Introduction

Welcome to Cross-Number! This companion document will be available to you throughout the entire duration of the round. It's highly recommended that everyone on your team work through all provided examples.

A reminder about difficulty: Puzzles are arranged in increasing difficulty **by section only**. Feel free to skip to different sections, where puzzles may be easier.

Basic Cross-Number

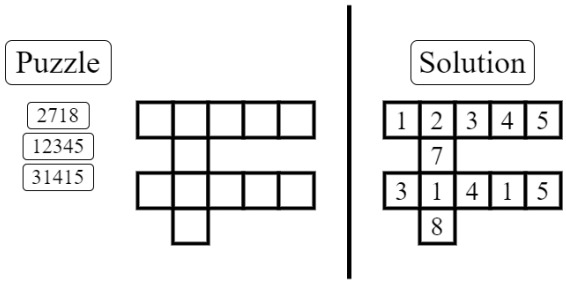
The main goal of a Cross-Number is to use a list of provided numbers to fill in a crossword-like puzzle. A cross-number consists of two components: A grid of squares, and a list of numbers. Place one digit (0-9) in every square in the grid, such that:

Every number listed can be found in the grid as a sequence of horizontally-adjacent digits read left to right, or as a sequence of vertically-adjacent digits read top to bottom, with no additional digits before or after the number (in other words, the first and last digit of every number must be on the edge of the grid).

Every sequence of two or more horizontally-adjacent digits and every sequence of two or more vertically-adjacent digits can be read left-to-right or top-to-bottom as a number listed.

Every number two digits or longer is given: this means no other numbers of length 2 or more may appear in the across or down orientation.

Example. Given the numbers `2718, 12345, 31415`, fill out the following grid:



Compact Cross-Number

The rules for Compact Cross-Numbers are the same as for the basic rules. The name difference is to highlight the different shape and higher amount of intersections of these puzzles.

Blocks Cross-Number

Basic Cross-Numbers omit one rule that will be standard to the rest of the puzzle types.

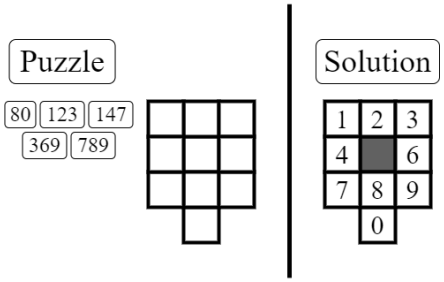
In Blocks Cross-Numbers, some squares may be left unfilled by any digit. These squares are instead marked as *blocks*, which is done by coloring in the square completely.

After placing all blocks, the remaining squares in the grid must be connected. These remaining squares must form a valid cross-number as per the Basic rules.

As before, every number listed must be in the grid as a sequence of horizontally-adjacent digits or as a sequence of vertically-adjacent digits. Every sequence of two or more horizontally-adjacent digits and every sequence of two or more vertically-adjacent digits is listed as a number, so no additional numbers may be present in the grid.

For example, two numbers may occupy the same row or column given that they are separated by one or more blocks.

Example. Given the numbers `80, 123, 147, 369, 789`, fill out the following grid:



Variants

Note that each variant is independent of the other variants; additional rules in the Minesweeper variant do not apply to the Reversible variant, for example.

Variant 1: Minesweeper

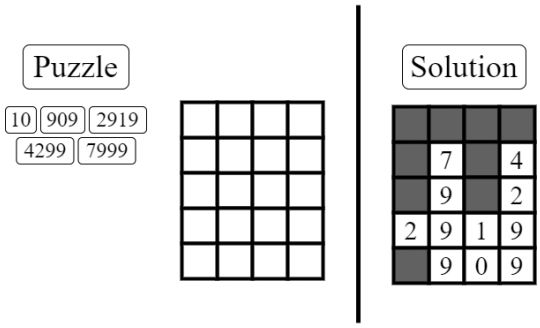
This is a variation of the **Blocks Cross-Number**.

