Welcome to CS106B!

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

Who's Here Today?

- African Studies
- Applied Physics
- Bioengineering
- Biology
- Business Administration
- Chemical Engineering
- Chemistry
- Classics
- Civil and Environmental Engineering
- Computational and Mathematical Engineering
- Computer Science
- Creative Writing
- East Asian Studies
- Economics
- Education
- Electrical Engineering
- Energy Resource Engineering
- English
- Financial Mathematics
- Film and Media Studies
- French
- History
- International Relations
- Japanese
- Law
- Materials Science and Engineering
- Mathematical and Computational Sciences
- Mathematics
- Mechanical Engineering
- Medicine
- Management Science and Engineering
- Modern Language
- Music
- Neuroscience
- Physics
- Political Science
- Psychology
- Science, Technology, and Society
- Statistics
- Symbolic Systems
- Undeclared!

Course Staff

Instructor: Keith Schwarz (htiek@cs.stanford.edu)

Head TA: Dawson Zhou (zhoud@stanford.edu)

The CS106B Section Leaders
The CS106B Course Helpers

Course Website

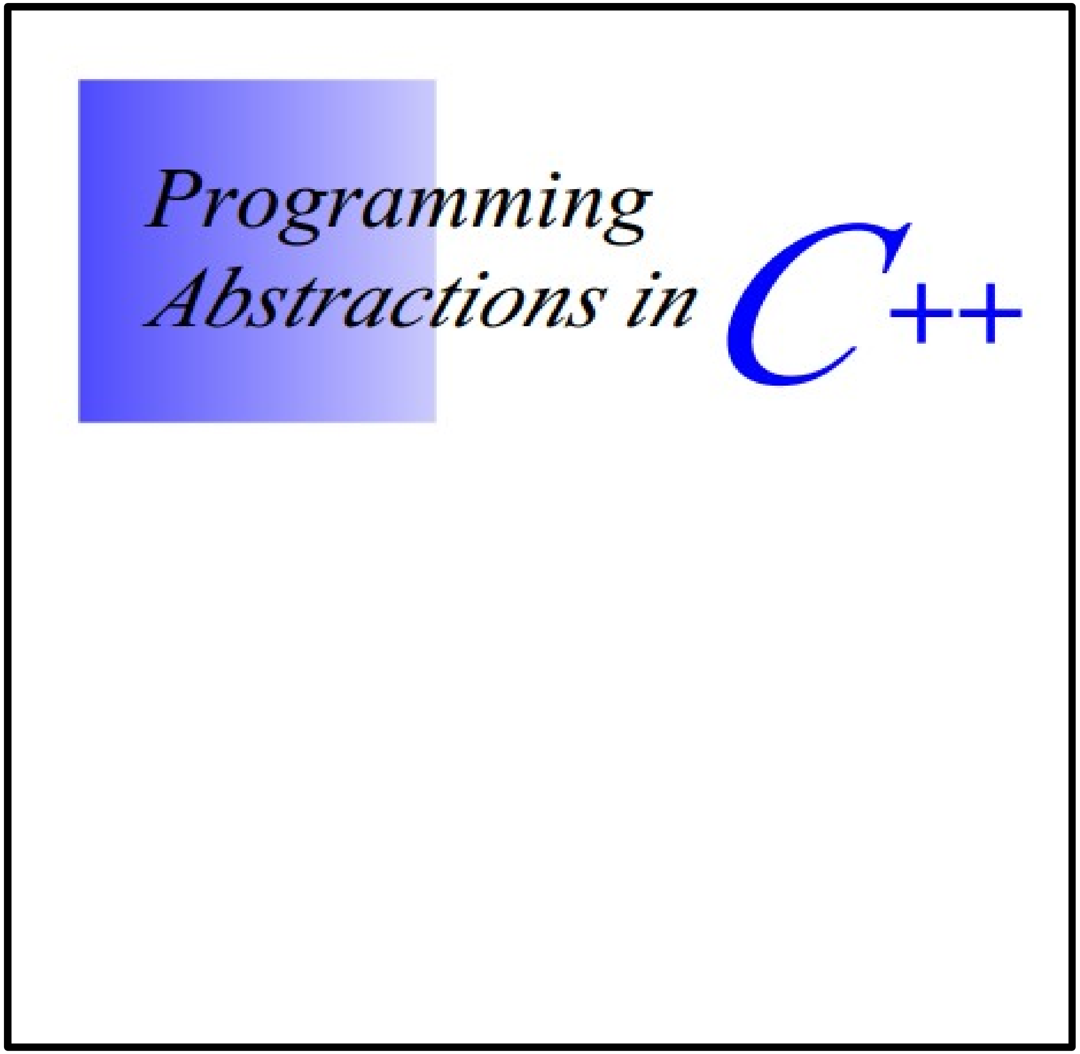
http://cs106b.stanford.edu

Prerequisites

CS106A

(or equivalent)

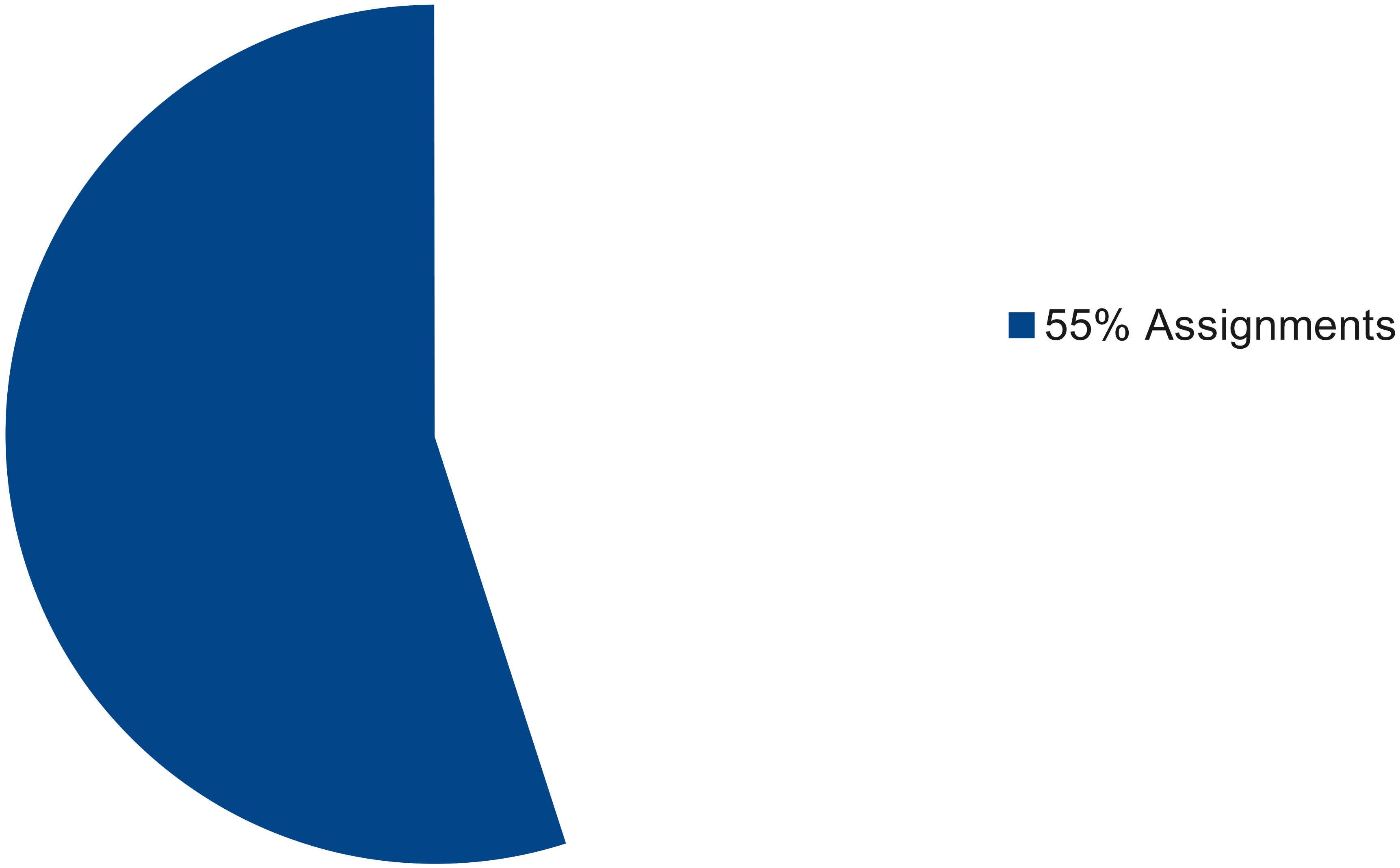
Required Reading



Programming Abstractions in C++

Grading Policies

Grading Policies



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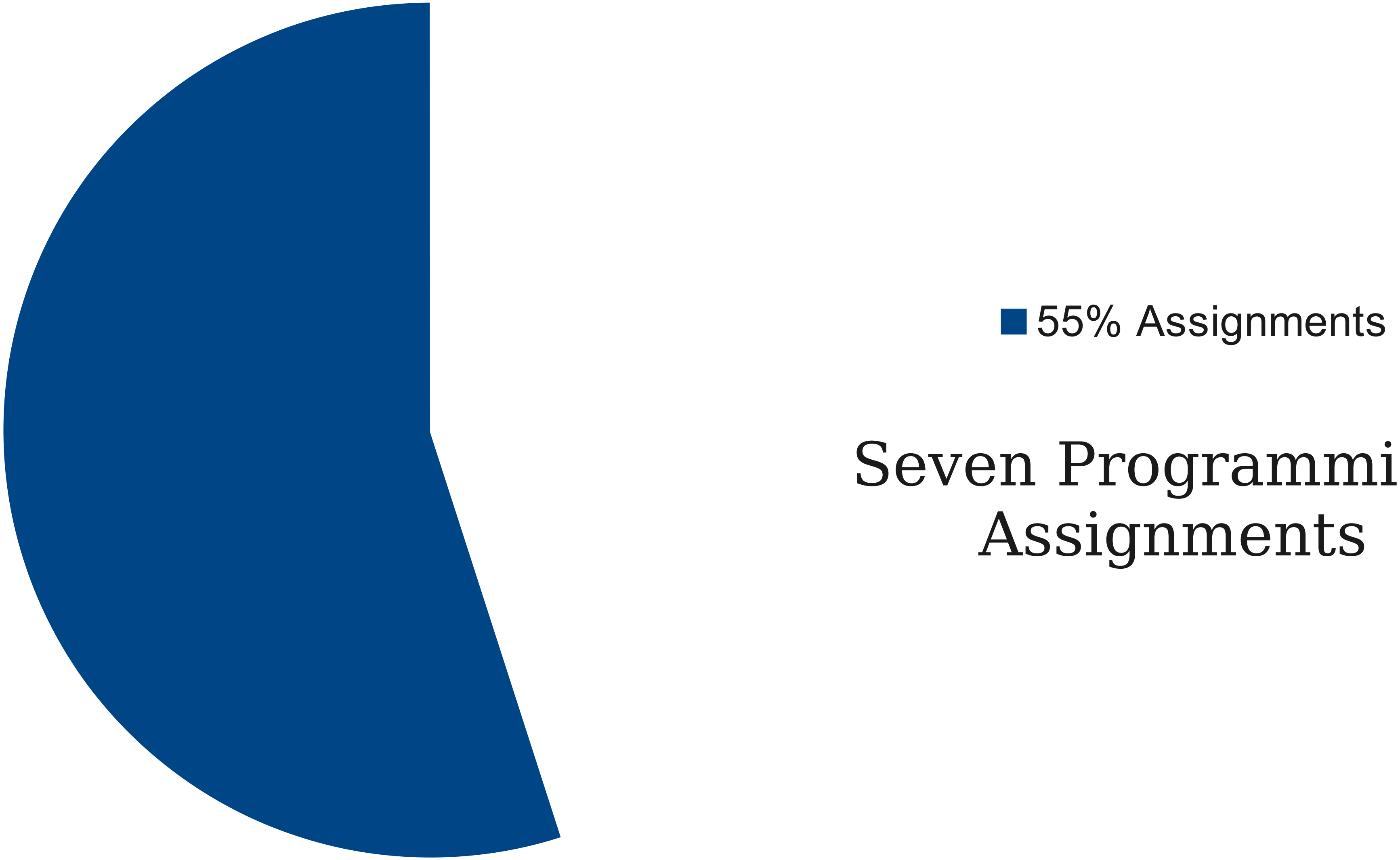
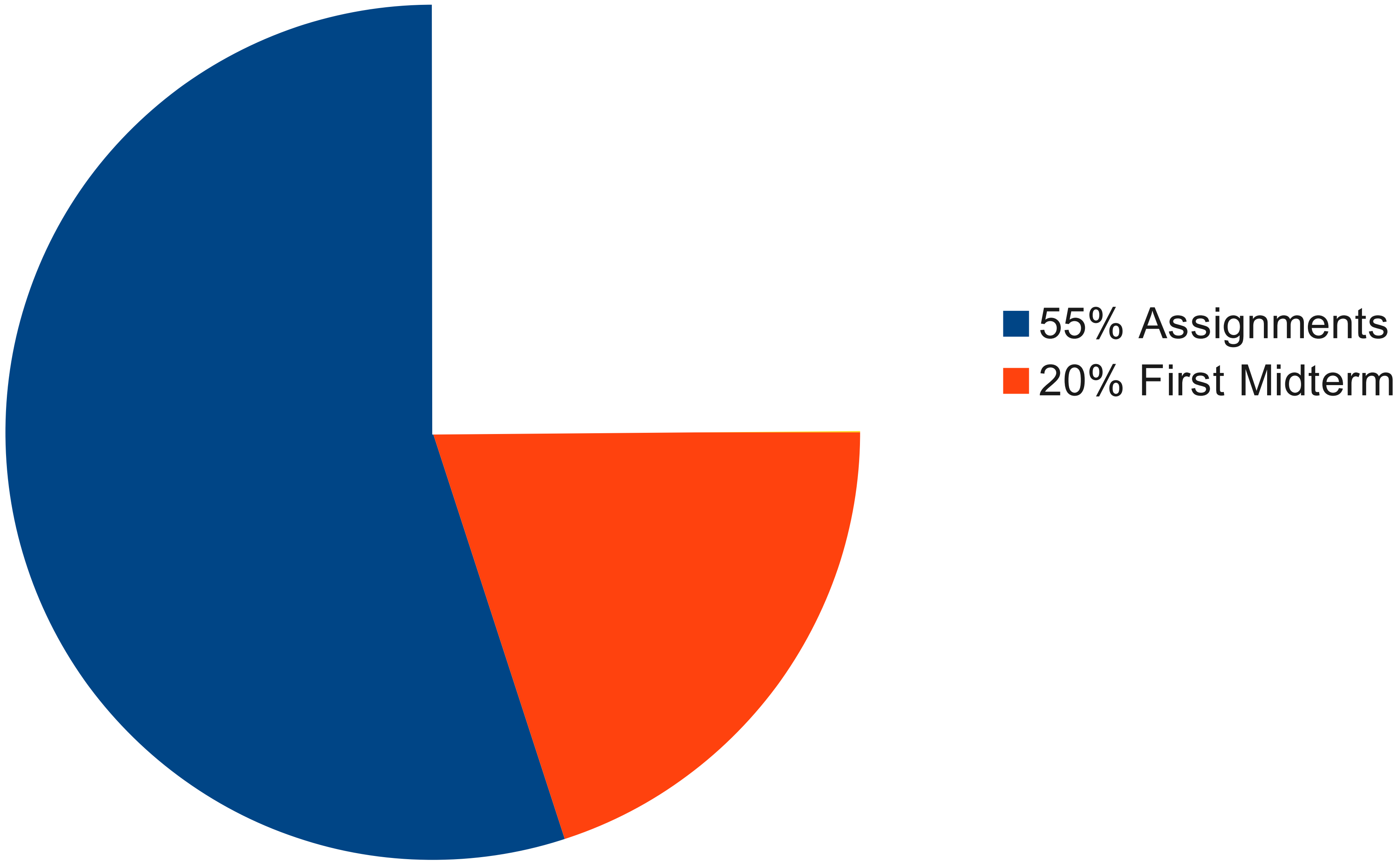


Seven Programming Assignments

Grading Policies



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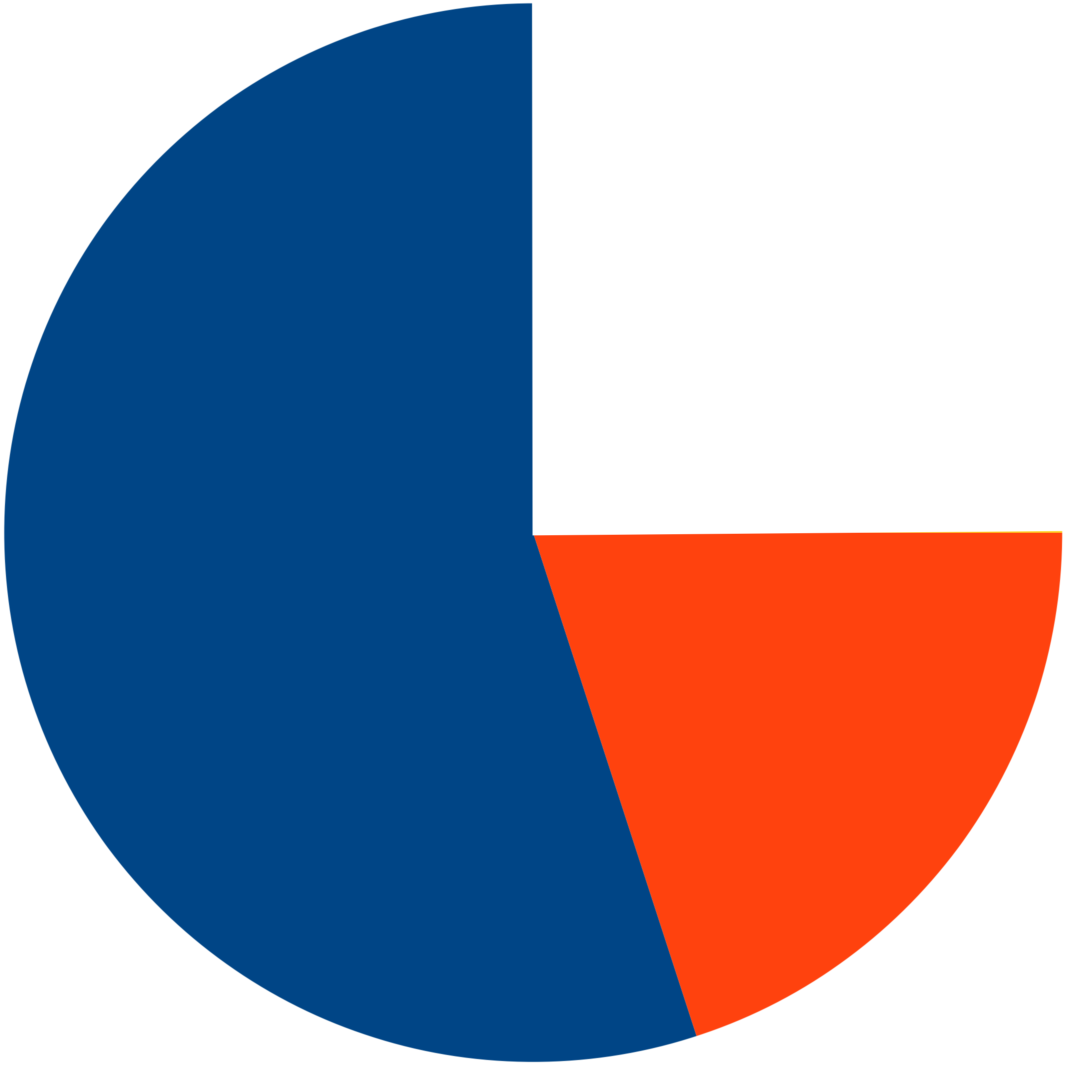
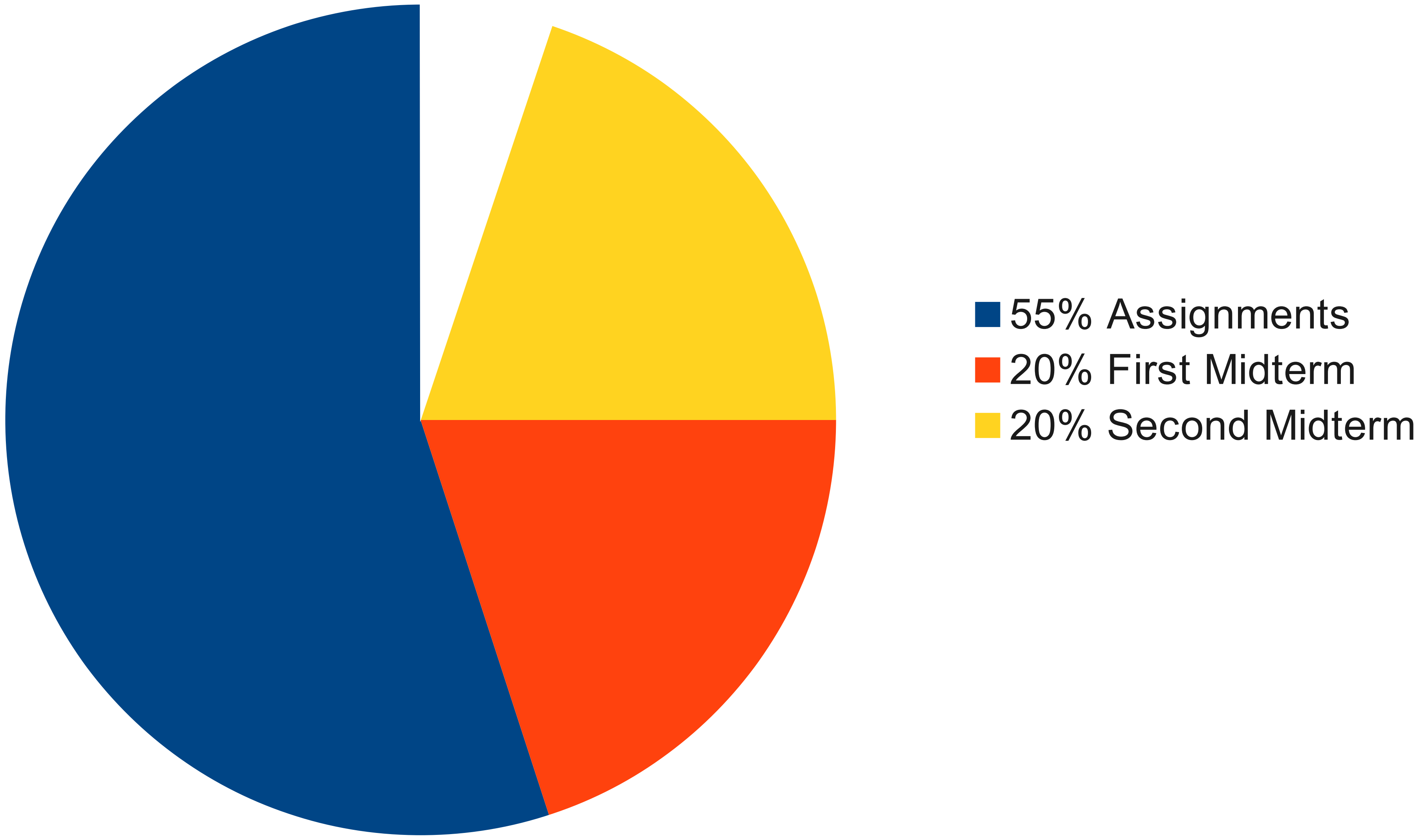


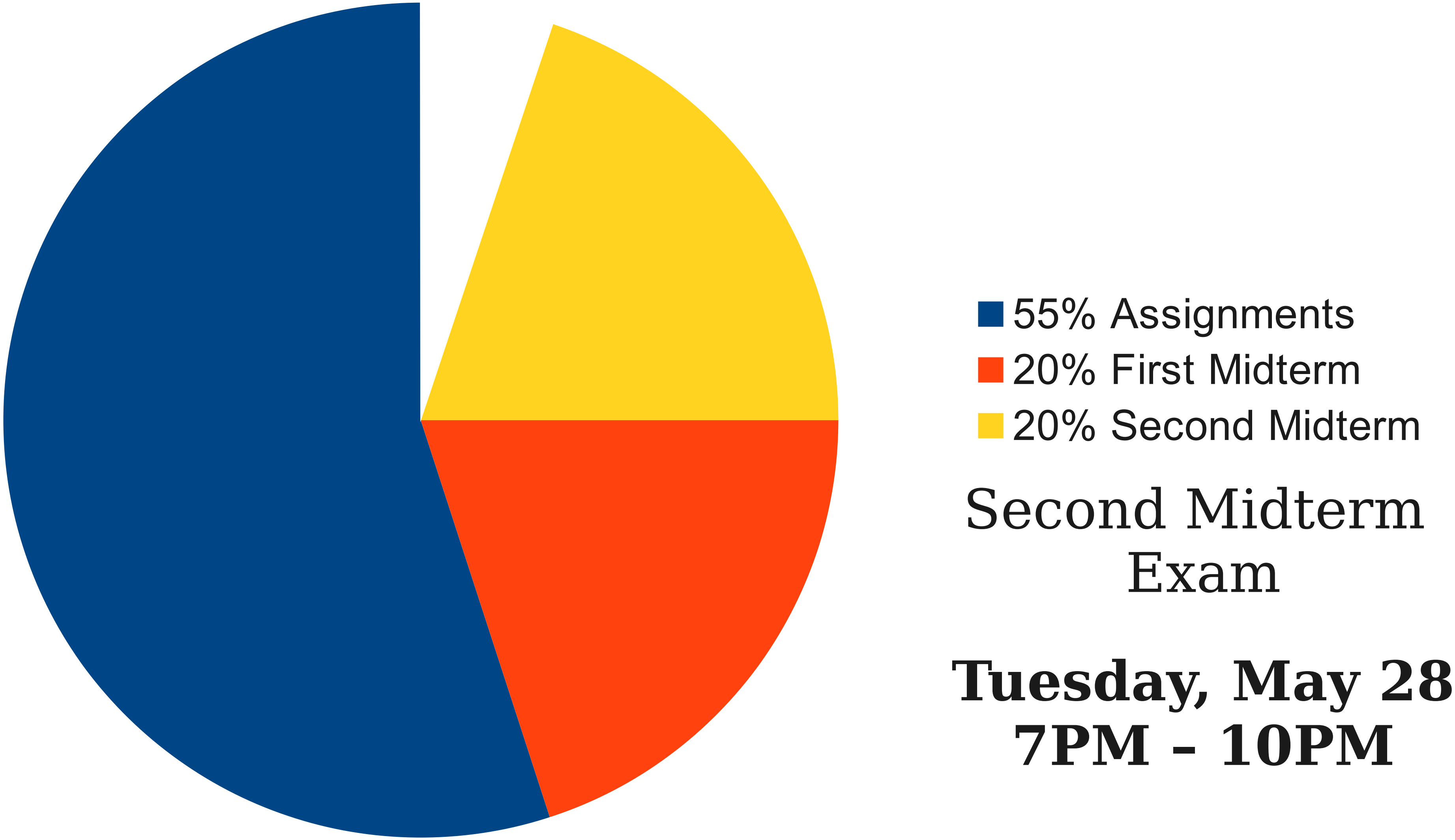
First Midterm Exam

Tuesday, May 7
7PM – 10PM

Grading Policies



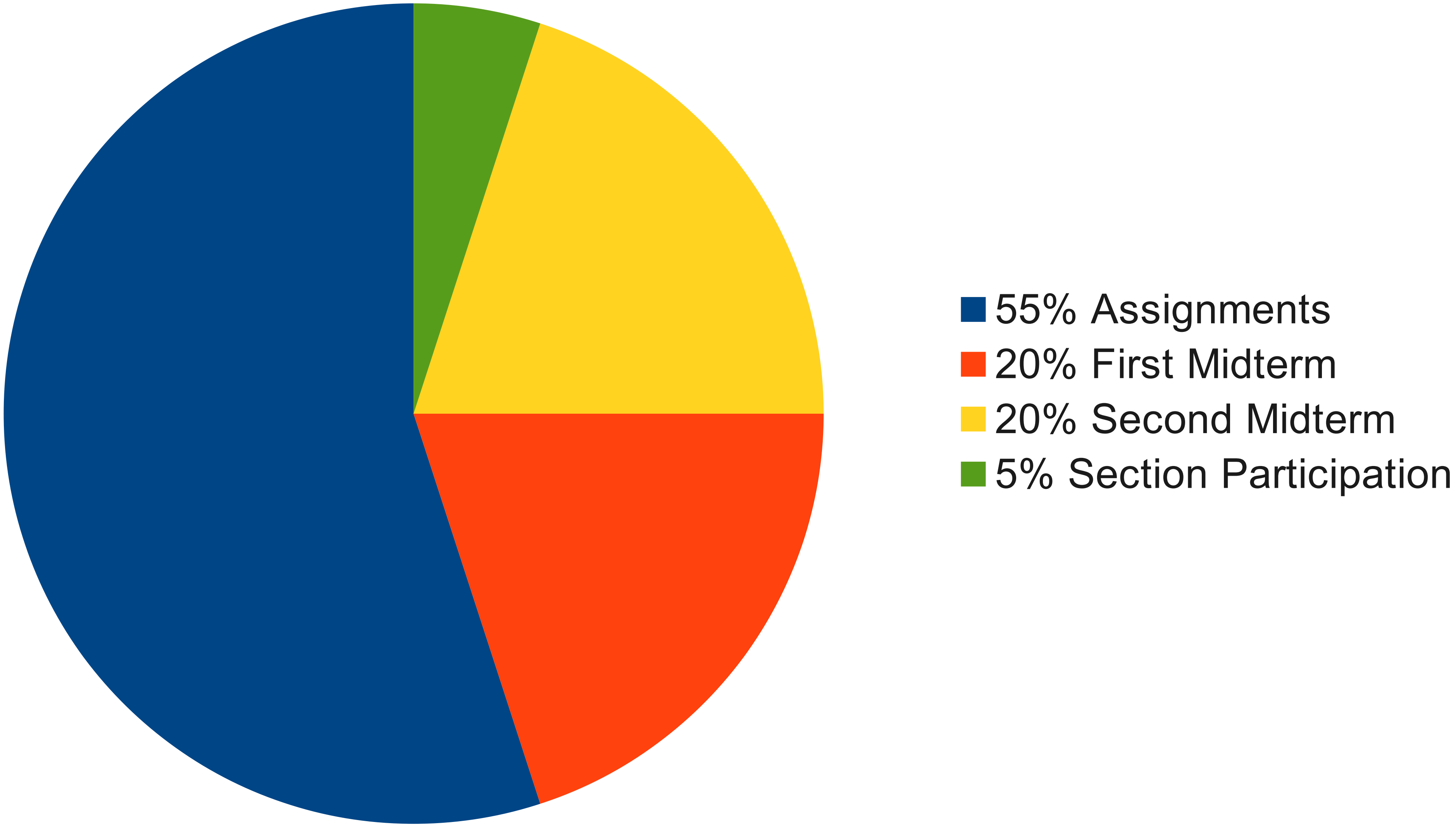
Grading Policies



Second Midterm Exam

Tuesday, May 28
7PM – 10PM

Grading Policies



Discussion Sections

- Weekly discussion sections.
- Section attendance is **required** in CS106B.
- Sign up between Thursday, April 4 at 5:00PM and Sunday, April 7 at 5:00PM at

http://cs198.stanford.edu/section

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

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!
  - Sunday – Thursday, 6PM – Midnight
  - Starts next week.
- Dawson's Office Hours in Gates 160
  - Monday/Wednesday 11AM – Noon
  - Tuesday/Thursday 1PM – 2PM
- Keith's Office Hours in Gates 178
  - Tuesday / Thursday, 2PM – 4PM

What's Next in Computer Science?

Goals for this Course

- **Learn how to model and solve complex problems with computers.**
- To that end:
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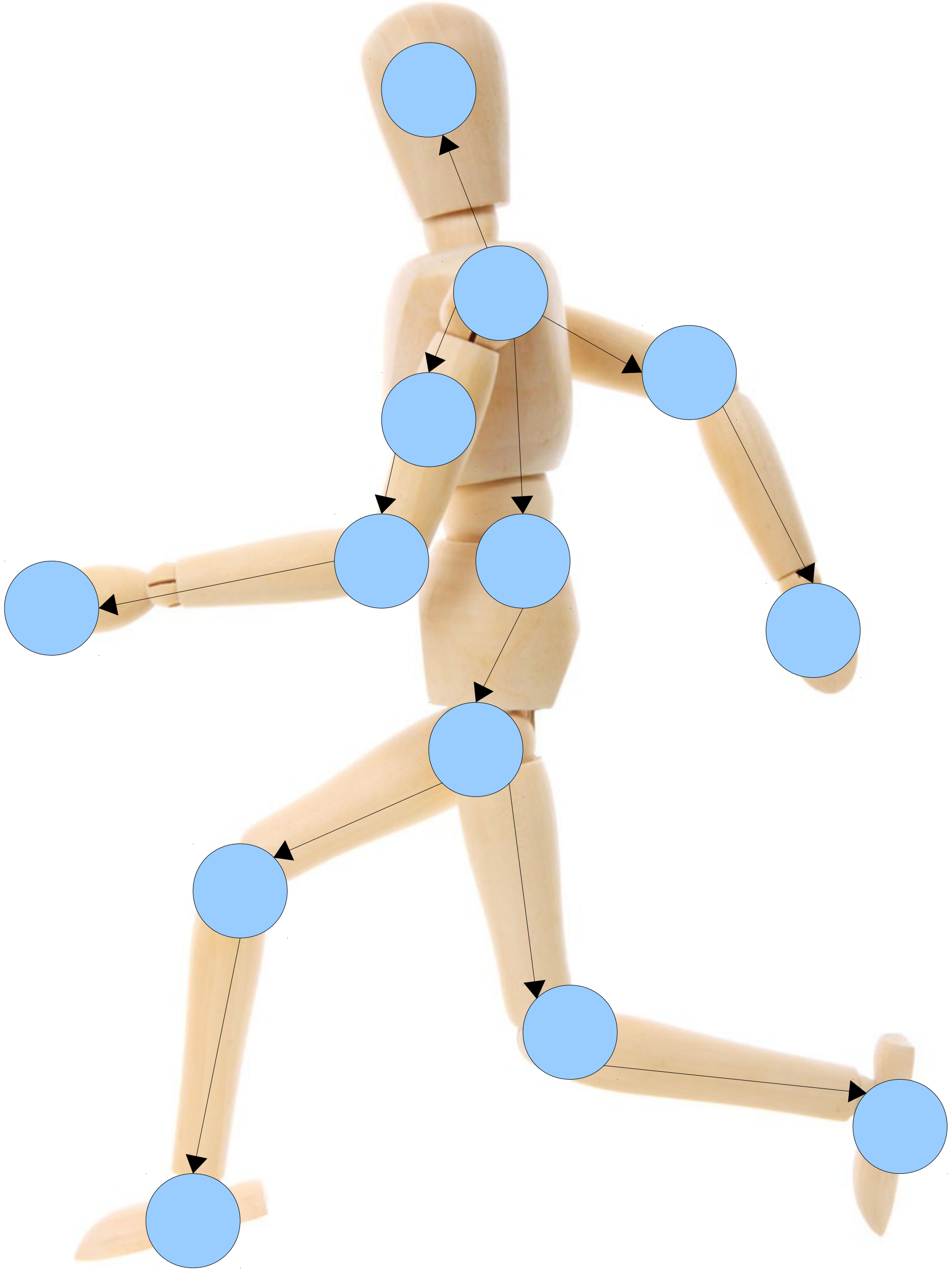
http://www.publicdomainpictures.net/pictures/10000/velka/1-1265899974oKJ9.jpg



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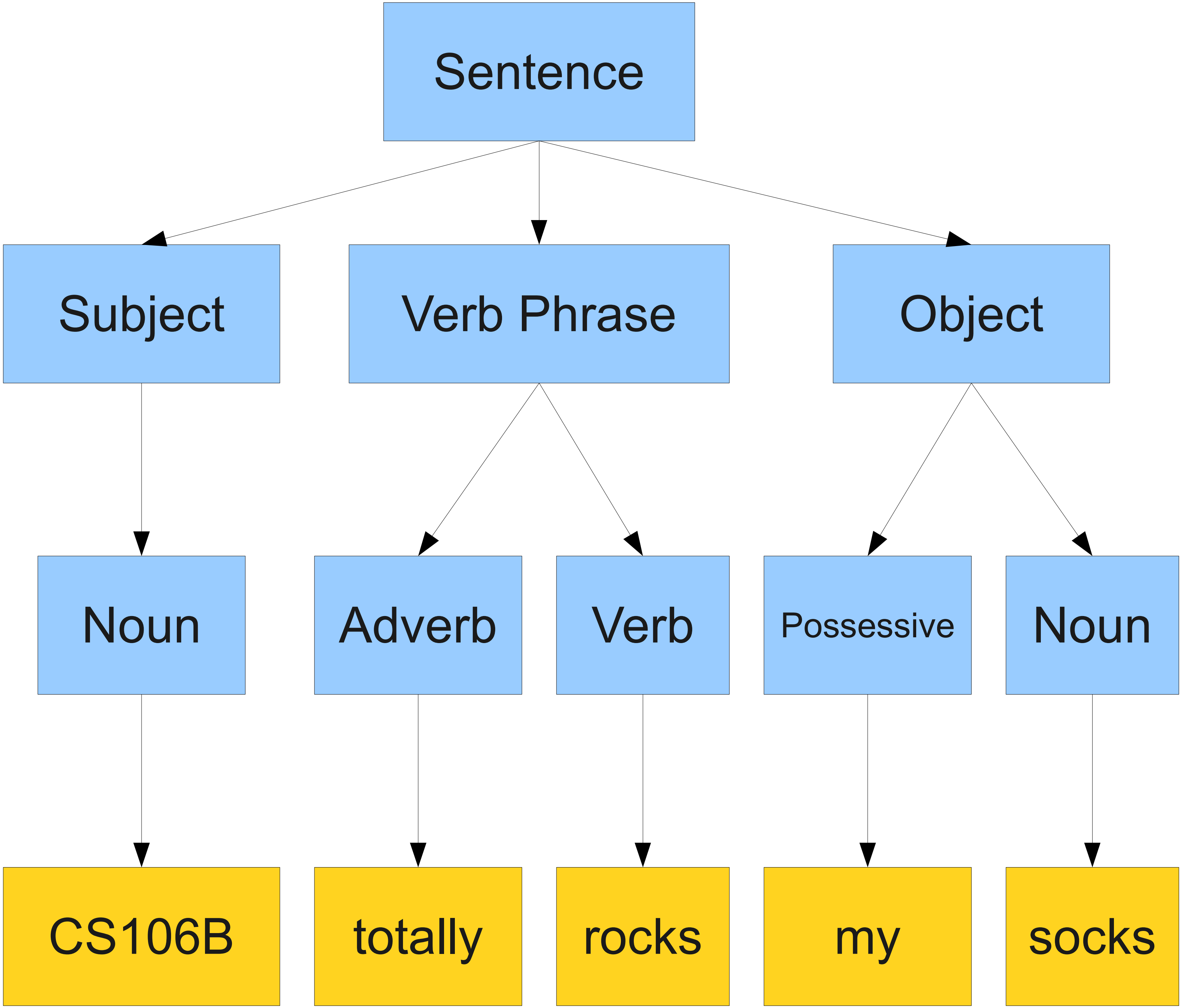

