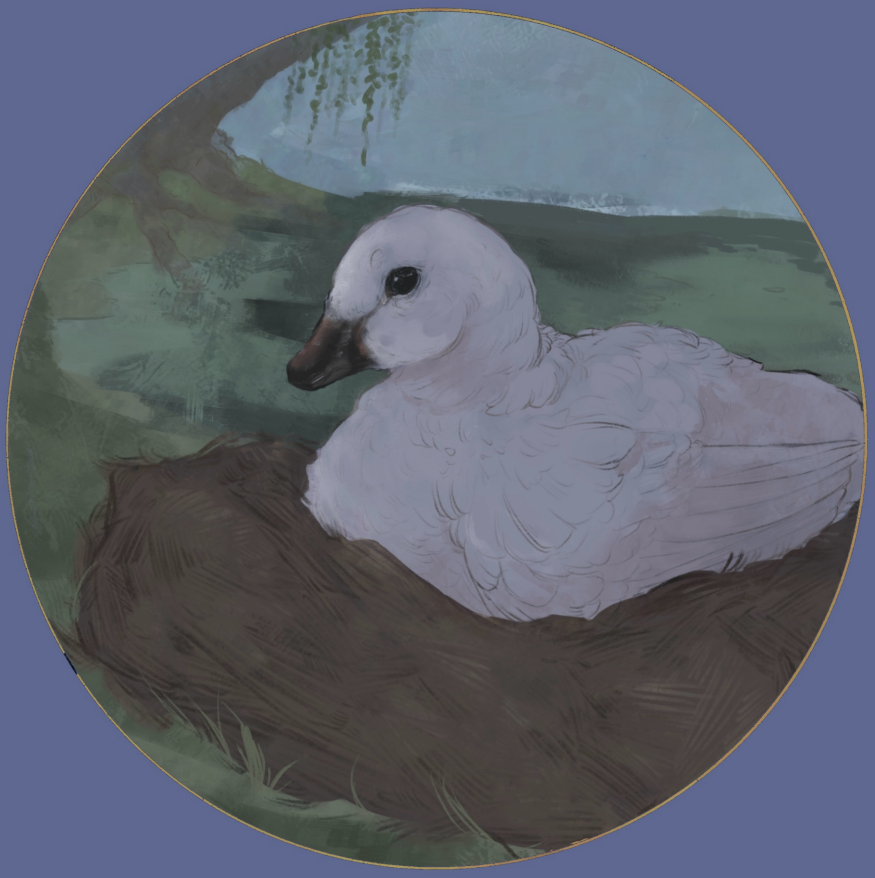
Cygnet Sudoku
Volume I



Cygnet Sudoku Volume 1

Fall 2023

Puzzle Constructors

Adam
ArkAngel0
bitmask
Bronze
Chaos
Coredump110010100
Falconi
GlitchHorse
GoldenGate
Hallalujah
Kwame
Ms. Peacock
Nash
Roundout
Scaly Griffon
Stuart

Edited by FullDeck and Missing a Few Cards

This edition first published in 2024.

Original cover art by Nikolai Gallagher.

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ISBN (paperback) 979-8-89298-943-5

Contents

Foreword

This book is the result of a class project in our Puzzles and Paradoxes course. Sixteen students went from never having seen variant sudoku, to solving others' puzzles, documenting their solves, and finally setting variant sudoku puzzles of their own. Watching their growth as solvers and setters has been a source of tremendous joy for us. One of the questions we are often asked is: how did we first find variant sudoku ourselves?

In March 2020, at the beginning of the COVID lockdown, I (Missing a Few Cards) responded to a YouTube recommendation to watch the Cracking the Cryptic sudoku and cryptic crossword solving channel. I was instantly hooked, especially as they started solving more and more interesting variants. Some time later, once society started opening up again, I managed to persuade my long-time friend, FullDeck, to watch a few of the more spectacular videos. She was also instantly hooked. In December 2021, she surprised me with a Christmas gift: a puzzle she had created. I had never seriously considered that ordinary people could *set* puzzles, and asked her to teach me how to do it.

We started setting puzzles together and have published consistently ever since as FullDeck and Missing a Few Cards, occasionally collaborating with other setters, such as BremSter, Crusader175 and Dream Librarian. Some of our puzzles are credited

as MissingDeck, a portmanteau of our two setting pseudonyms or, as we prefer to call them, our sudokunyms.

Eager to share our love of puzzles, we proposed an honors seminar on Puzzles and Paradoxes at our university. That course was approved and first offered in Fall 2022. A significant portion of the course dealt with variant sudoku, and we learned that we could in fact teach students to solve and even set good variant sudoku puzzles. Several of our students' puzzles were featured on BremSter's Puzzles YouTube channel, and one student, Lumos, even recorded video solves as guest features for BremSter. At the request of the students, we established an ongoing variant sudoku project, 9×9*: Building Math Identity One Digit at a Time*, through our university's undergraduate research program. Many of the Fall 2022 students continue to set puzzles either through that program or independently after graduation.

In Fall 2023, we taught the Puzzles and Paradoxes course again. This time, with greater confidence in our ability to support students in their growth as constructors, we challenged them to produce a series of puzzles good enough to put together as a puzzle pack. We were initially hoping to curate a collection of 16 puzzles, one from each student. Every puzzle put in for consideration was tested and reviewed by the students in the class as well as by us. As the puzzles flowed, we found it impossible to choose just 16. We realized we needed to include all of the ones that passed testing. We also decided to produce a physical book for the class to keep as a memento of the course, and to make it easier to share their puzzles with the wider world.

The title of this book, Cygnet Sudoku Volume 1, comes from the name chosen by the 2022 class: the first puzzle they set was set collaboratively as a whole class suggesting constraints. The result was rather messy looking, and had yellow lines throughout the grid: they decided it looked like an ugly duckling and the name MissingDuck and the Ducklings came to be. Now, though, we feel that our students are not ducklings, and neither

they nor their puzzles are ugly! Indeed, we feel they are developing instead into swans, although still at an early stage, hence: Cygnet Sudoku. We have been audacious enough to call this Volume 1 since we intend this to be a continuing series, both through repeated offerings of the puzzles course, and through the ongoing work in the 9×9 Project. We hope to have Volume 2 appear in mid-2024.

