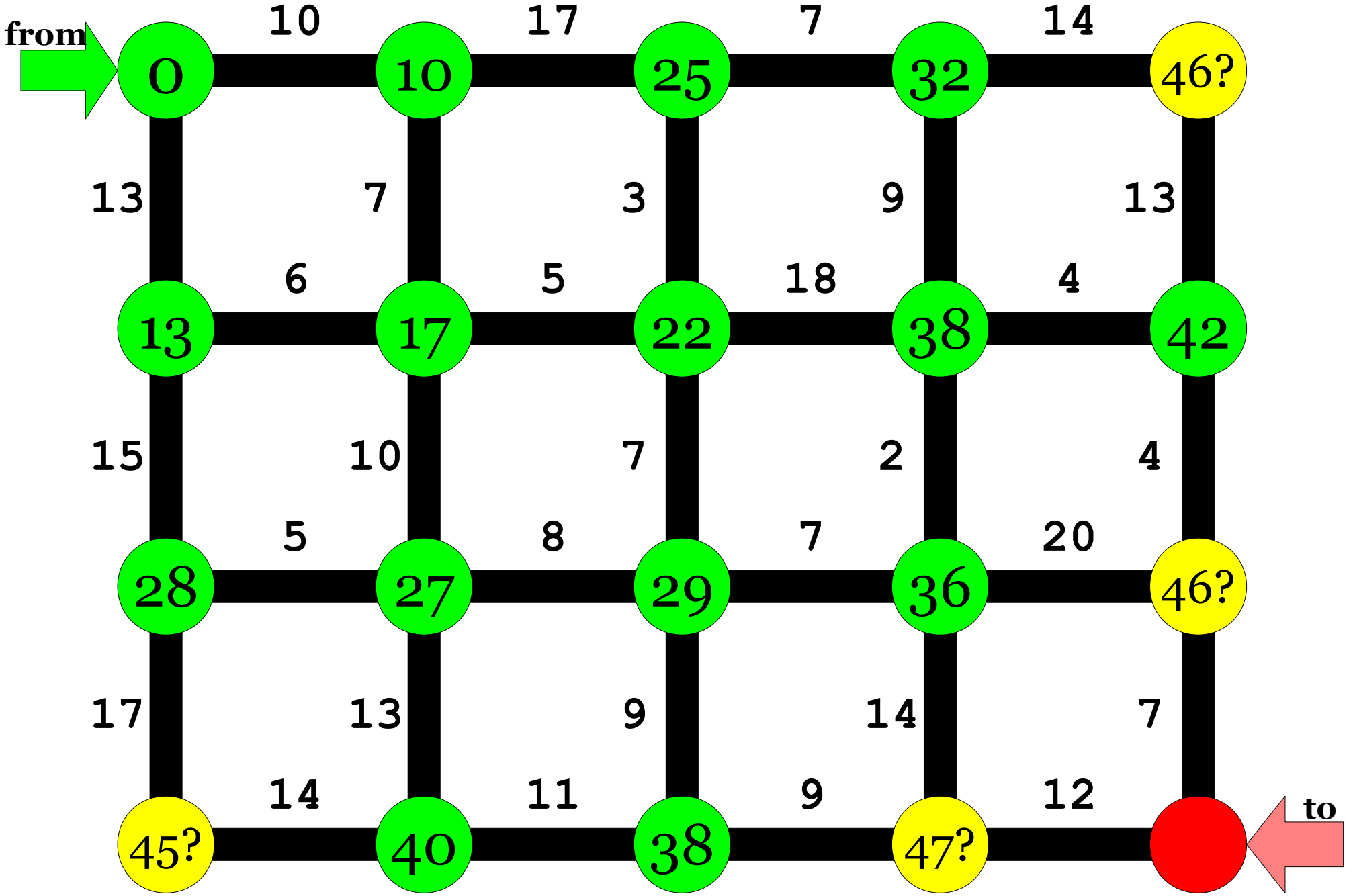
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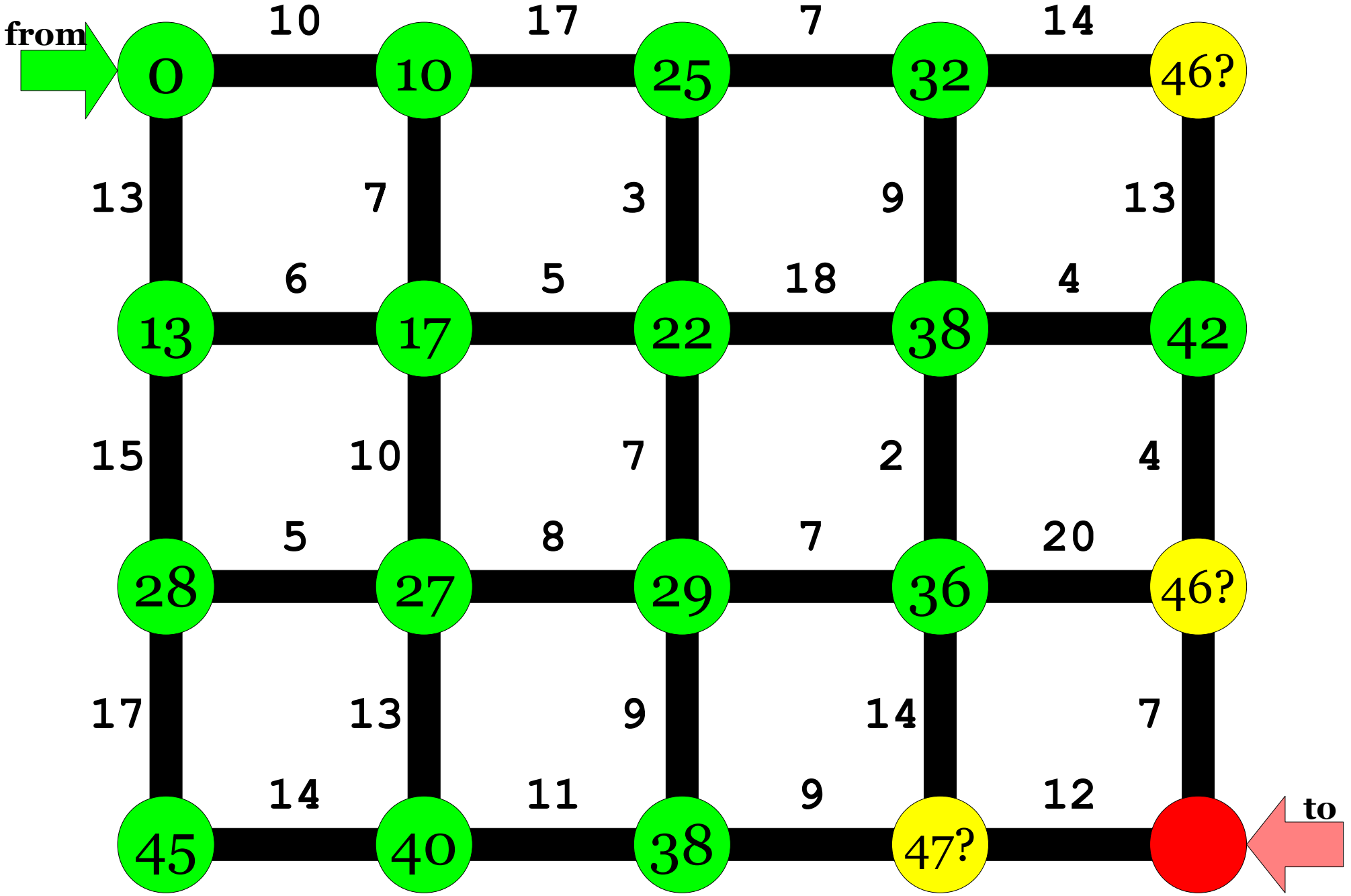
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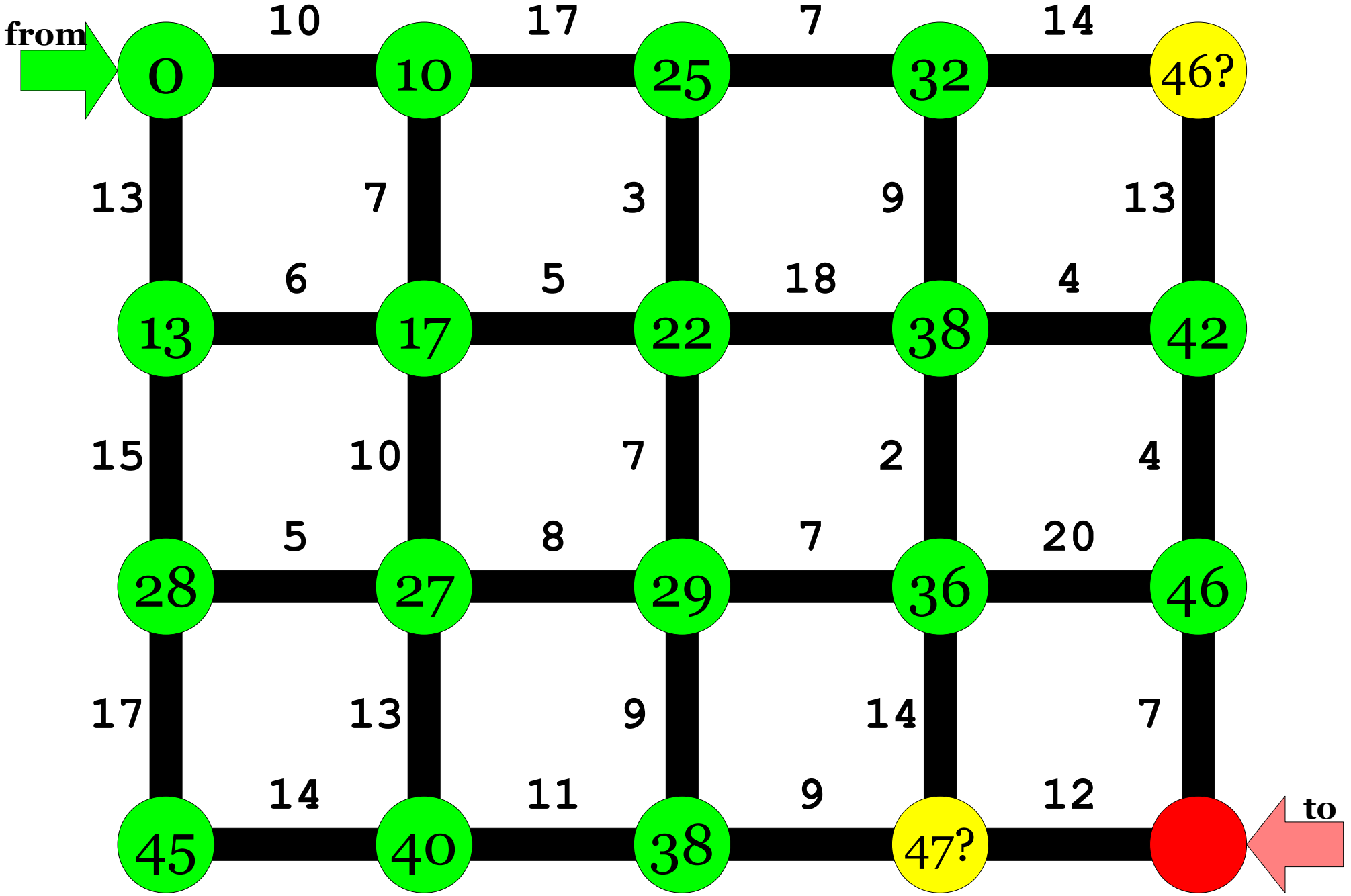