Sentence

Subject

Verb Phrase

Object

Noun

Adverb

Verb

Possessive

Noun

CS106B

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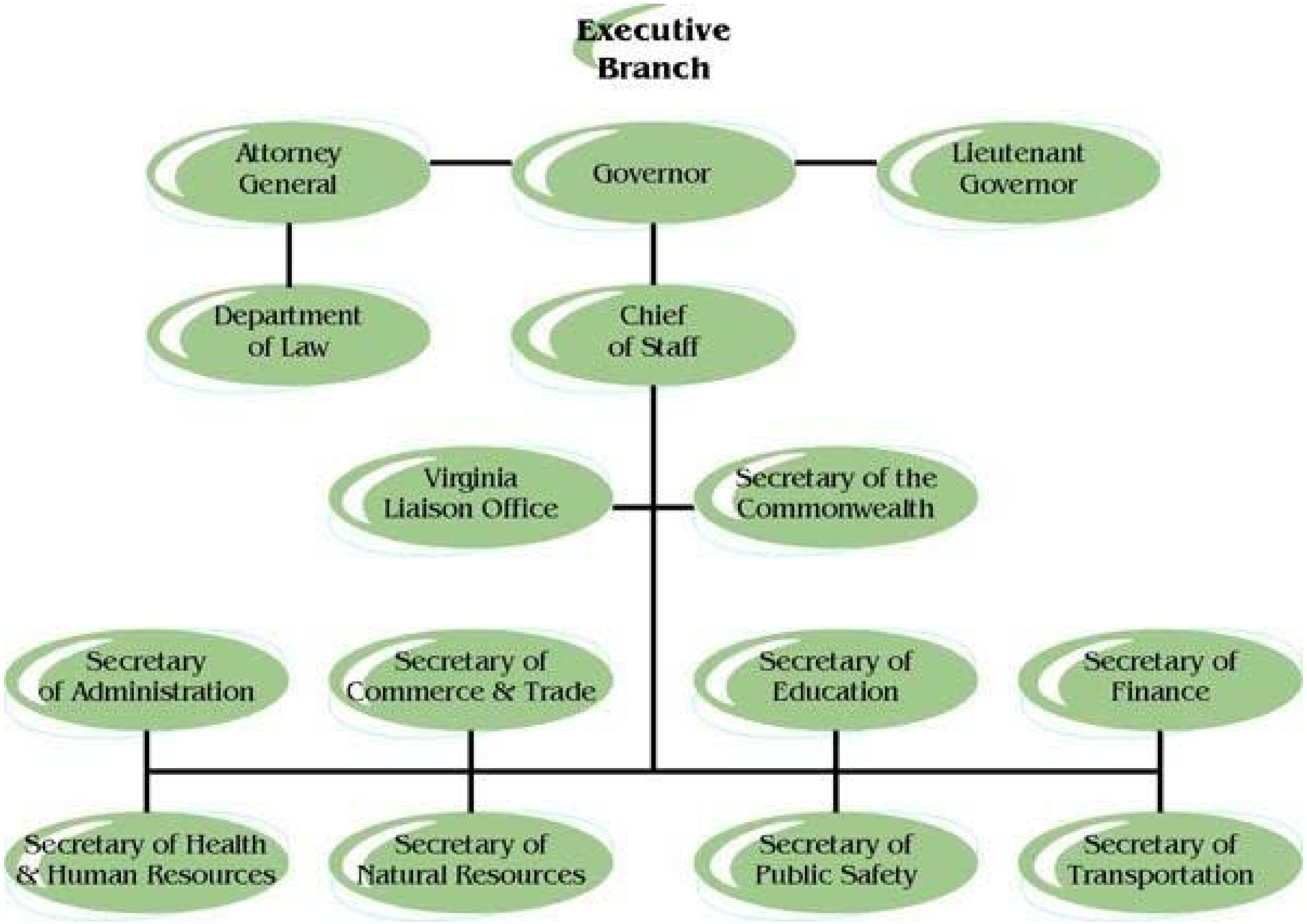
rocks

my

socks



Executive Branch

Attorney General

Governor

Lieutenant Governor

Department of Law

Chief of Staff

Virginia Liaison Office

Secretary of the Commonwealth

Secretary of Administration

Secretary of Commerce & Trade

Secretary of Education

Secretary of Finance

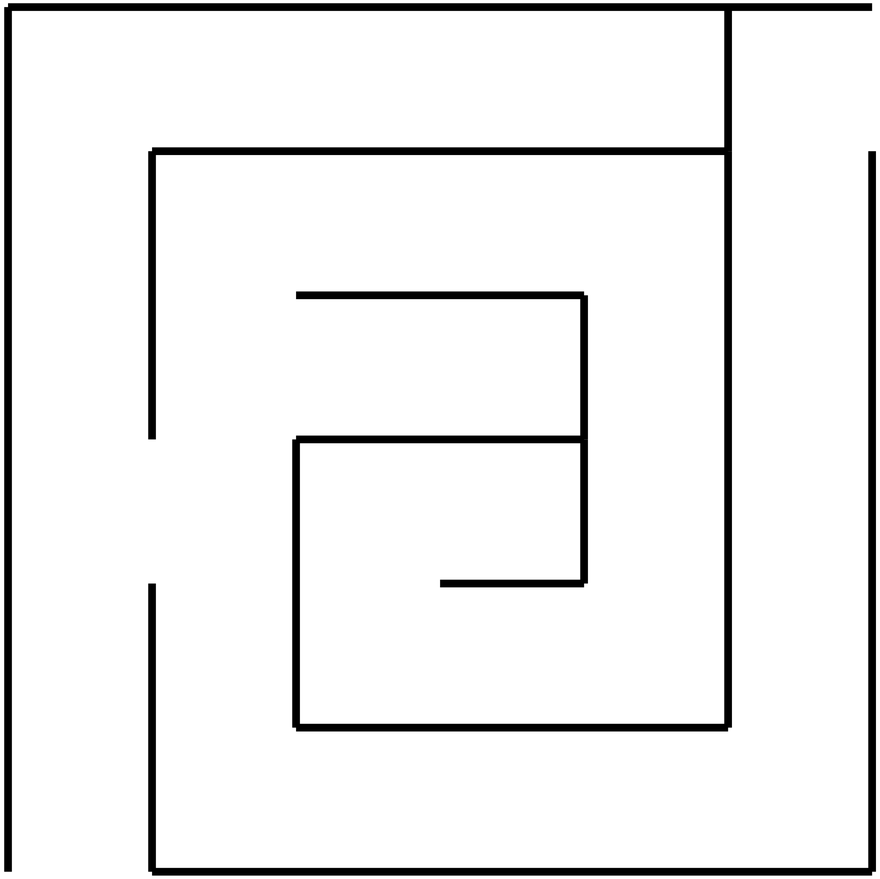
Secretary of Health & Human Resources

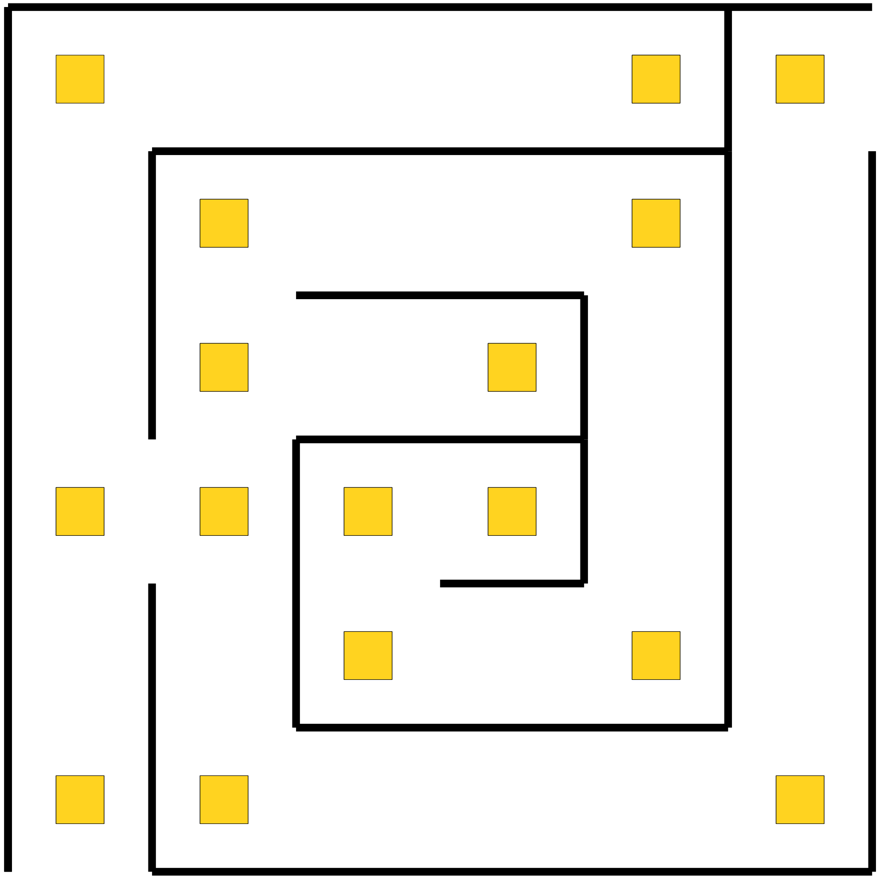
Secretary of Natural Resources

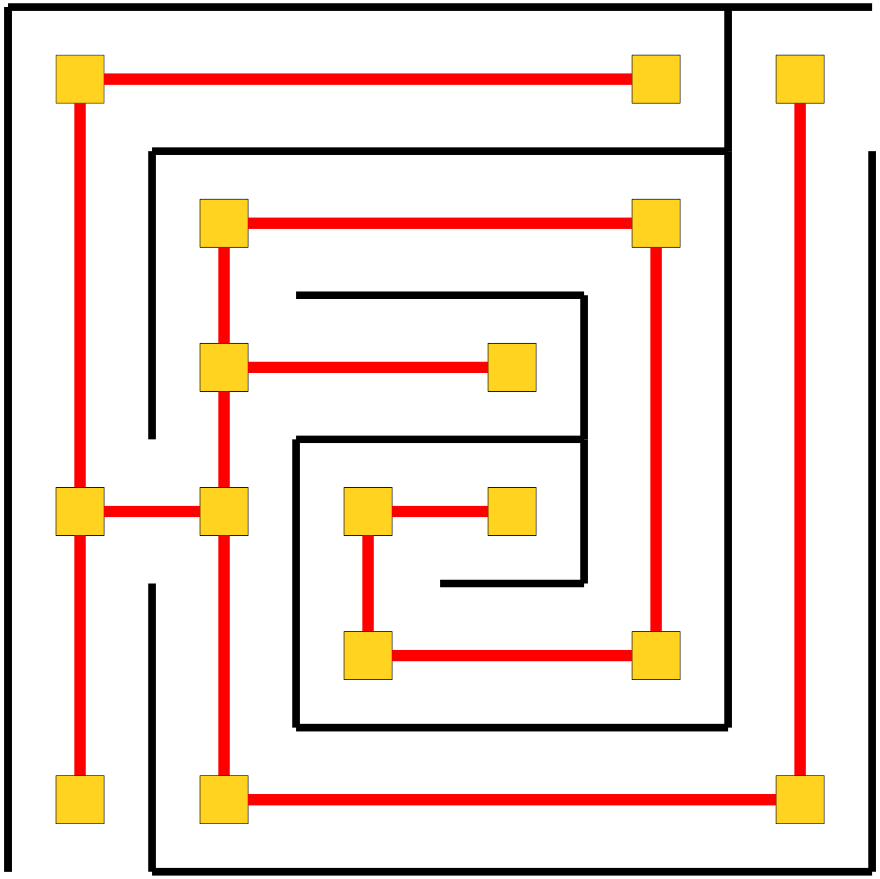
Secretary of Public Safety

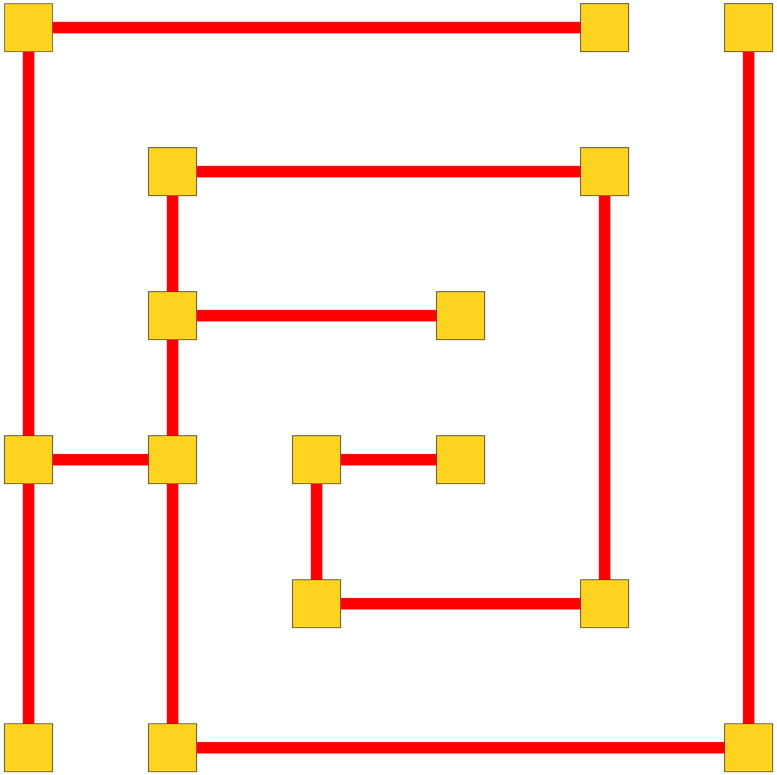
Secretary of Transportation

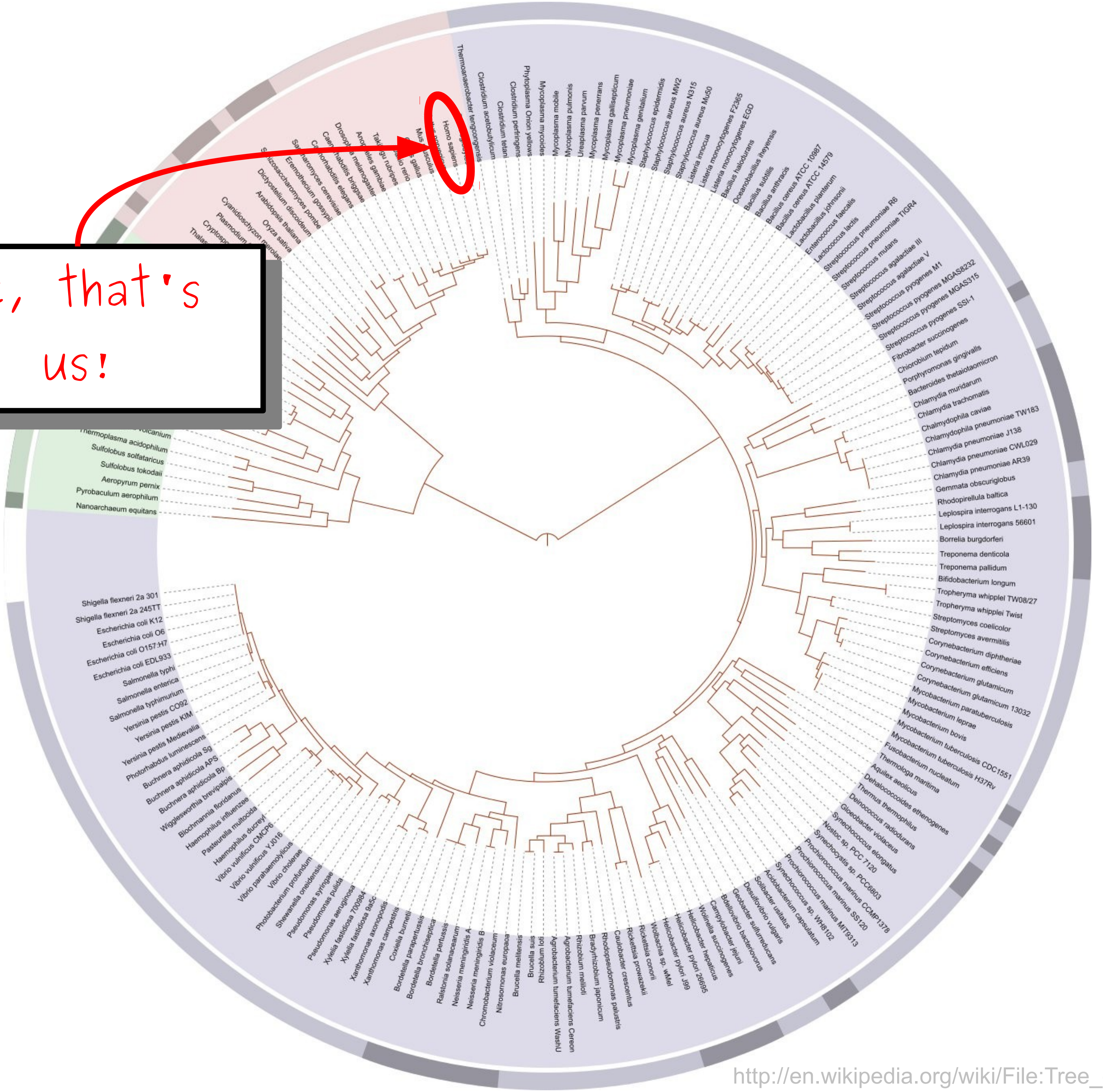
http://www.virginia.gov/images/wholeexecbranch2.jpg





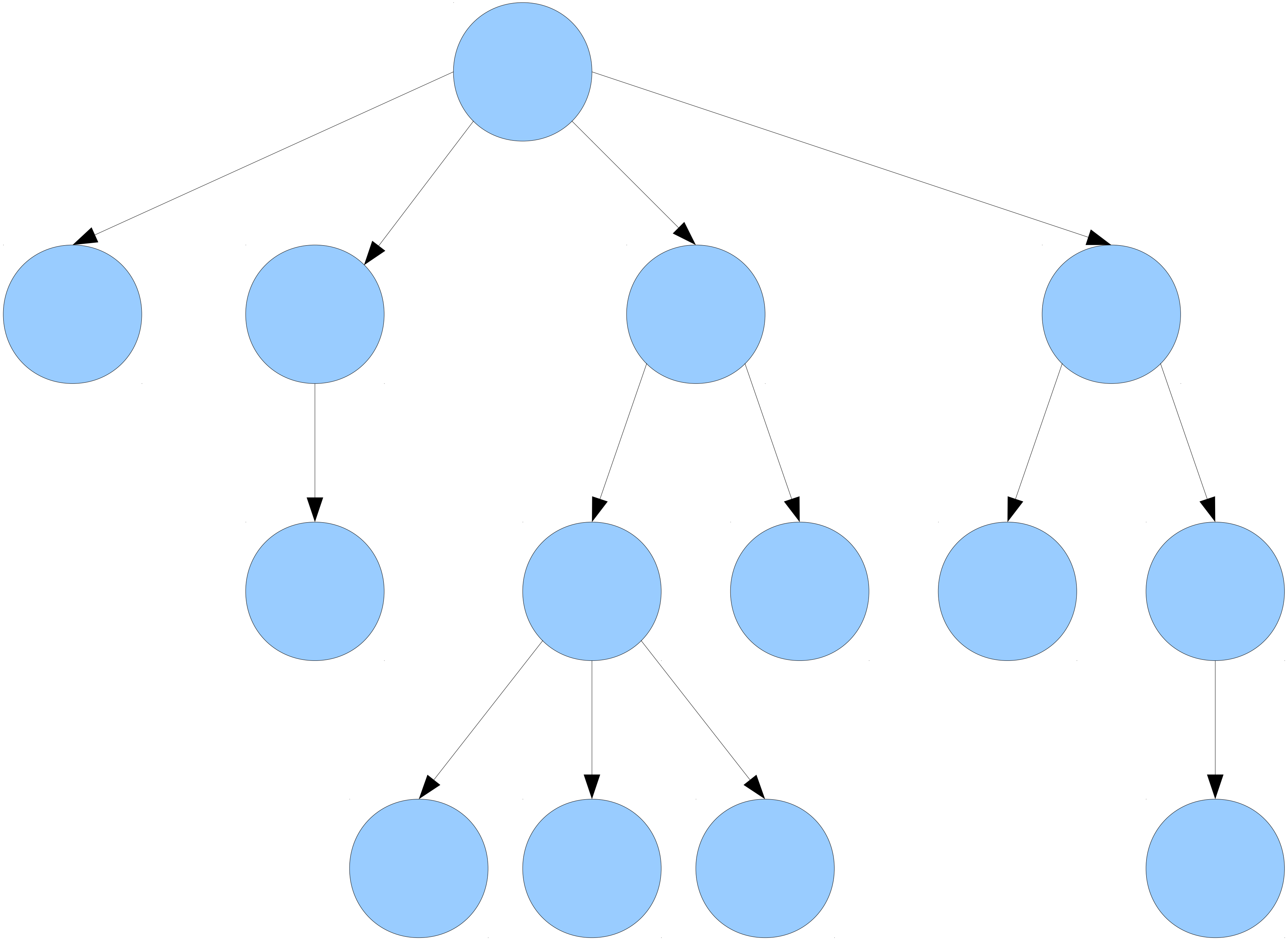






Hey, that's us!

http://en.wikipedia.org/wiki/File:Tree_of_life_SVG.svg



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

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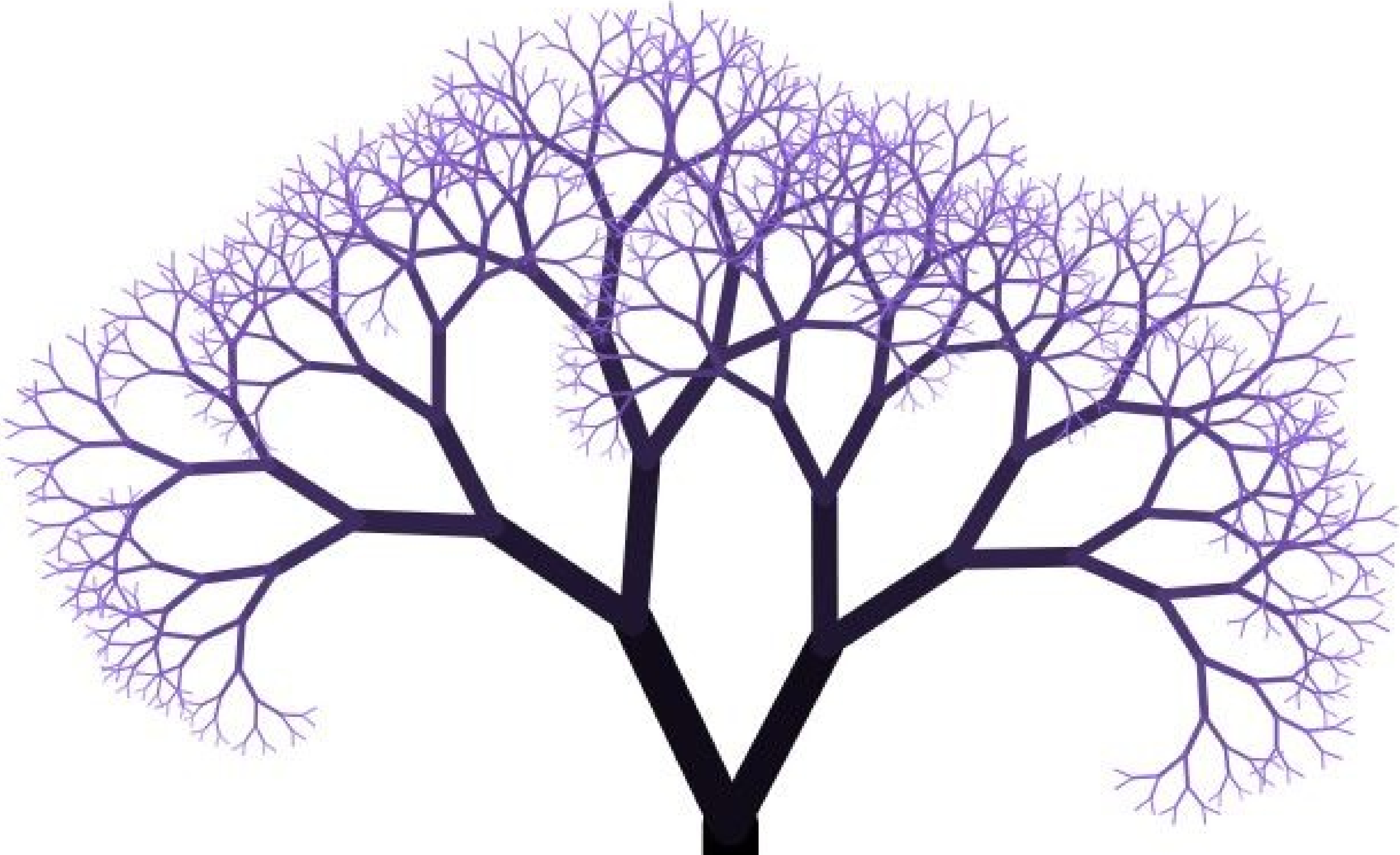

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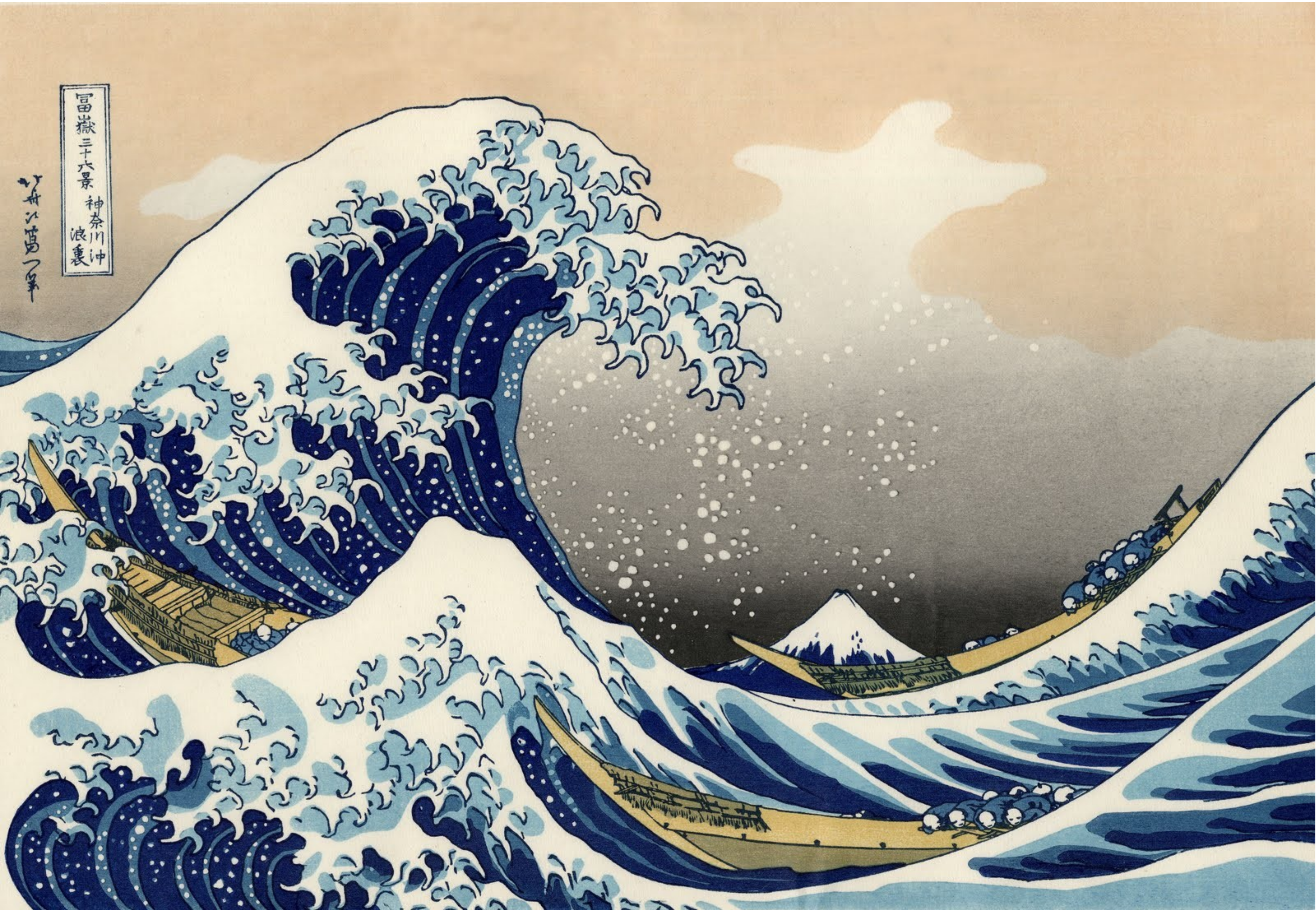

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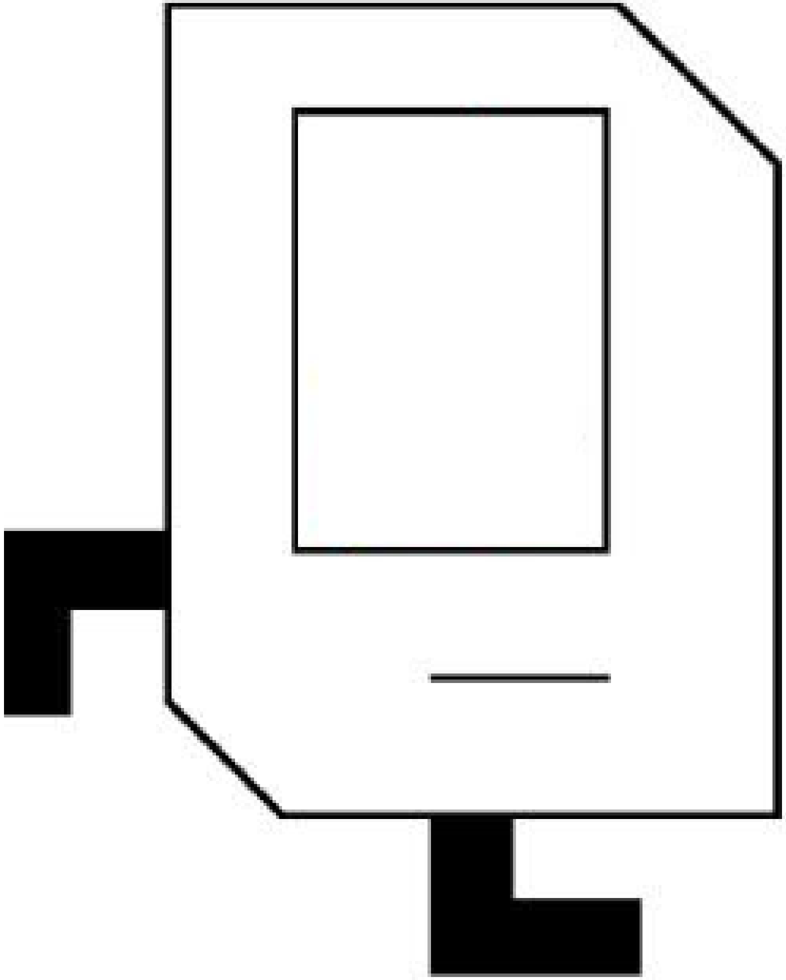
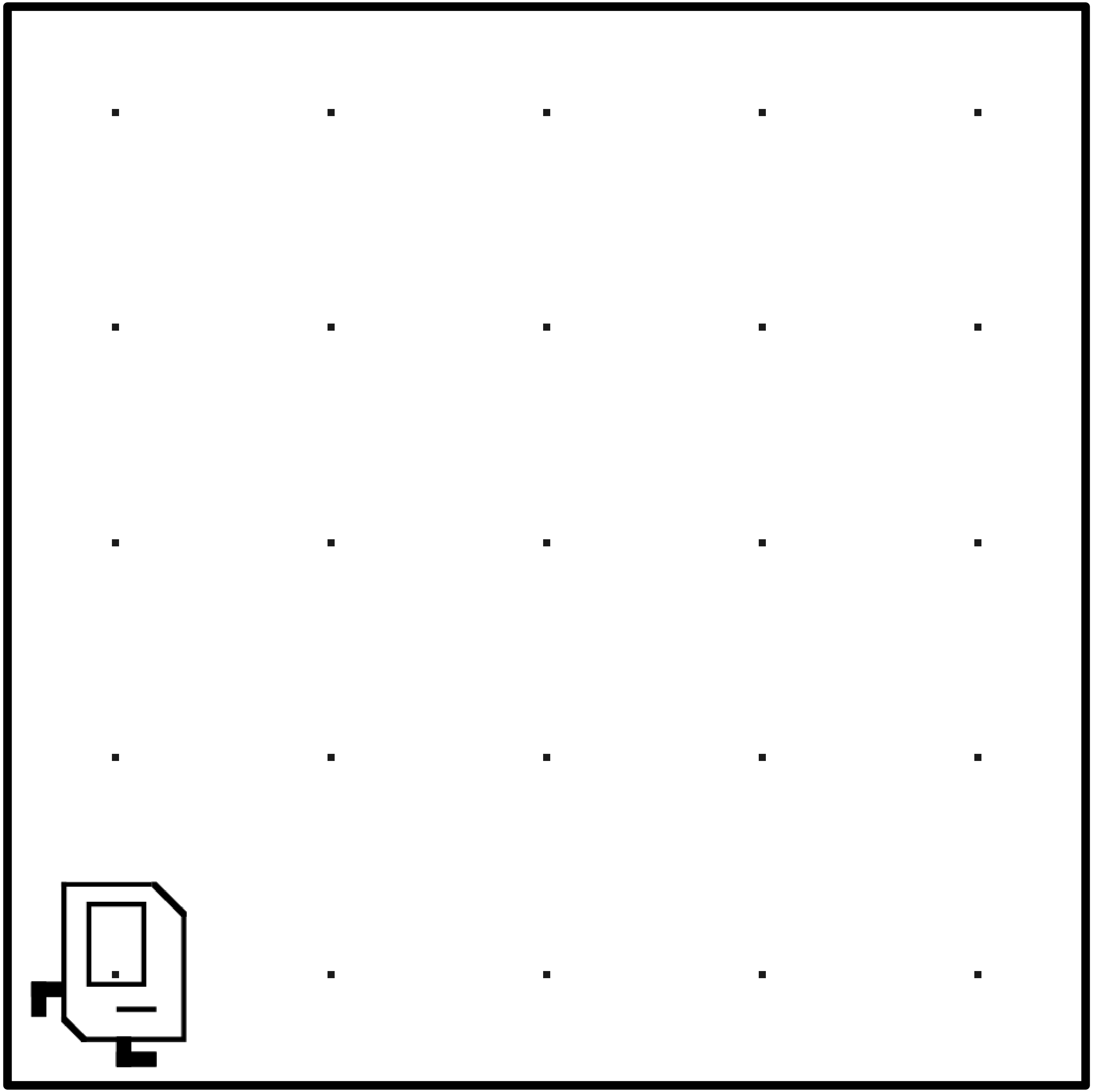
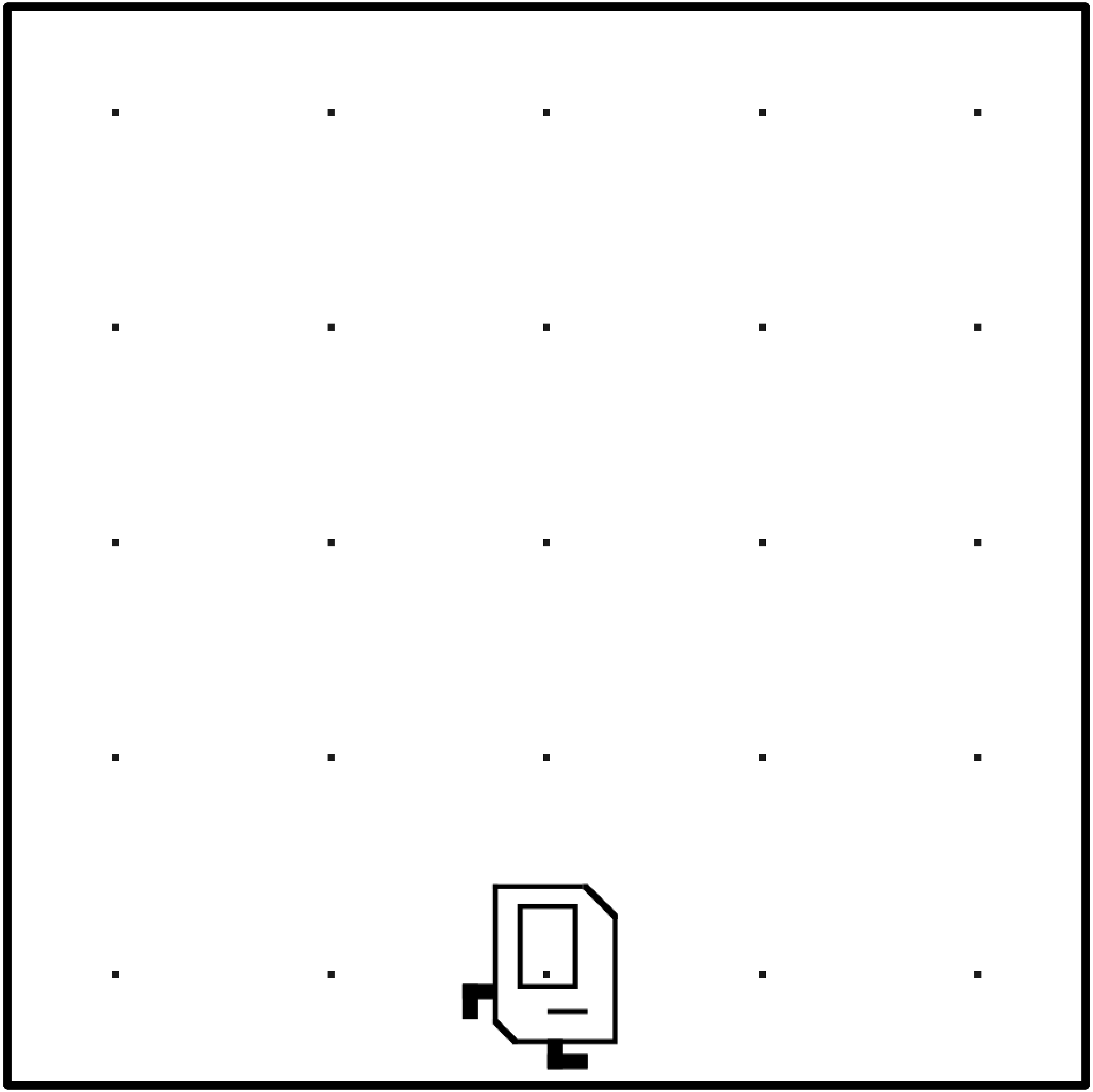
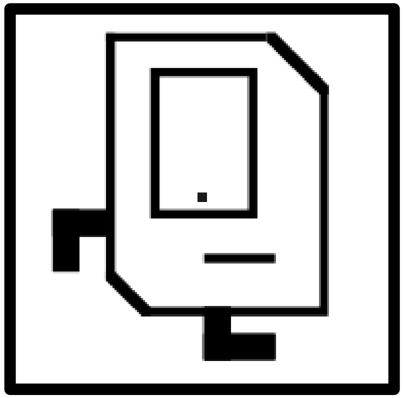