The 65 puzzles in this volume are arranged roughly by difficulty based on testing and feedback from the class. All of the puzzles have been thoroughly tested and can be solved by humans, without guessing or extensive pencil-marking. See the Solving Online chapter starting on page 85 for information about effective ways to use corner and centermarks to help you track deductions and use them to solve puzzles. If you choose to solve online (which we highly recommend), you will get confirmation that your solution is correct once you complete the puzzle. If you want to avoid typing in the short links, you can find a PDF of this book with clickable links on our website:

`https://missingdeck.net/cygnet1.html`

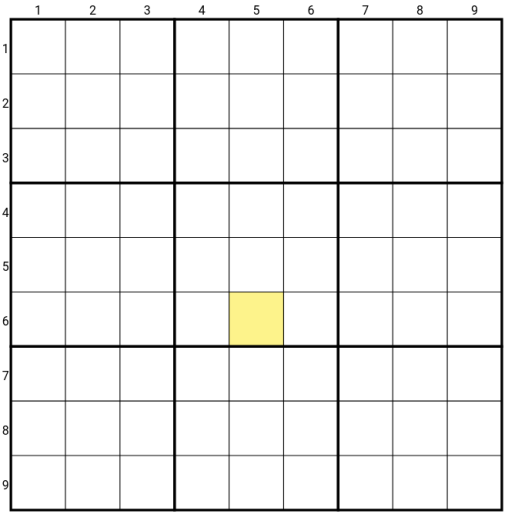
At the end of the book, you will find an alphabetical list of puzzles, as well as a setter index, so that you can locate specific puzzles or constructors easily within the collection.

As our friend BremSter says, good luck with your solving!

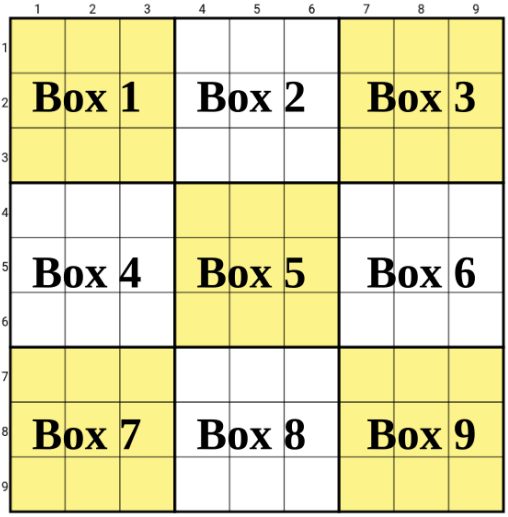
FullDeck and Missing a Few Cards
December 2023

Variant Sudoku

What is variant sudoku, and how does it differ from classic sudoku? Both forms have a (typically) 9×9 grid, with the grid composed of nine 3×3 square boxes. Individual cells are referred to by row and column number, so that r6c5 refers to the cell in row 6 (counting from the top to bottom) and column 5 (counting from left to right).



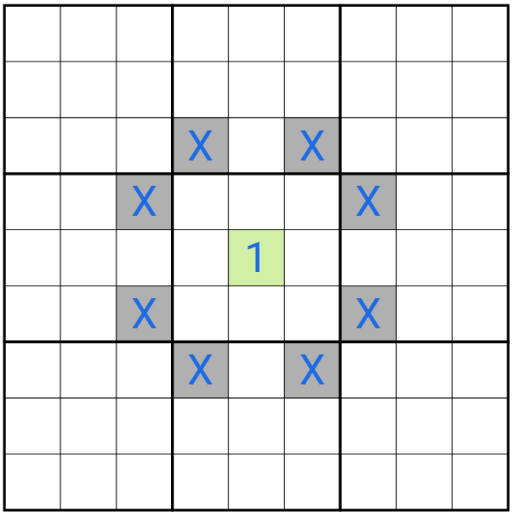
The boxes are labeled 1-9, with boxes 1, 2, 3 in the top band; 4, 5, 6 in the middle band; and 7, 8, 9 in the bottom band of three boxes.



In classic sudoku, the starting grid is populated with some given digits, and the goal is to fill the entire grid with digits 1-9 so that every row, column and box contains a complete set of the digits 1-9. It is known that for a classic sudoku puzzle to have a unique solution it must have at least 17 given digits, although many more may be necessary depending on their placement. Often, the number of given digits is used as a proxy for difficulty – the fewer the given digits, the harder the puzzle is assumed to be – although there are lots of examples demonstrating that this is a poor proxy.

In variant sudoku, extra types of clues are included, other than given digits. These may involve certain types of lines in the grid (palindromes, thermometers, arrows, modular lines, renbans, between lines, and more) or other symbols indicating re-

lationships between cells (kropki dots, quadruples, Xs, Vs, and more). Sometimes the additional rules needn't have any symbols or digits given at all! Such rules might involve restrictions on how digits are positioned relative to each other. For example, in an antiknight puzzle, digits that are a chess knight's move apart must be different. In this antiknight puzzle, 1 cannot appear in any of the cells marked with an 'X', since each of those cells could be reached in a single move of a chess knight from the 1 in the green cell.



The constraints used for each puzzle in this book are stated in full with the puzzle, and should be self-explanatory. If you need further explanation, though, please reach out to us at `mailto:fulldeck@missingdeck.net`. For tips on how to use the online solving platform, see the Solving Online chapter starting on page 85 or check out some of our videos about learning to solve variant sudoku at `https://mdp.tiny.us/learning-videos`.

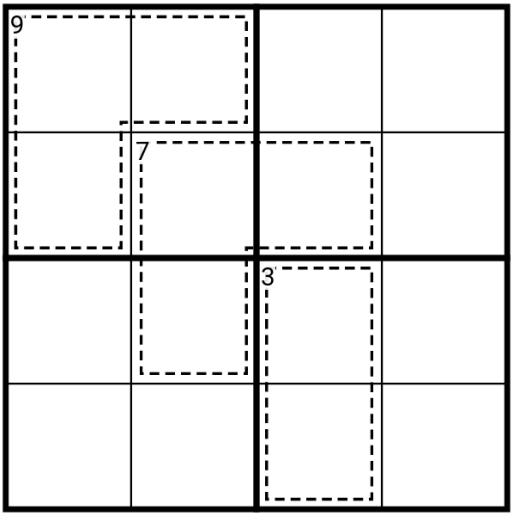
Introductory Puzzles

The puzzles in this section are all either 4×4 or 6×6 puzzles designed to introduce core ideas for some of the constraints used later in the book. Most are solvable with little to no pencil-marking. As with all of the puzzles in this book, we recommend solving online, rather than on paper.

Do not, however, be taken in by Wittle Kiwwas! Despite its disarming title and inclusion in this section, it has some sophisticated logic that may be a challenge for newer solvers.