Every digit except 9 must be surrounded by an appropriate number of blocks. The number of blocks neighboring (by neighboring, we mean touching side-to-side or diagonally) a square must equal the digit inside the square. The outside of a grid does *not* count as a block.

If the digit in a square is 9, then *any* number of neighboring squares may be a block.

As before, the remaining squares after placing all blocks must be connected.

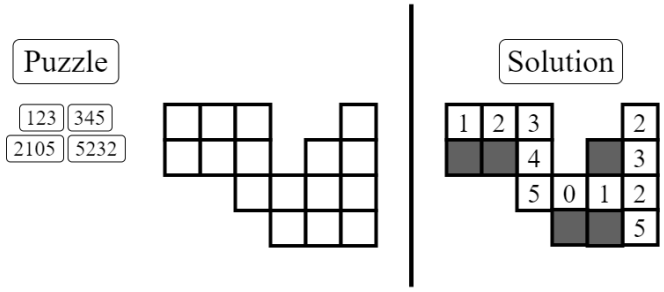
Example. Given the numbers `10, 909, 2919, 4299, 7999`, fill out the following grid:



Variant 2: Reversible

In addition to numbers appearing as a sequence of digits from left-to-right or top-to-bottom, numbers can also appear in the grid reading right-to-left or bottom-to-top. For every sequence of two or more horizontally-adjacent digits, either the number read left-to-right or the number read right-to-left is listed as a number. For every sequence of two or more vertically-adjacent digits, either the number read top-to-bottom or the the number read bottom-to-top is listed as a number.

Example. Given the numbers `123, 345, 2105, 5232`, fill out the following grid:



Note: in this instance we fill in the numbers `2105` and `5232` in reverse order. Reminder: Leading zeroes ARE permitted, so a number like `120` could appear reversed in a puzzle grid.

Variant 3: Clues

This section uses the same rules as the **Blocks Cross-Number**, but the numbers are presented differently.

Instead of providing the exact number, a clue relating to the number will be given. There are some additional pieces of information relating to the position, length, and orientation of the number in the puzzle that may or may not be given.

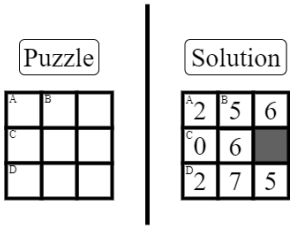
Some letters are provided on the grid in small text. If a clue begins with a letter (with a colon following it), the leading digit of the corresponding number will be placed in the square marked with that letter. If a clue does not have this information, its corresponding number may be placed anywhere in the grid.

Some clues will specify whether the number is to go across or down. If provided, this information will be at the start of the clue before a colon. Numbers with a clue marked "Across" must be placed in horizontally-adjacent cells and read left-to-right, while numbers with a clue marked "Down" must be placed in vertically-adjacent cells and read top-to-bottom. If not provided, the number may go in either orientation.

Some clues will specify the number of digits of the number they refer to, denoted by a number in parentheses at the end of the clue. This number of digits *includes* leading zeroes. If this length is not given, the number may be of any length longer than one digit.

Each number two digits or longer in the grid will have a corresponding clue, and *no other numbers may appear*. As a final reminder, leading zeroes ARE permitted.

For example, consider the following clues and the following grid:

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A across: A perfect 4th power (3)
C across: The sum of its digits is divisible by 6
D across: A multiple of 25
A: A positive multiple of 101
B down: A number with consecutive digits in ascending order (3)
```

Clue Clarifications

Here, we provide some clarifications on some terminology clues may use. Please read this carefully, as misinterpreting a clue makes solving the puzzles correctly impossible. If you are unsure how to interpret a clue during the round, please refer to this clarification section.

Digits refer to parts of numbers, whereas *squares* refer to parts of the grid. All squares are either filled with a digit or marked as a *block*. Blocks are introduced in the Blocks variant.

A *palindrome* refers to the digits of the number in the grid, not the value of the number itself. For example, `020` would be an example of a palindrome in the grid, even though 20 is not a palindrome.

Adjacent digits of a number are ones that are next to each other when the number is written down. *Consecutive* digits are ones that differ by 1 from each adjacent digit, and are in increasing or decreasing order. Digits forming a *consecutive set* are ones that could be rearranged to form consecutive digits.

For example, in the number 5836, 5 and 8 are adjacent but not consecutive. On the other hand, in the number 512943, all of the digits except 9 form a consecutive set, despite not being adjacent. The numbers 456 and 765 are both examples of numbers with consecutive digits.

A *semiprime* is a number that is the product of exactly two prime numbers. For example, $15 = 3 \cdot 5$ is a semiprime.