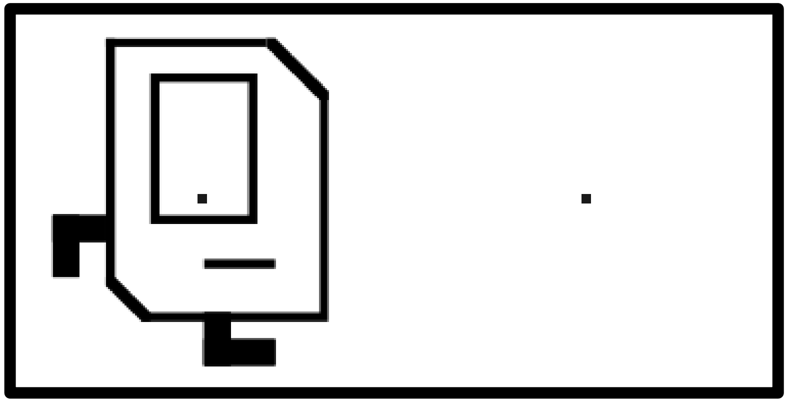


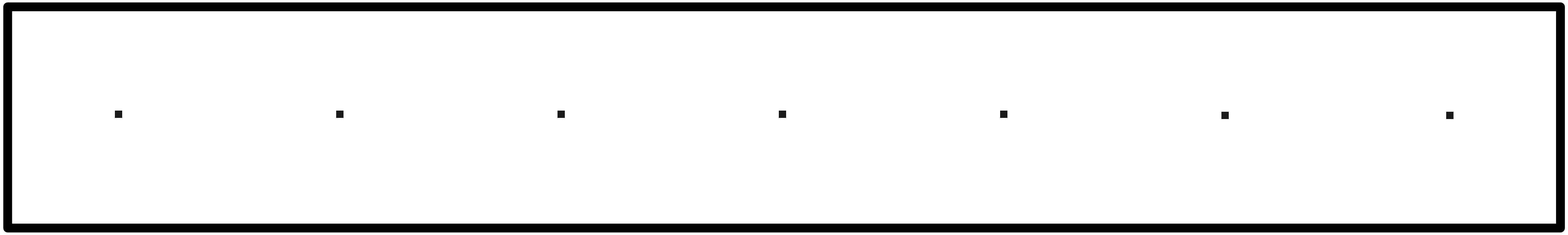


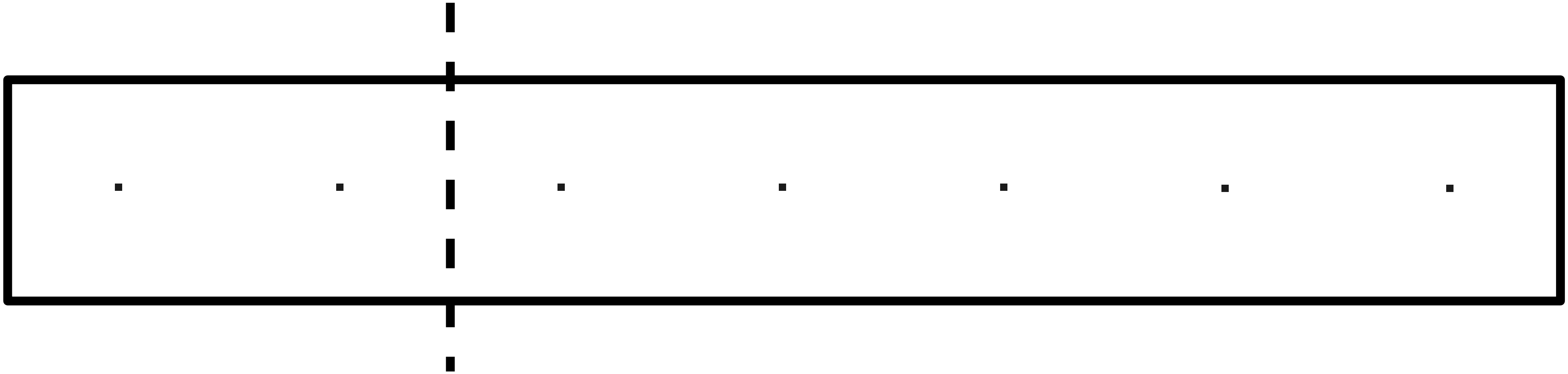
Width 1

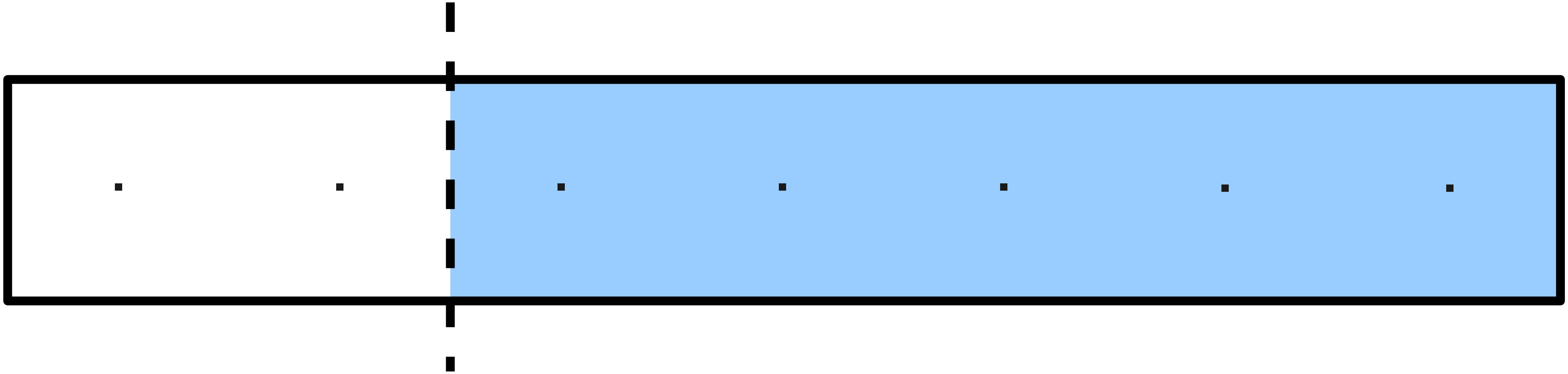


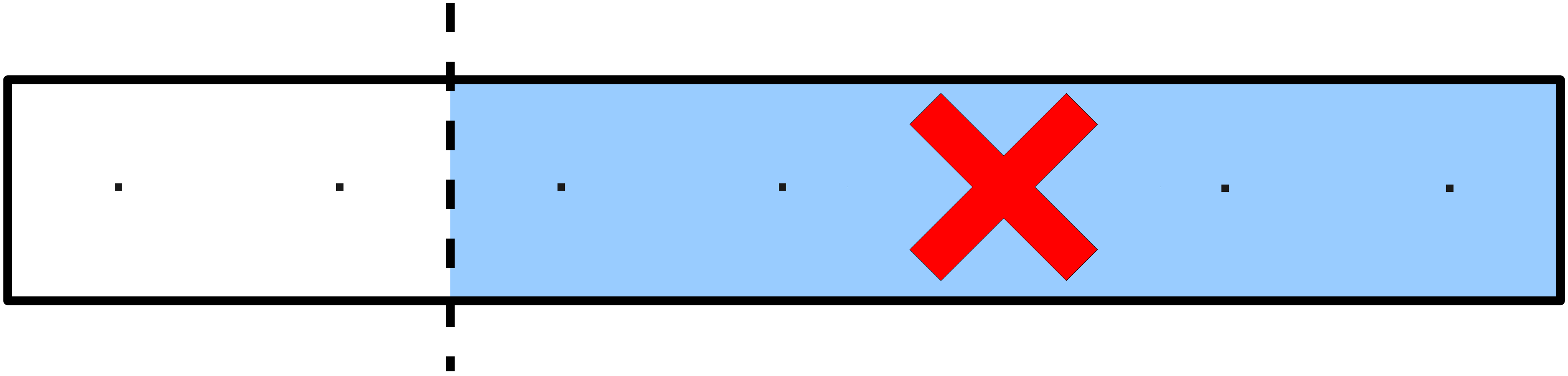
Width 2

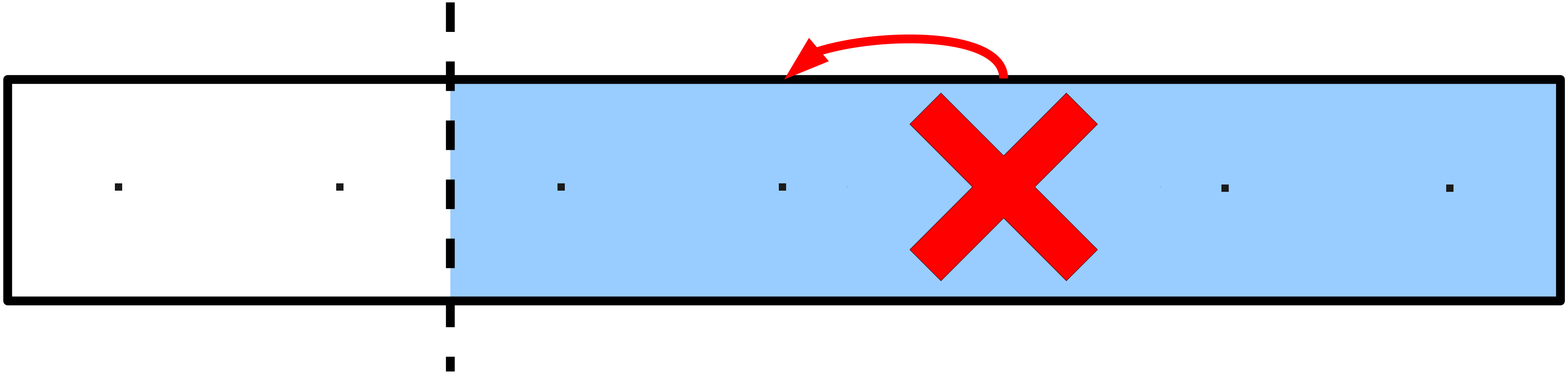


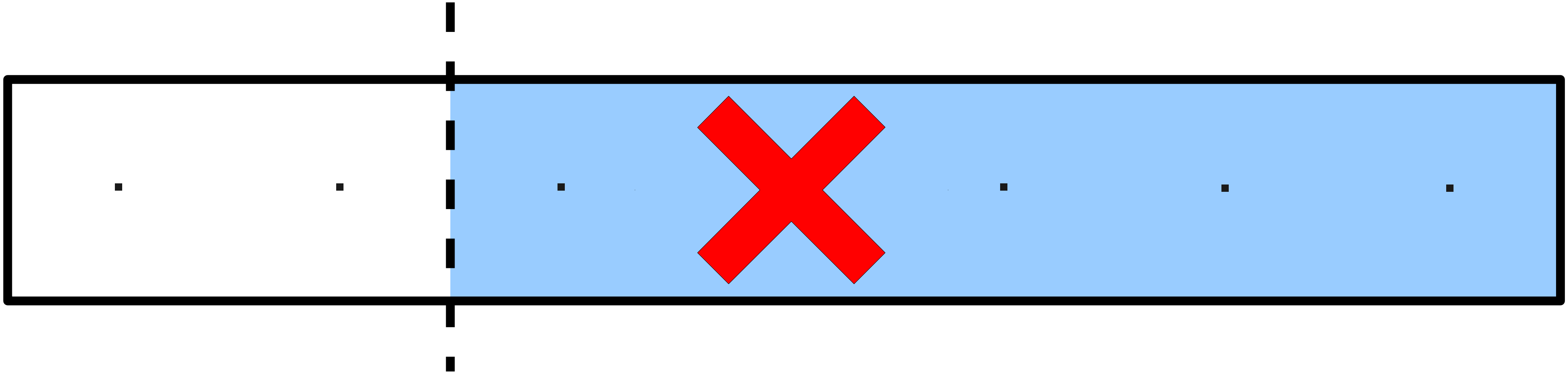


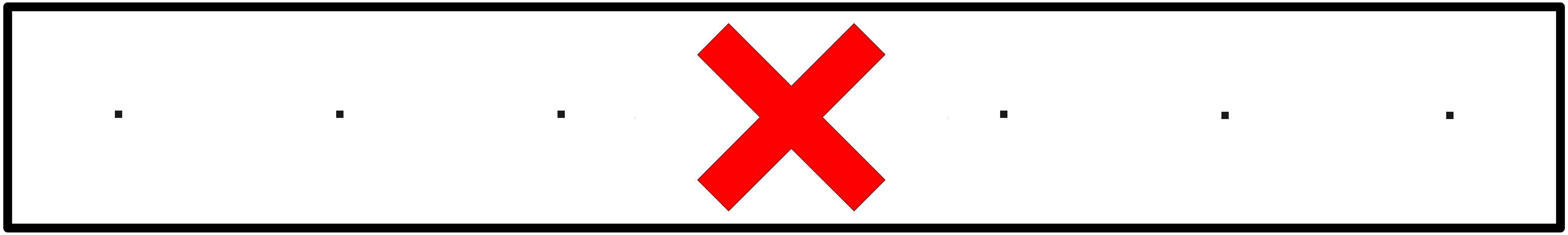












Finding the Midpoint

- If the width is 1, Karel is standing on the midpoint.
- If the width is 2, either position can be considered the midpoint.
- Otherwise:
  - Take two steps forward.
  - Find the midpoint of the rest of the world.
  - Take one step backward.

A Surprisingly Short Solution

A **recursive solution** is a solution that is defined in terms of itself.

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

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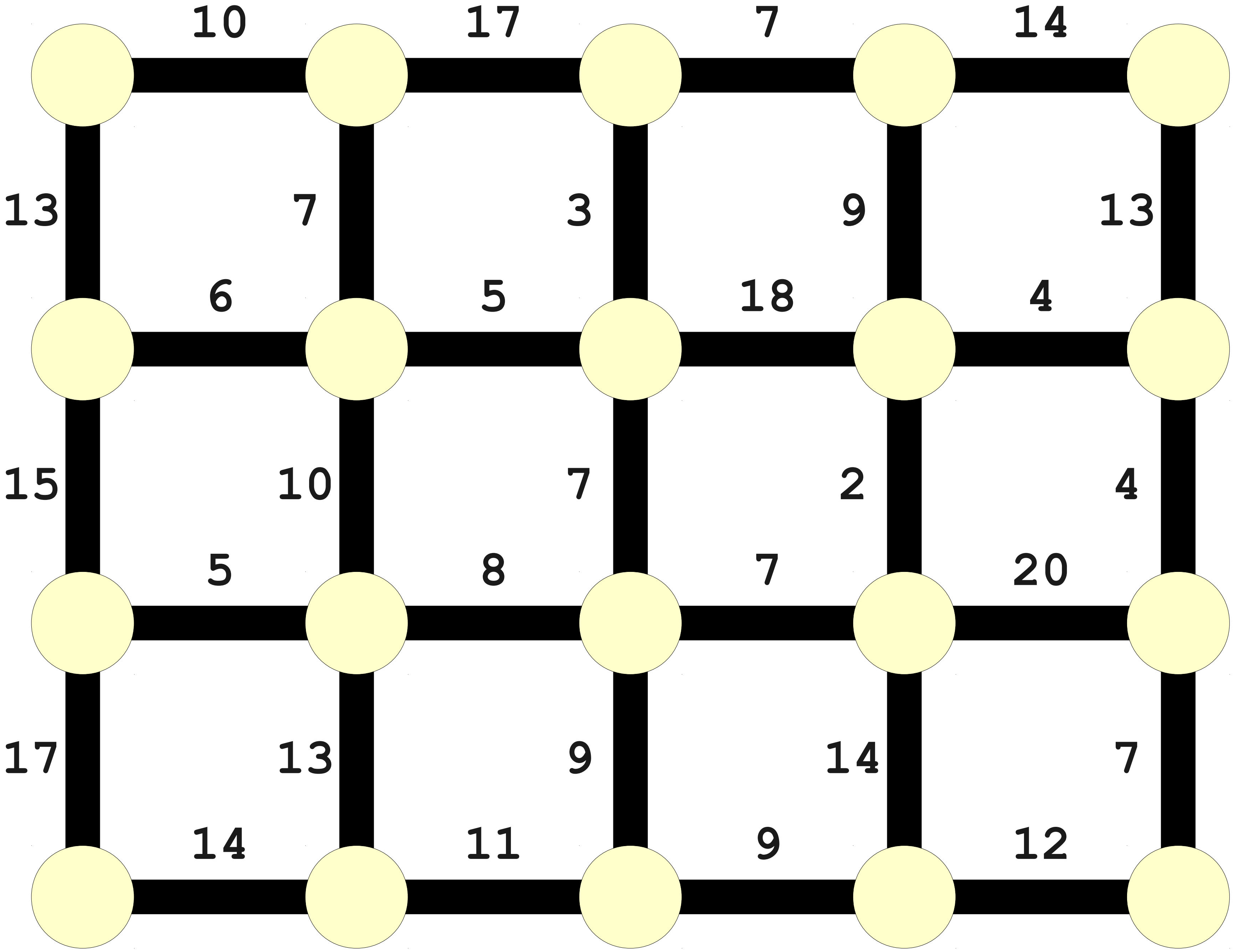
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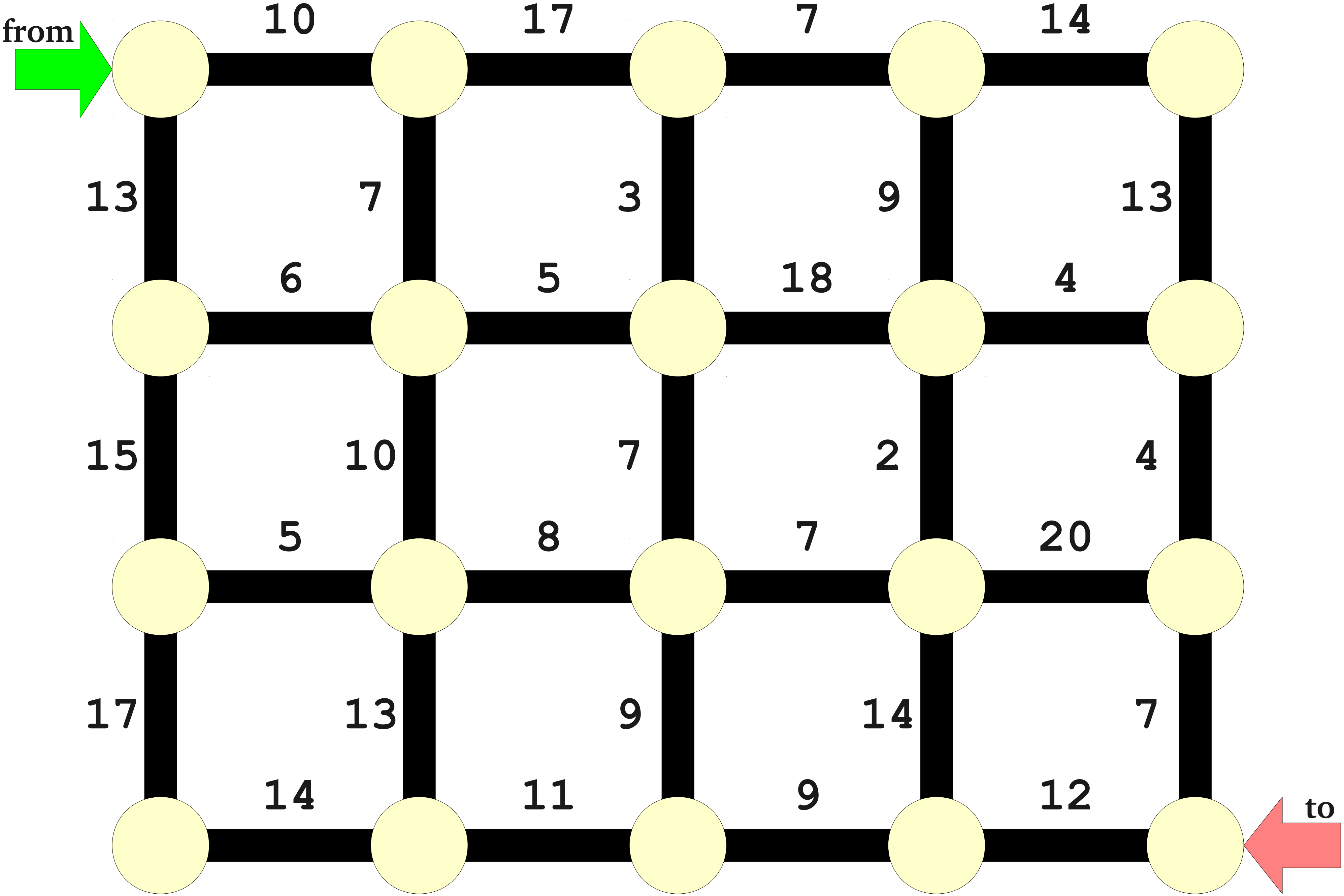
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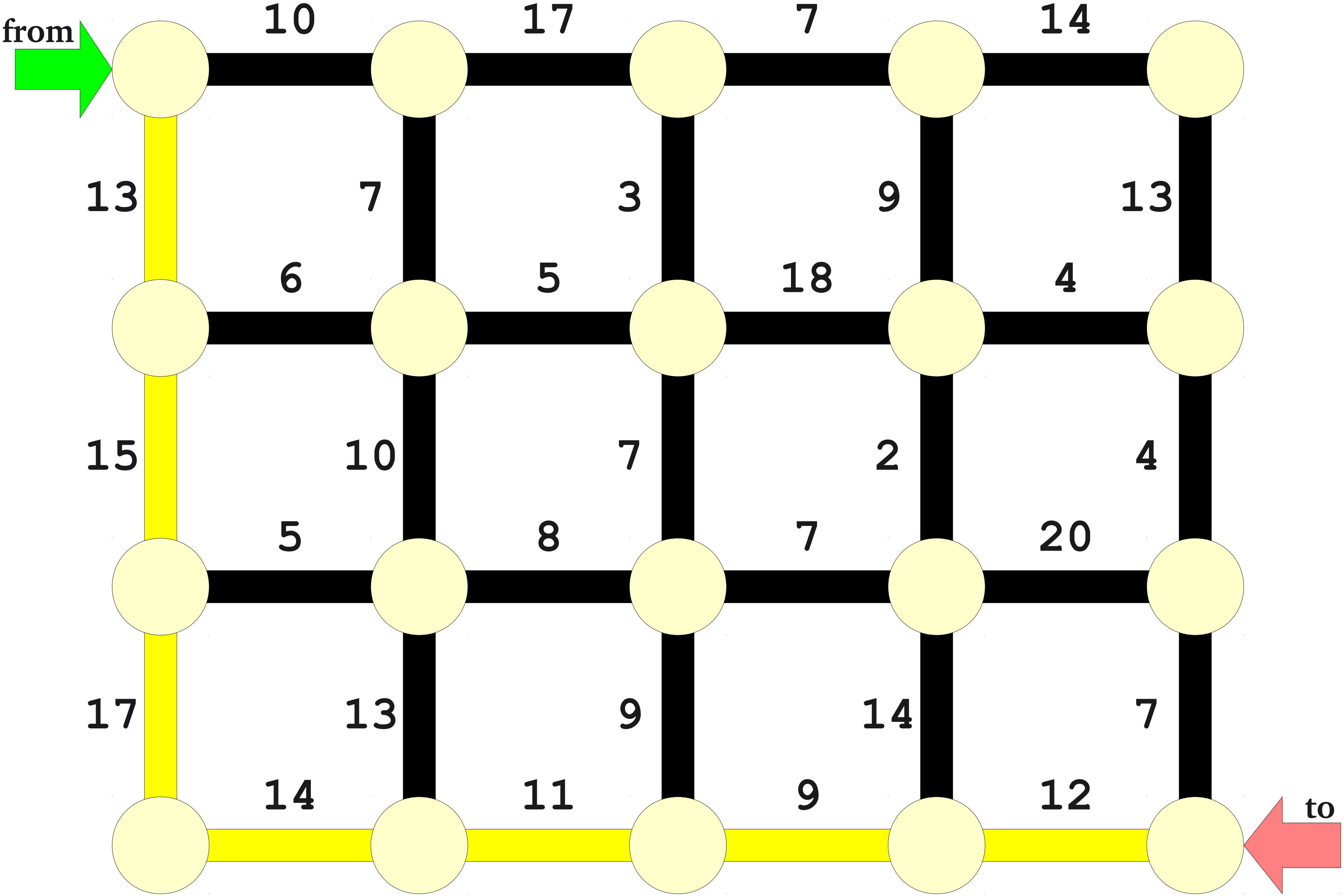
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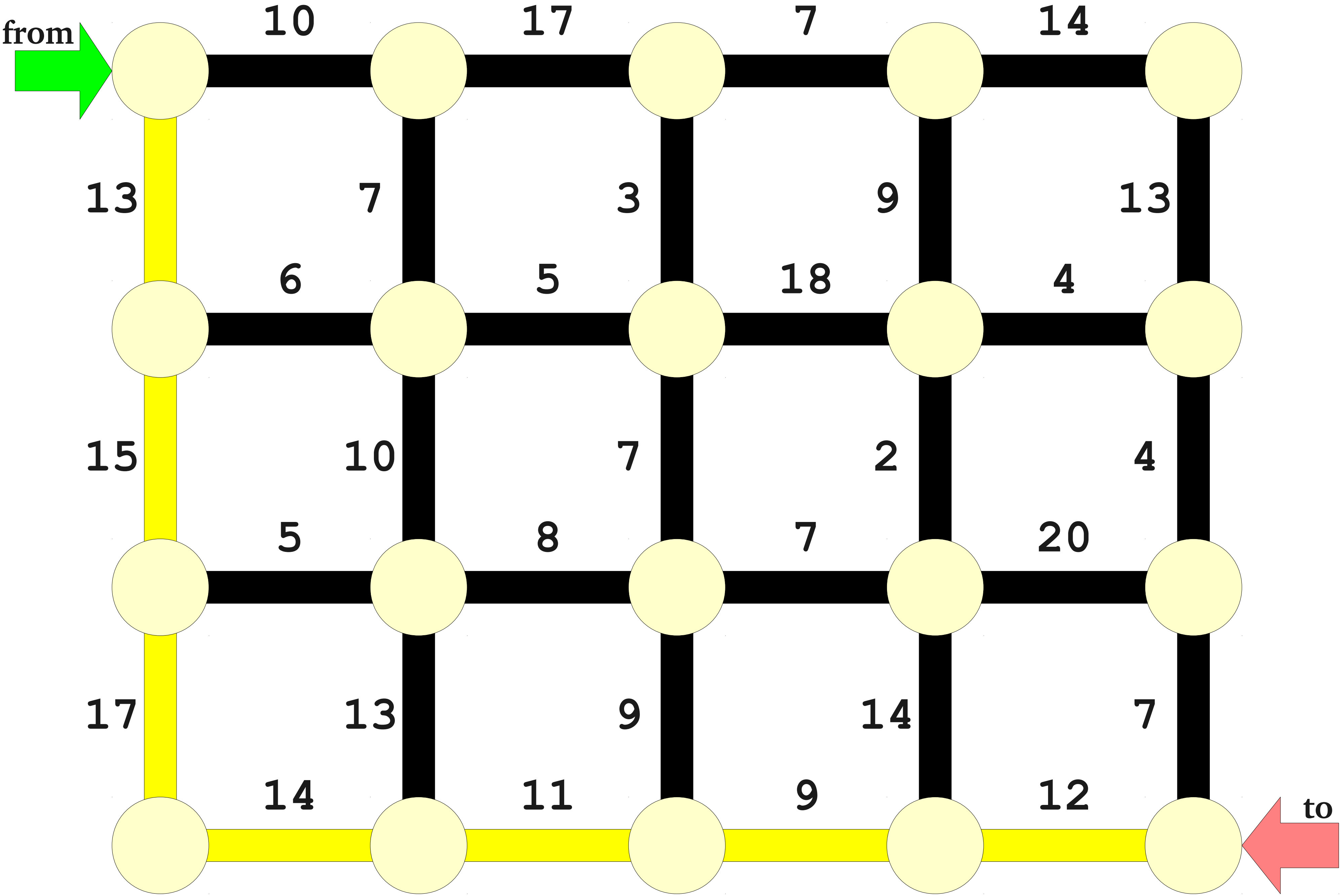
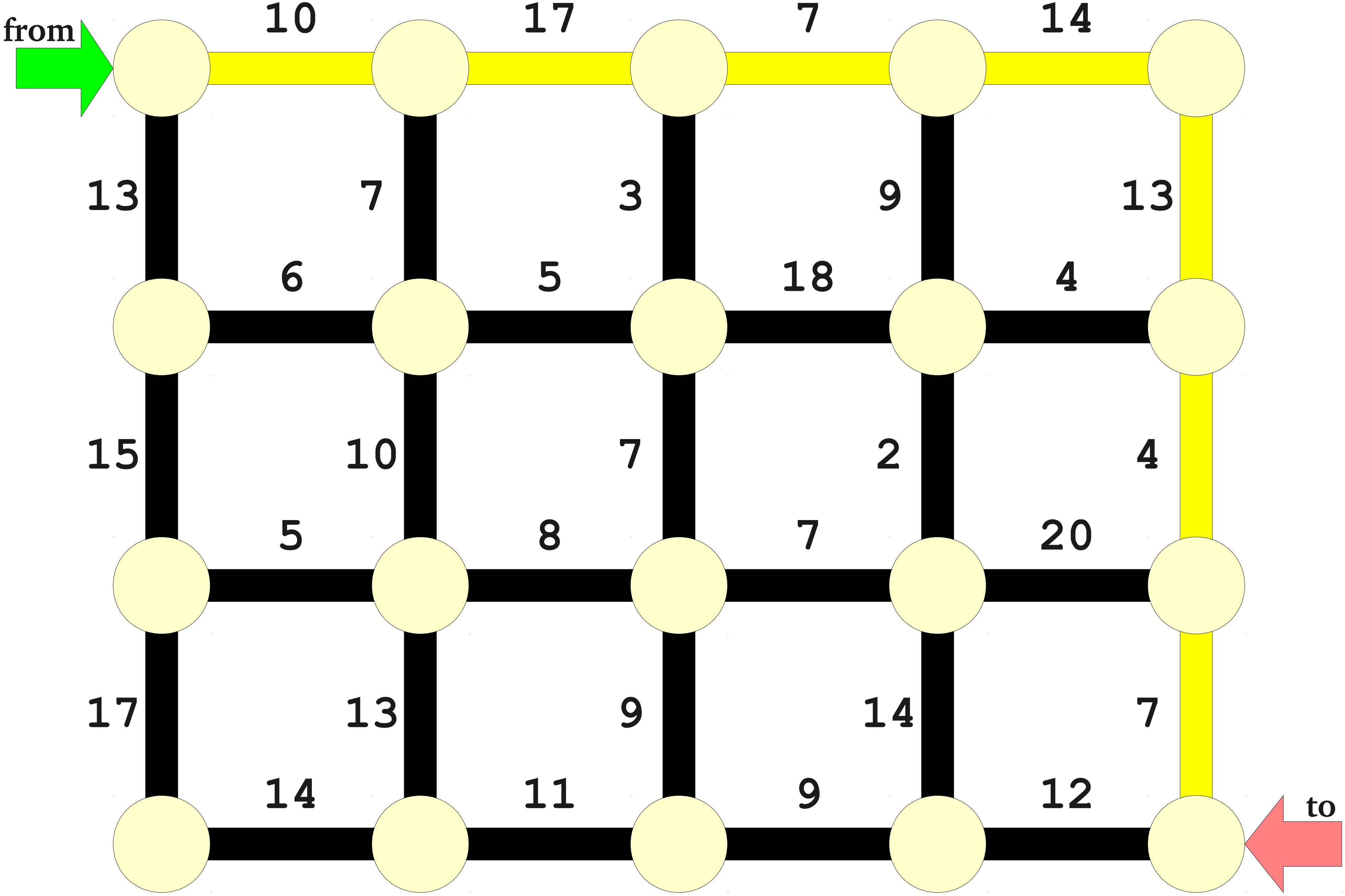


Travel Time: 13 + 15 + 17 + 14 + 11 + 9 + 12 = **91**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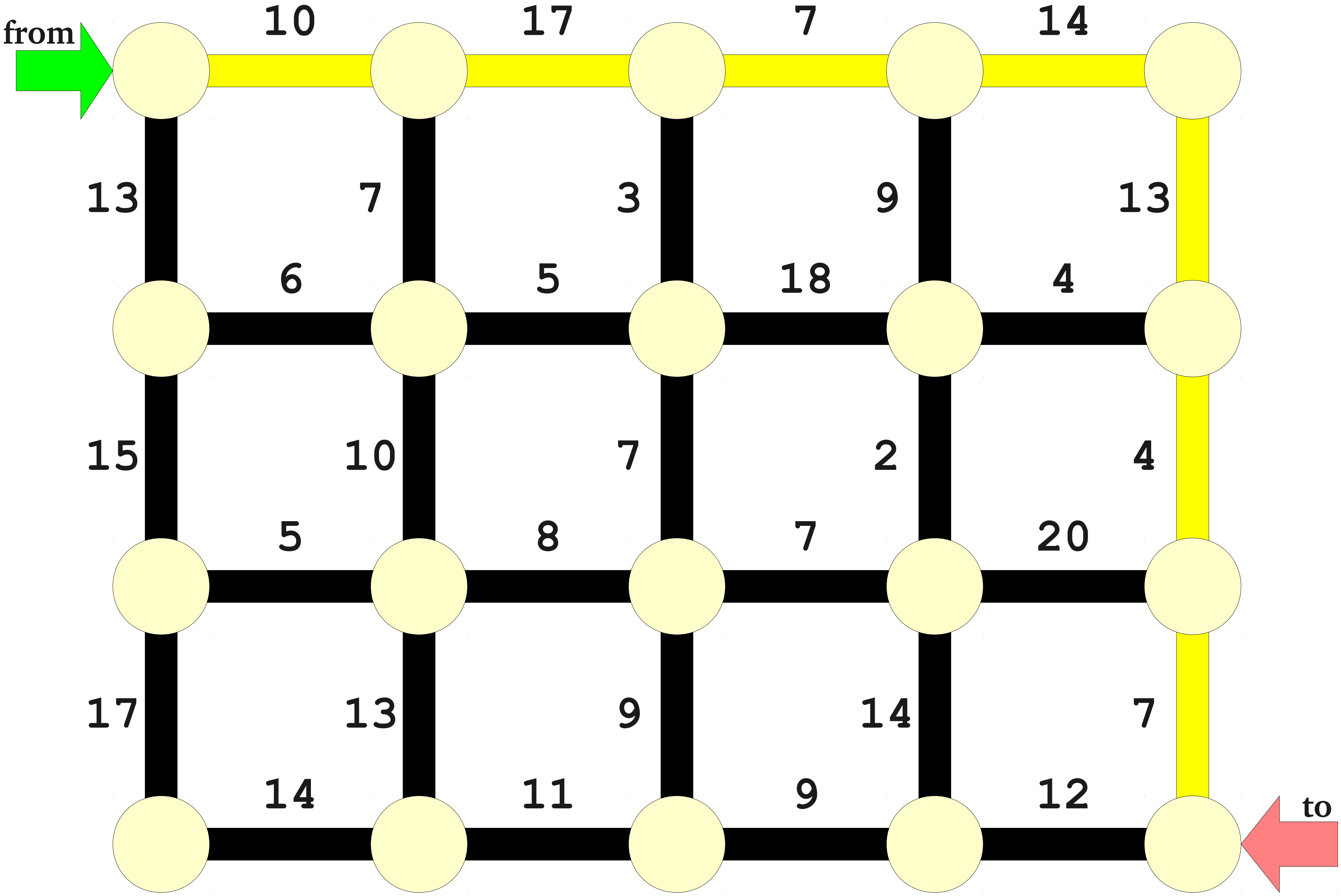
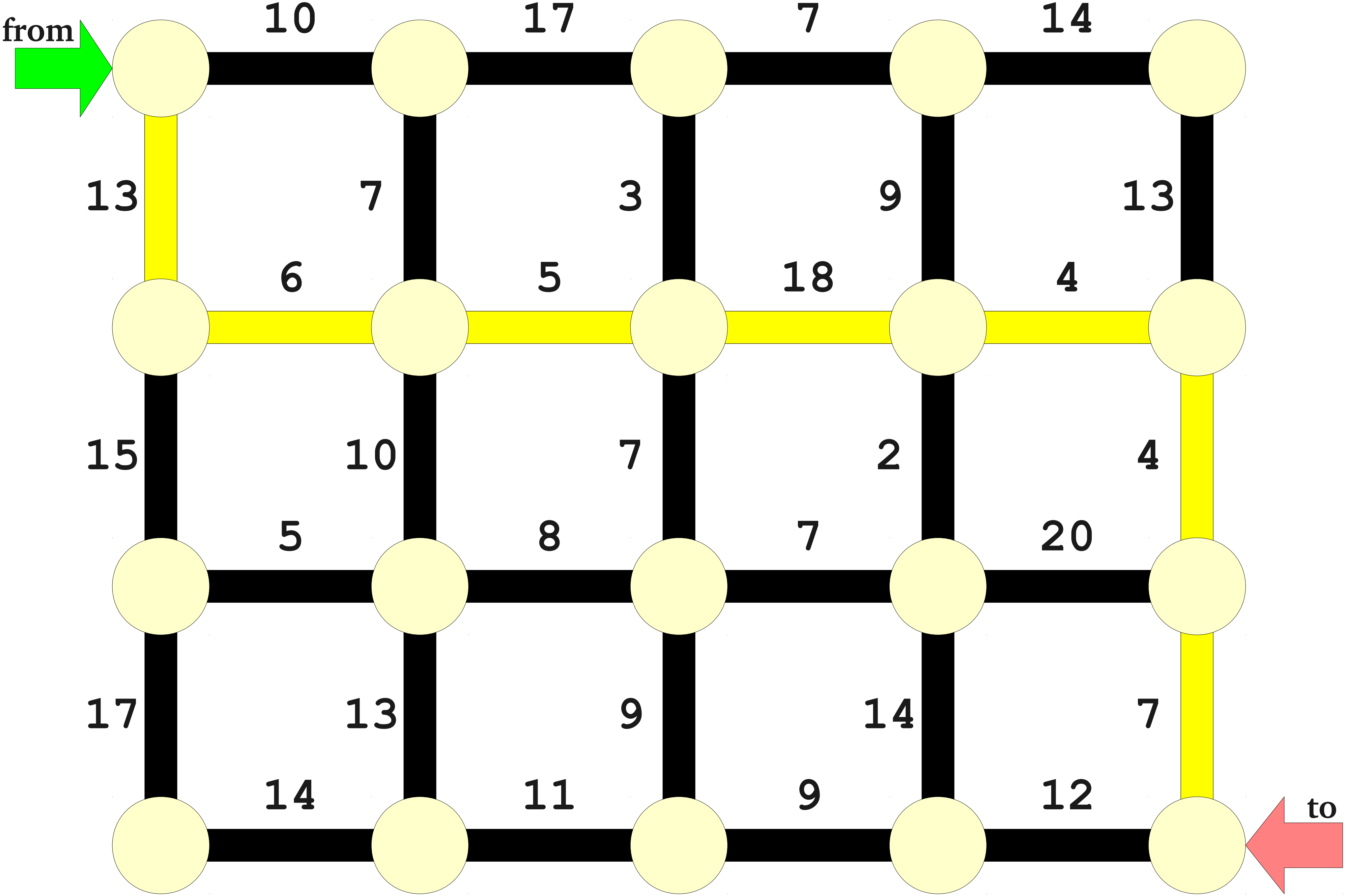