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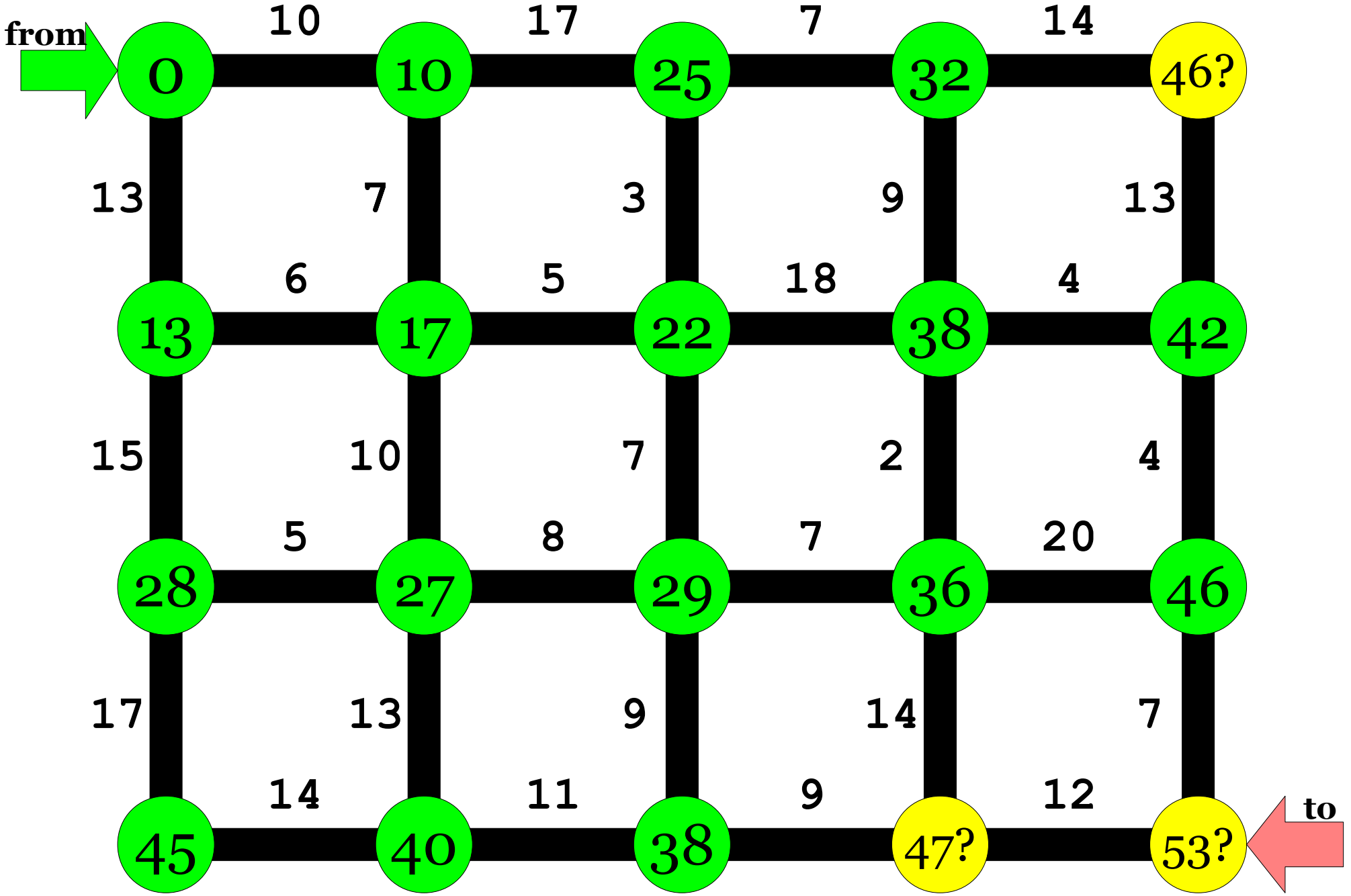
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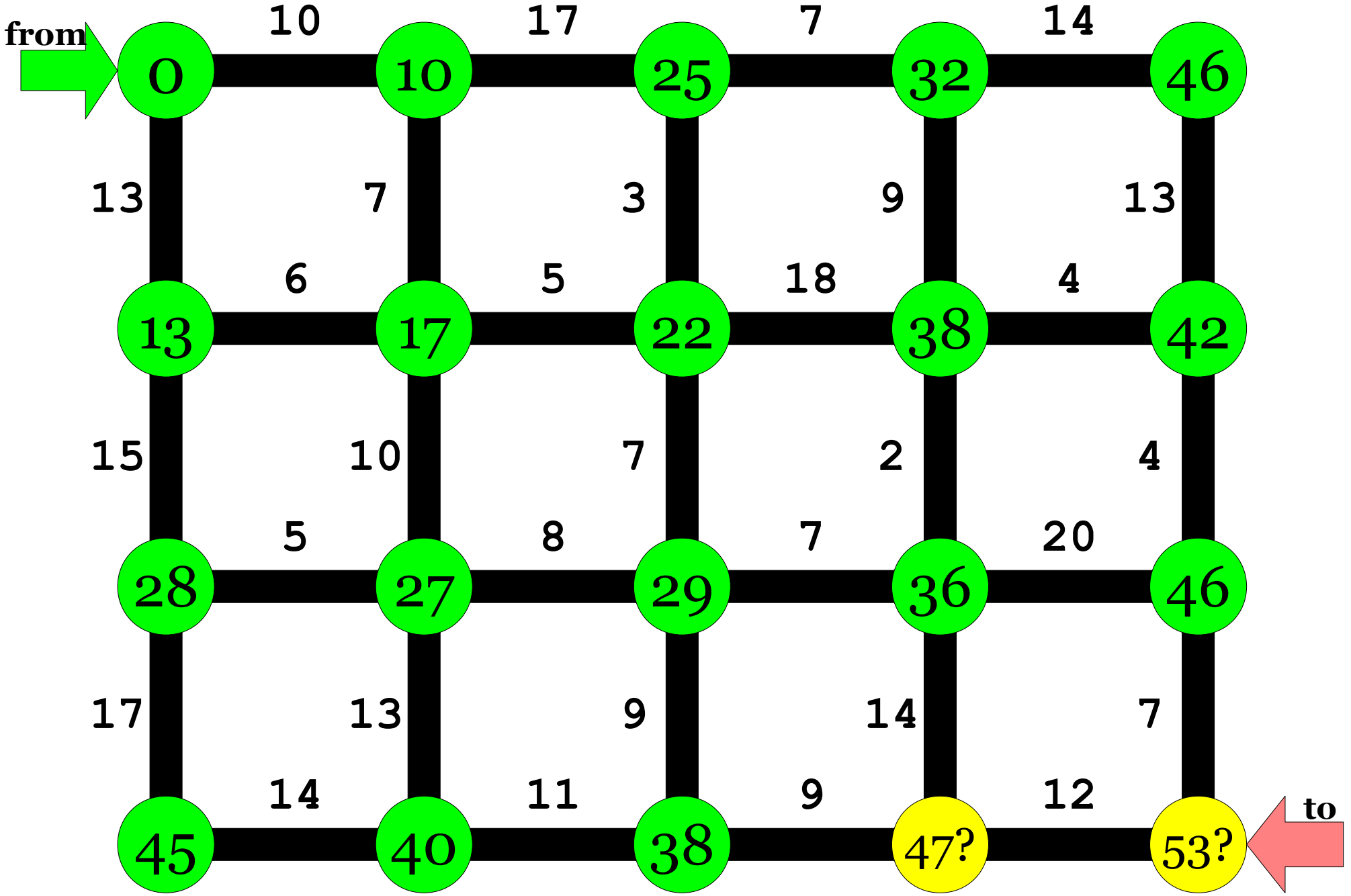