Two numbers are *coprime* if the only factor they share is 1. We consider 1 to be coprime with every integer, and 0 to not be coprime with any positive integer except 1.

Basic

10 points

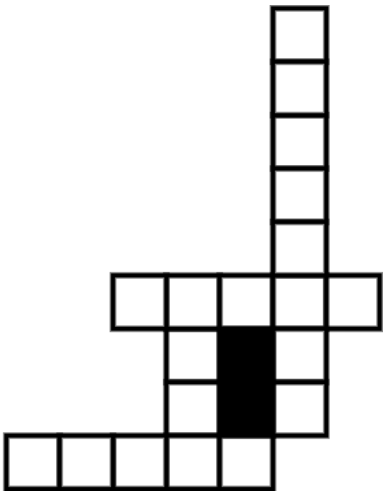
Basic 1

2023

32768

65536

52200625



11 points

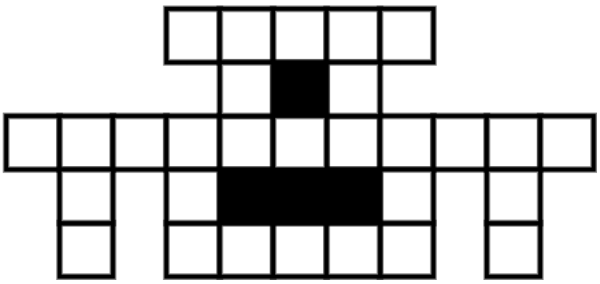
Basic 2

251 252 352

353 354 451

12121 41212

24232513232

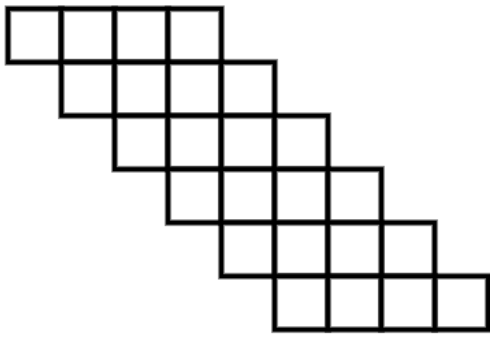


Compact

12 points

Compact 1

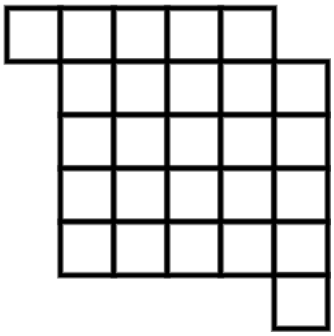
21 81 266 686
1614 1616
1841 1862
2428 4282
6141 6261
8468



12 points

Compact 2

10053 20469
23083 34262
40879 43149
48460 65608
97608 99836



Blocks

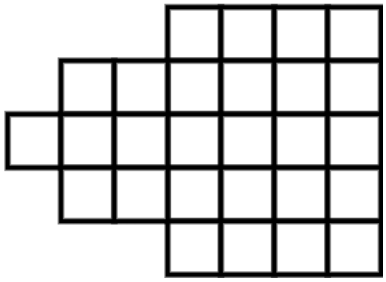
11 points

Blocks 1

3344

33344 44455

1223224



12 points

Blocks 2

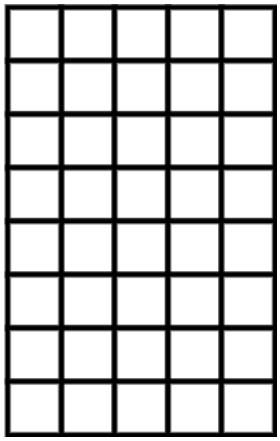
11111 11111

11111 21112

111112

2111111

2111111



15 points

Blocks 3

1130411 2230422

2233311 2244411

11444055522

33666044411

44111011166

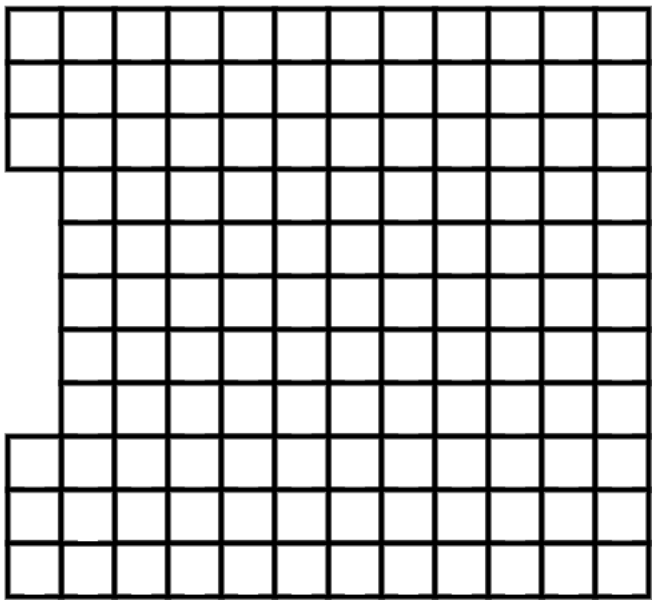
55222022244

711555044433

722444066611

744222011166

755222011144

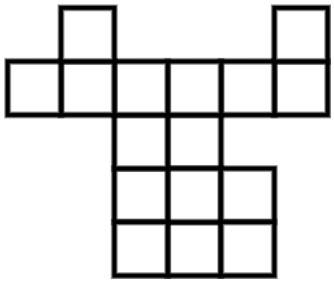


Minesweeper

11 points

Minesweeper 1

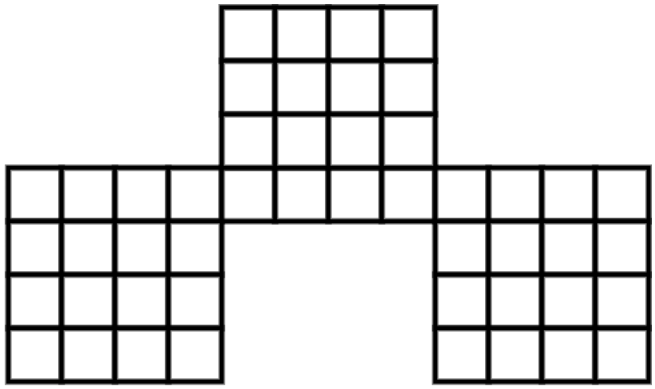
10 21 90
229 912
119921



12 points

Minesweeper 2

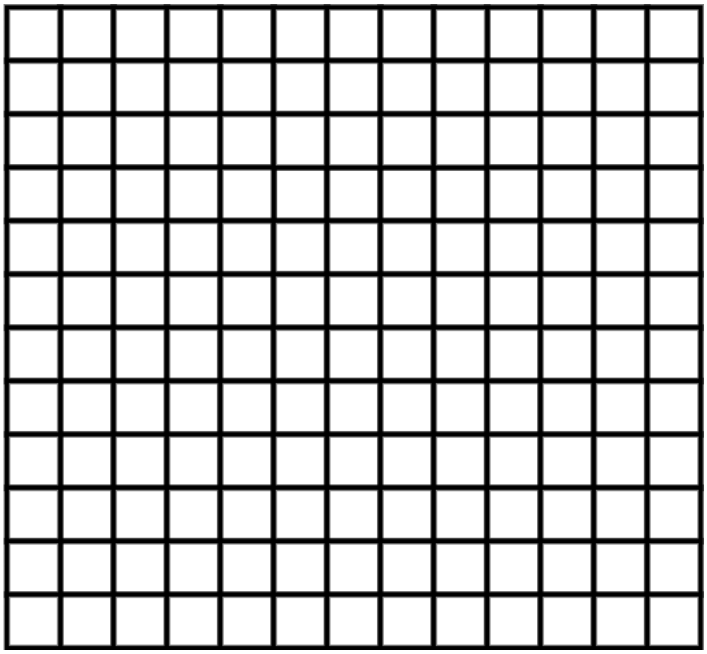
09 14 42
66 92 99
190 296
1992 2999
9232 9999
222222222119



15 points

Minesweeper 3

01 02 02
10 14 14
29 92 536
924 4959
7544 74947
99567 6994993
7494942
2944999695
2499655996694

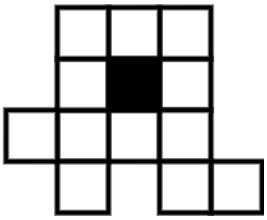


Reversible

11 points

Reversible 1

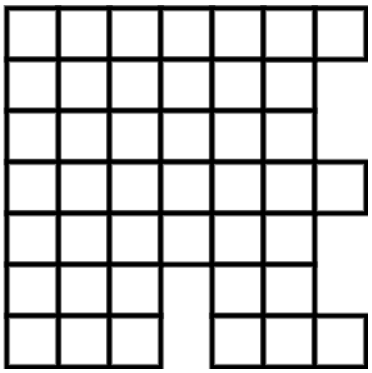
26 246 0906
1086 2306



13 points

Reversible 2

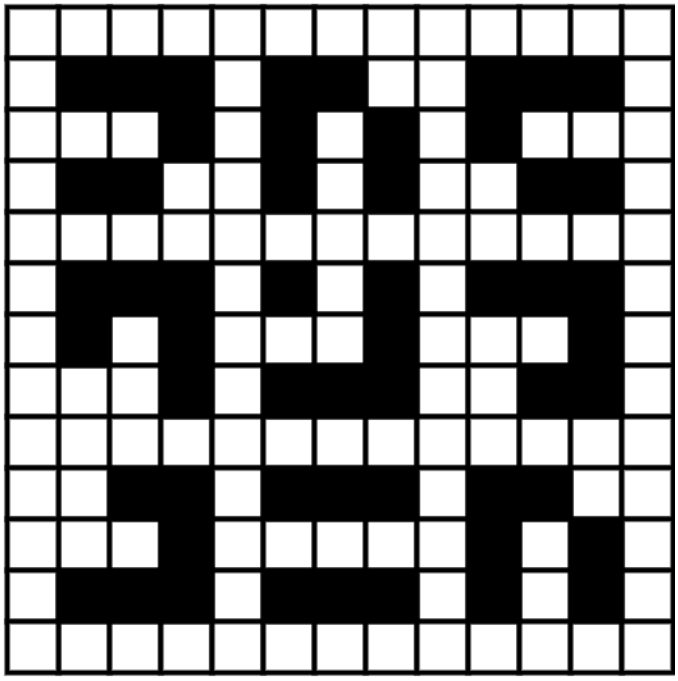
77 184 282 777