Travel Time: 10 + 17 + 7 + 14 + 13 + 4 + 7 = **72**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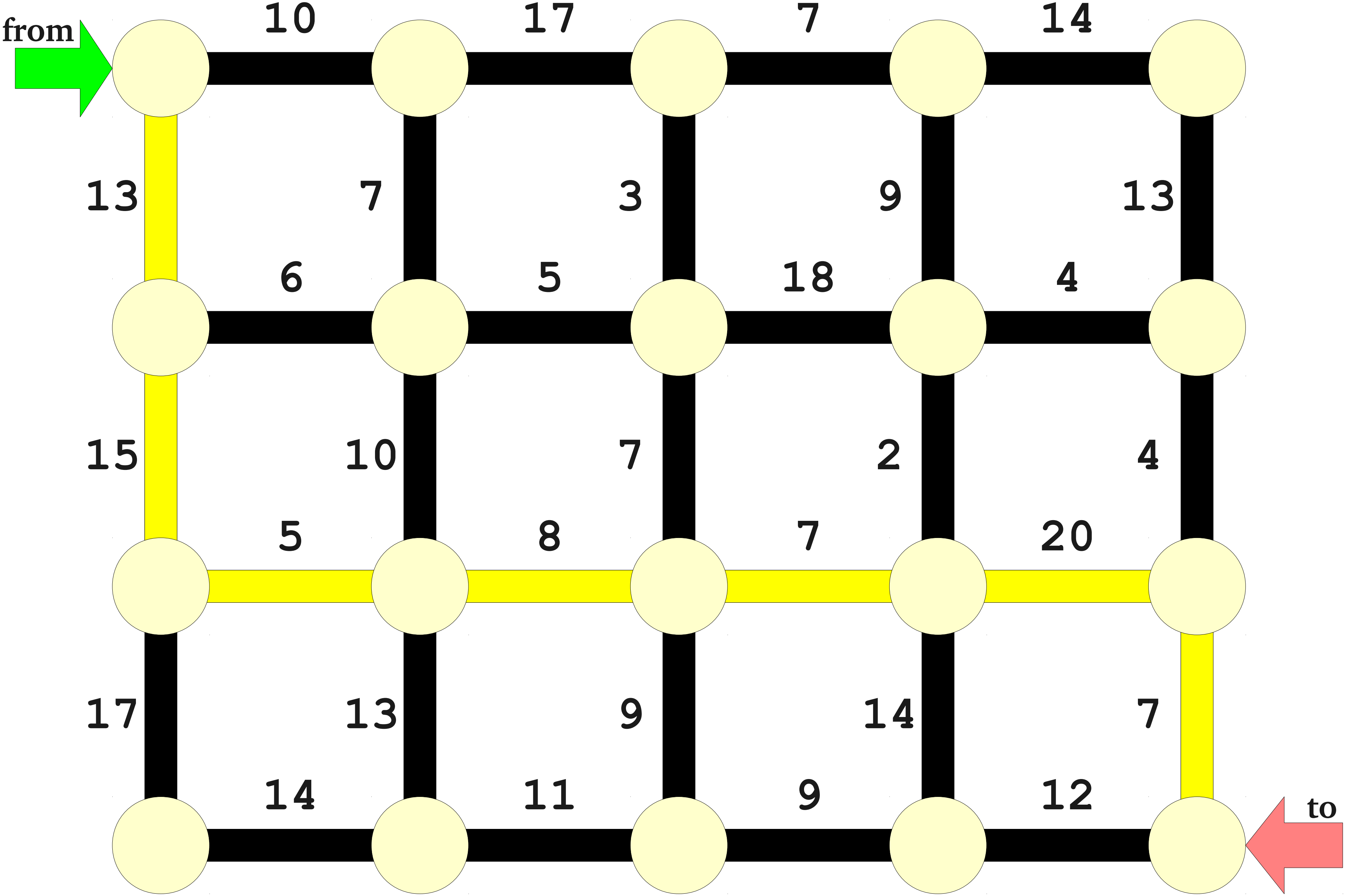
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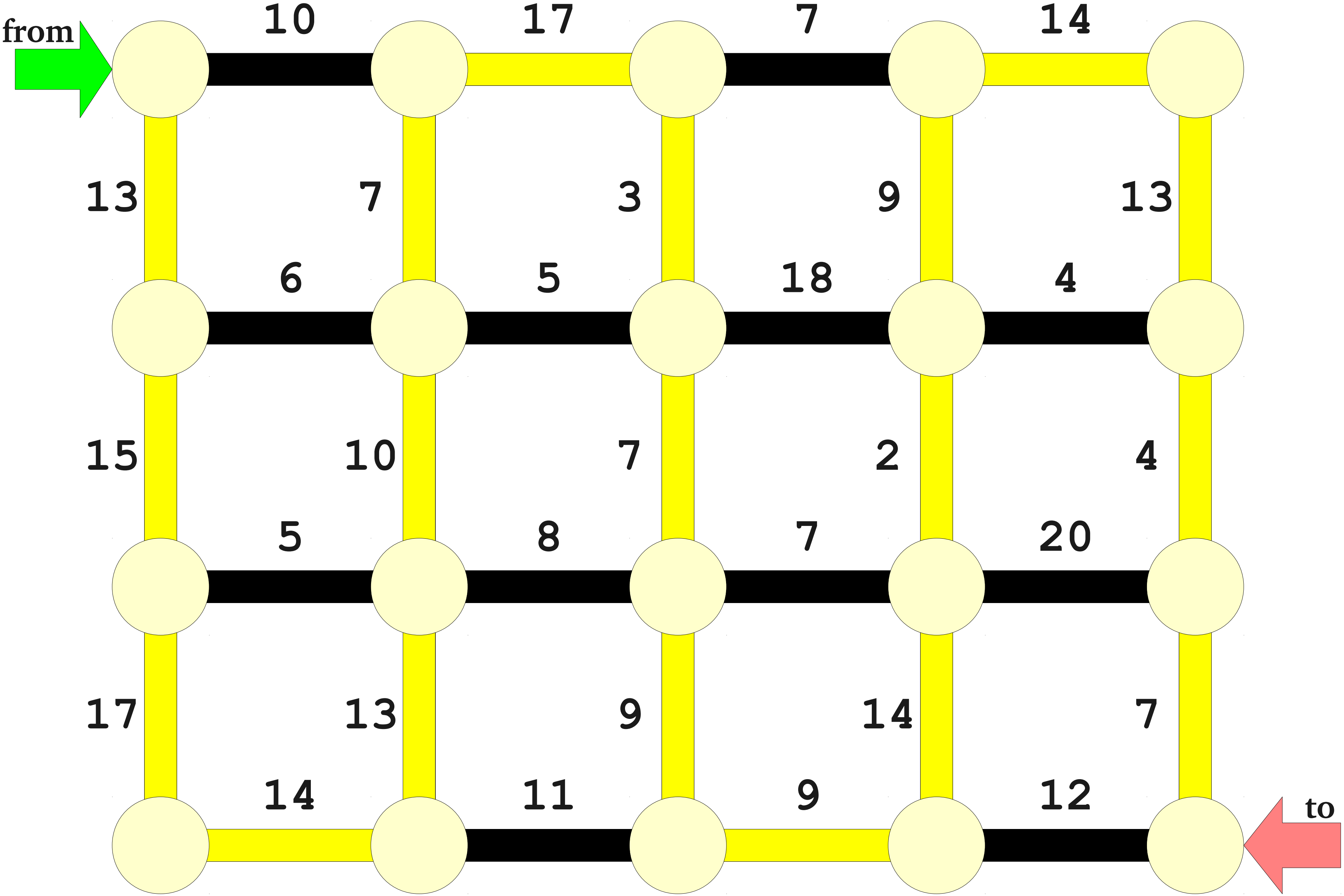
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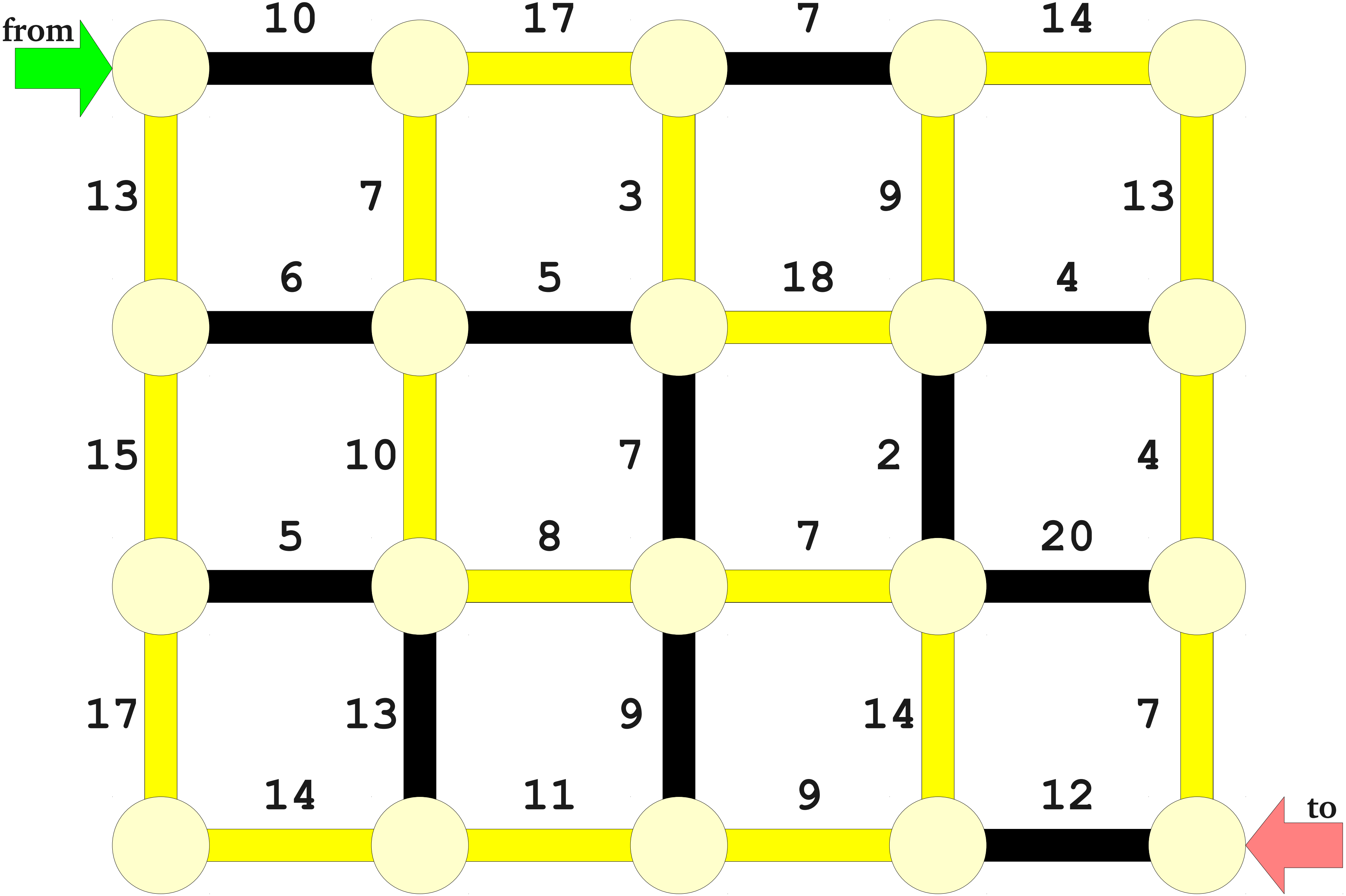
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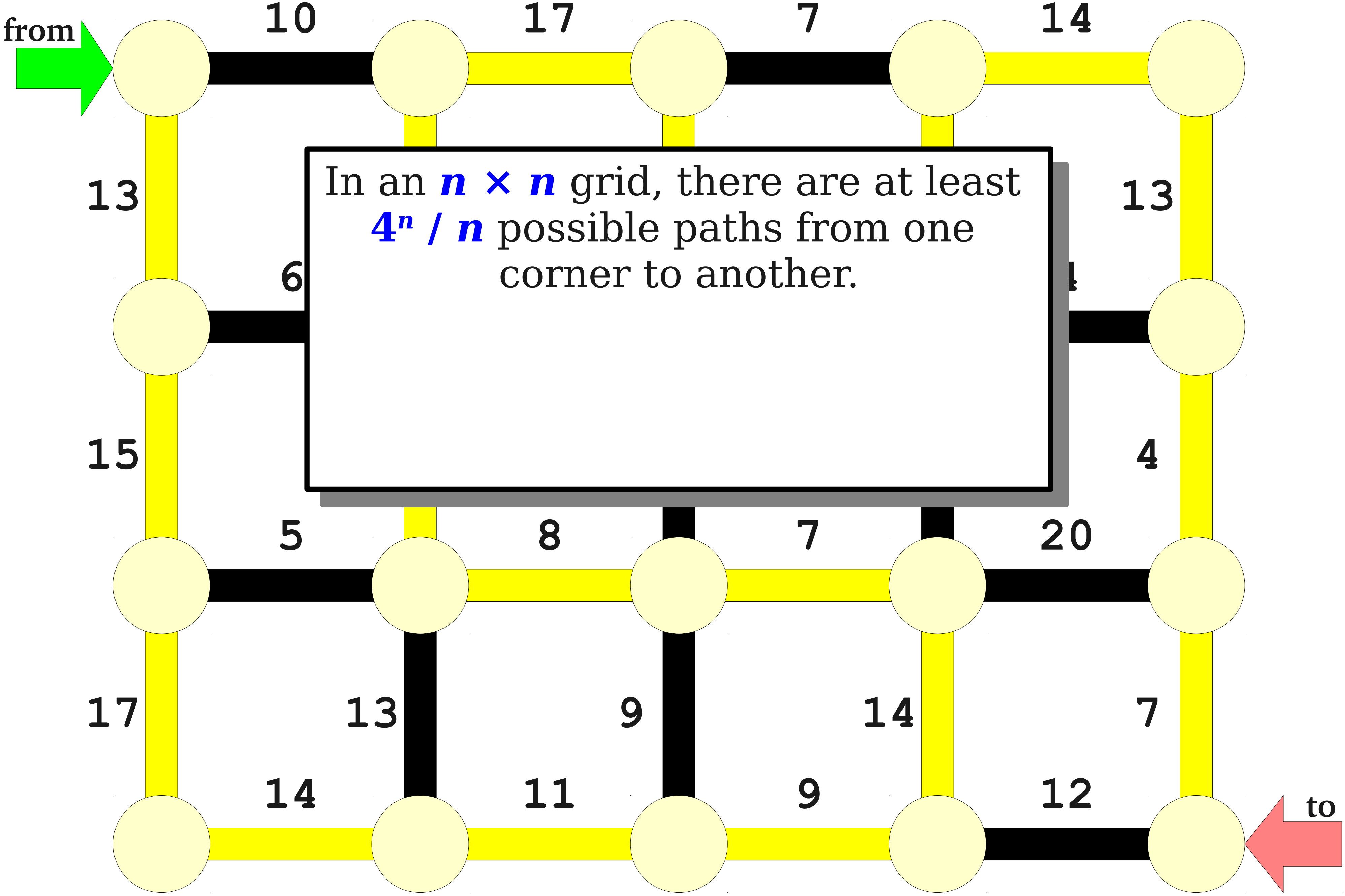
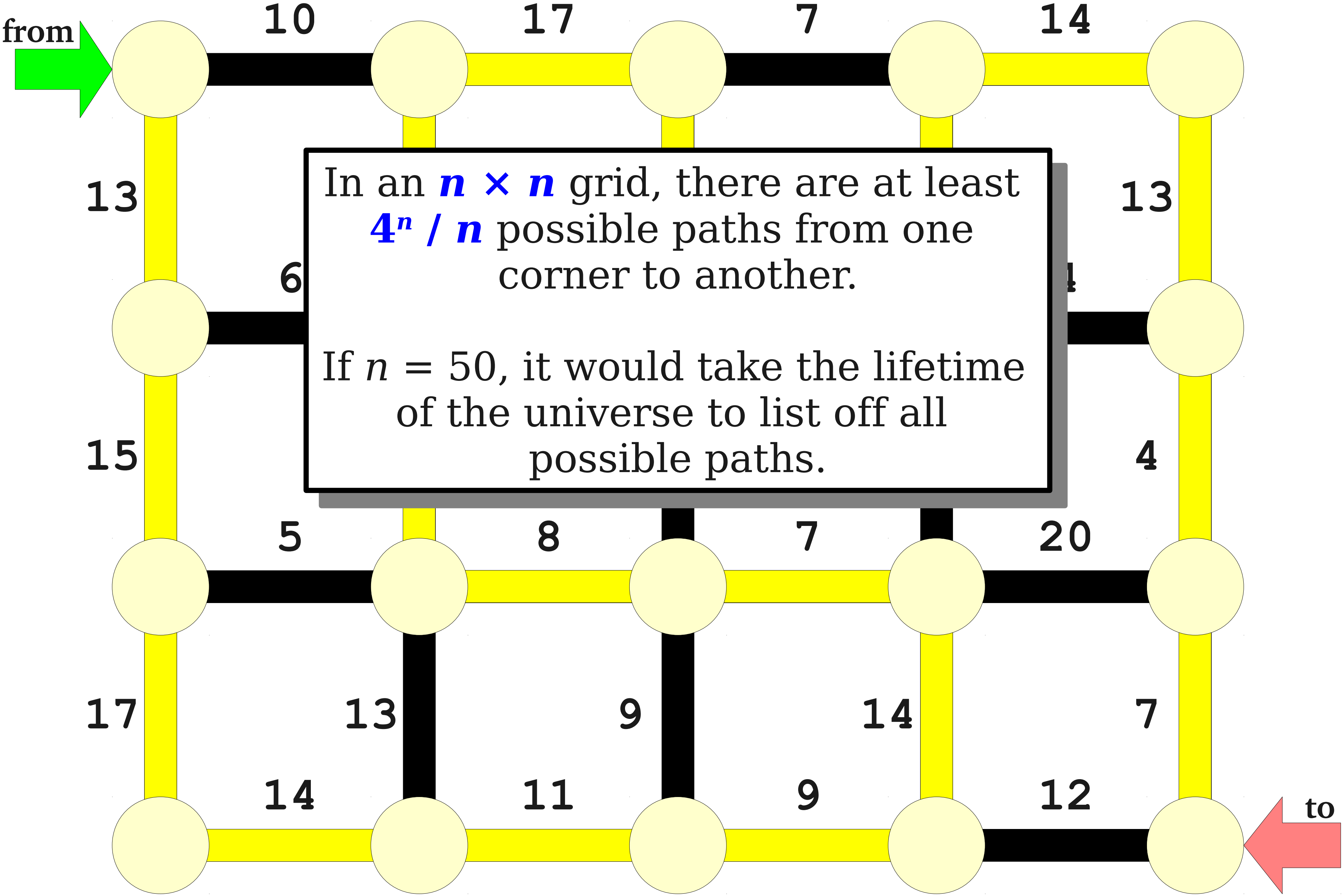
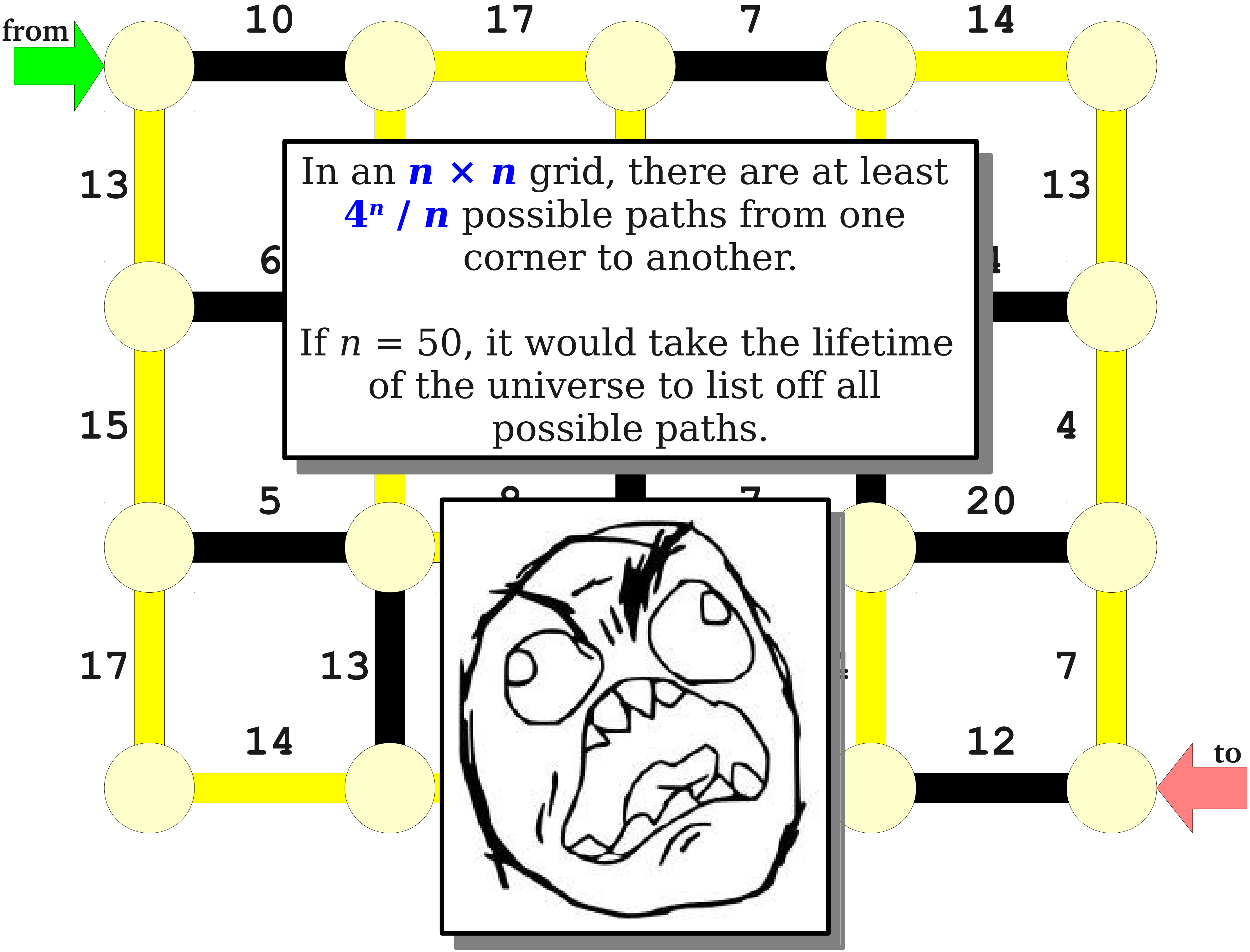


In an $n \times n$ grid, there are at least $4^n / n$ possible paths from one corner to another.