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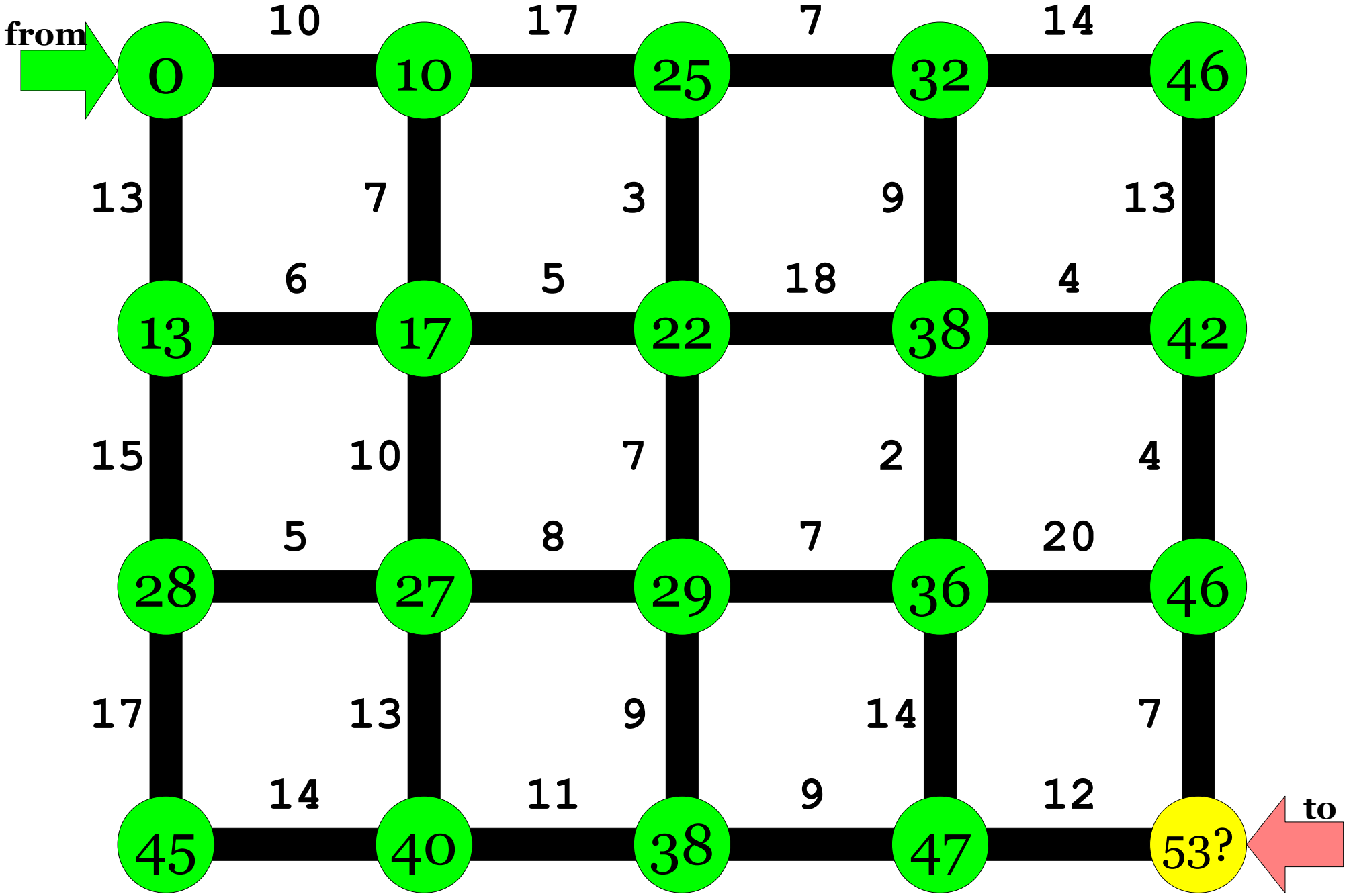
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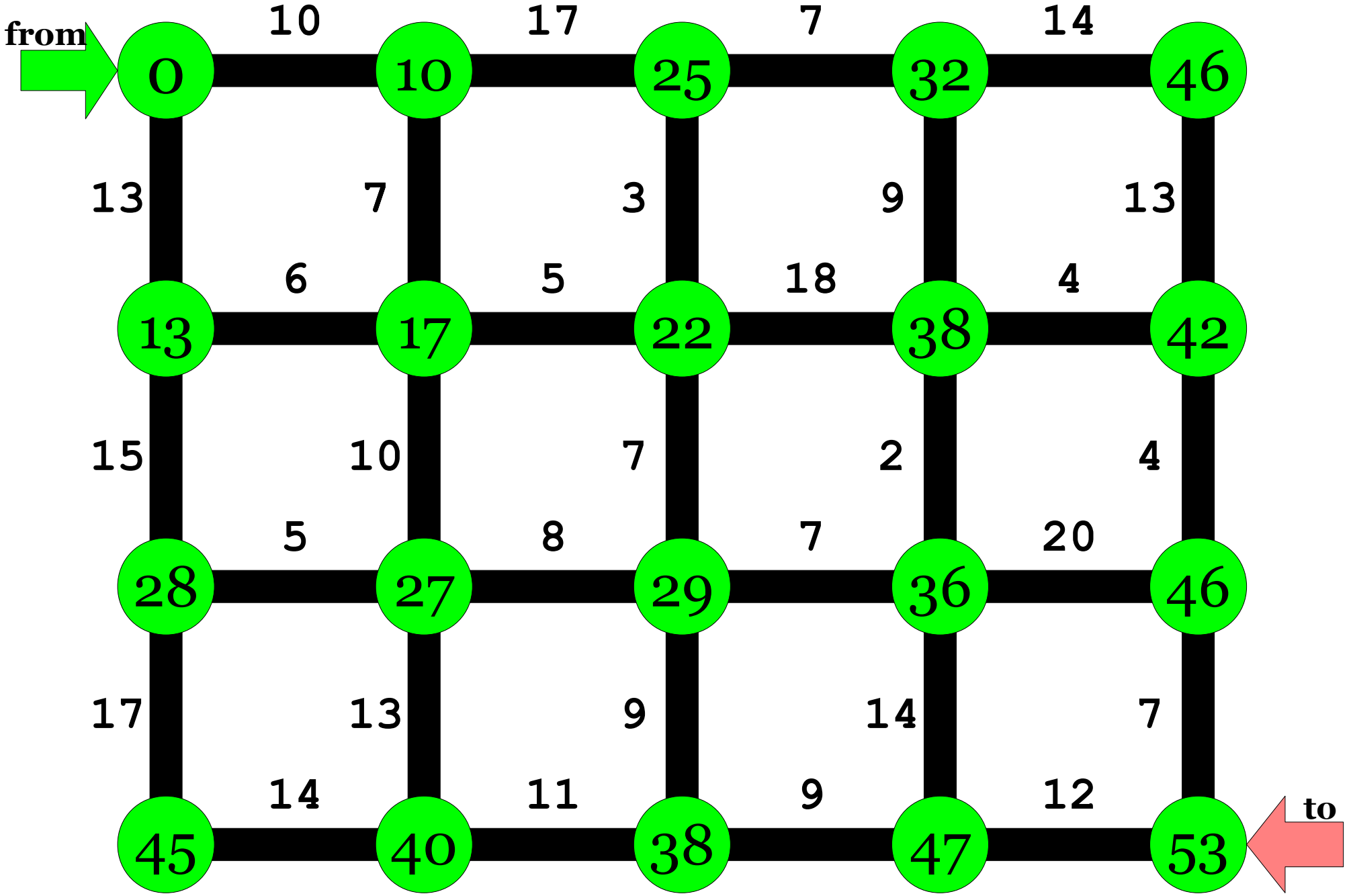
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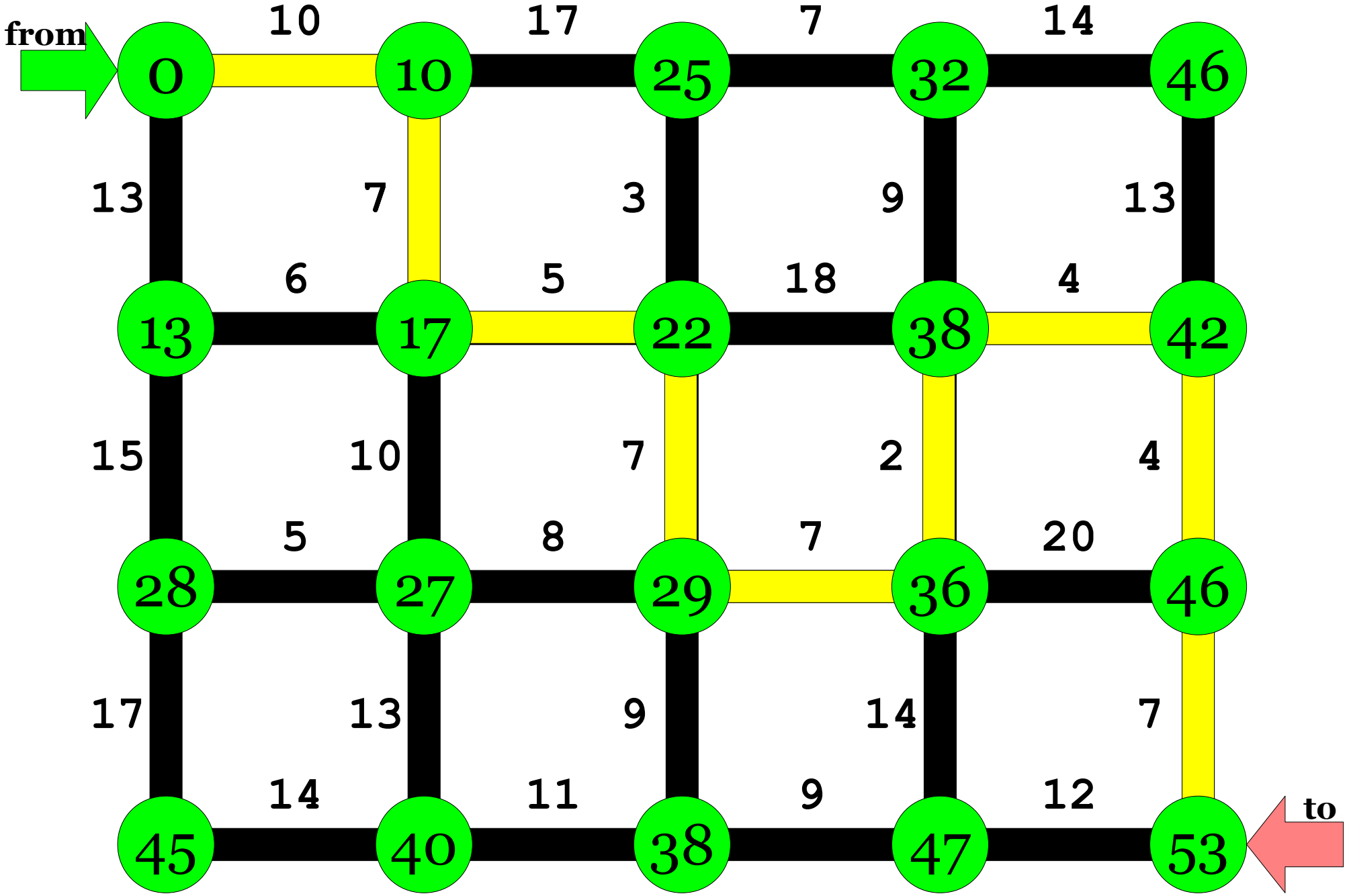