Assassin's Apprentice

by Stuart



Rules:

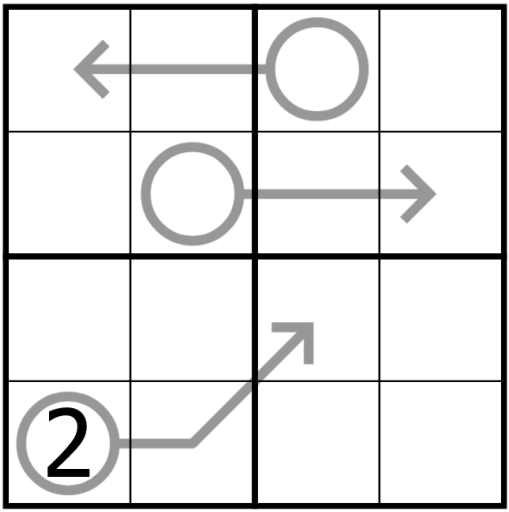
• *Normal* 4×4 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-4.

• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

`https://sudokupad.app/wkaw3xlvyu`

Intro to Arrows

by Adam and GoldenGate



Rules:

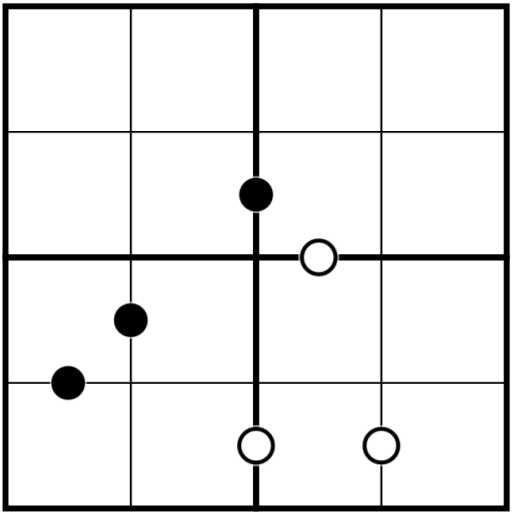
• *Normal* 4×4 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-4.

• *Arrows:* Digits along an arrow must sum to the number indicated in the circle from which the arrow emerges.

`https://sudokupad.app/rguhb6oixj`

Intro to Kropki Dots

by Nash



Rules:

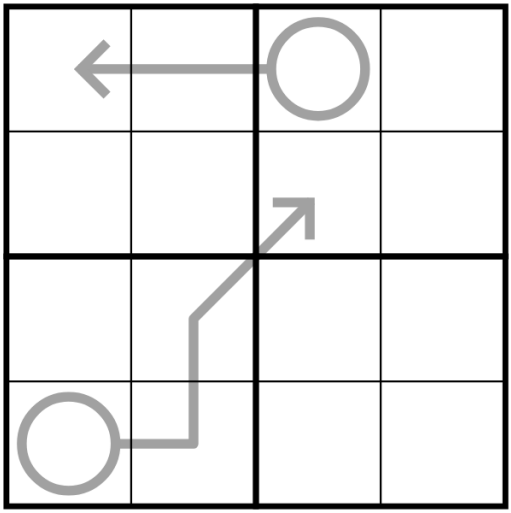
• *Normal* 4×4 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-4.

• *Kropki Dots:* Digits separated by a black dot are in a $1 : 2$ ratio. Digits separated by a white dot are consecutive. Not all dots are necessarily given.

`https://sudokupad.app/mt0b2jsjl8`

Beginner Arrows

by GoldenGate



Rules:

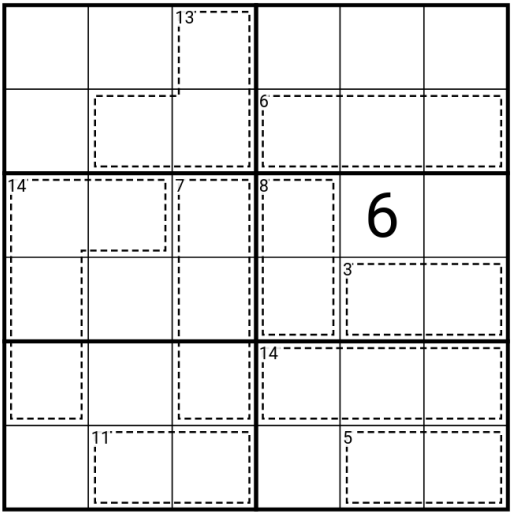
• *Normal* 4×4 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-4.

• *Arrows:* Digits along an arrow must sum to the number indicated in the circle from which the arrow emerges.

`https://sudokupad.app/u4aunbn39s`

First Kill

by Kwame and Falconi



Rules:

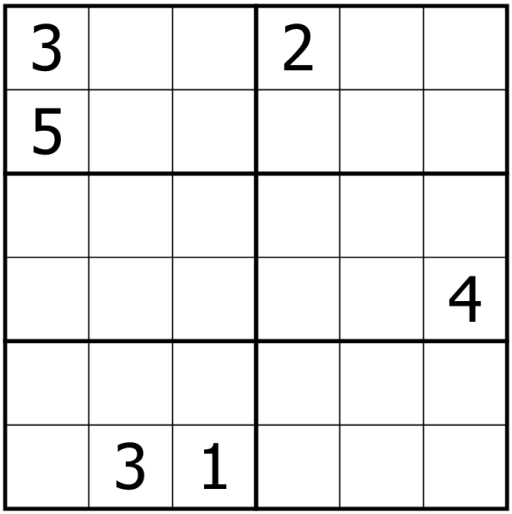
• *Normal* 6×6 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-6.

• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

`https://sudokupad.app/uy95je9ot1`

Roped Into It

by bitmask and CoreDump110010100



Rules:

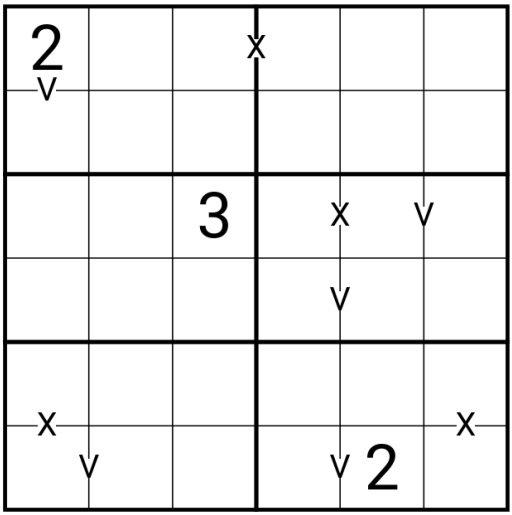
• *Normal* 6×6 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-6.

• *Antiknight:* Cells that are a chess knight's move apart cannot contain the same digit.