In an ***n* × *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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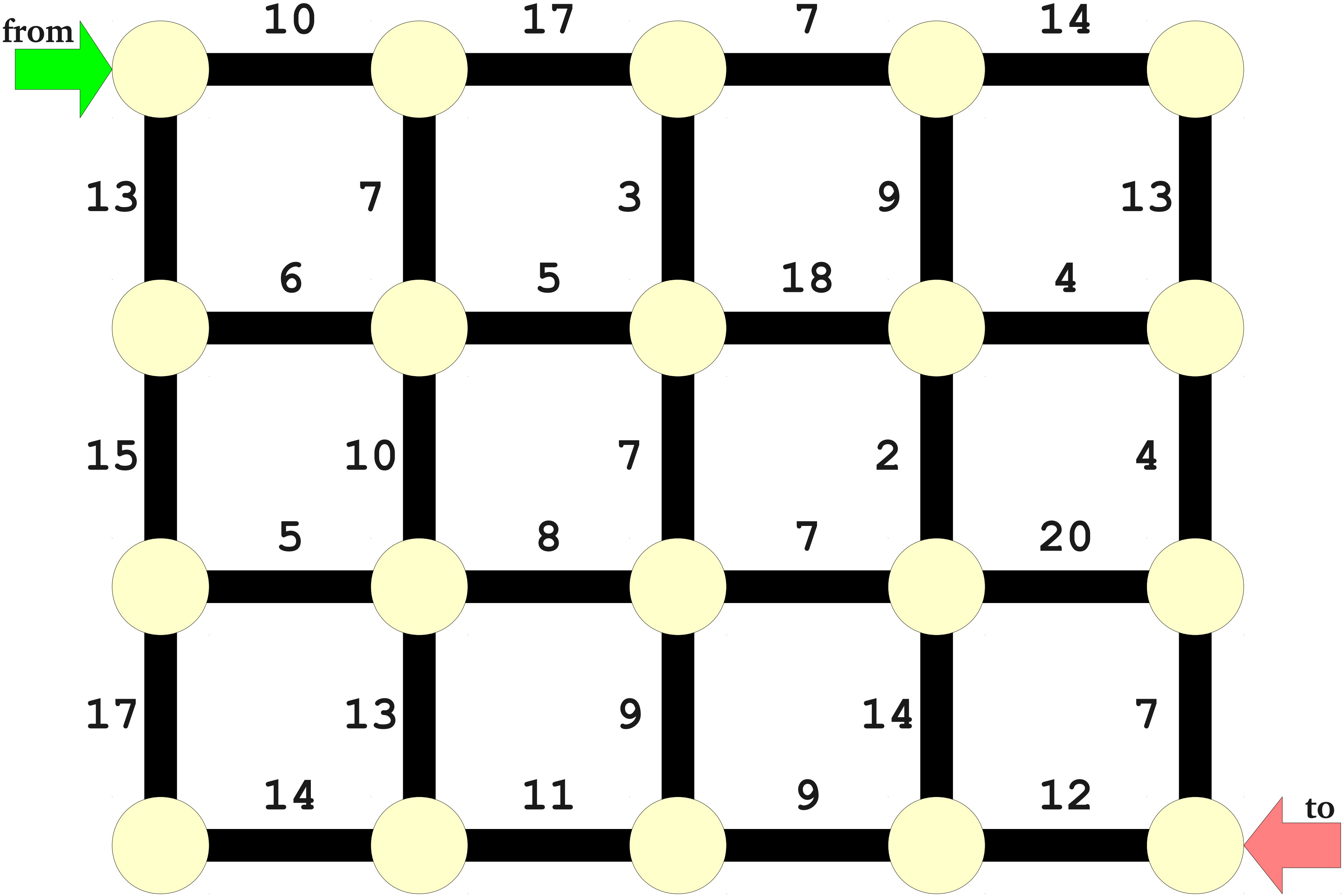
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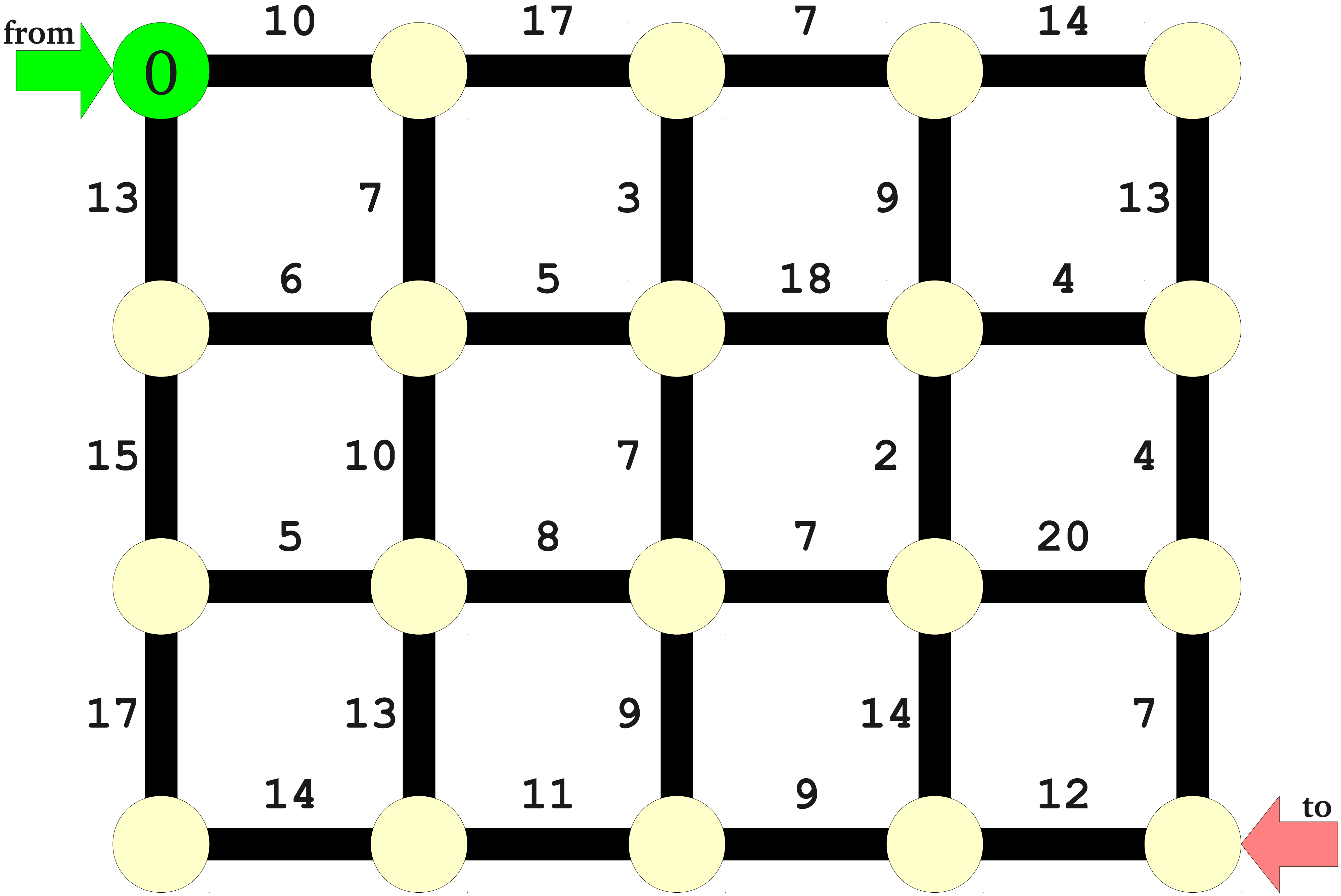
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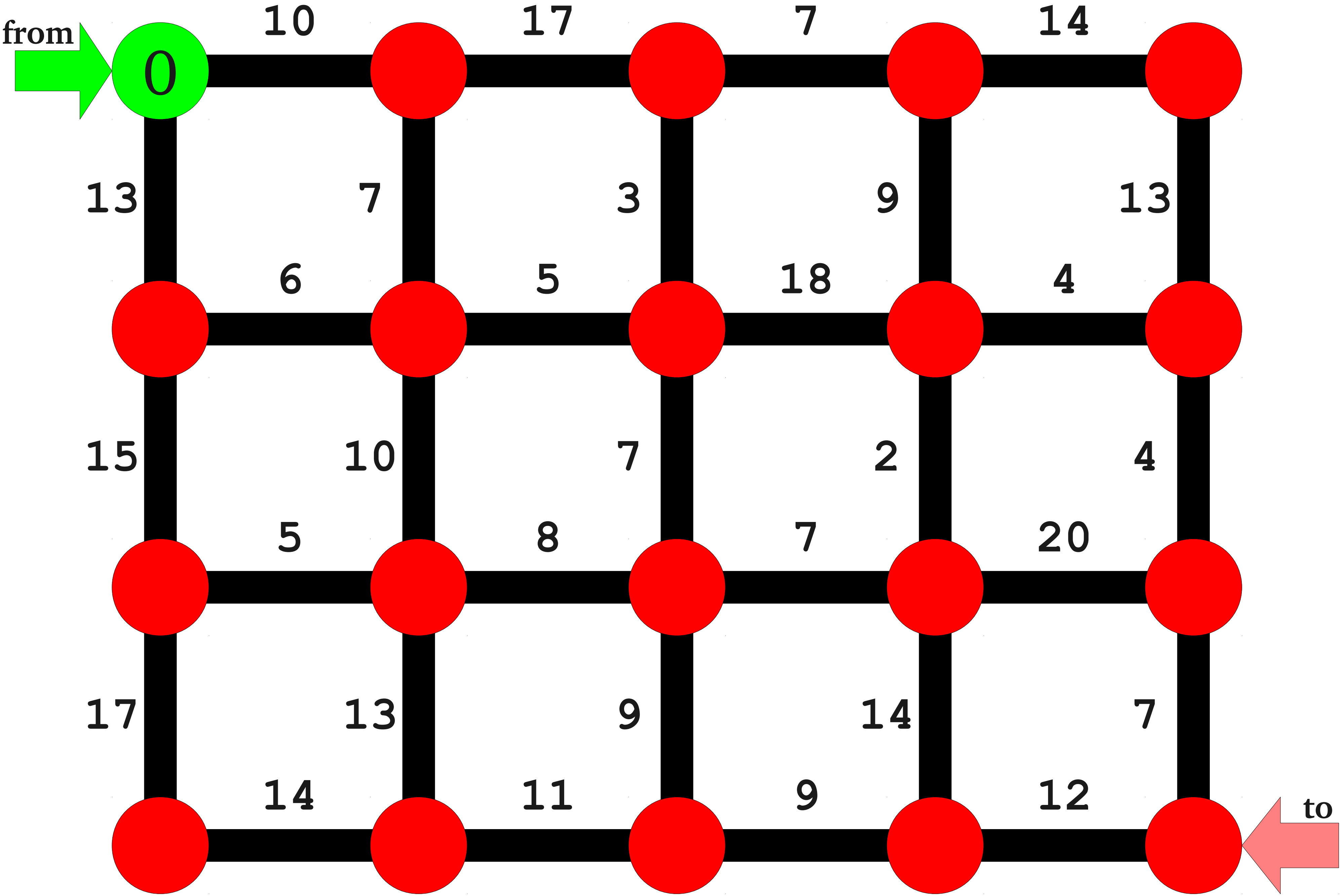
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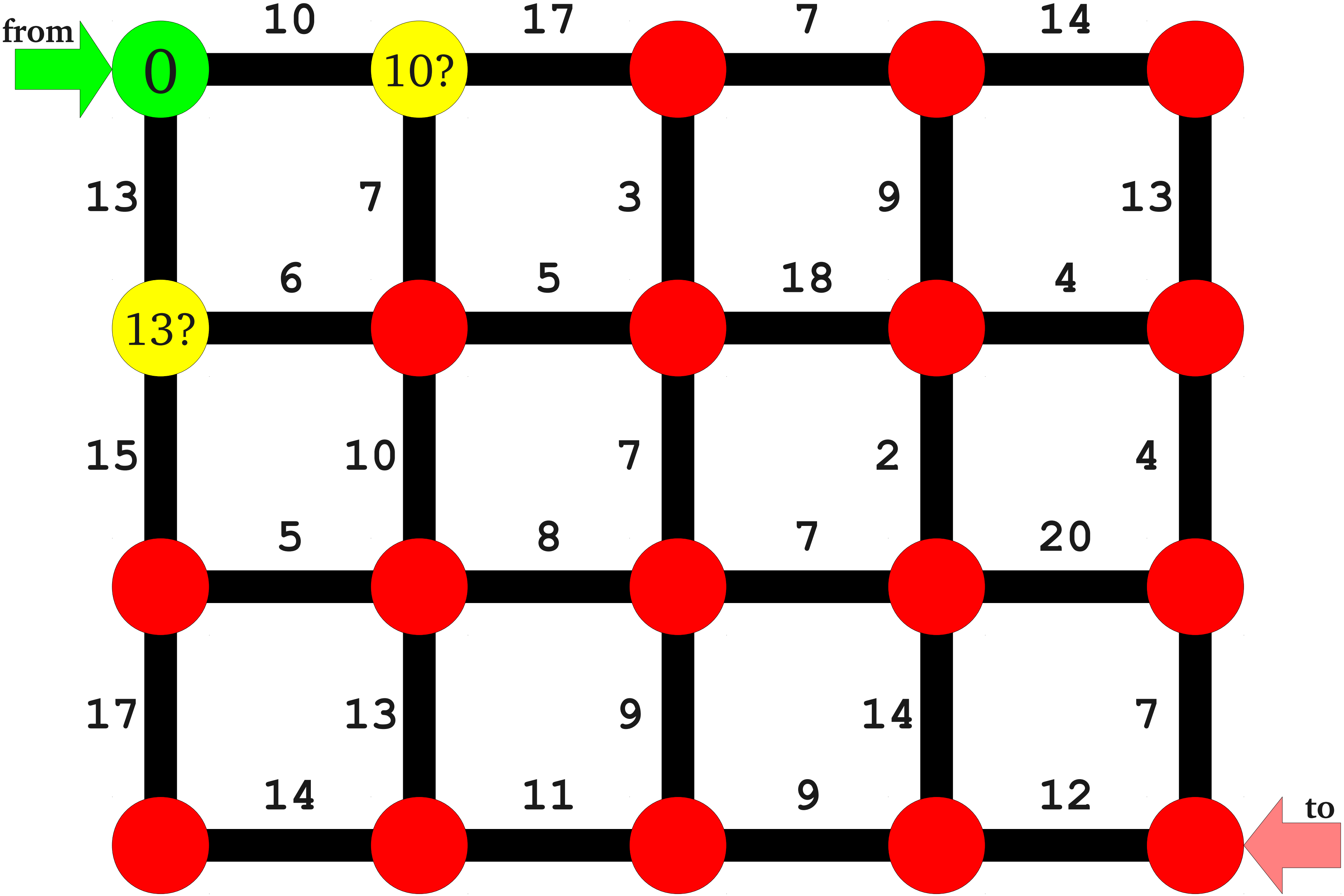
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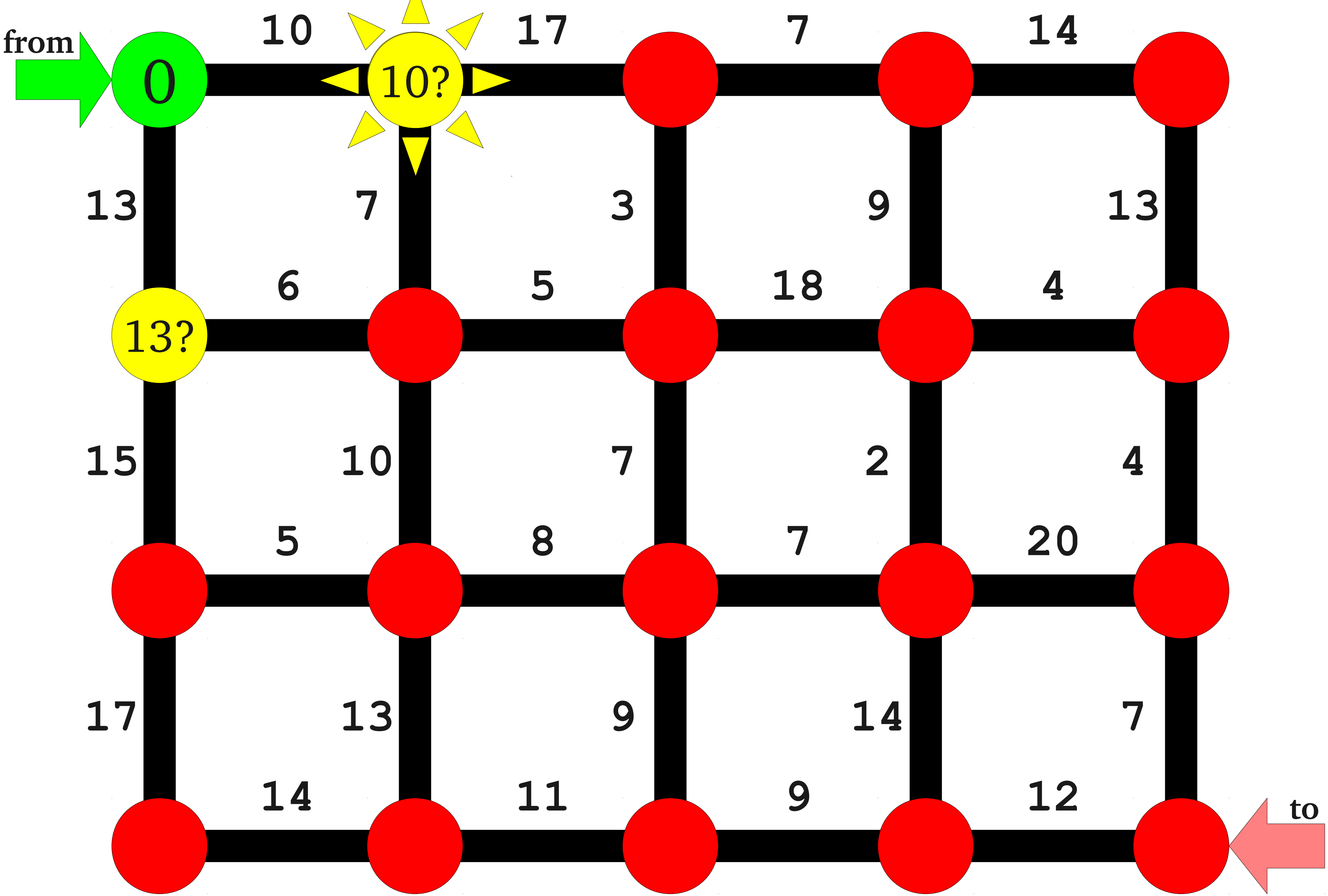
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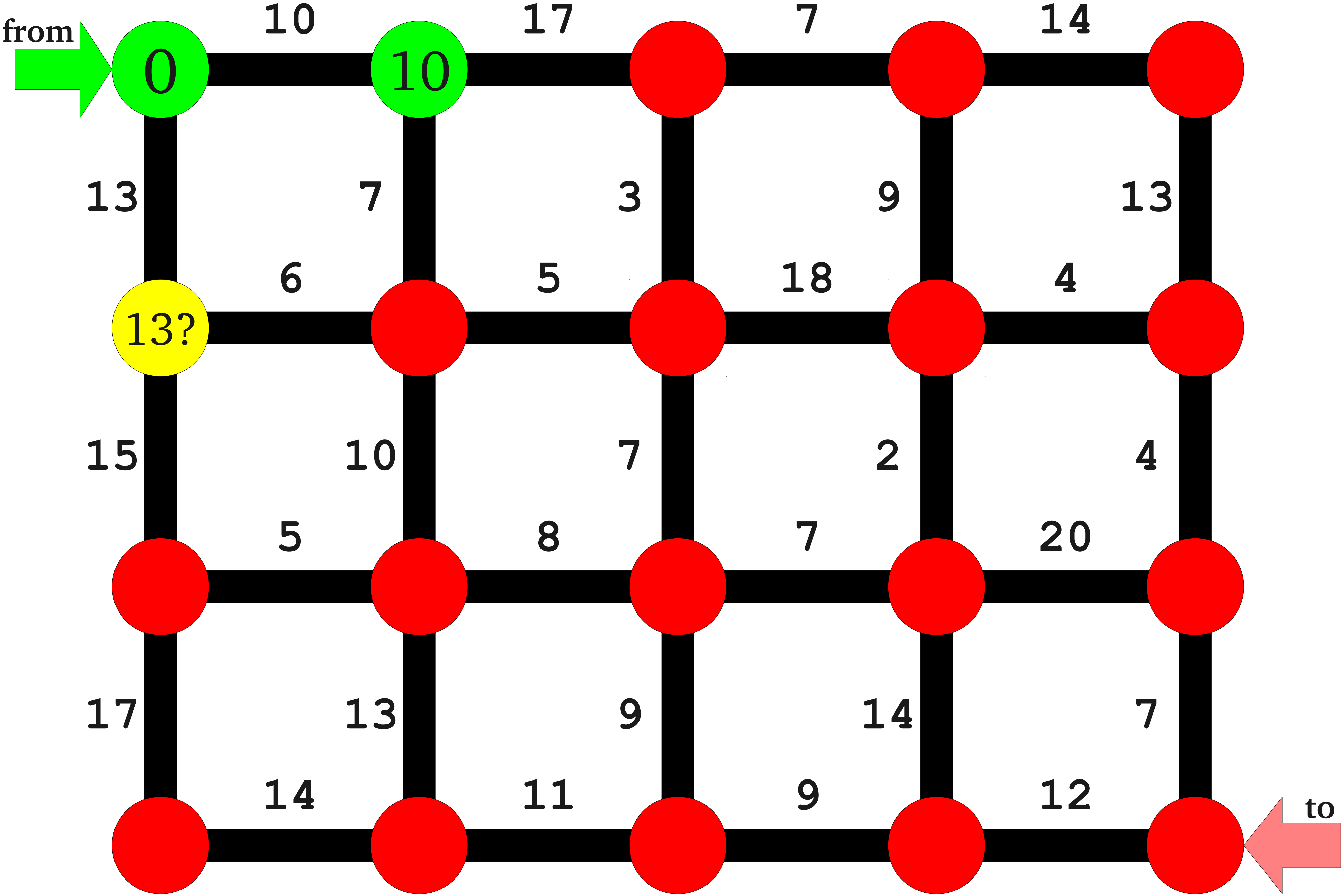
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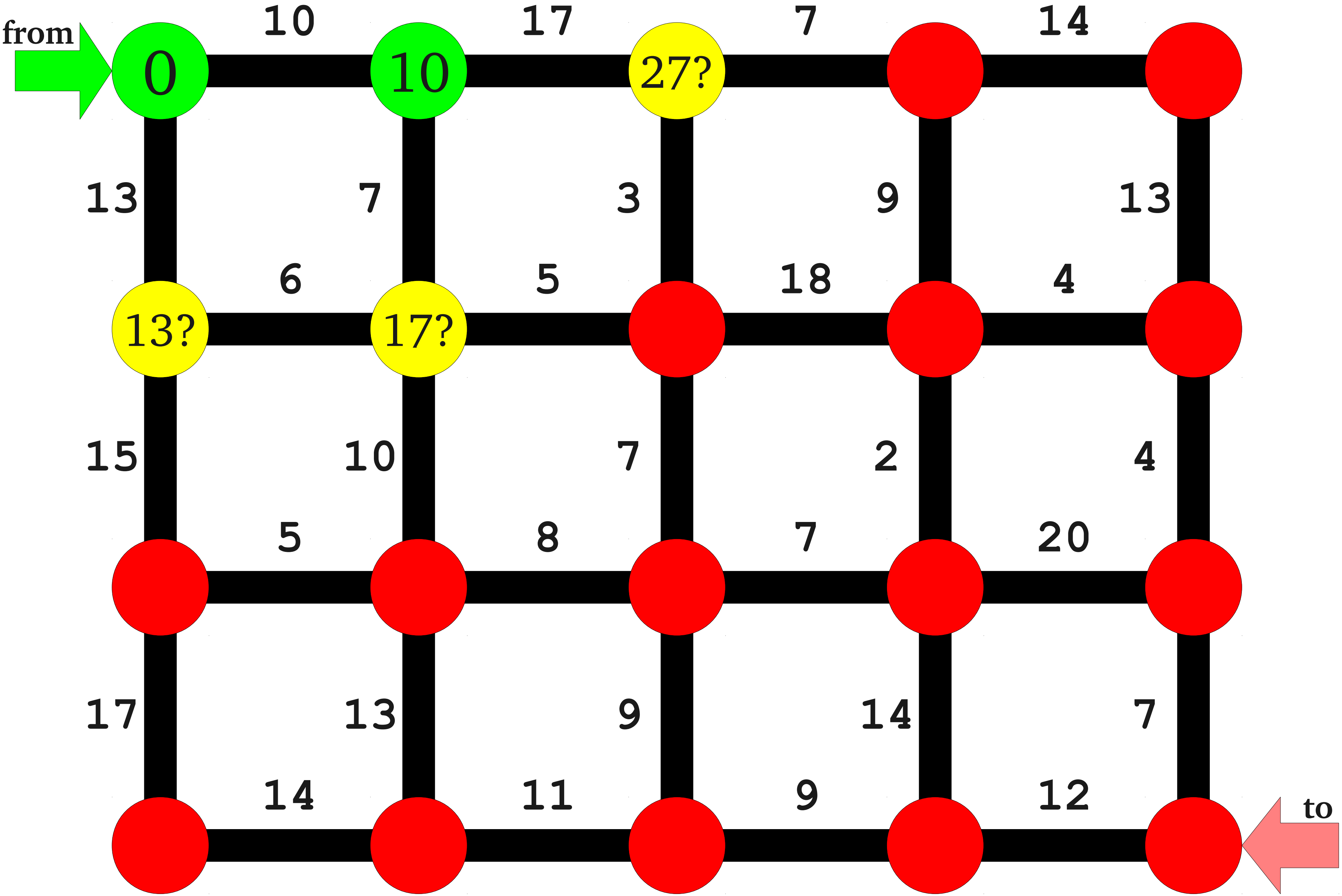
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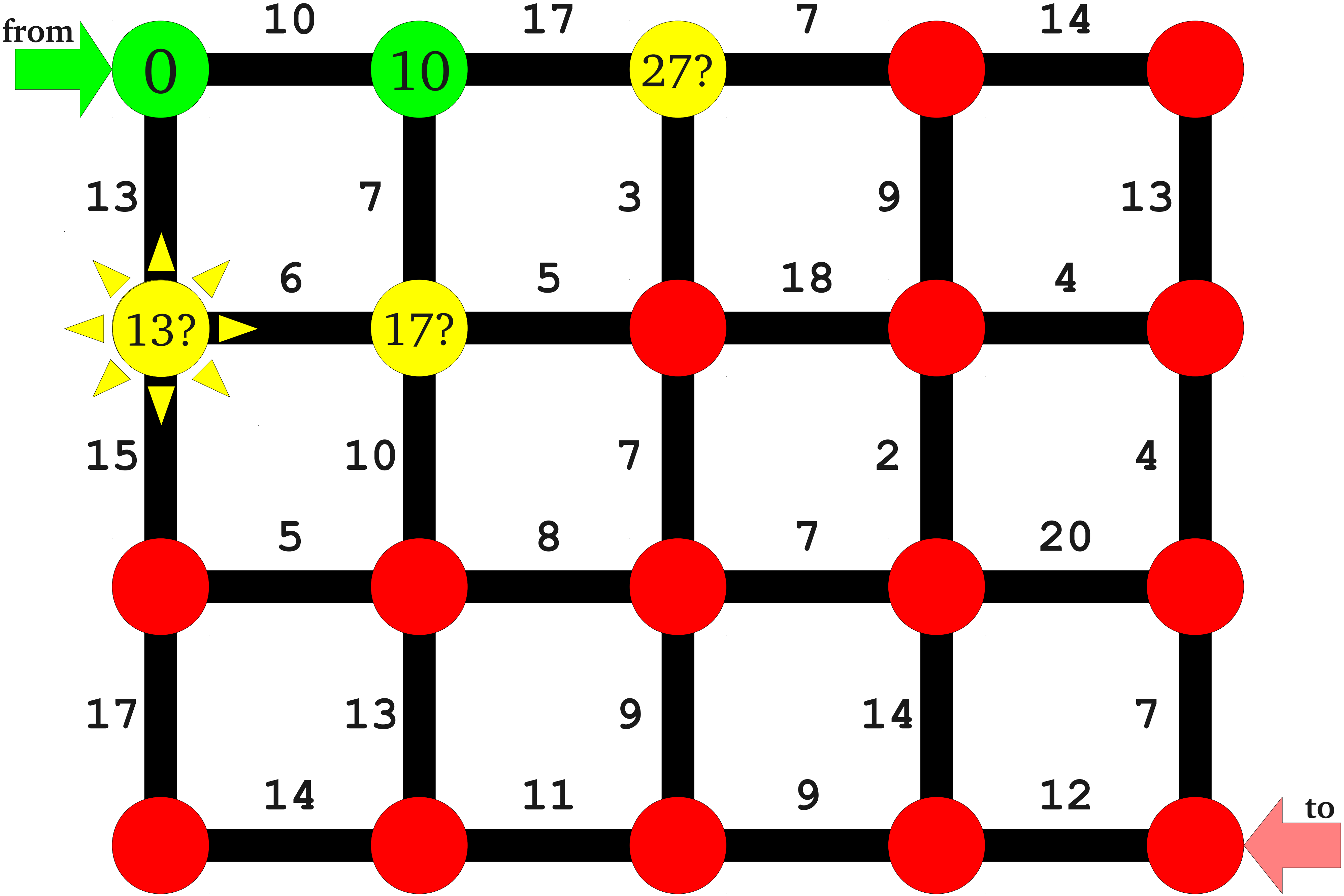
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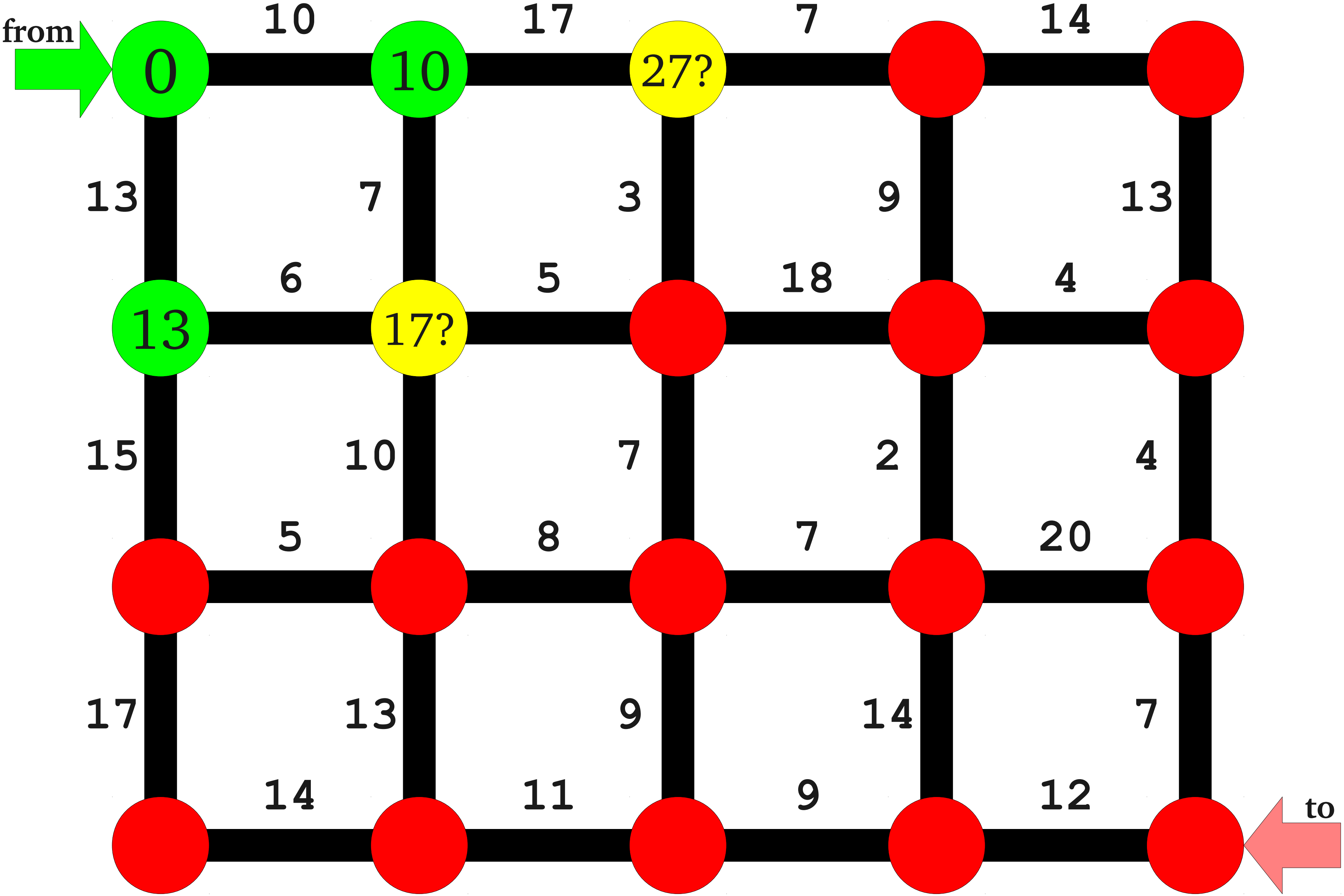
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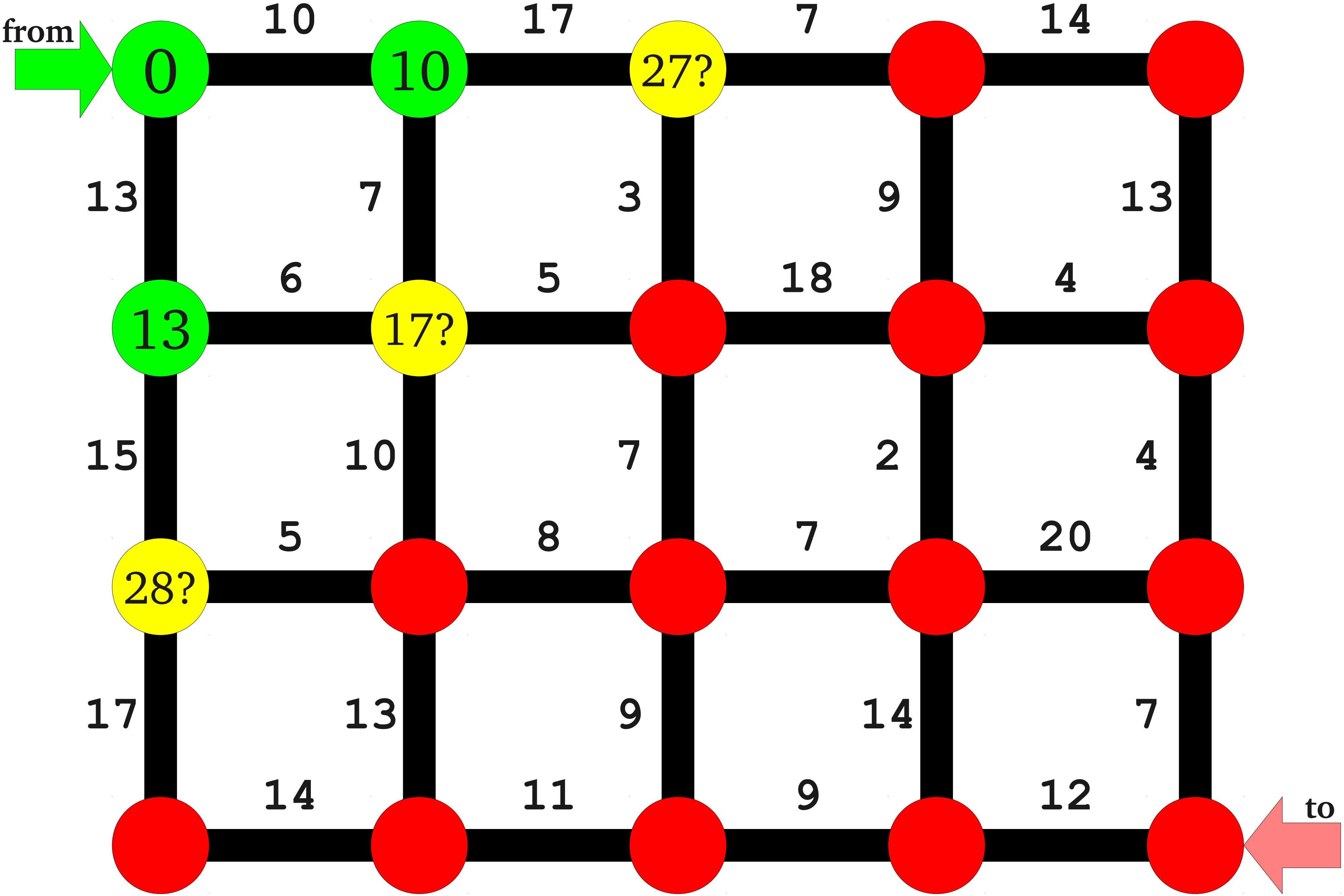
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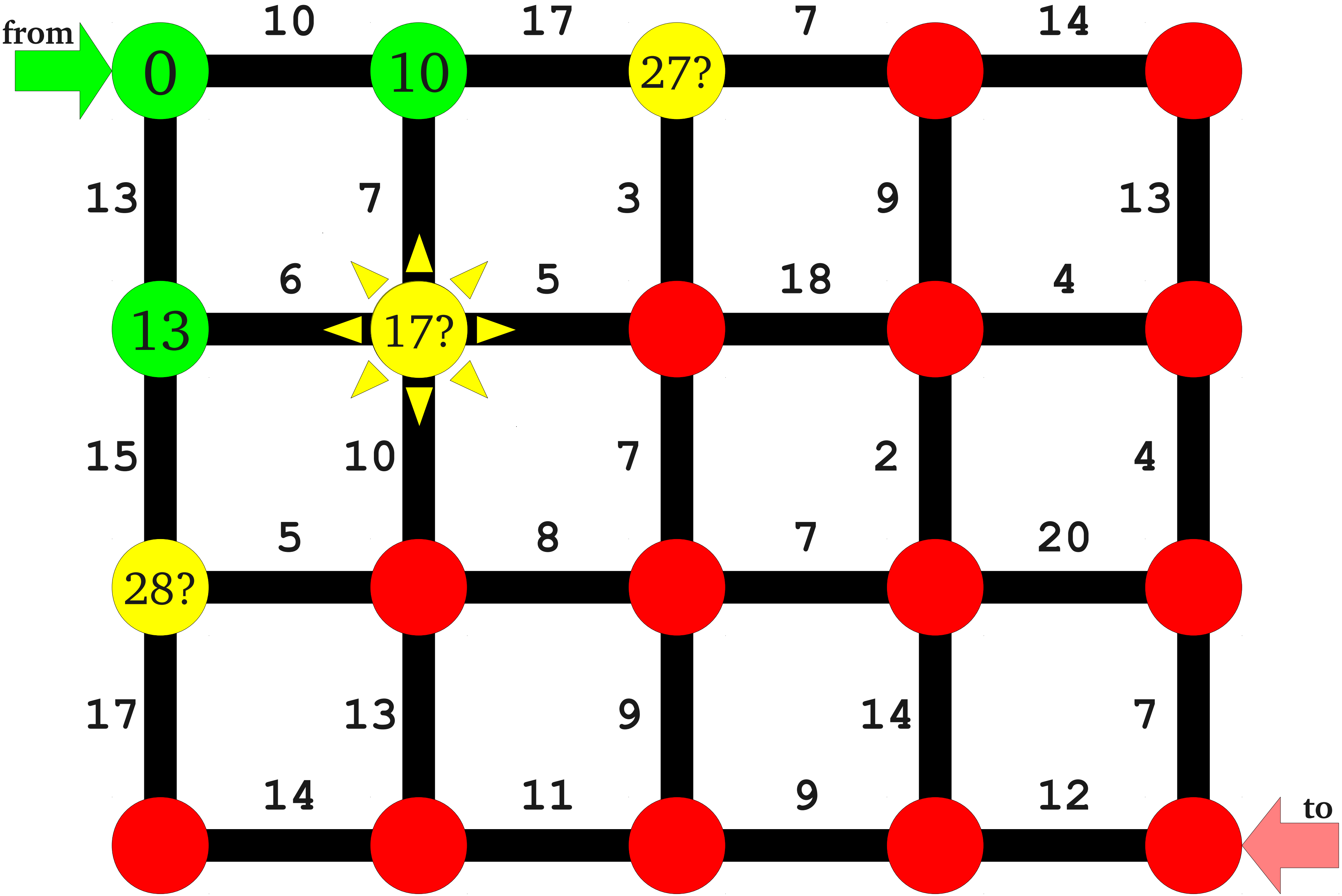
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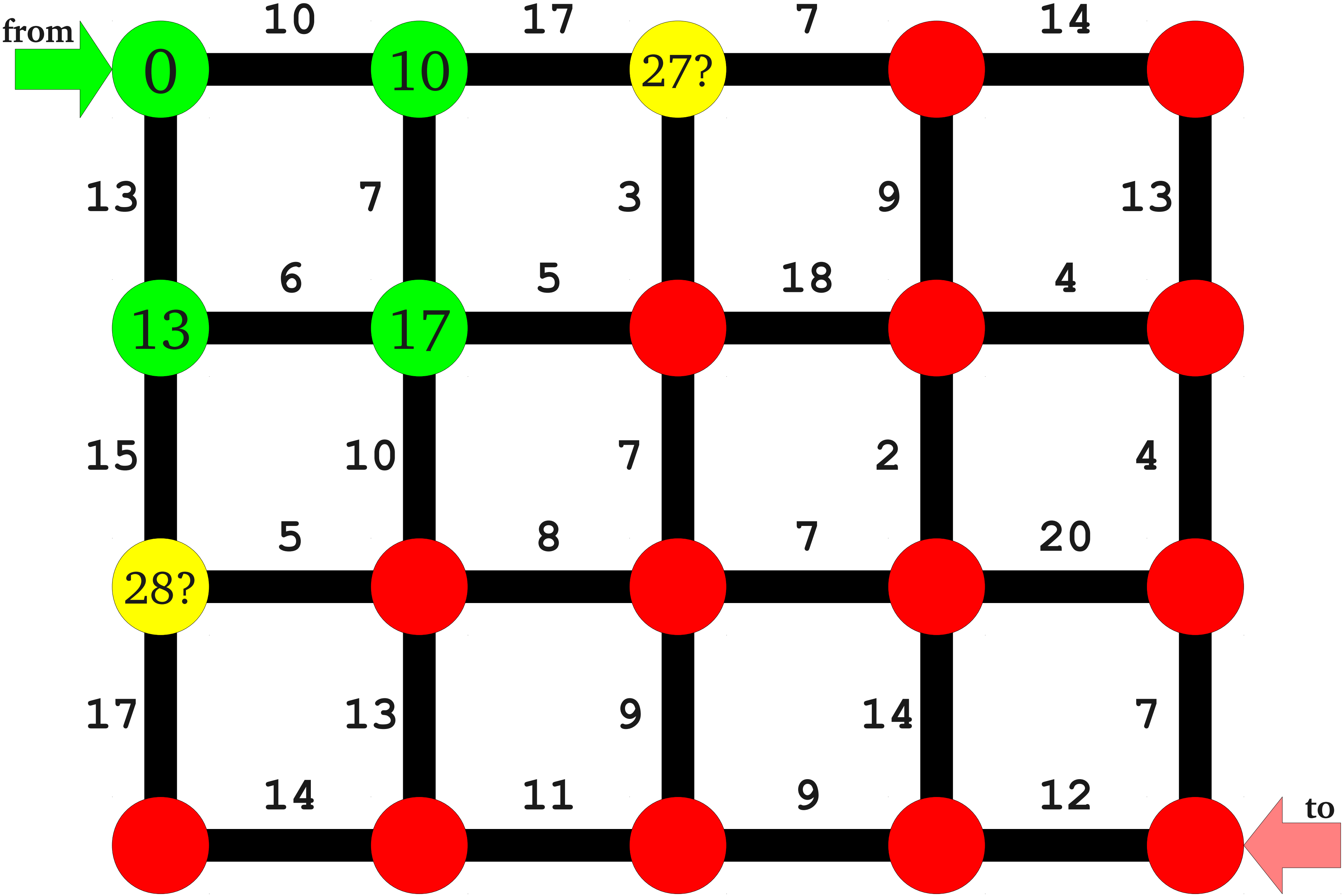
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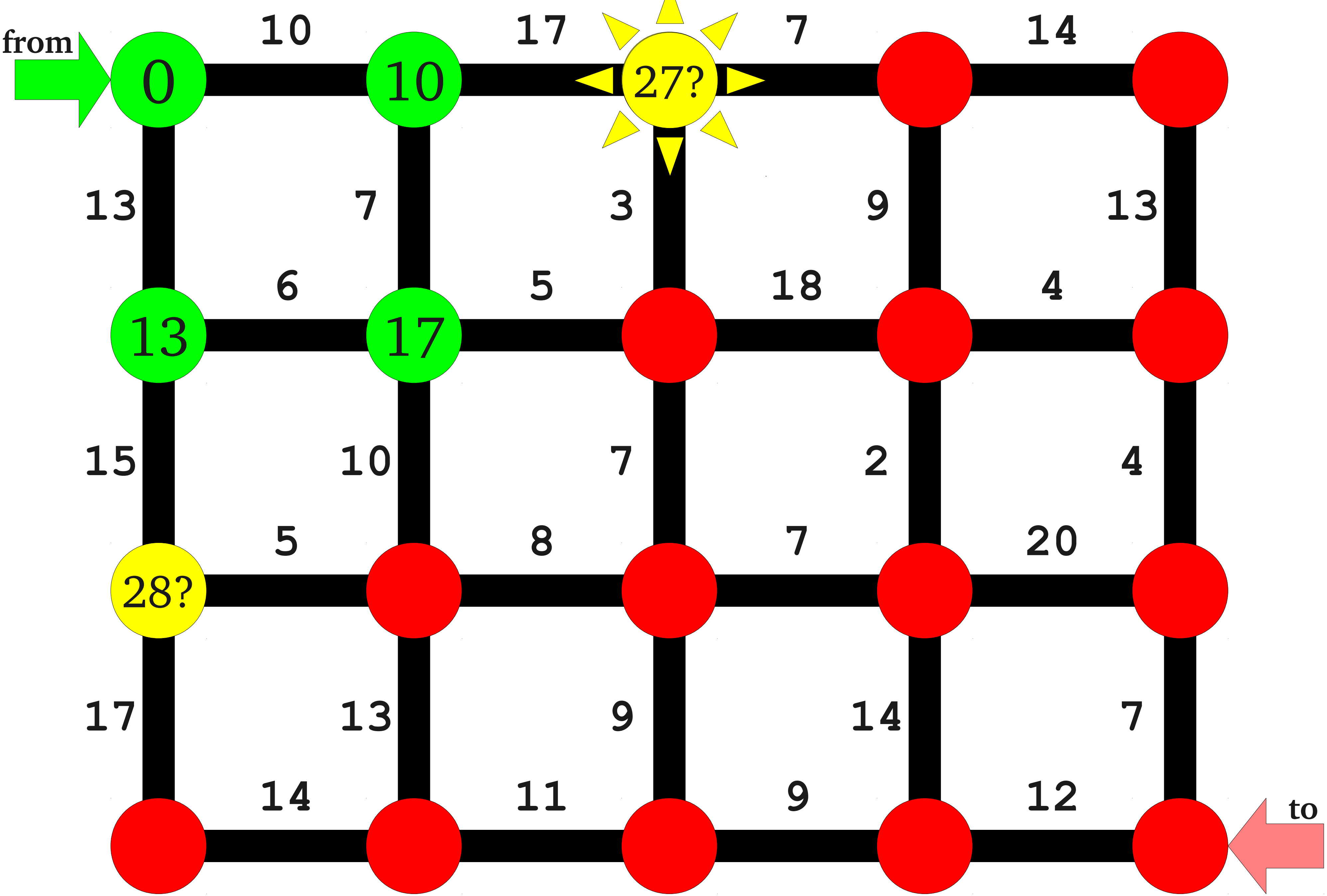
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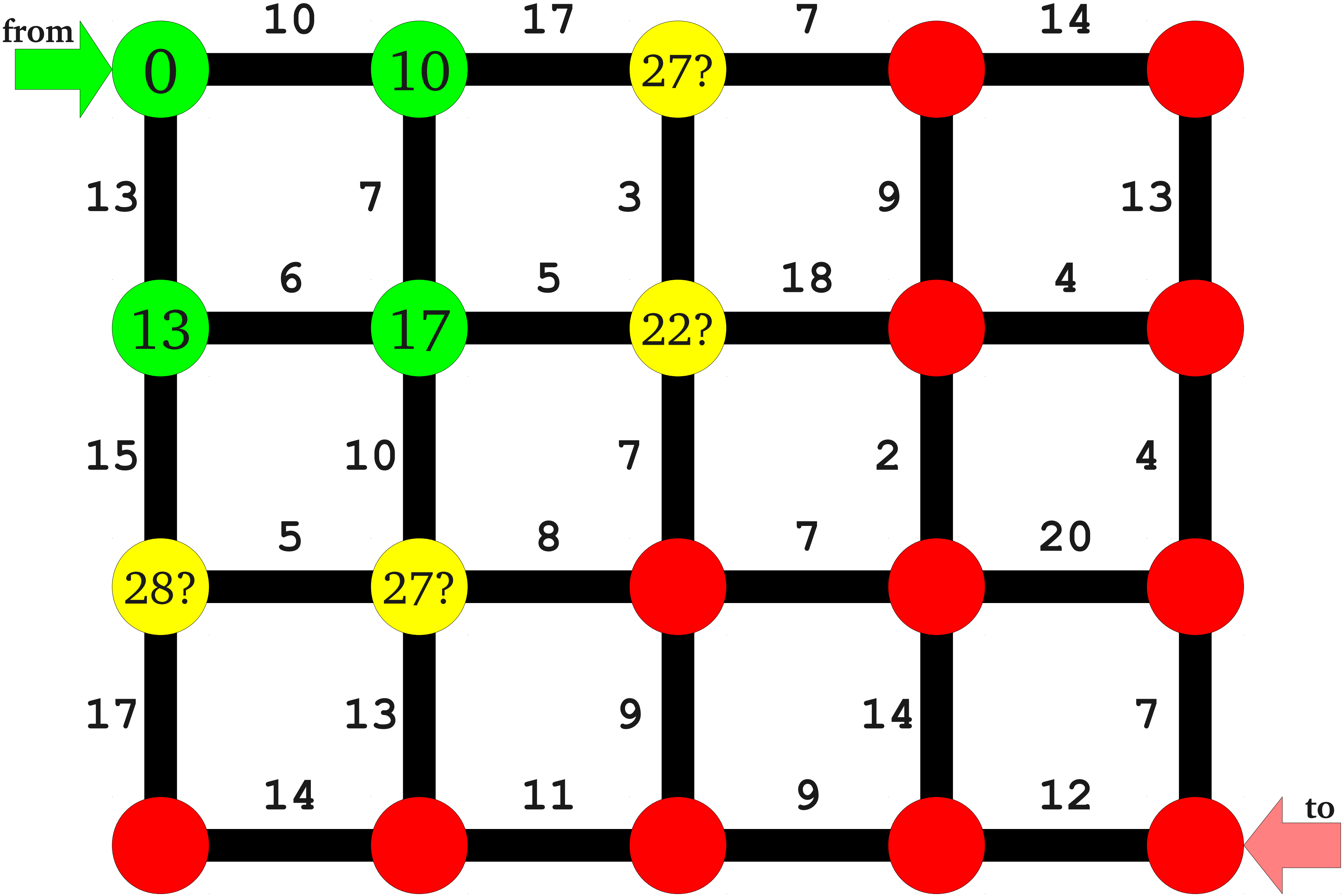