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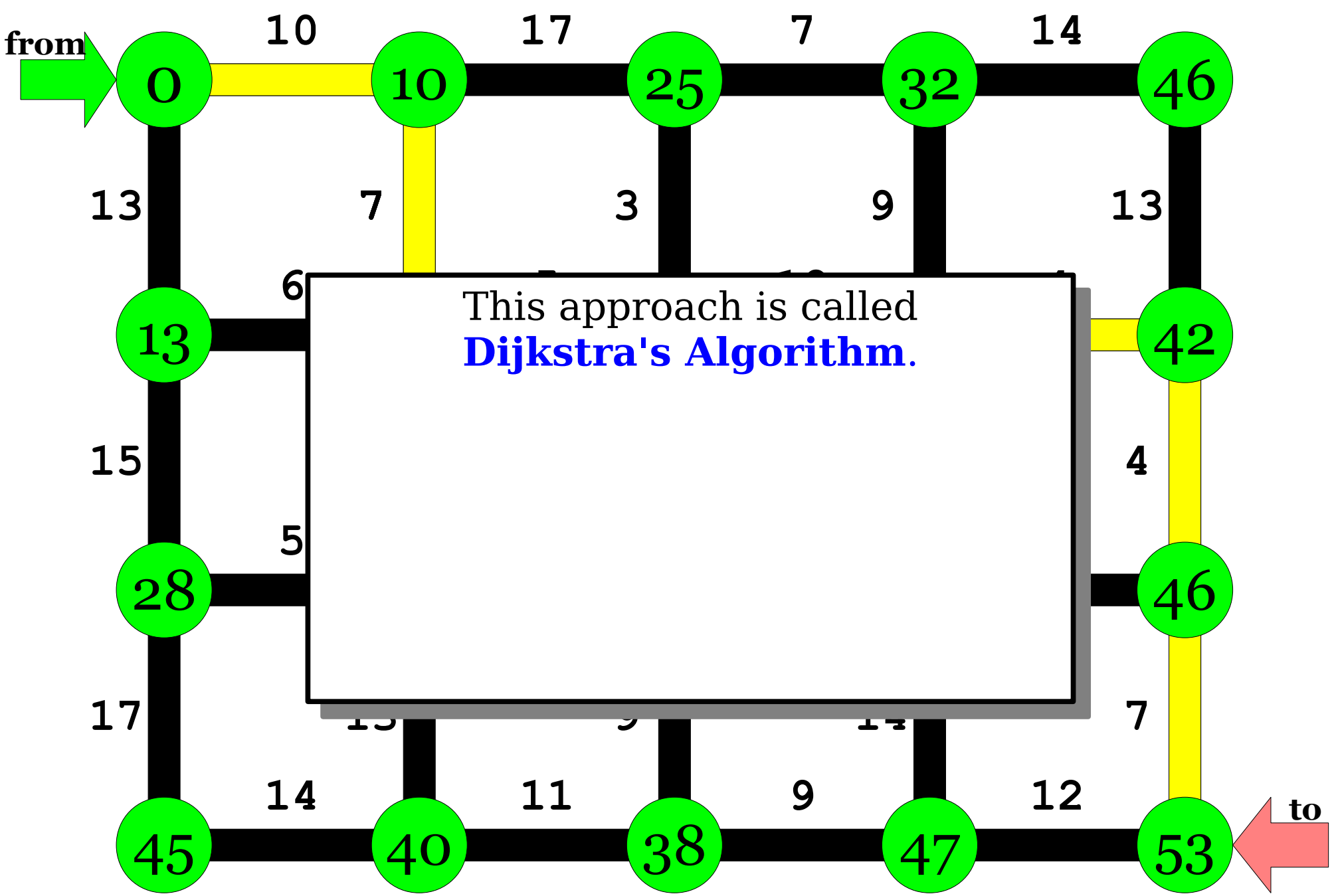
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This approach is called
Dijkstra's Algorithm.