`https://sudokupad.app/50fe8wvvoc`

Xtremely Good Vibes

by Hallalujah



Rules:

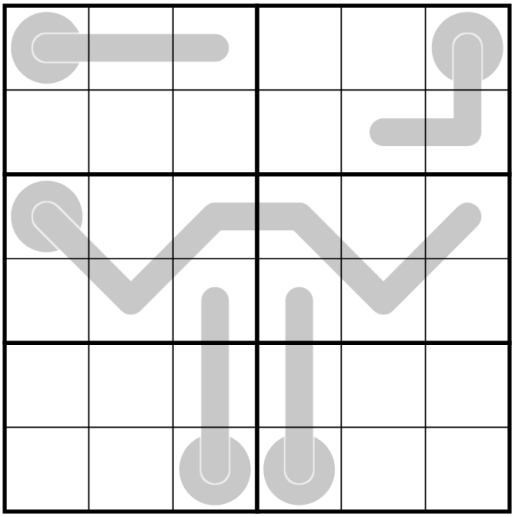
• *Normal* 6×6 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-6.

• *XV:* Digits separated by a V must sum to 5. Digits separated by an X must sum to 10. Not all Xs and Vs are necessarily given.

`https://sudokupad.app/kk0yl3kwqr`

Circuits

by Chaos and Roundout



Rules:

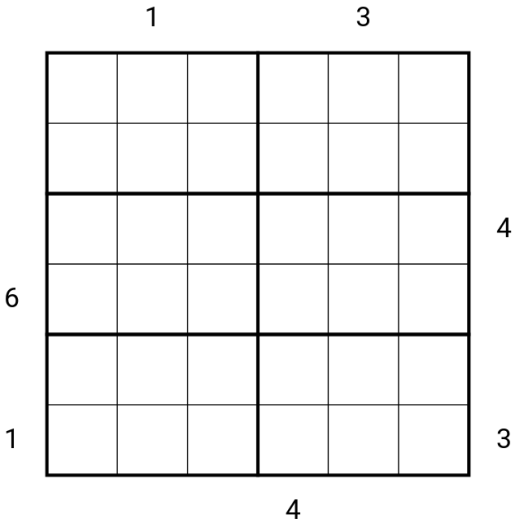
• *Normal* 6×6 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-6.

• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

`https://sudokupad.app/x4kztuojes`

Beginner City

by ArkAngel0 and Bronze



Rules:

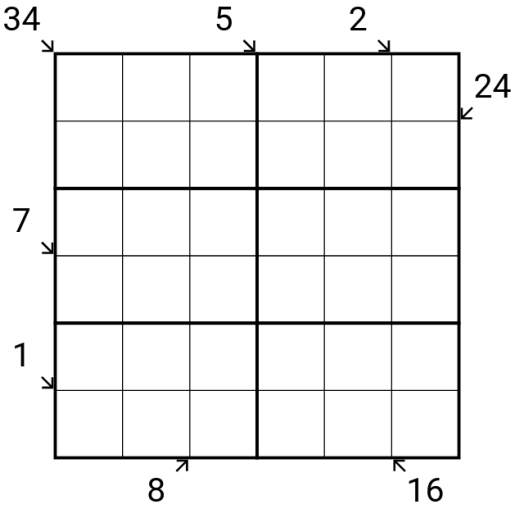
• *Normal* 6×6 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-6.

• *Skyscrapers:* Each cell represents a skyscraper whose height is the digit in that cell. Taller skyscrapers obscure the view of smaller ones. Clues outside the grid tell how many skyscrapers are visible looking across the row or column from the direction of the clue.

`https://sudokupad.app/ek3rsh29i2`

Wittle Kiwwas

by Ms. Peacock and Scaly Griffon



Rules:

• *Normal* 6×6 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-6.

• *Little Killers:* Clues outside the grid give the sum of the digits along the indicated diagonal. Digits can repeat if allowed by other rules.

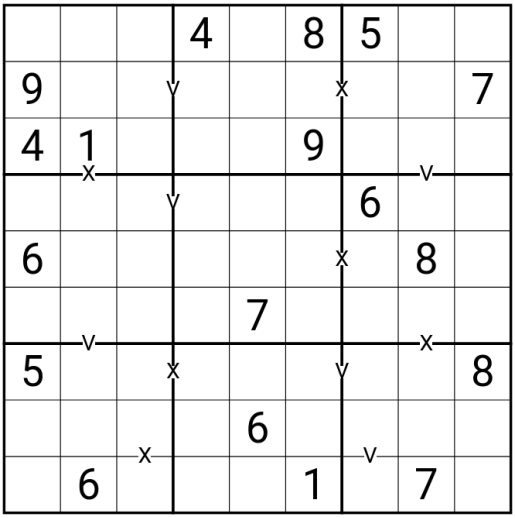
`https://sudokupad.app/9hxjlhtwcr`

Easy Puzzles

The puzzles in this section should be straightforward for those with some experience. The solutions may include logical interactions between constraints, as well as the use of pointing pairs and triples. You may need to use centermarks and cornermarks to keep track of some of your deductions.

Xs and Vs

by bitmask



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

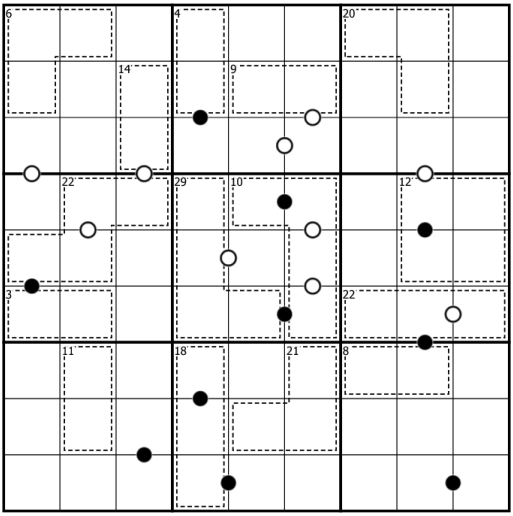
• *XV:* Digits separated by a V must sum to 5. Digits separated by an X must sum to 10. Not all Xs and Vs are necessarily given.

• *Antiking:* Cells that are a chess king's move apart cannot contain the same digit.

`https://sudokupad.app/2n1c374516`

Cruella de Vil

by GoldenGate and Hallalujah



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

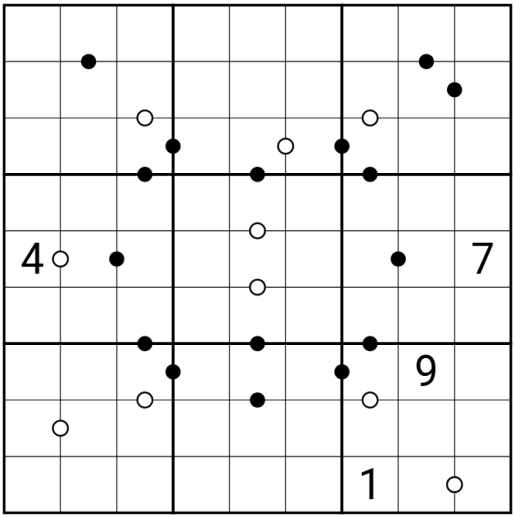
• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

• *Kropki Dots:* Digits separated by a black dot are in a $1 : 2$ ratio. Digits separated by a white dot are consecutive. Not all dots are necessarily given.