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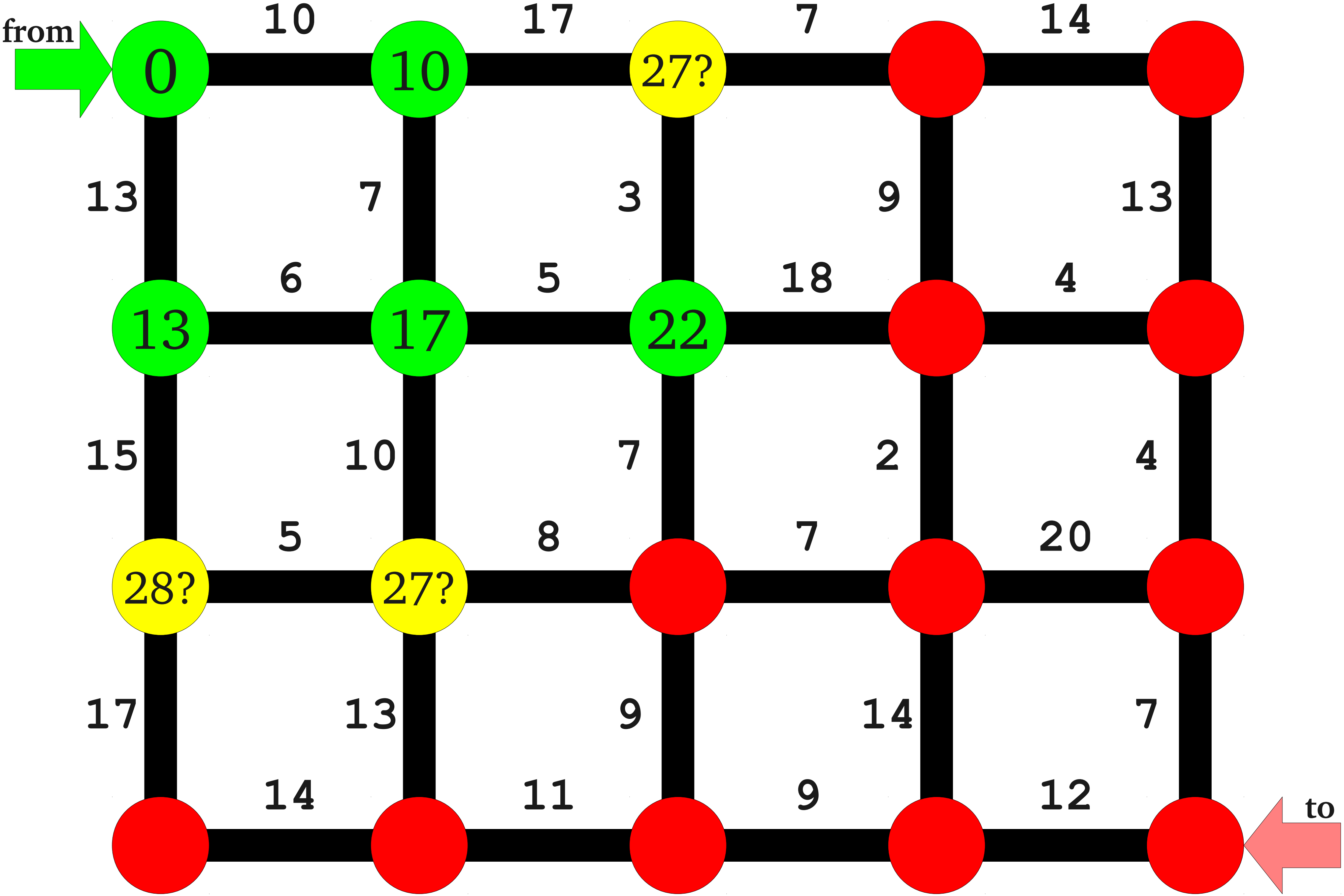
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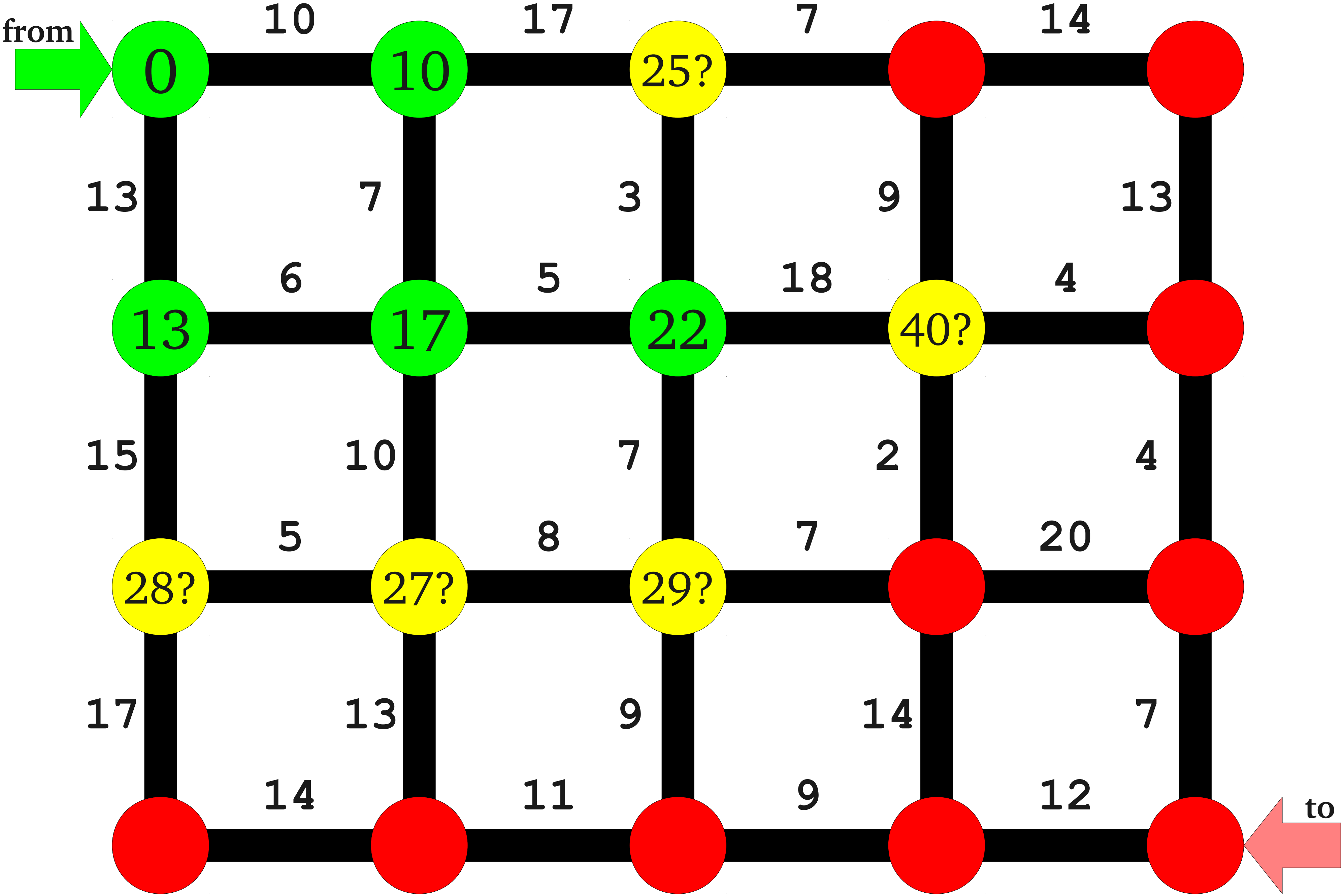
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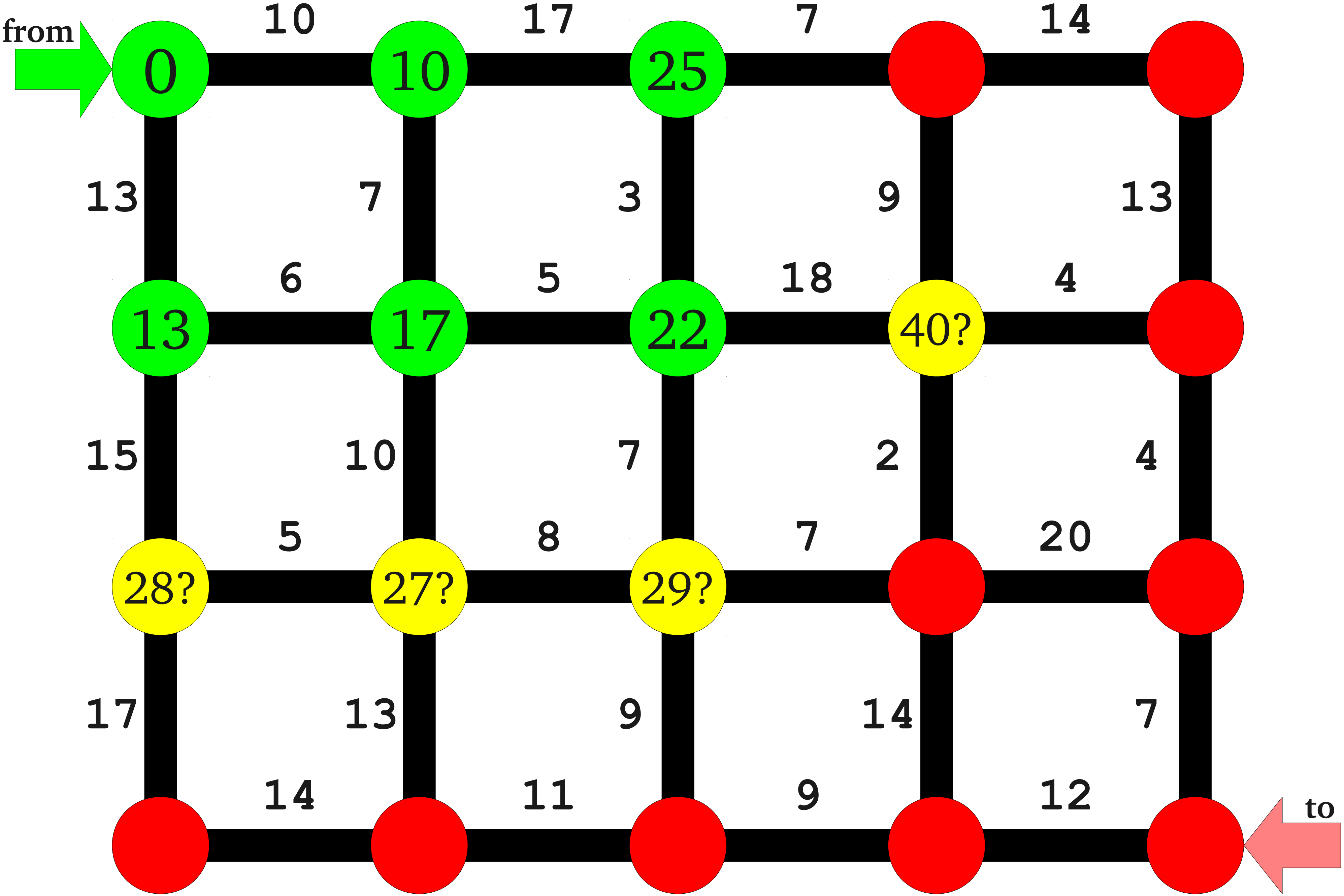
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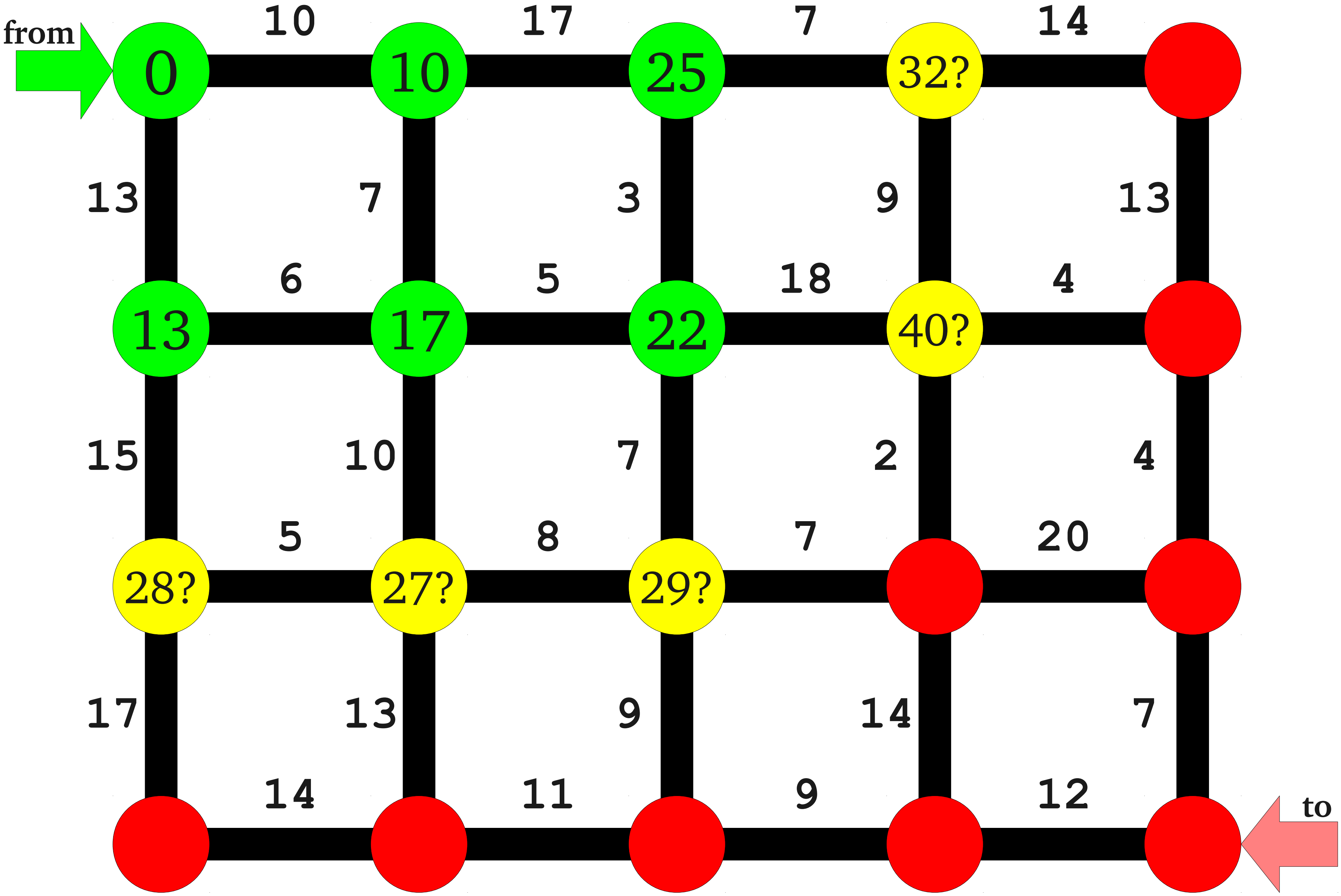
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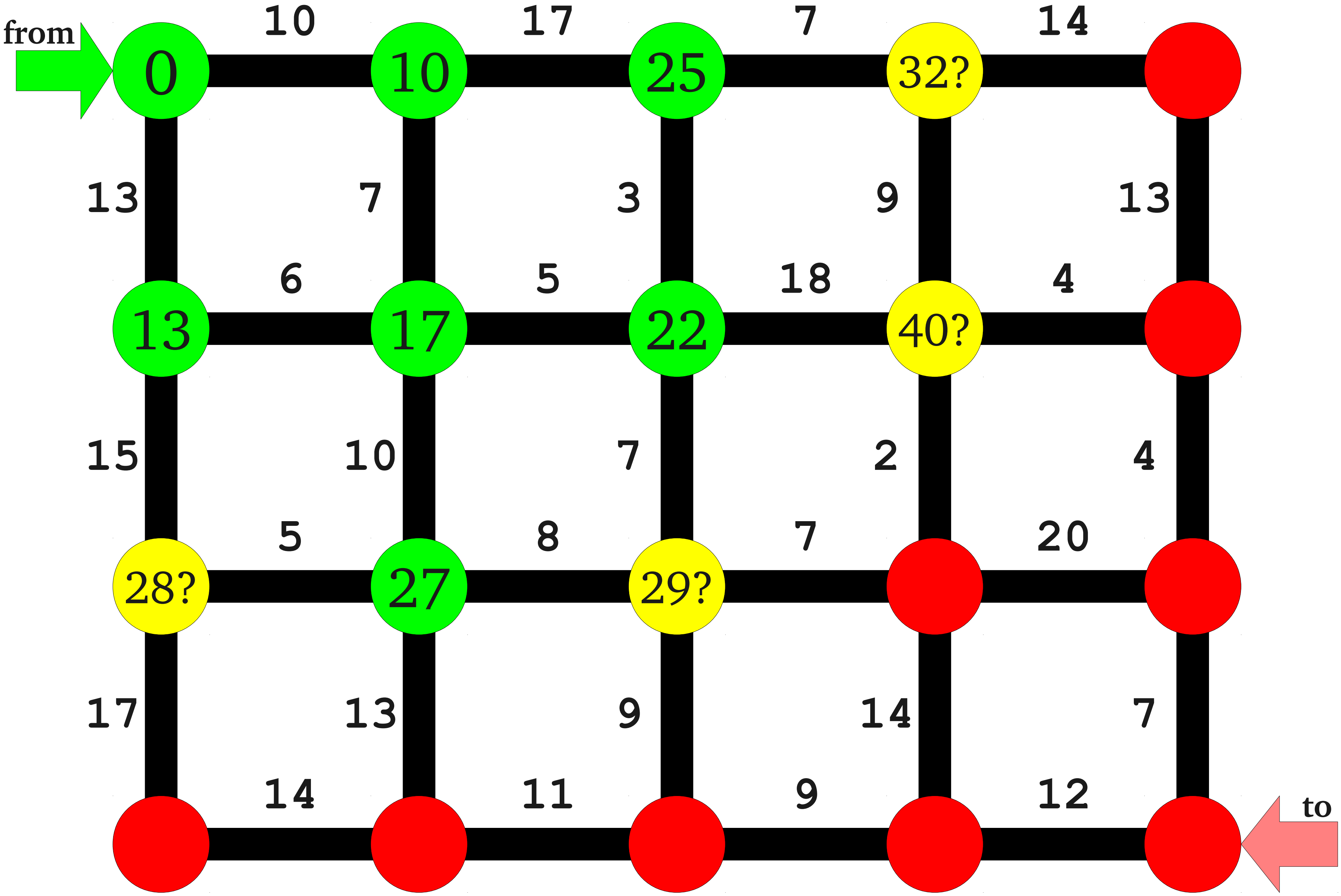
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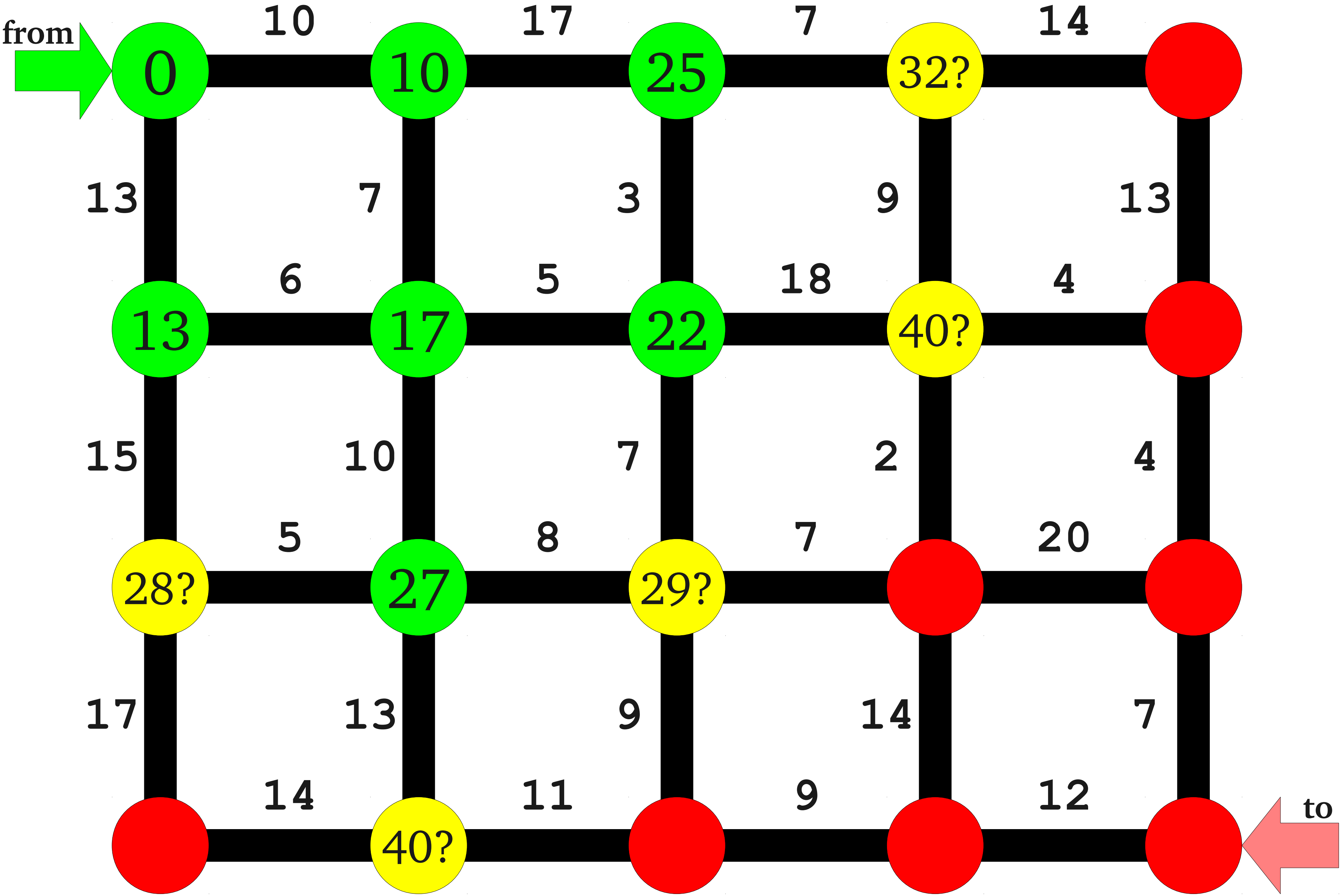
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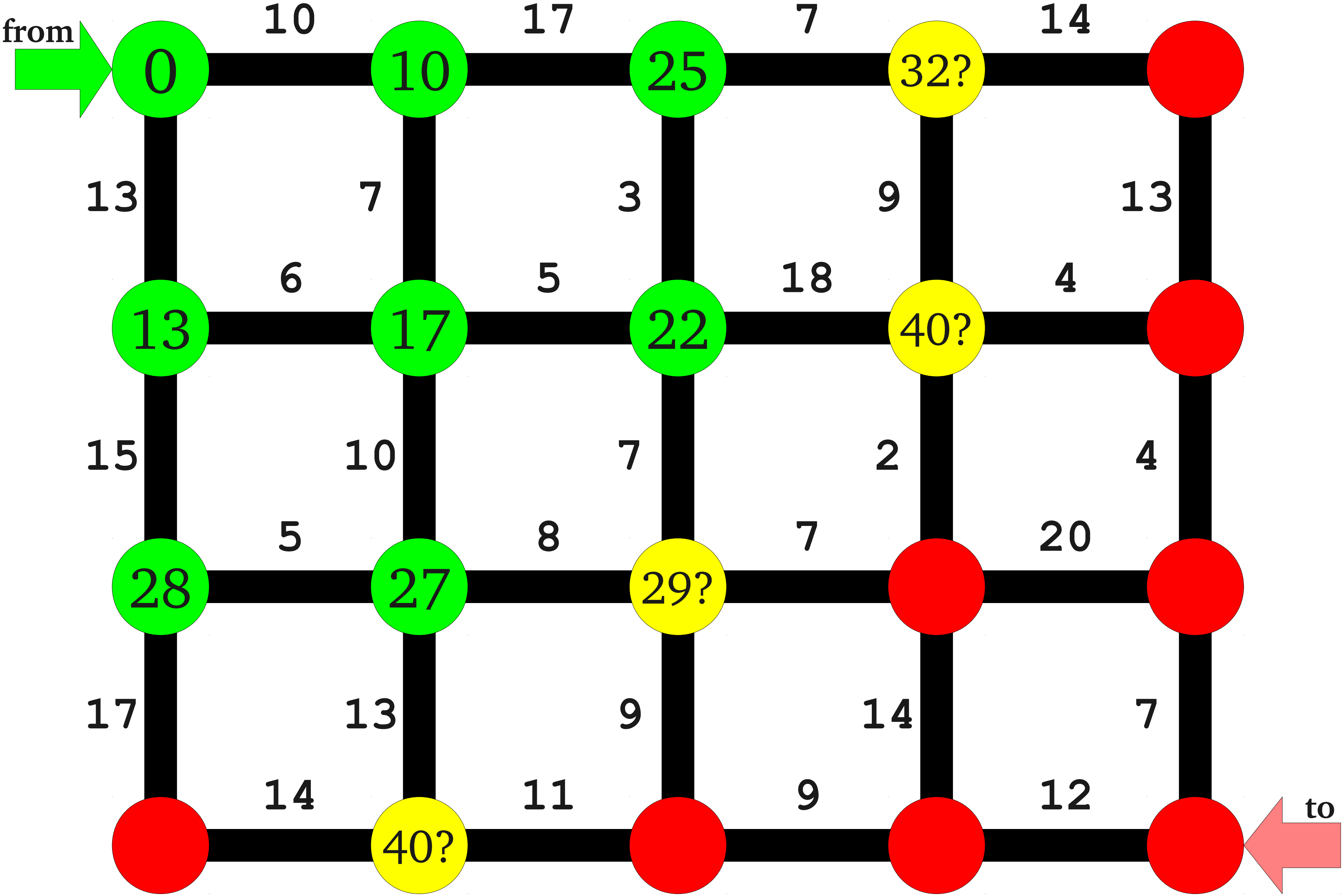
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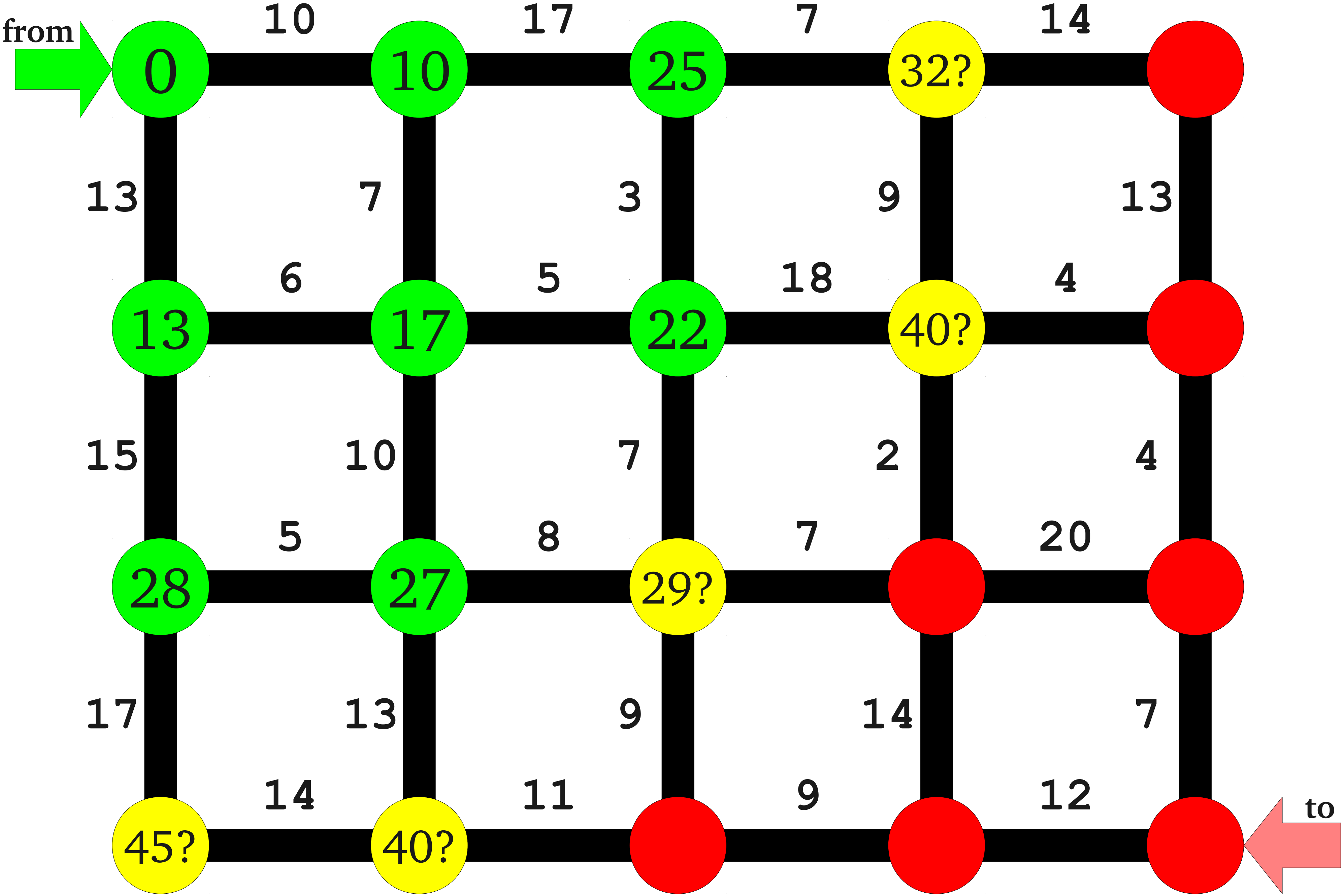
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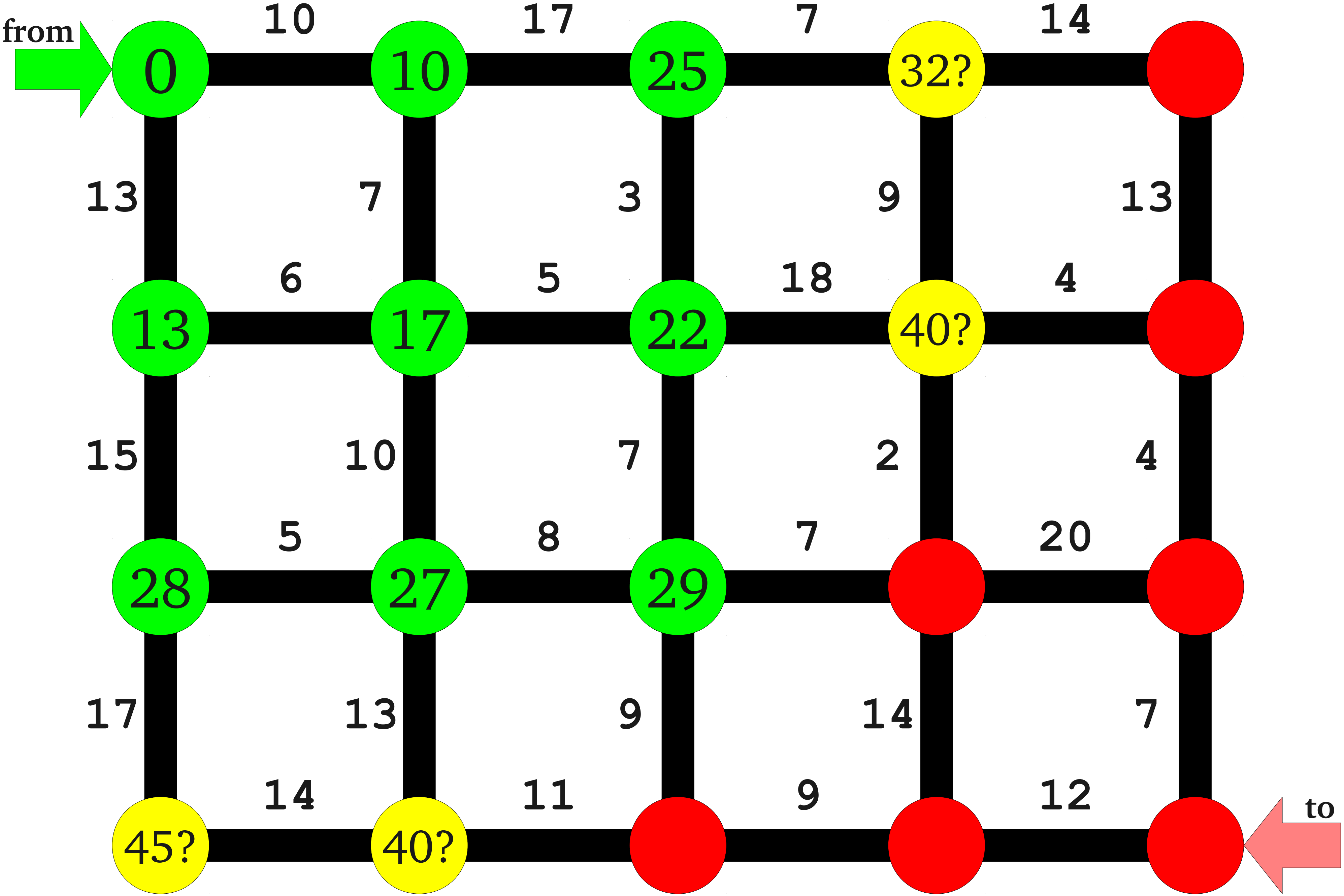
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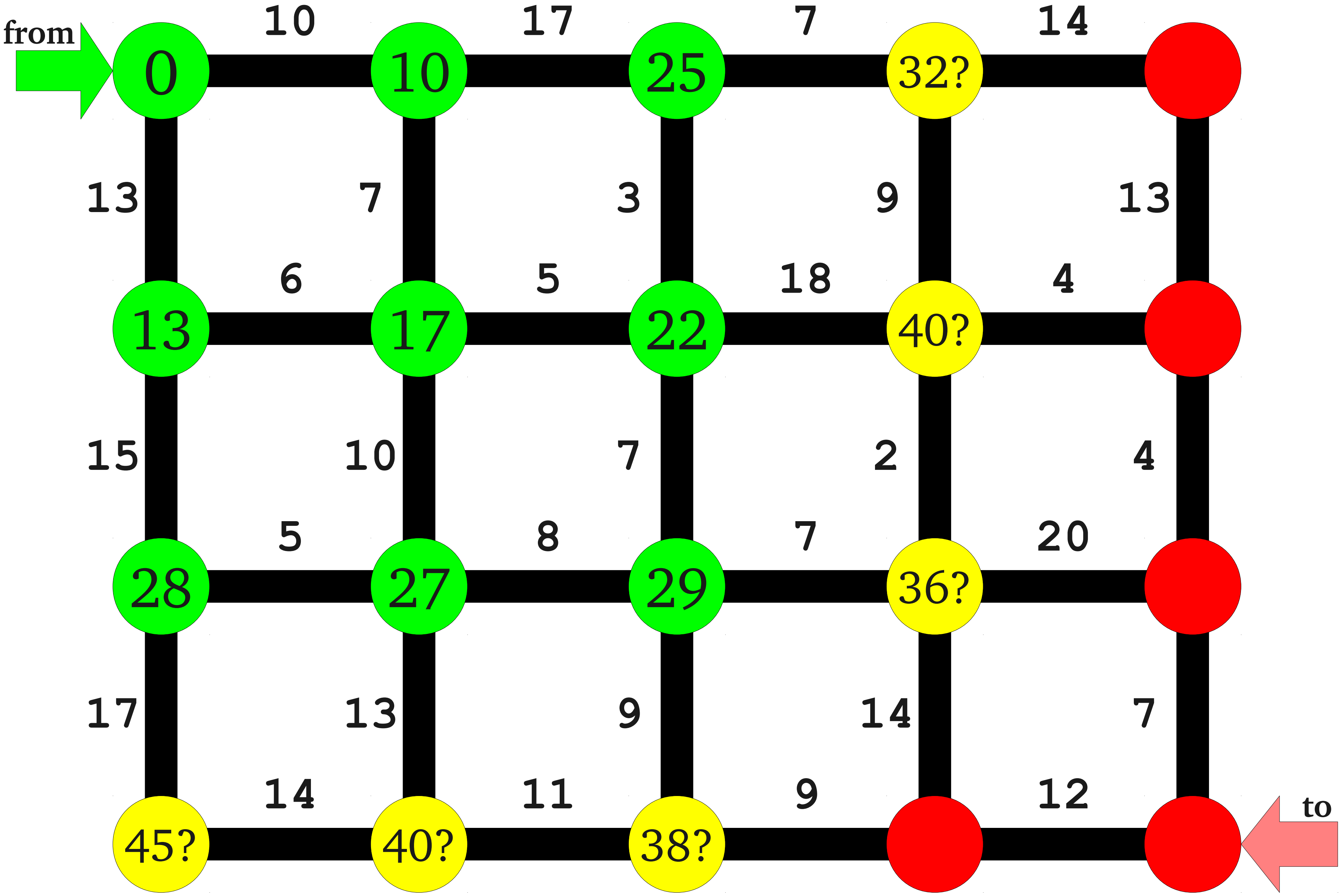
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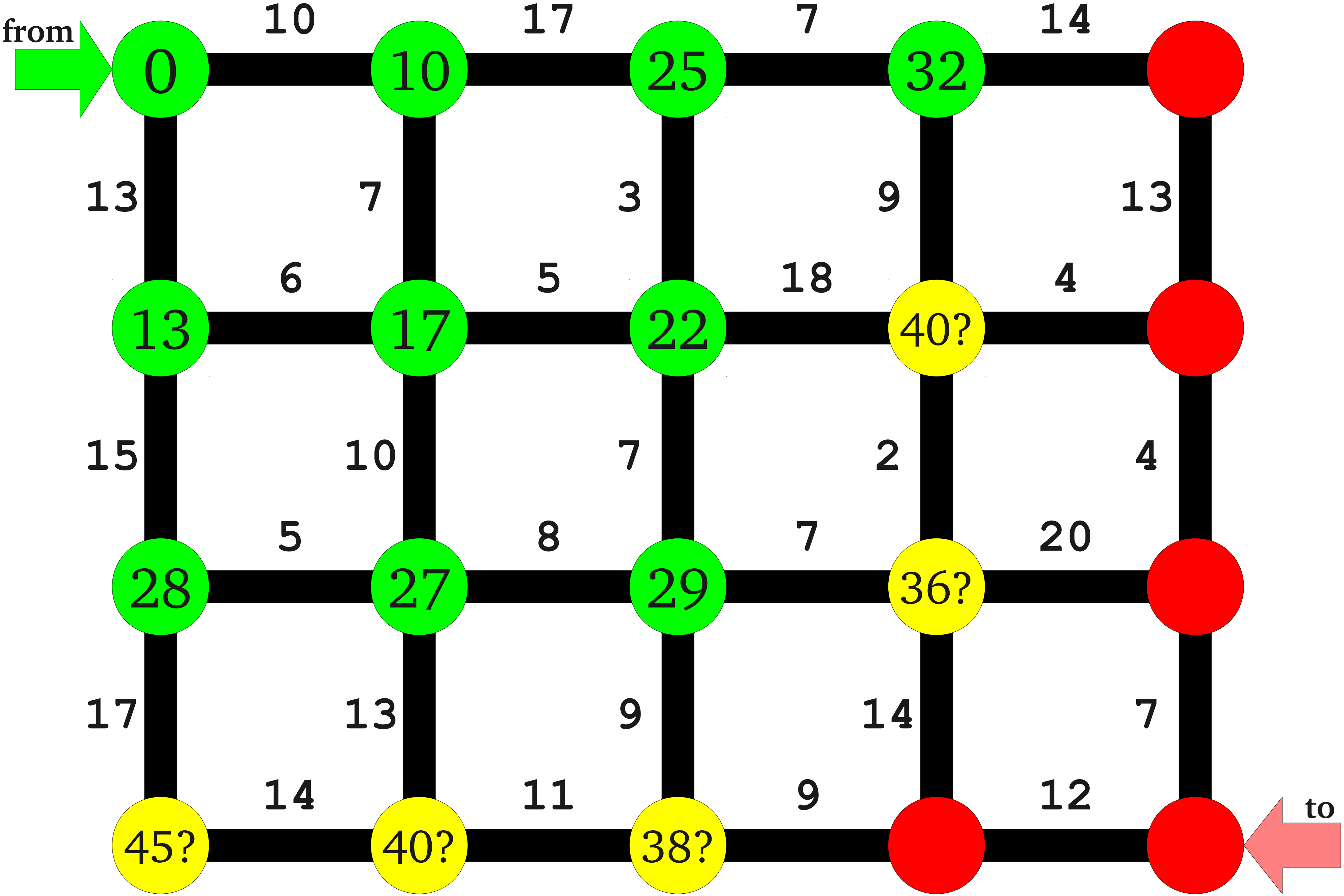
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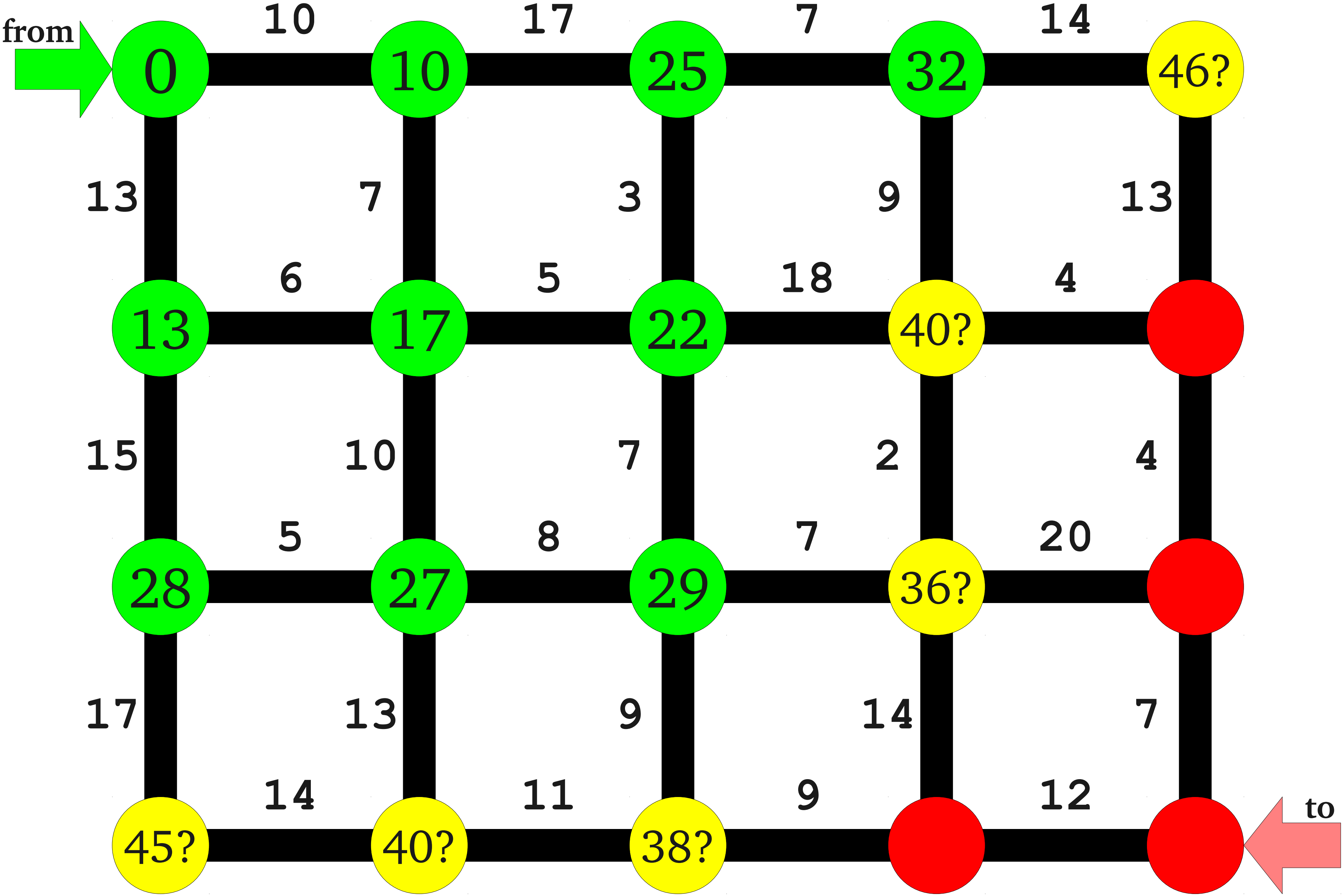
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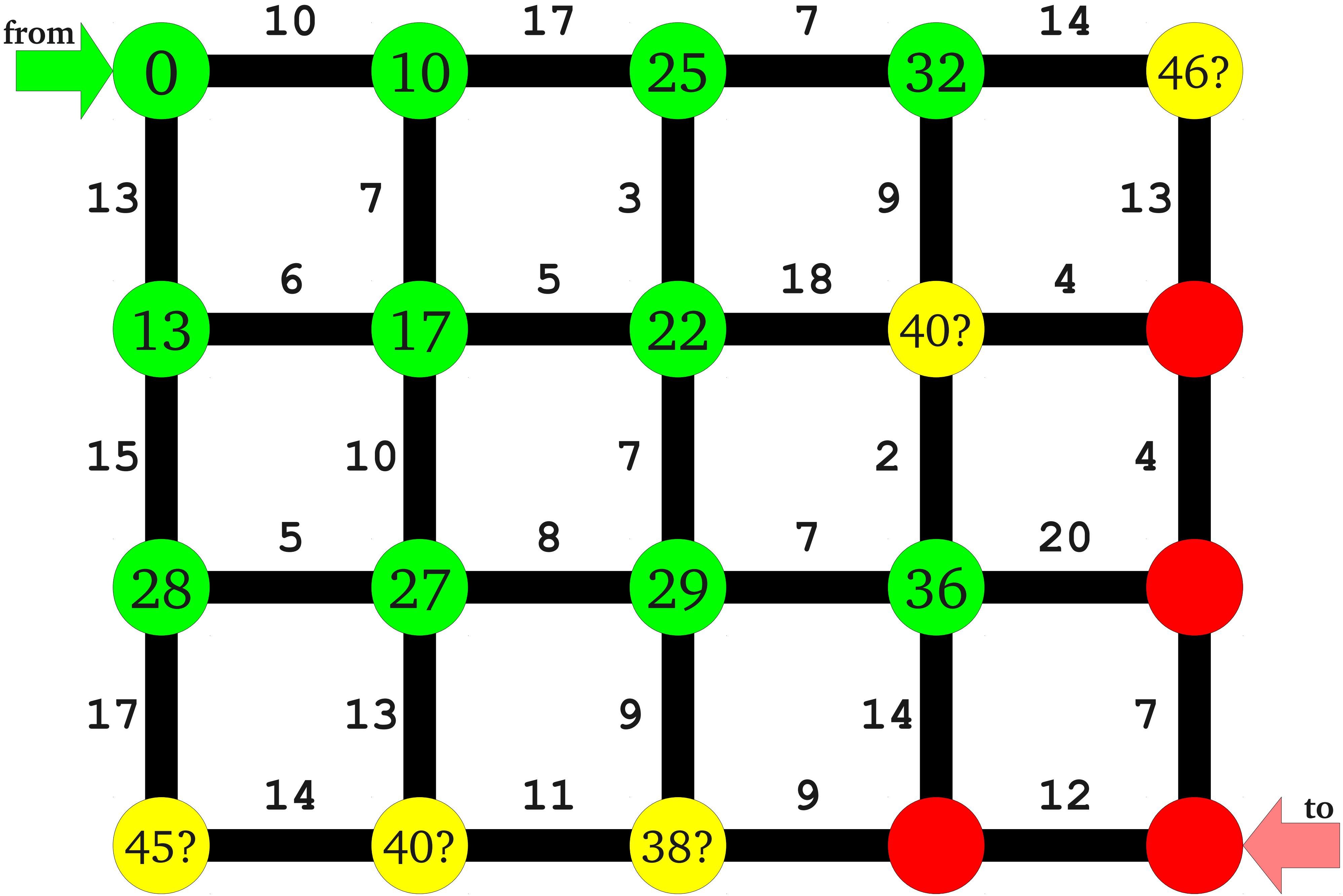
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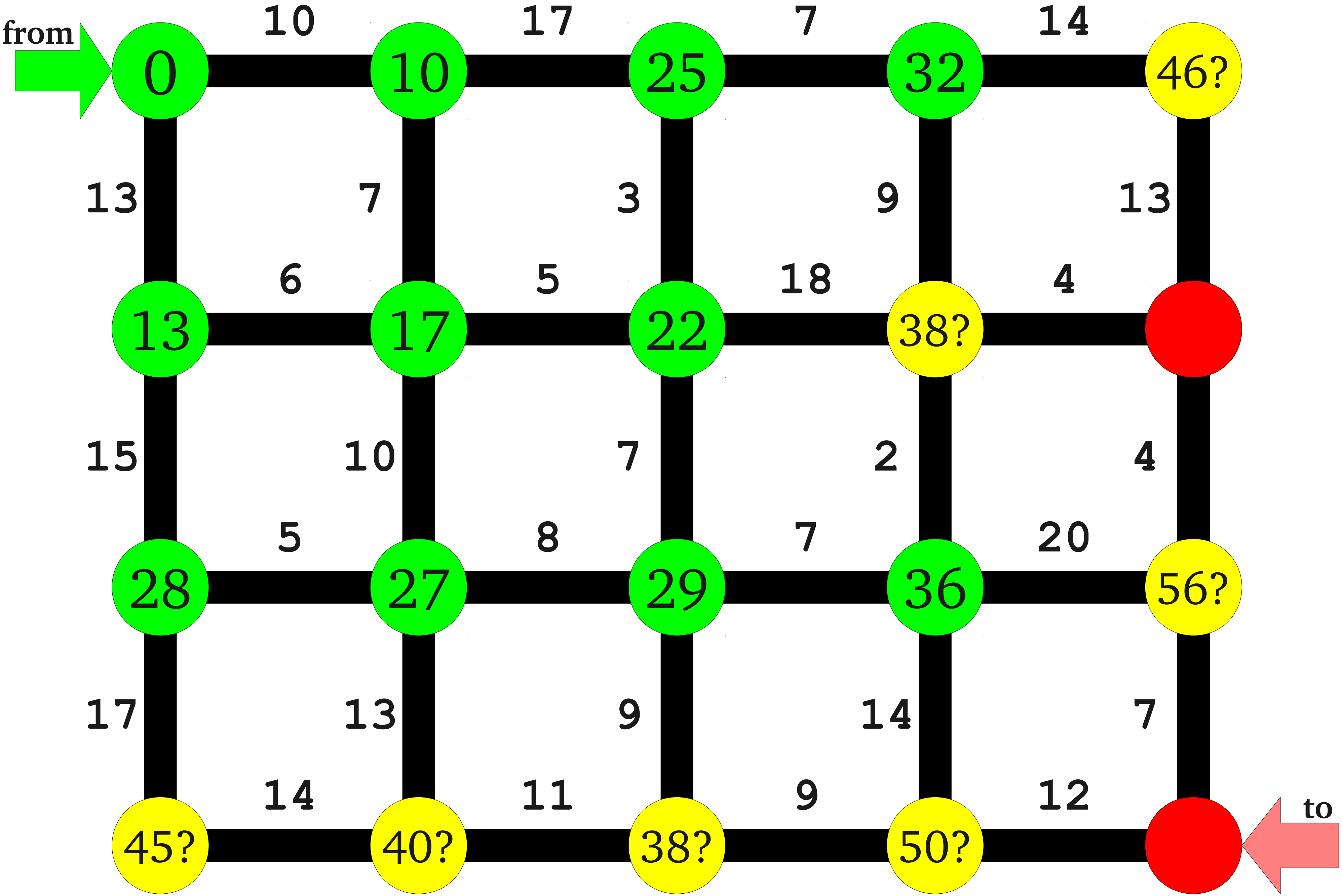
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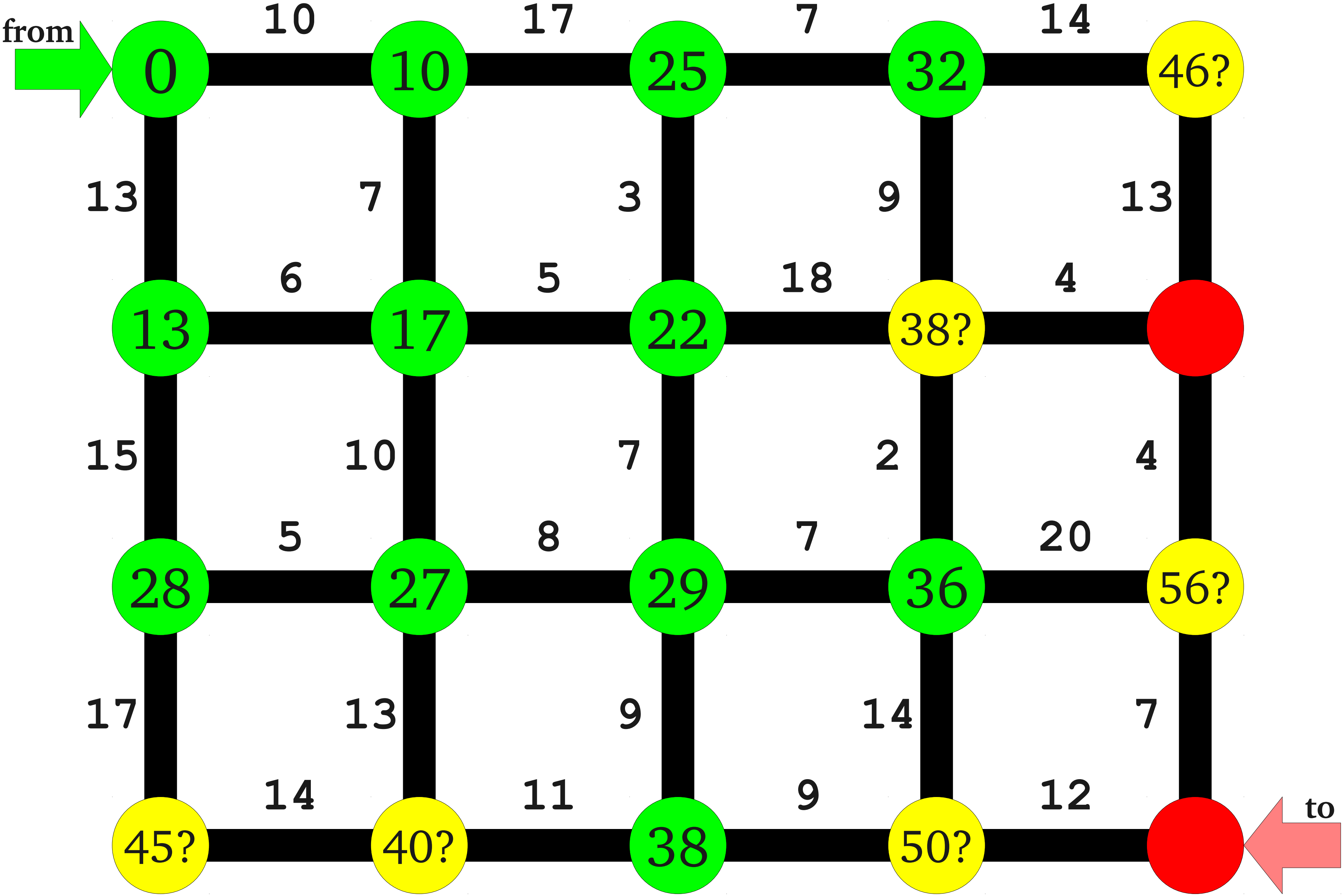