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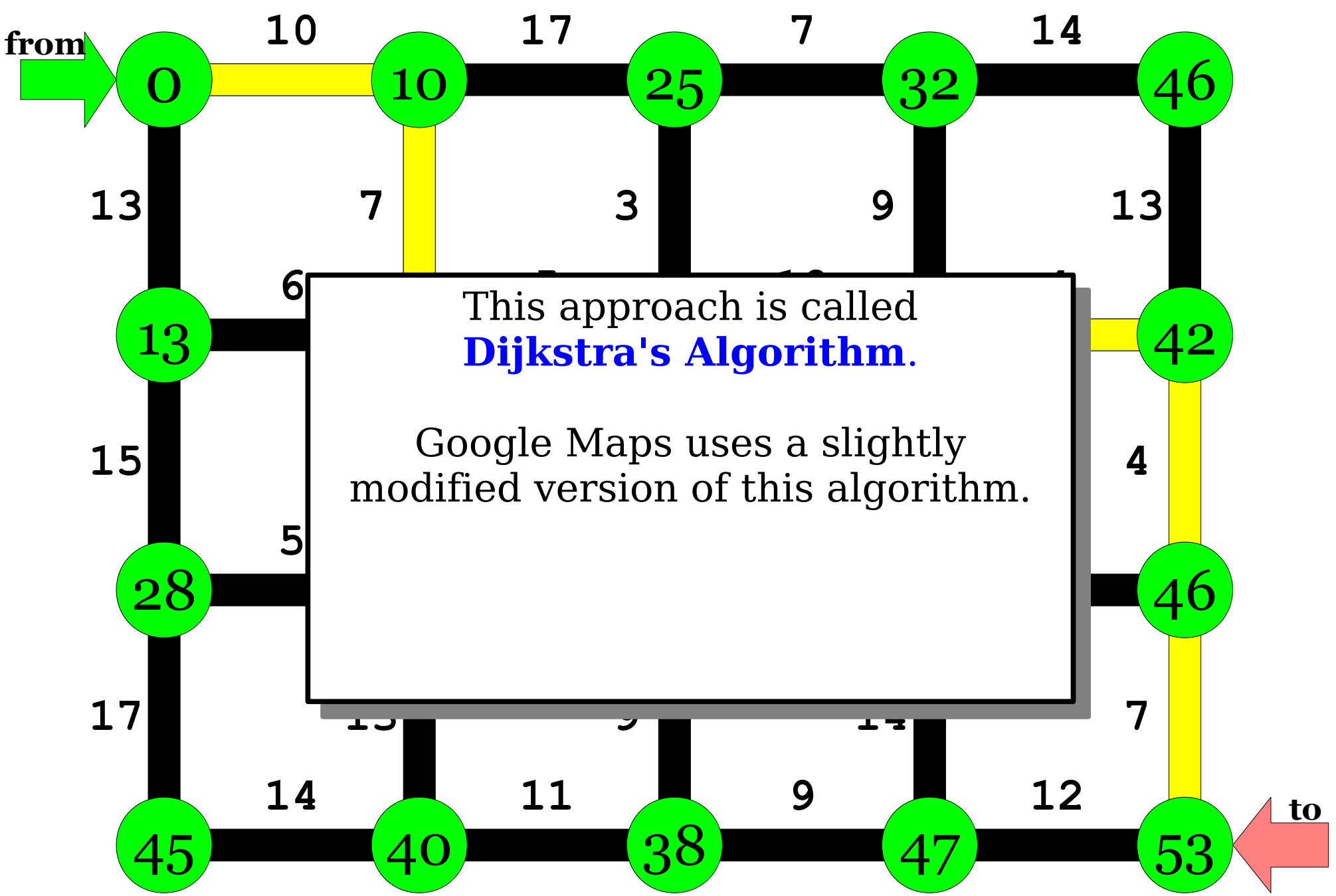
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This approach is called
Dijkstra's Algorithm.
Google Maps uses a slightly