`https://sudokupad.app/49liuz460n`

A Ratio For You

by Kwame and Falconi



Rules:

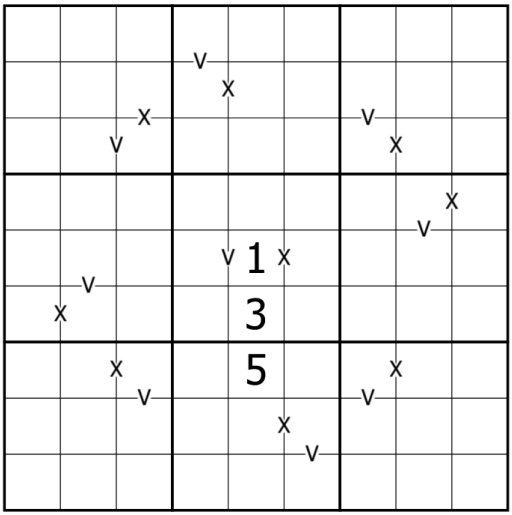
• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

• *Kropki Dots:* Digits separated by a black dot are in a $1 : 2$ ratio. Digits separated by a white dot are consecutive. Not all dots are necessarily given.

`https://sudokupad.app/dq75zdulqk`

Anemone

by Bronze



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

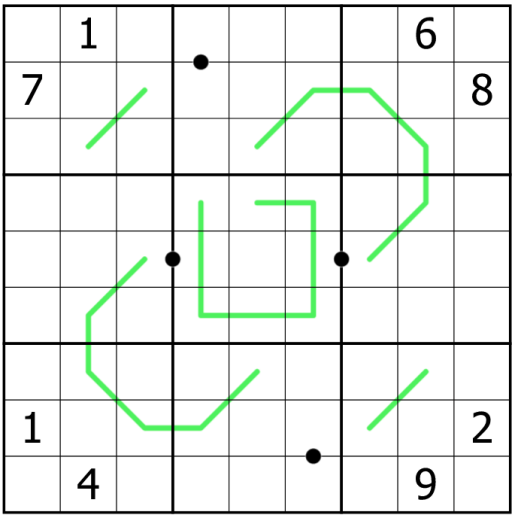
• *XV:* Digits separated by a V must sum to 5. Digits separated by an X must sum to 10. Not all Xs and Vs are necessarily given.

• *Antiknight:* Cells that are a chess knight's move apart cannot contain the same digit.

`https://sudokupad.app/9gohp77gxb`

Patching up the Grid

by Scaly Griffon and Glitch Horse



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

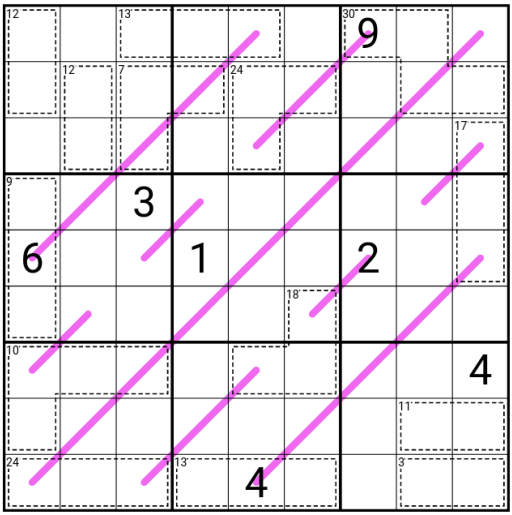
• *German Whispers:* Adjacent digits along a green German Whispers line differ by at least 5.

• *Ratio Dots:* Digits separated by a black dot are in a $1 : 2$ ratio. Not all dots are necessarily given.

`https://sudokupad.app/9637cip1oi`

Four Lane Highway

by GoldenGate



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

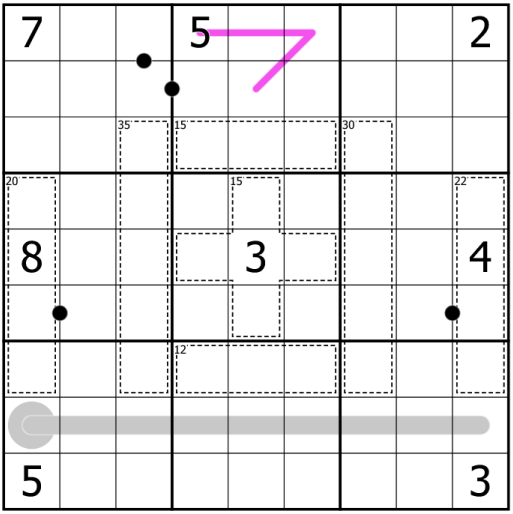
• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

• *Renban Lines:* Digits placed on purple Renban Lines must be a set of consecutive, non-repeating digits, in any order.

`https://sudokupad.app/zum7m21ovr`

Presents

by Nash



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

• *Ratio Dots:* Digits separated by a black dot are in a $1 : 2$ ratio. Not all dots are necessarily given.

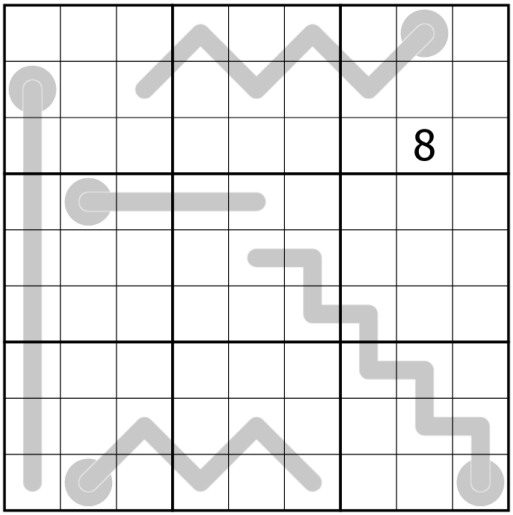
• *Renban Lines:* Digits placed on purple Renban Lines must be a set of consecutive, non-repeating digits, in any order.

Note from the Setter: This is an easier version of The Grinch, which appears later in the collection.