1005073 1706004
1739483 2005004
6059506



14 points

Reversible 3

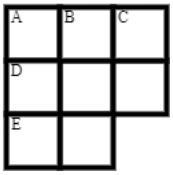
12 12 12
14 15 15
16 17 18 19
021 022 023
024 025 026
028 214 218
1812
02720 62029
1333211135554
1666377759992
1666544434442
1999377728884
2888577718883
2999122252223
3555133321114
3555244416664



Clues

11 points

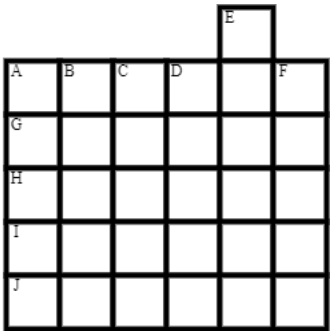
Clues 1



A Across: A number with only even digits, in strictly descending order (3)
D Across: A number not divisible by 9 (3)
E Across: A number divisible by 11 (2)
A Down: A number with consecutive digits, in ascending order (3)
B Down: A number where the product of the lesser-valued two digits is equal to the largest digit (3)
C Down: A prime number greater than 10 (2)

14 points

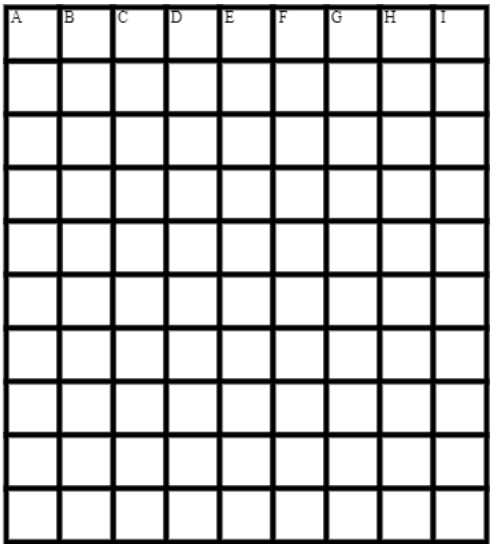
Clues 2



A Across: This palindrome is a multiple of 4
G Across: This odd number's digits are in strictly descending order
H Across: This number has exactly two distinct digits (4)
I Across: This number starts and ends with the same digit (4)
J Across: This number is the product of B Down's digits, and its leading digit is 2
A Down: This number only has even digits
B Down: The product of this number's digits has exactly 4 distinct prime factors
C Down: Each digit of this number is 2 more than some digit of D Down
D Down: Each digit of this number is 2 less than some digit of C Down
E Down: This number is less than 10, and the number of blocks in the grid is half of this number. (2)
F Down: Its digits are in strictly ascending order, and 4 of these digits do not appear in any other number in the grid (5)

16 points

Clues 3



A Down: The only number in this grid with every digit 0-9