modified version of this algorithm.
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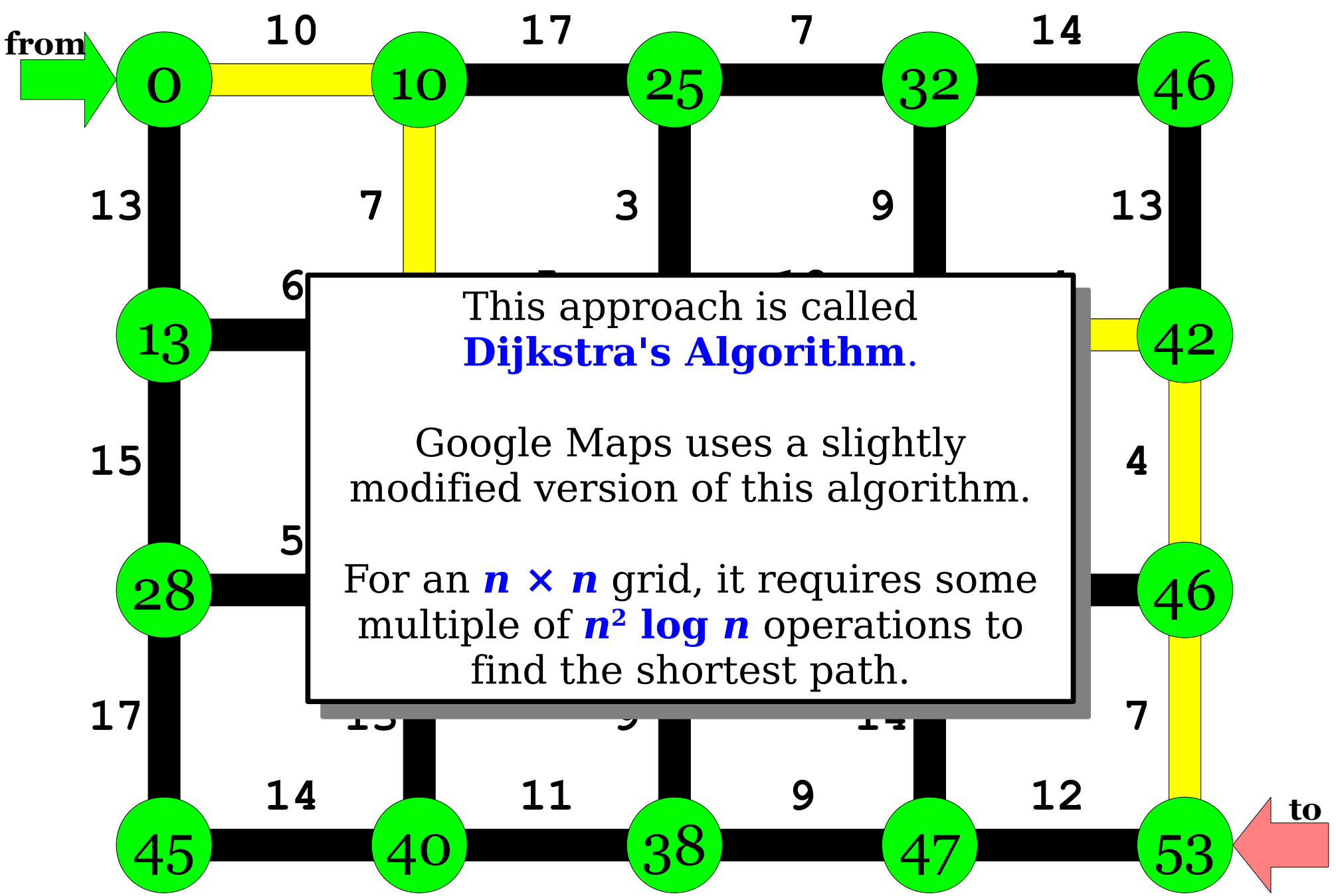
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This approach is called
Dijkstra's Algorithm.
Google Maps uses a slightly
modified version of this algorithm.
For an n × n grid, it requires some
multiple of n² log n operations to
find the shortest path.
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Goals for this Course