`https://sudokupad.app/117kivb6wb`

Chutes and Ladders

by GoldenGate and Hallalujah



Rules:

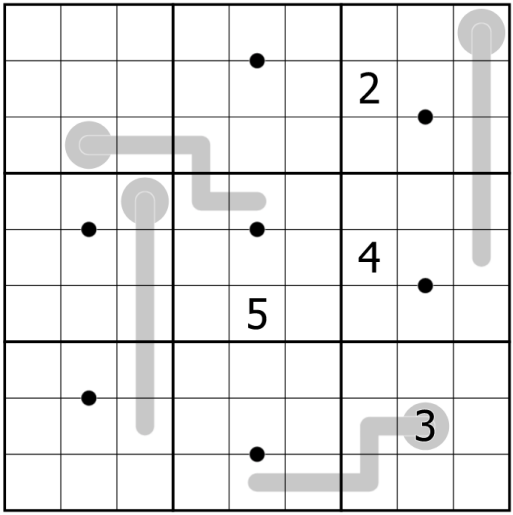
• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

`https://sudokupad.app/5534nx7pyp`

Snakes and Apples

by Nash



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

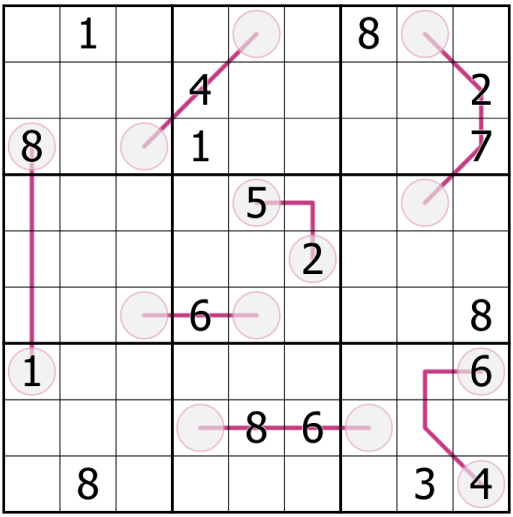
• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

• *Ratio Dots:* Digits separated by a black dot are in a $1 : 2$ ratio. Not all dots are necessarily given.

`https://sudokupad.app/czy456qu02`

Knights at the Round Tables

by GoldenGate and Hallalujah



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

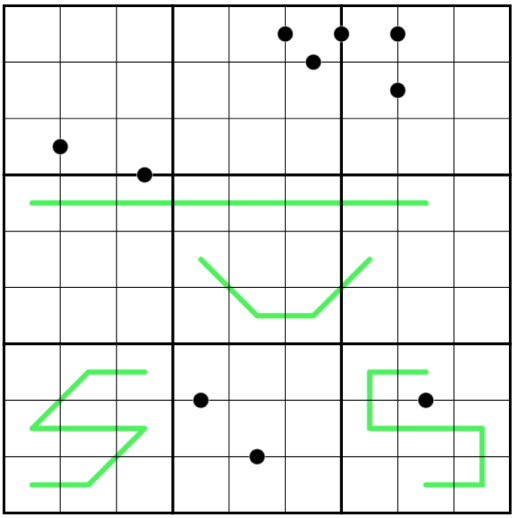
• *Antiknight:* Cells that are a chess knight's move apart cannot contain the same digit.

• *Double Arrows:* The sum of digits placed on a line must be equal to the sum of digits in the circles at each end of the line.

`https://sudokupad.app/t32lhbi555`

Radio Whiskers

by Stuart



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

• *German Whispers:* Adjacent digits along a green German Whispers line differ by at least 5.

• *Kropki Dots:* Digits separated by a black dot are in a $1 : 2$ ratio. Digits separated by a white dot are consecutive. Not all dots are necessarily given.

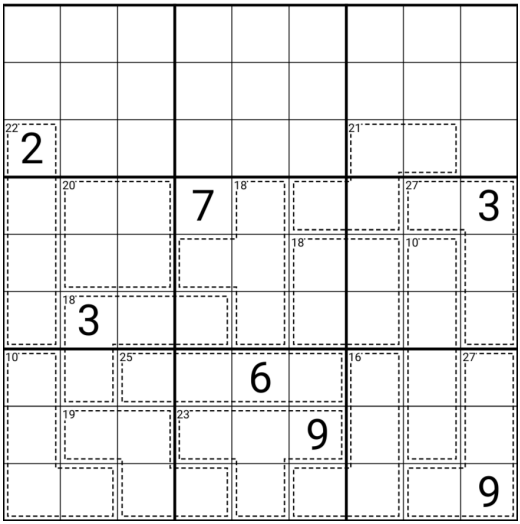
`https://sudokupad.app/iteu3lx13k`

Moderately Difficult Puzzles

The puzzles in this section are more challenging. You may need to think about how different constraints interact to limit or force placement of digits. You will almost certainly need centermarking, and may need cornermarking, to keep track of intermediate deductions. If you are new to variant sudoku and haven't already looked at the tips in the chapter on Solving Online, now might be a good time to do that!

Tetris King Killer

by Kwame, Adam, and Falconi



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

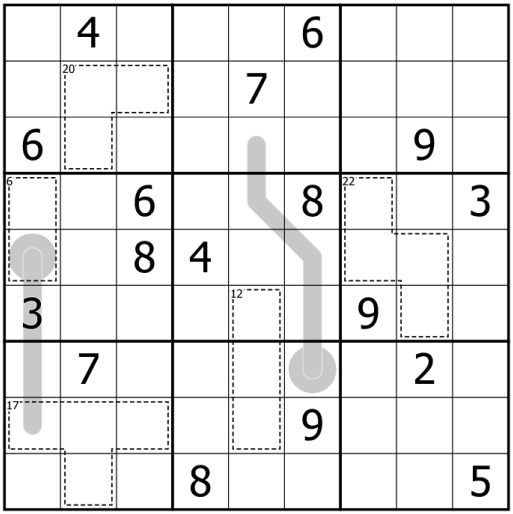
• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

• *Antiknight:* Cells that are a chess knight's move apart cannot contain the same digit.