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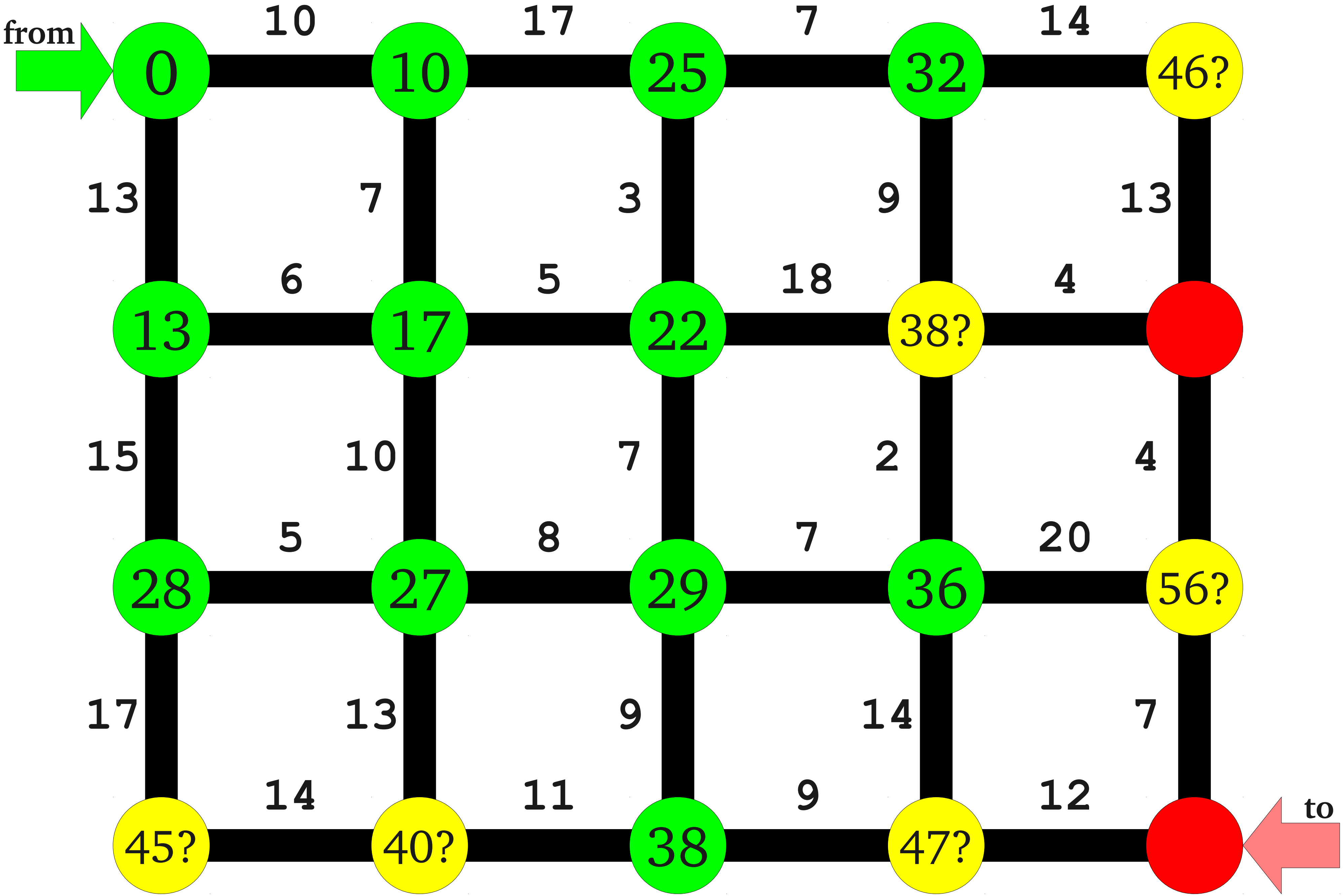
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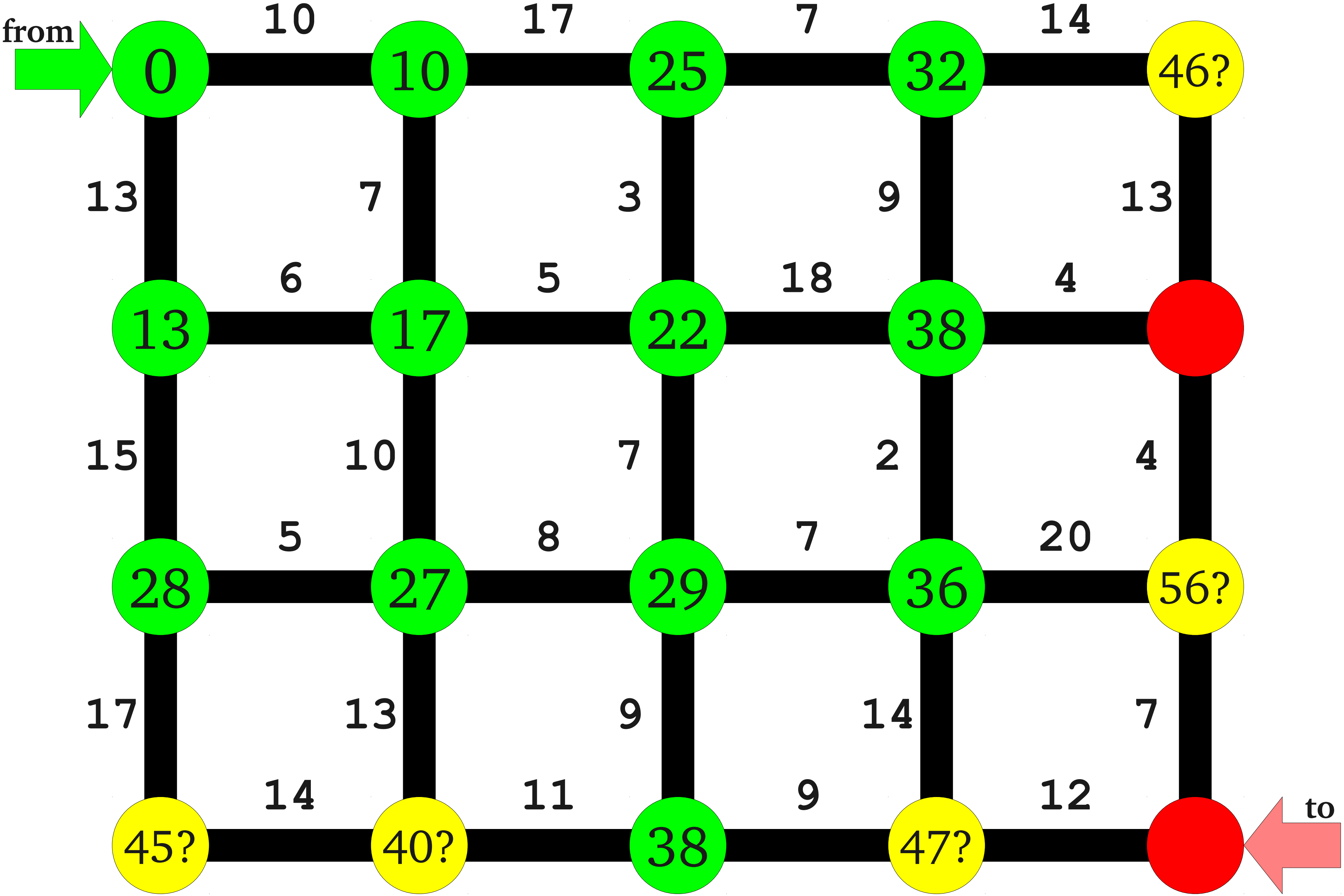
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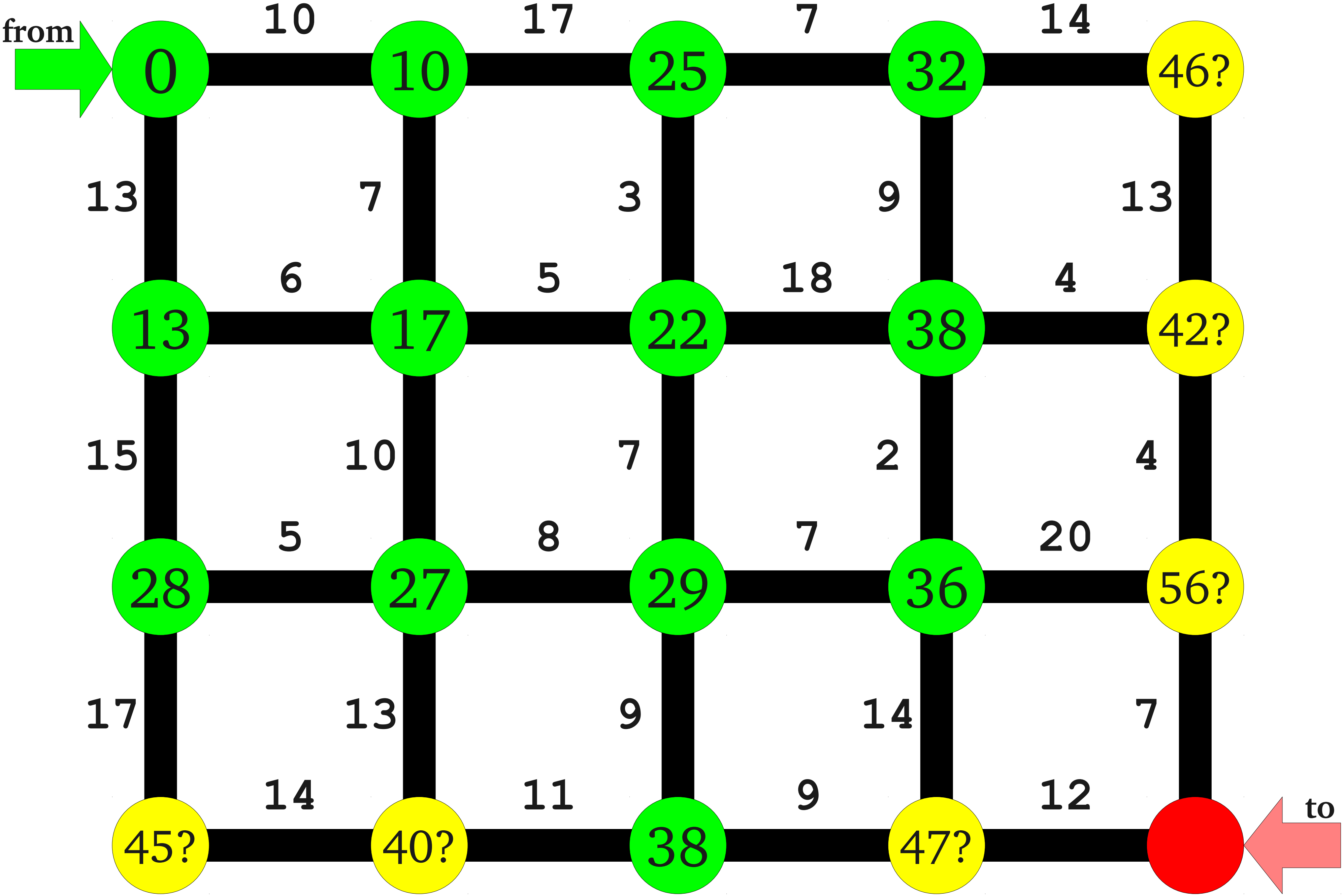
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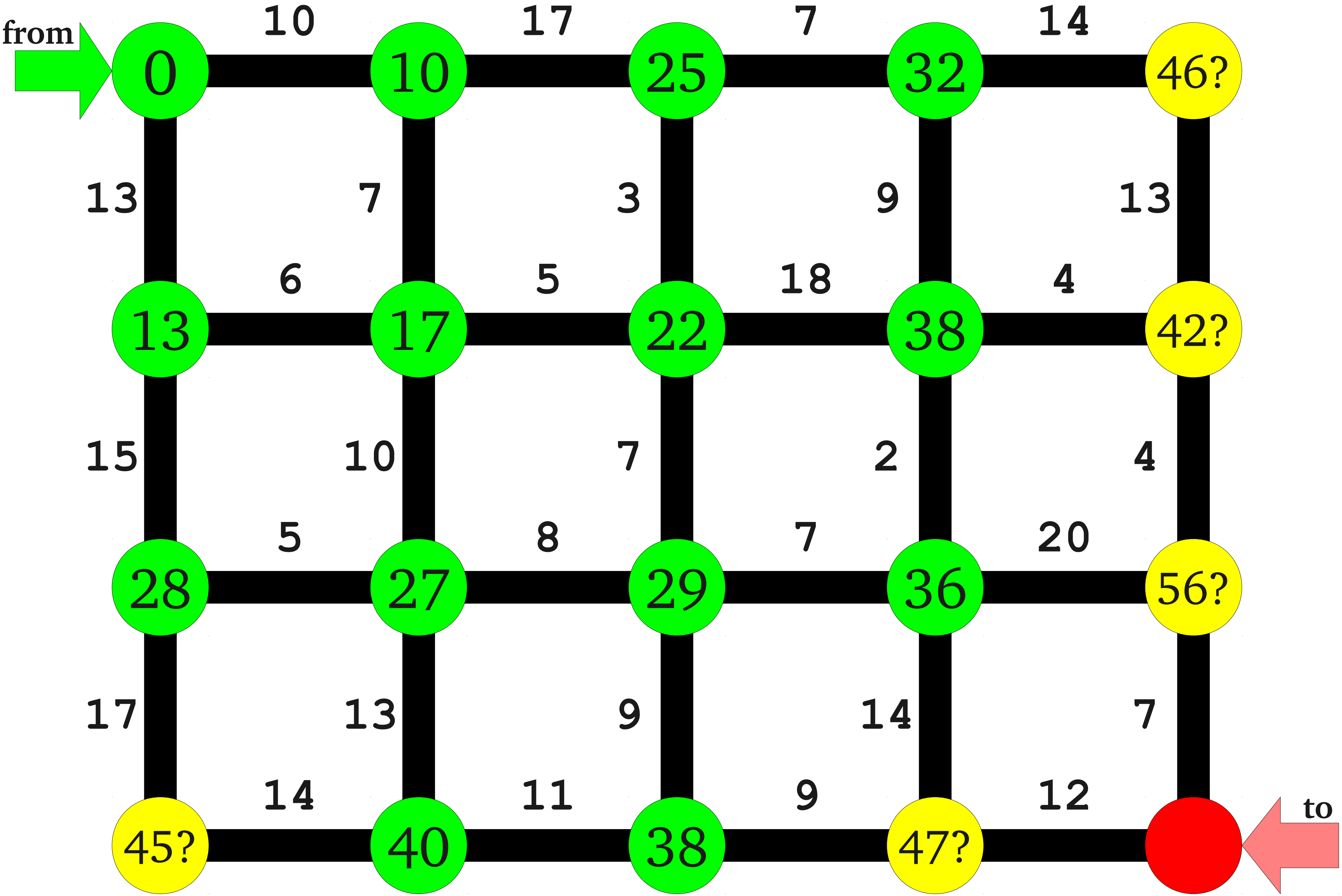
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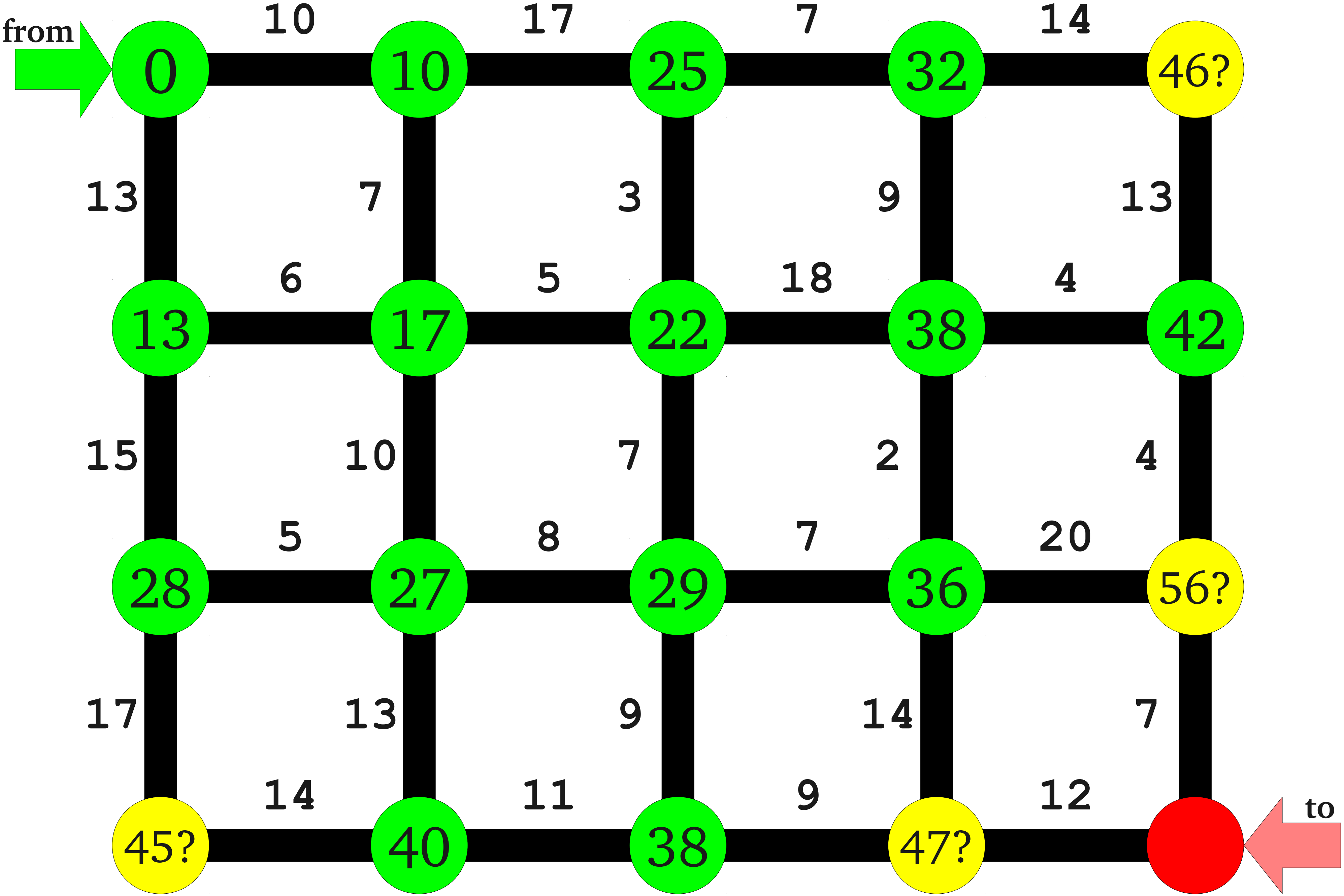
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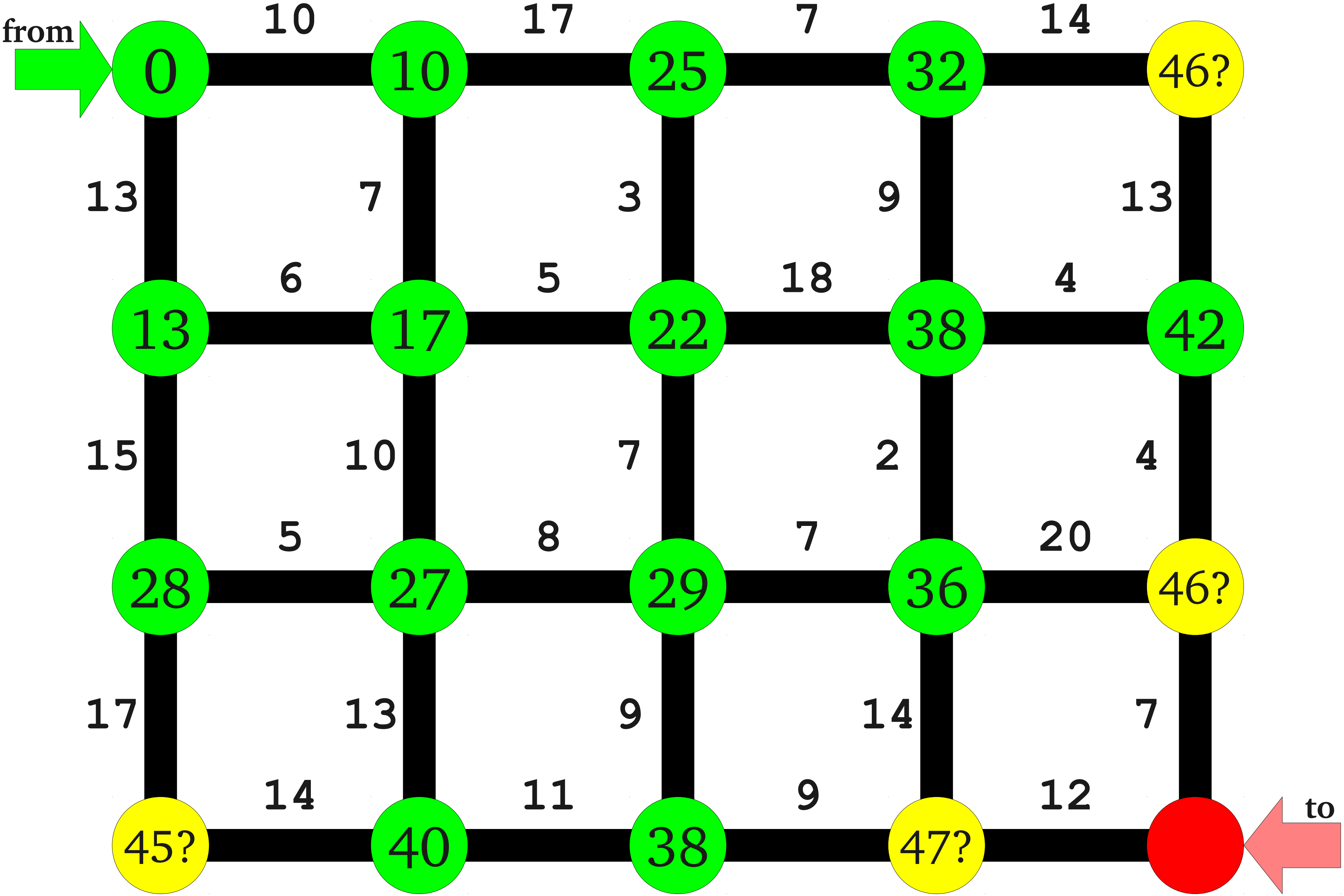
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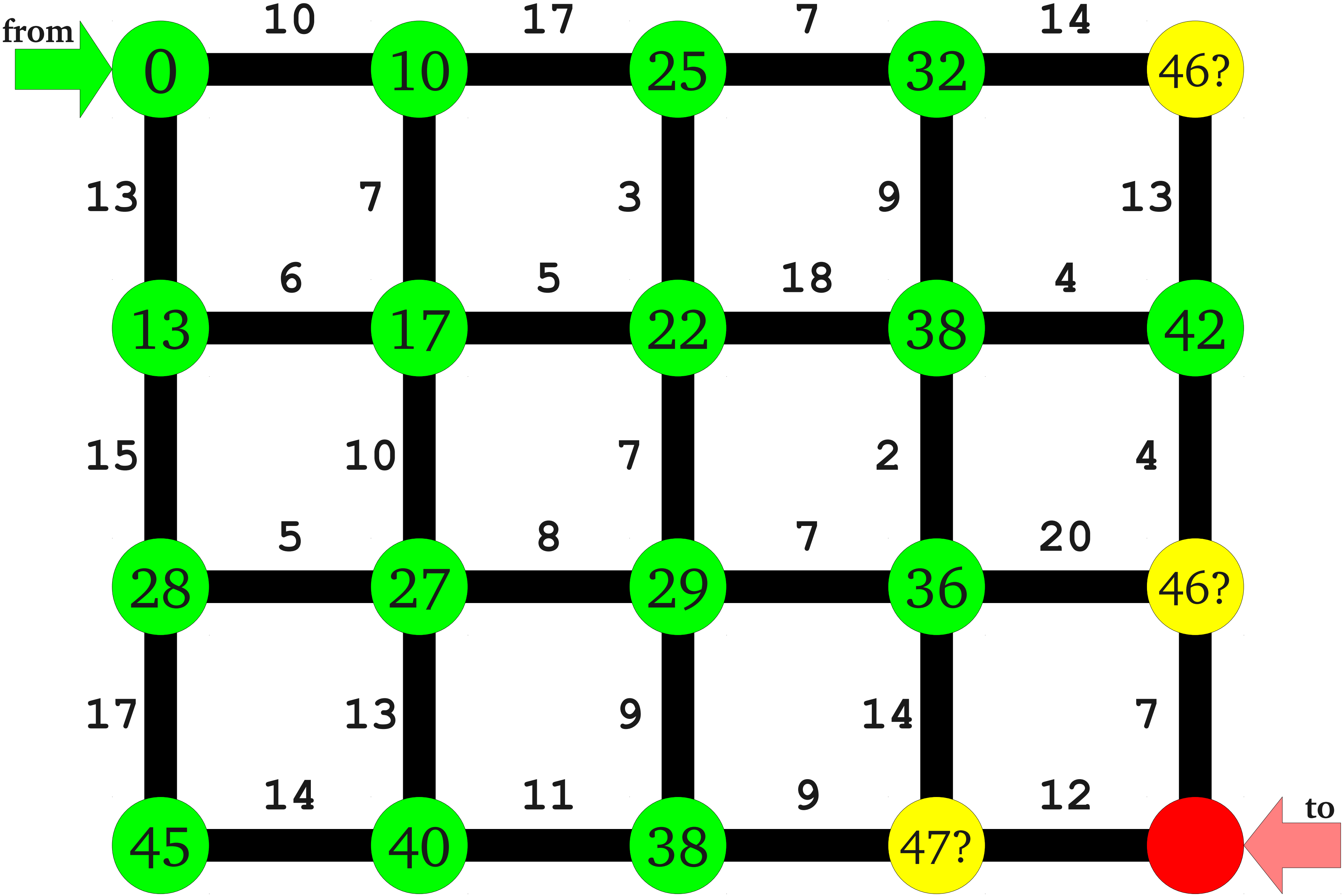
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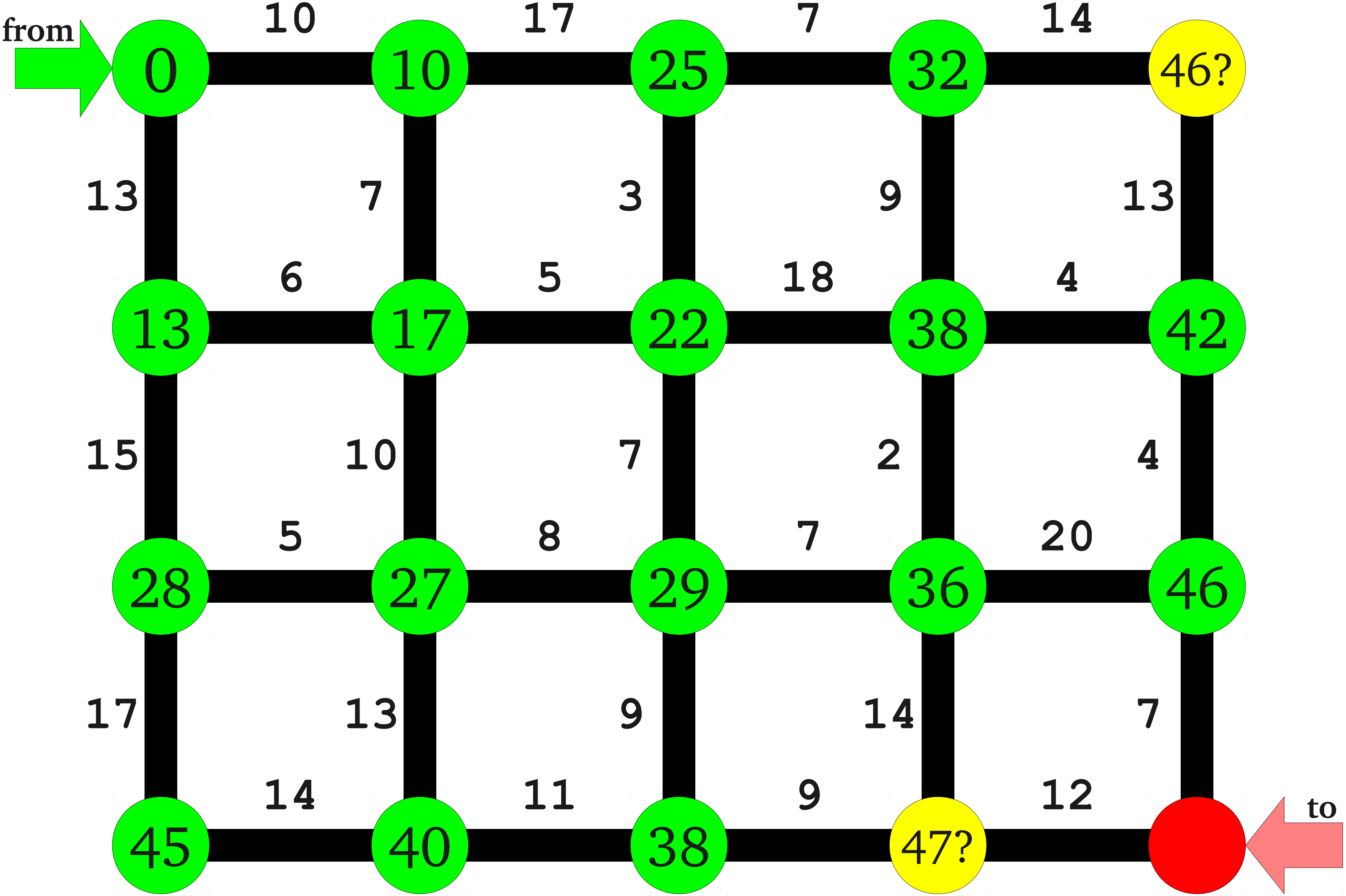
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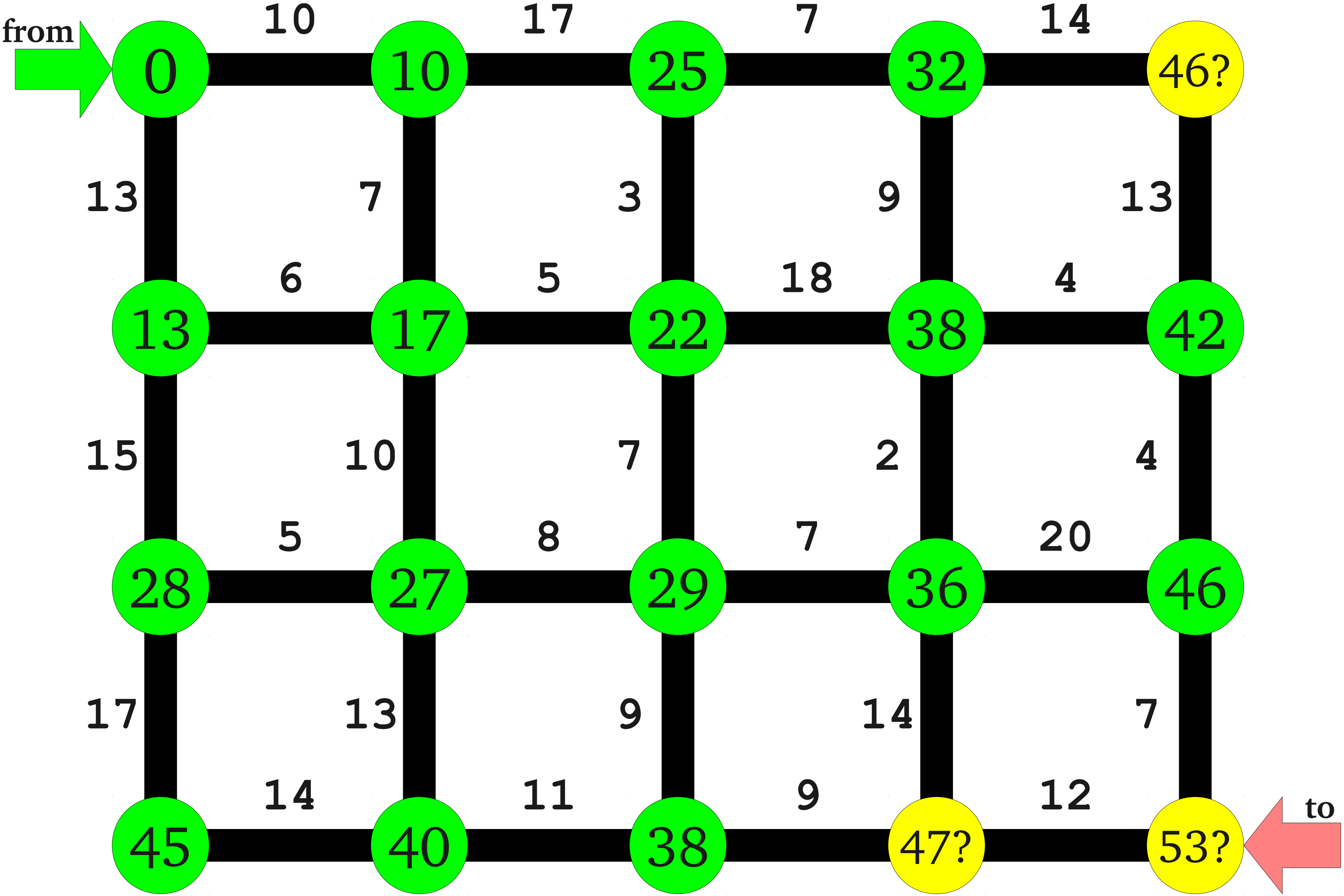
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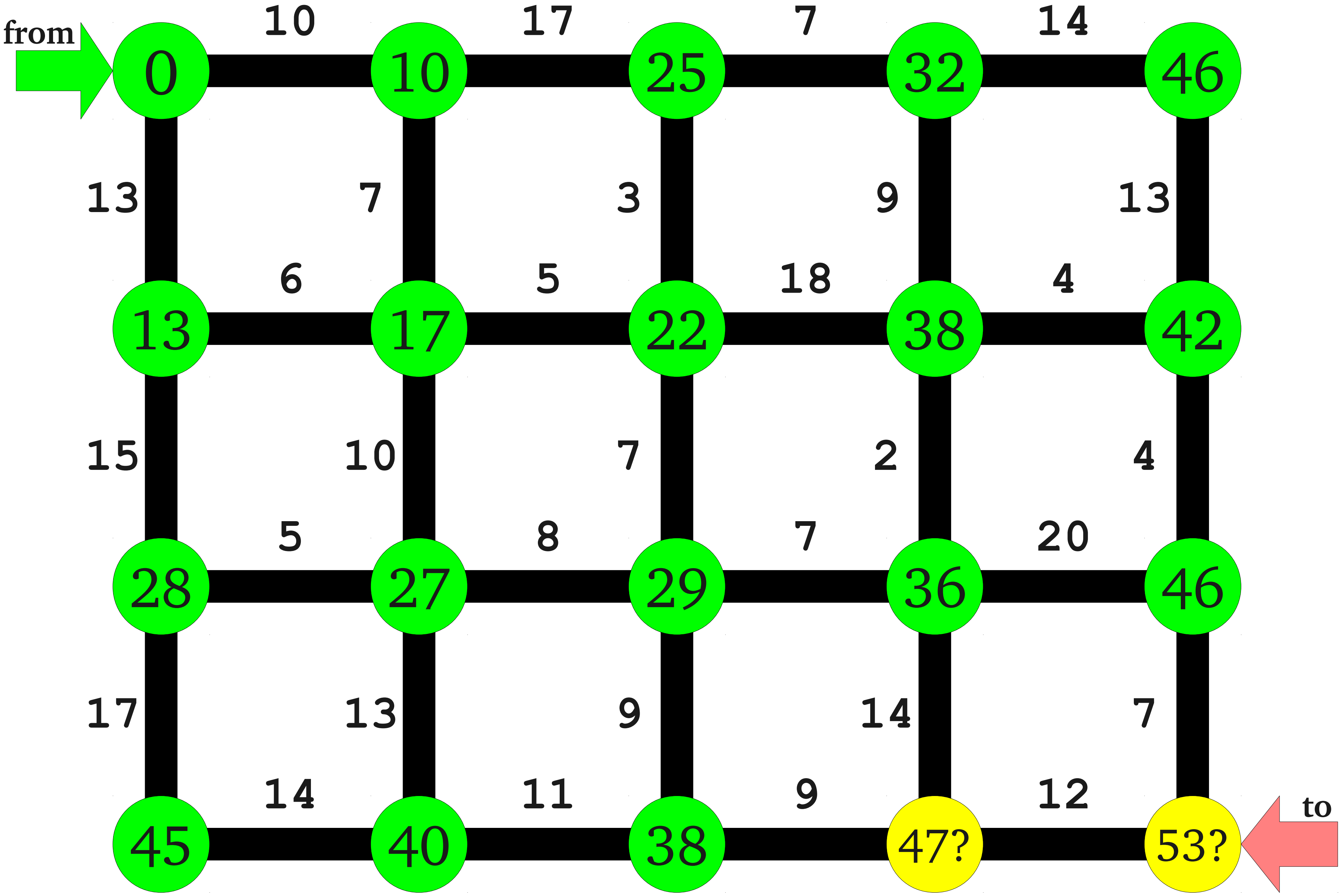
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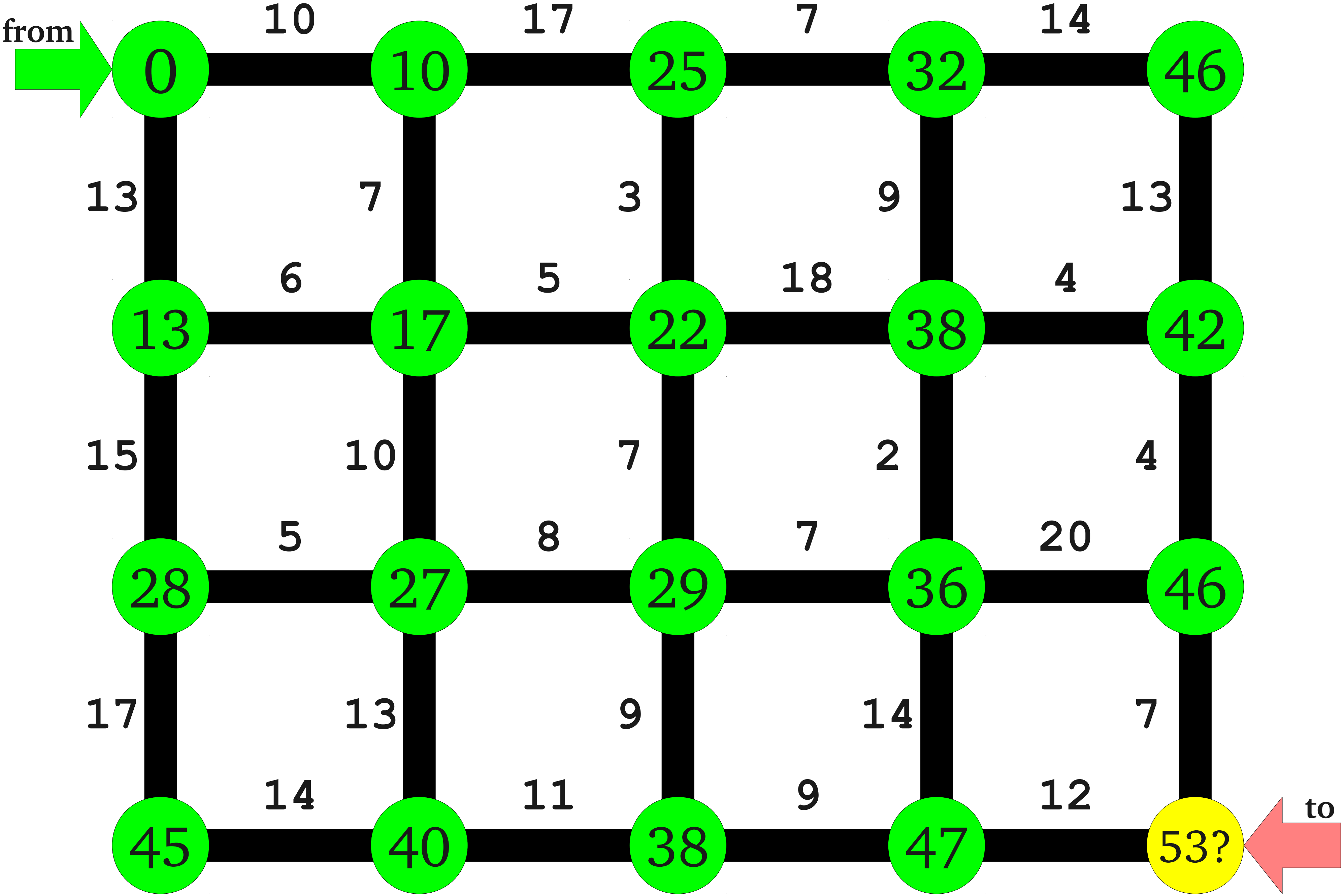
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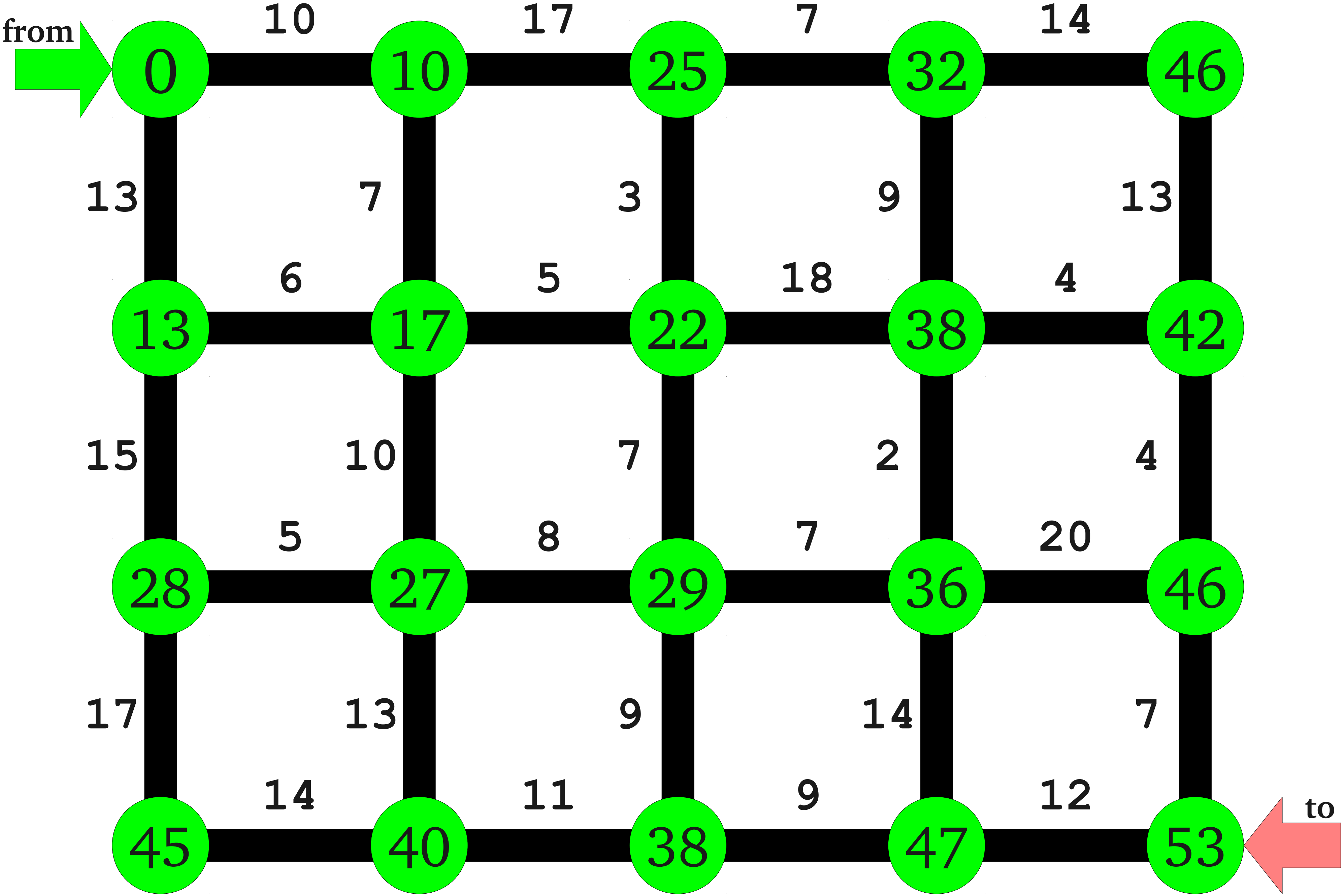
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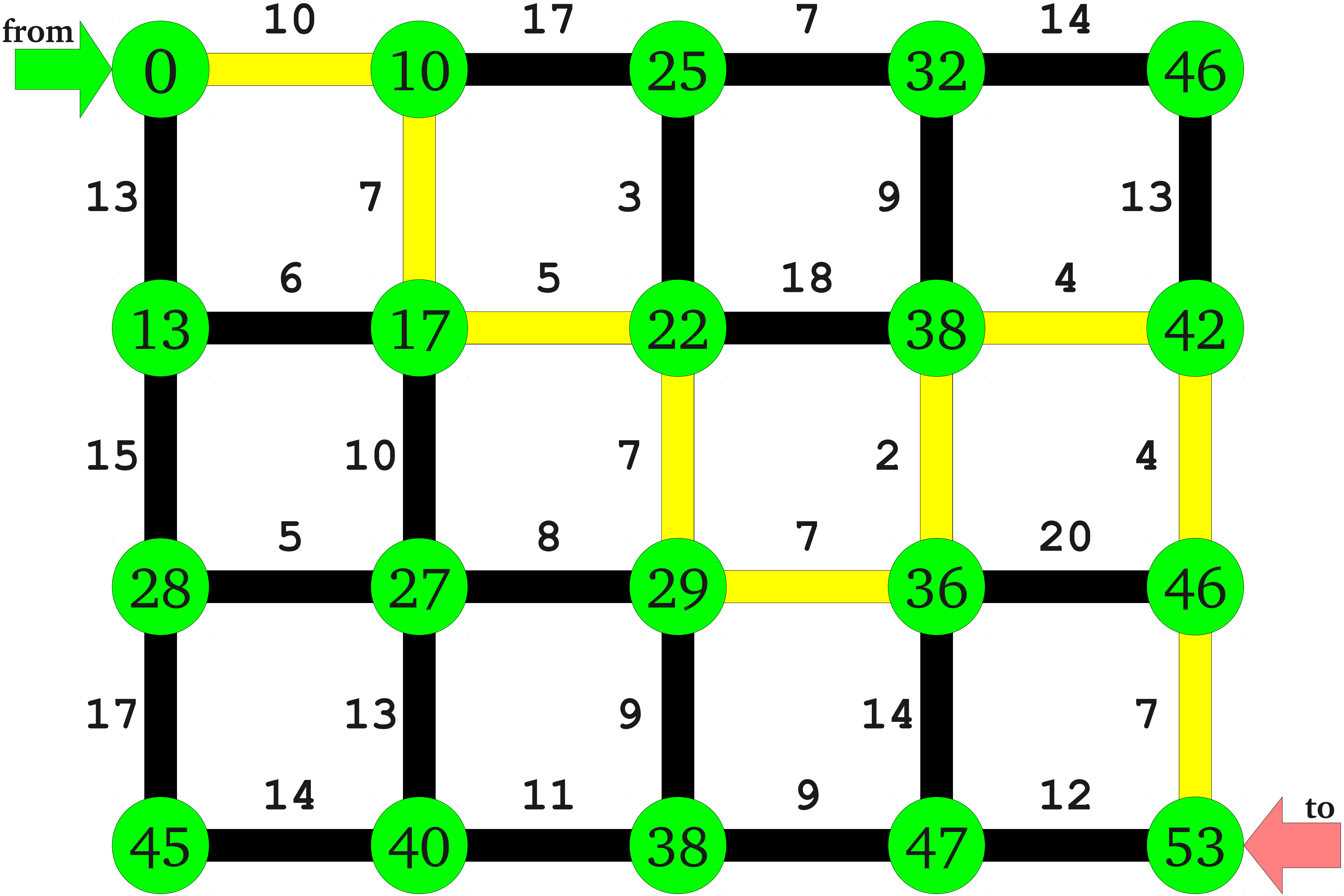
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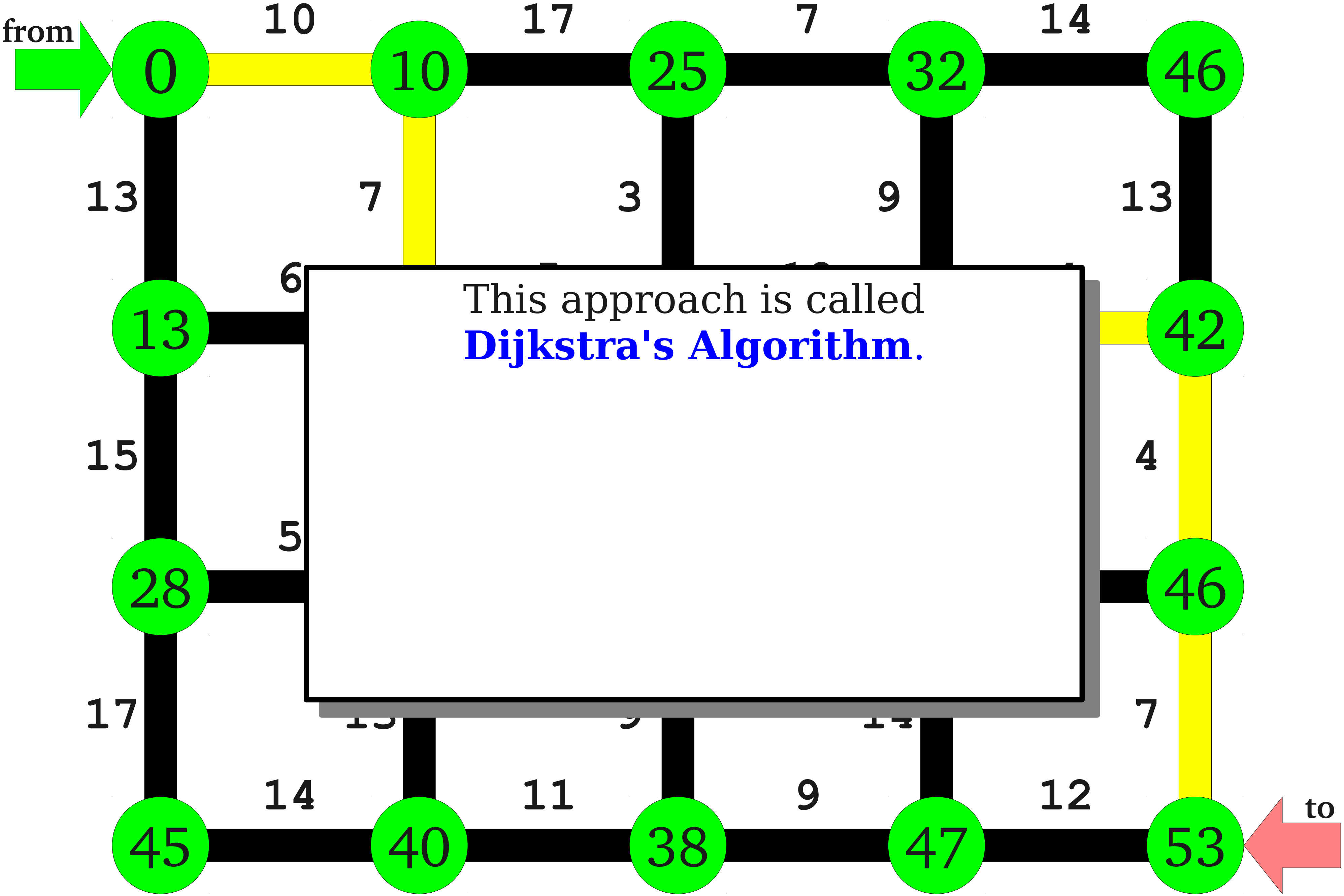
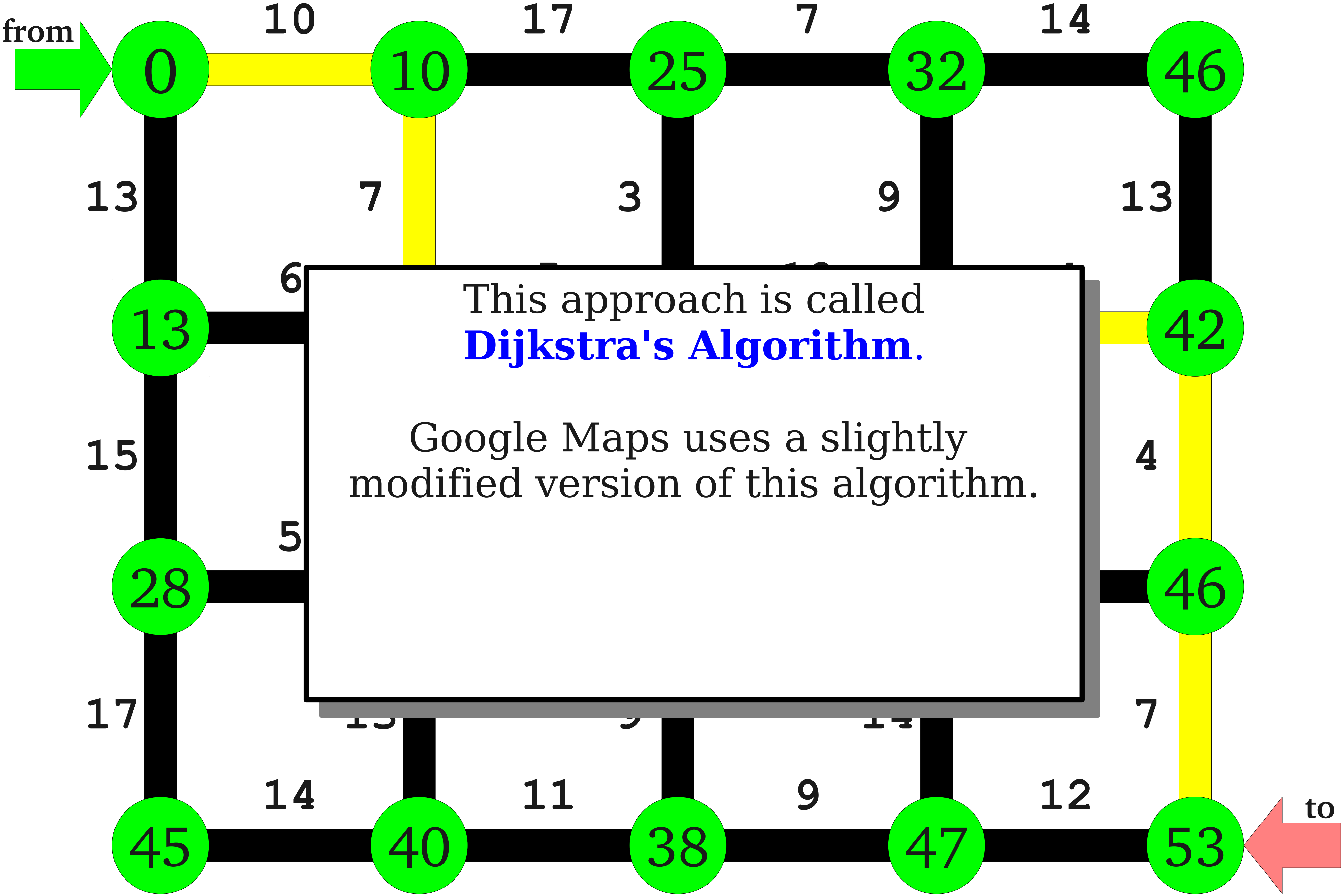
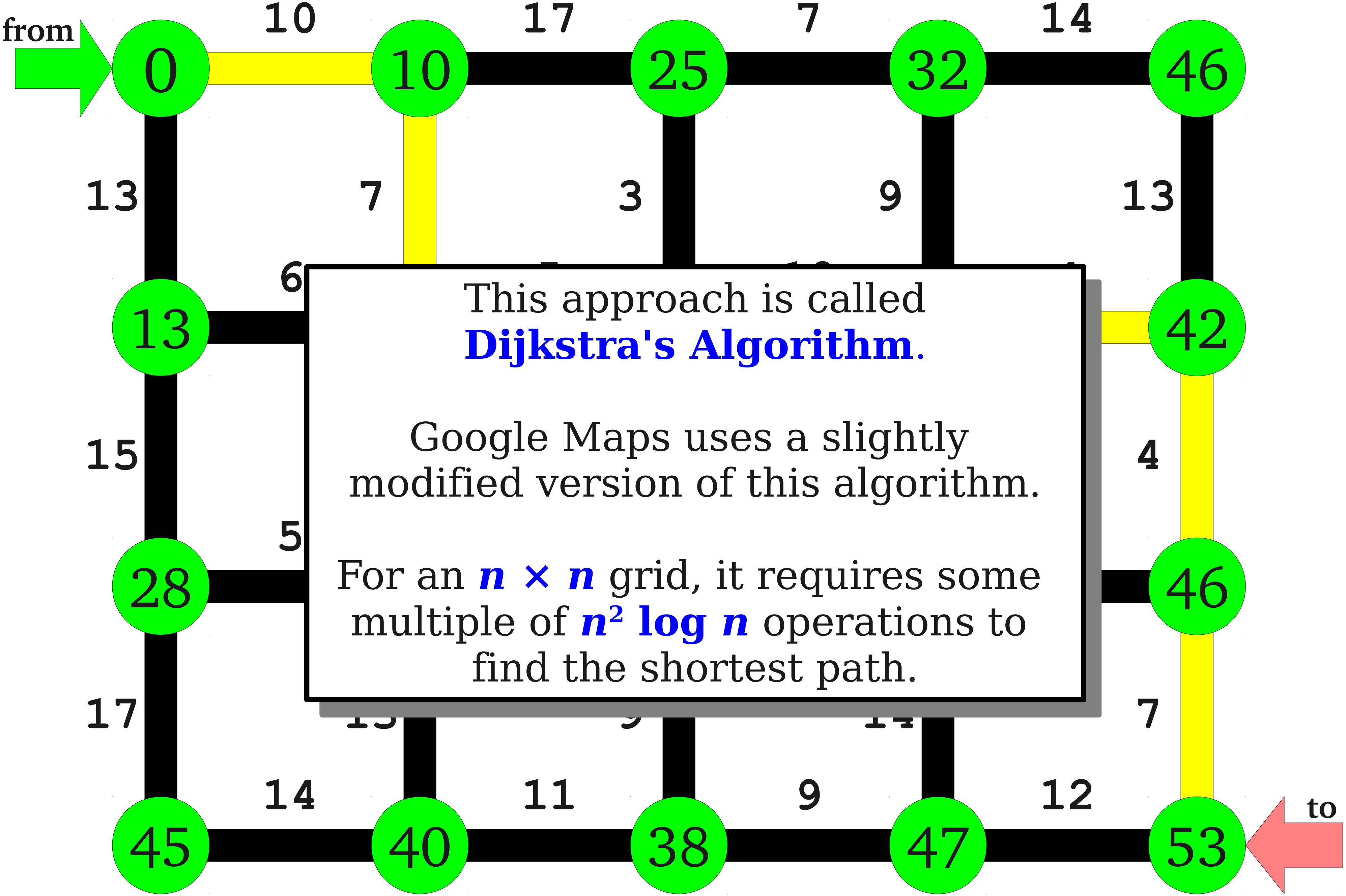