- **Learn how to model and solve complex problems with computers.**
- To that end:
  - Explore common abstractions for representing problems.
  - Harness recursion and understand how to think about problems recursively.
  - Quantitatively analyze different approaches for solving problems.

Secondary Goal

- **Get better at writing “good” code**
  - What makes code “good”?

Example: Naming

```
int numUnits(bool isGrad, bool wantsFewerUnits) {
    if (!isGrad) return 5;
    if (!wantsFewerUnits) return 5;
    if (reallyBusy()) {
       return 3;
    } else {
       return 4;
    }
}
```

Example: Naming

```
int NU(bool isGrad, bool wantsFewerUnits) {
    if (!isGrad) return 5;
    if (!wantsFewerUnits) return 5;
    if (reallyBusy()) {
       return 3;
    } else {
       return 4;
    }
}
```

Example: Naming

```
int NU(bool IG, bool WFU) {
    if (!IG) return 5;
    if (!WFU) return 5;

    if (reallyBusy()) {
       return 3;
    } else {
       return 4;
    }
}
```

Secondary Goal

- **Get better at writing “good” code**
  - What makes code “good”?

Secondary Goal

- **Get better at writing “good” code**
  - What makes code “good”?
- One possible definition: code that's easy to understand, use and build upon
  - e.g. How hard would it be for someone to start working with this code?

Secondary Goal

- **Get better at writing “good” code**
  - What makes code “good”?
- One possible definition: code that's easy to understand, use and build upon
  - e.g. How hard would it be for someone to start working with this code?
- Get better at this with practice, examples from class/section/course reader, advice from section leaders

One more detail...

C++

What is C++?

- Programming language developed in 1983 by Bjarne Stroustrup.
- Widely used for general programming when performance is important.
- Supports a variety of programming styles.

C++ and CS106B

- The focus of CS106B is developing a set of problem solving skills.
- Learning C++ is not the focus of CS106B
- We teach you just enough C++ in order to cover the topics in the course.
  - C++ just happens to be a useful language to cover these topics.

```
/* File: hello-world.cpp
 *
 * A canonical Hello, world! program
 * in C++.
 */

#include <iostream>
using namespace std;

int main() {
    cout << "Hello, world!" << endl;
}
```

#include ~ import
cout ~ println()

```
/* File: retain-evens.cpp
 *
 * A program to filter out odd numbers from a list.
 */
#include <iostream>
#include "vector.h"
using namespace std;

Vector<int> retainEvens(Vector<int> values) {
    Vector<int> result;
    for (int i = 0; i < values.size(); i++) {
        if (values[i] % 2 == 0)
            result += values[i];
    }
    return result;
}

int main() {
    Vector<int> values;
    values += 1, 2, 3, 4, 5;

    Vector<int> processed = retainEvens(values);

    for (int i = 0; i < processed.size(); i++) {
        cout << processed[i] << endl;
    }
}
```

Vector<int> ~ ArrayList<int>

C++

- Takeaway Point: Learning a new programming language is *not* like learning a new spoken language.
  - Most languages have similar features

CS106L

- Not offered over the Summer :(
- Optional, one-unit companion course to CS106B.
- In-depth treatment of C++'s libraries and language features.
- Excellent complement to the material from CS106B; highly recommended!

Having a Good Time in CS106B

- Start assignments early.
- Work during LAIR hours so you can ask a section leader if you have any questions.
- Go to section.
- Learn to use the debugger.
- Ask questions in lecture and section!

Next Time

- **Welcome to C++!**
  - Defining functions.
  - Reference parameters.
  - Introduction to recursion.