B Down: The only number in this grid with repeated digits, with all 3 distinct odd digits placed above all 7 even digits
C Down: Adjacent pairs of digits of this number are not consecutive (7)
D Down: A perfect 8th power of a prime number (7)
E Down: The only number greater than 100 with only even digits (4)
F Down: A number with only prime digits (4)
G Down: 4 more than H Down, and the only number in this grid with a unique length (number of digits)
H Down: The only number in this grid that shares a prime factor with every other number in the grid (2)
I Down: An even number, and the only number in this grid filling squares that aren't filled by any other number (6)
Across: A factorial (2)
Across: A number whose digits don't appear in either the number immediately above it, or the number immediately below it (4)
Across: A number with only composite digits, with the first three digits forming a decreasing geometric sequence (4)
Across: A semiprime within 16 of both the number immediately above it, and the number immediately below it (2)
Across: An even number with three consecutive digits in ascending order, the smallest of which is larger than this number's length (6)
Across: The last four digits of this even number are present in reverse order in I Down, one of which is 5 (9)
Across: The only number in the grid greater than 100 with digits in descending order (4)
Across: The only number in the grid with a leading zero, and all of its nonzero digits form a consecutive set (7)
Across: The sum of the digits of the number immediately above it in the grid (2)

Across: This number ending in 2 has one pair of adjacent digits that are not coprime (9)