This approach is called
Dijkstra's Algorithm.



This approach is called **Dijkstra's Algorithm**.

Google Maps uses a slightly modified version of this algorithm.



This approach is called
Dijkstra's Algorithm.

Google Maps uses a slightly modified version of this algorithm.

For an $n \times n$ grid, it requires some multiple of $n^2 \log n$ operations to find the shortest path.

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.

Who's Here Today?

- African Studies
- Applied Physics
- Bioengineering
- Biology
- Business Administration
- Chemical Engineering
- Chemistry
- Classics
- Civil and Environmental Engineering
- Computational and Mathematical Engineering
- Computer Science
- Creative Writing
- East Asian Studies
- Economics
- Education
- Electrical Engineering
- Energy Resource Engineering
- English
- Financial Mathematics
- Film and Media Studies
- French
- History
- International Relations
- Japanese
- Law
- Materials Science and Engineering
- Mathematical and Computational Sciences
- Mathematics
- Mechanical Engineering
- Medicine
- Management Science and Engineering
- Modern Language
- Music
- Neuroscience
- Physics
- Political Science
- Psychology
- Science, Technology, and Society
- Statistics
- Symbolic Systems
- Undeclared!

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.

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

#include <iostream>
using namespace std;

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

```cpp
/* 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;
    }
}
```

CS106L

- 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!
- Not a replacement for section; it's purely an add-on.

Next Time

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