`https://sudokupad.app/h2huu2ssqk`

A Set Sequence

by bitmask



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

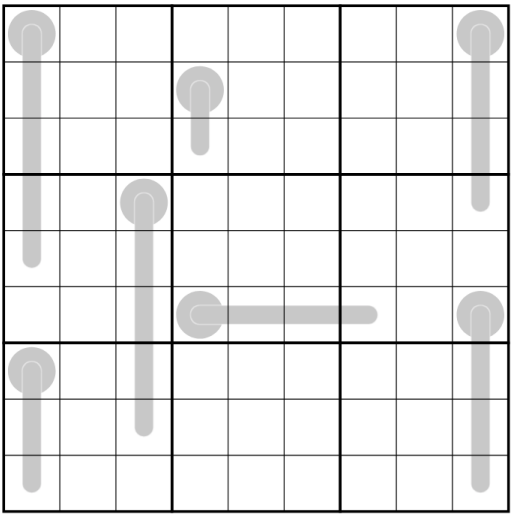
• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

`https://sudokupad.app/rf2oc3cq0m`

Rush Hour

by Stuart and Roundout



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

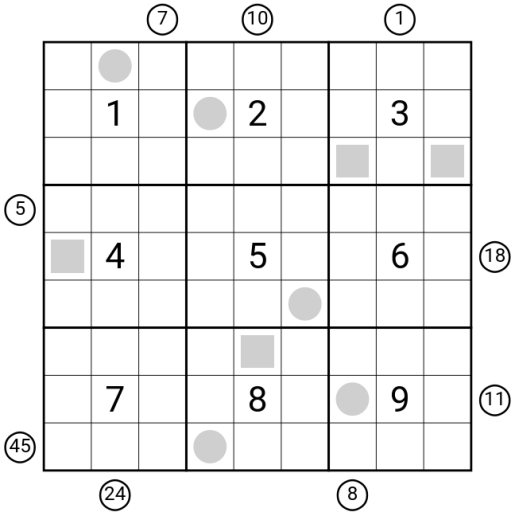
• *Non-consecutive:* Digits in orthogonally adjacent cells may not be consecutive.

• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

`https://sudokupad.app/8ji437zjg1`

Circles and Squares, Oh My!

by GoldenGate



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

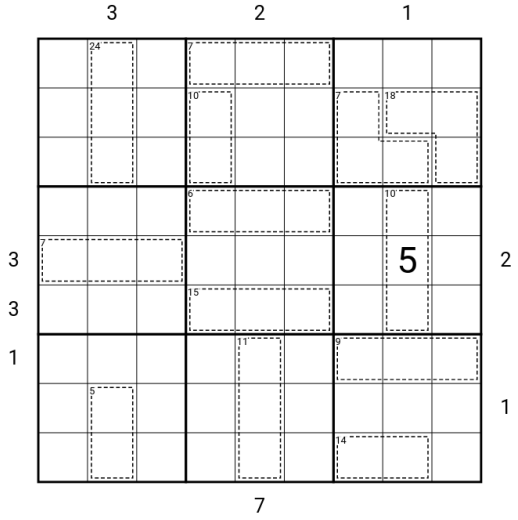
• *X-Sums:* Numbers outside the grid indicate the sum of the first X digits in that row or column, where X is the first digit seen from the direction of the clue.

• *Odd/Even:* Digits in grey squares must be even. Digits in grey circles must be odd.

`https://sudokupad.app/5al2a4yau7`

Tablet

by Bronze



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

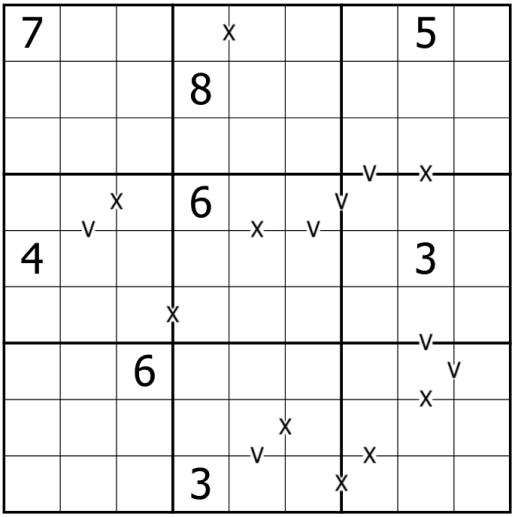
• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

• *Skyscrapers:* Each cell represents a skyscraper whose height is the digit in that cell. Taller skyscrapers obscure the view of smaller ones. Clues outside the grid tell how many skyscrapers are visible looking across the row or column from the direction of the clue.

`https://sudokupad.app/ad4cvrhim4`

X's and V's

by Chaos



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

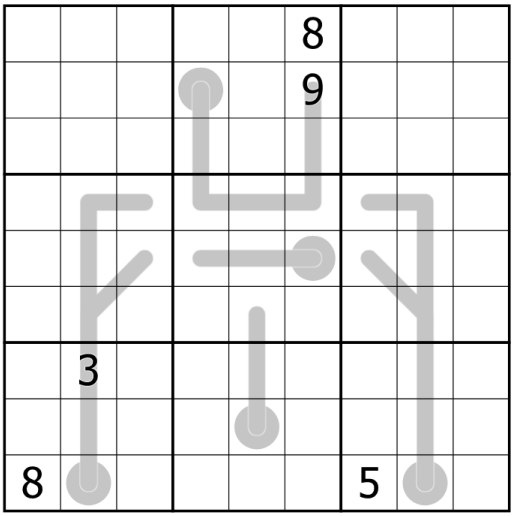
• *Antiknight:* Cells that are a chess knight's move apart cannot contain the same digit.

• *XV:* Digits separated by a V must sum to 5. Digits separated by an X must sum to 10. **All possible Xs and Vs are given.**

`https://sudokupad.app/1z23rh4pts`

The Gallows

by CoreDump110010100



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

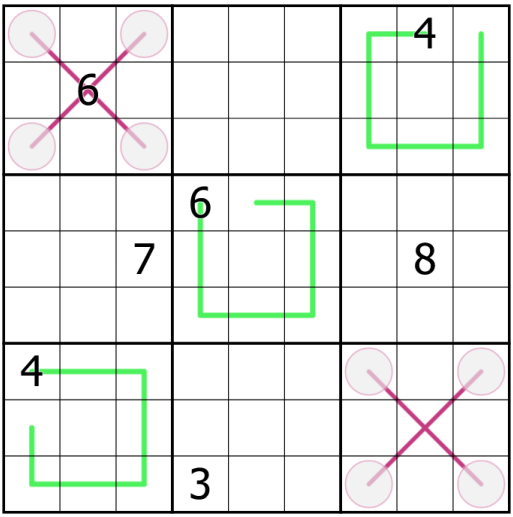
• *Antiking:* Cells that are a chess king's move apart cannot contain the same digit.

• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

`https://sudokupad.app/ds51nw8k8l`

Tic Tac Toe: O's Win!

by Stuart



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

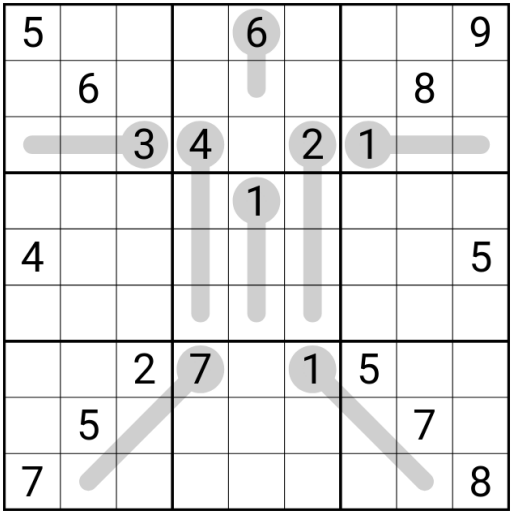
• *German Whispers:* Adjacent digits along a green German Whispers line differ by at least 5.

• *Double Arrows:* The sum of digits placed on a line must be equal to the sum of digits in the circles at each end of the line.

`https://sudokupad.app/t0m36n2y54`

King's Disease

by Roundout



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

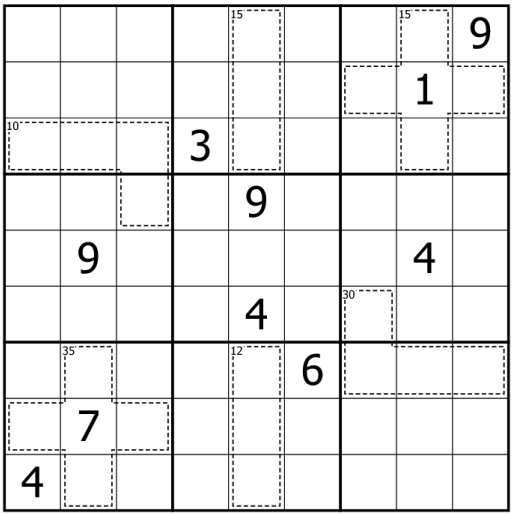
• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

• *Antiking:* Cells that are a chess king's move apart cannot contain the same digit.

`https://sudokupad.app/aevobgfx9o`

To the Dungeon!

by Ms. Peacock, Nash, and Glitch Horse



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

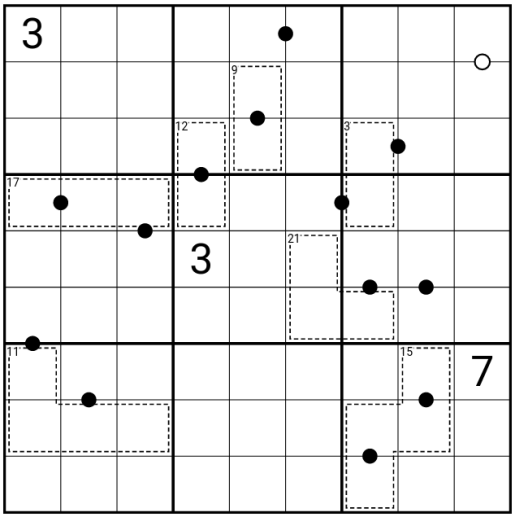
• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

• *Antiknight:* Cells that are a chess knight's move apart cannot contain the same digit.

`https://sudokupad.app/qrrk2m7pwy`

Deathly Constellation

by Falconi and Kwame



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

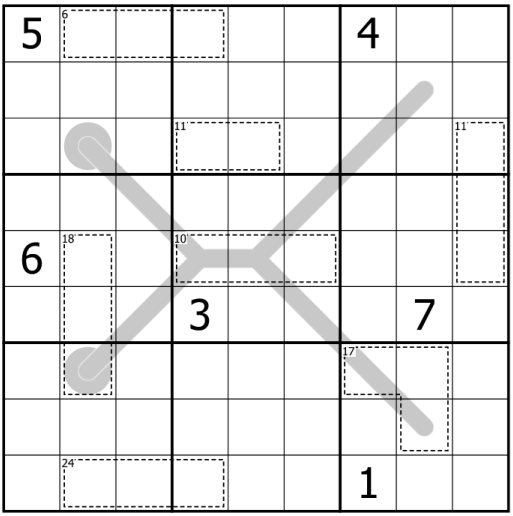
• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

• *Ratio Dots:* Digits separated by a black dot are in a $1 : 2$ ratio. Not all dots are necessarily given.

`https://sudokupad.app/d3lptjvh7n`

Cut Along the Dotted Line

by Glitch Horse and Scaly Griffon



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

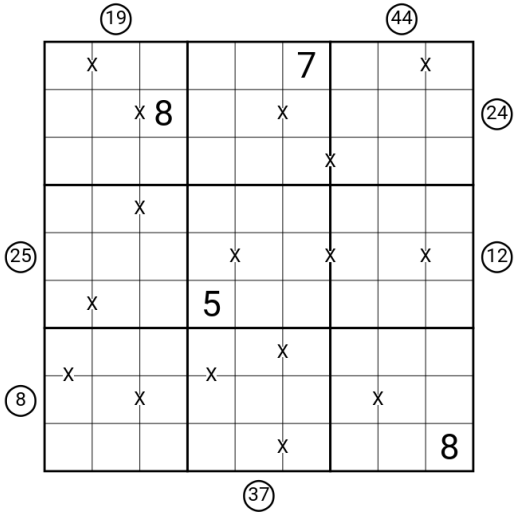
• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

`https://sudokupad.app/pu3hm503xm`

XLR8

by Kwame and Falconi



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

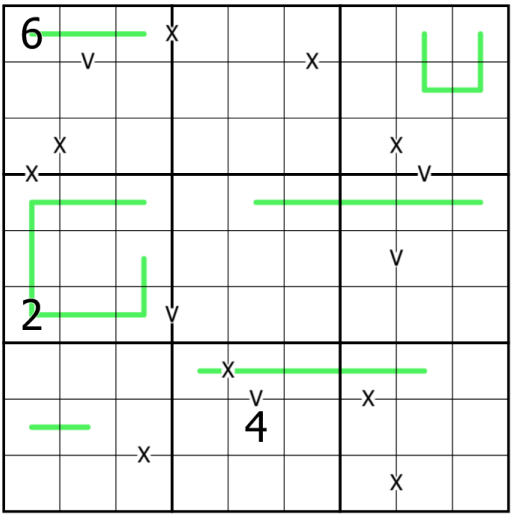
• *XV:* Digits separated by a V must sum to 5. Digits separated by an X must sum to 10. Not all Xs and Vs are necessarily given.

• *X-Sums:* Numbers outside the grid indicate the sum of the first X digits in that row or column, where X is the first digit seen from the direction of the clue.

`https://sudokupad.app/0ig3slx8s9`

The Quiet 15

by GoldenGate and Hallalujah



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

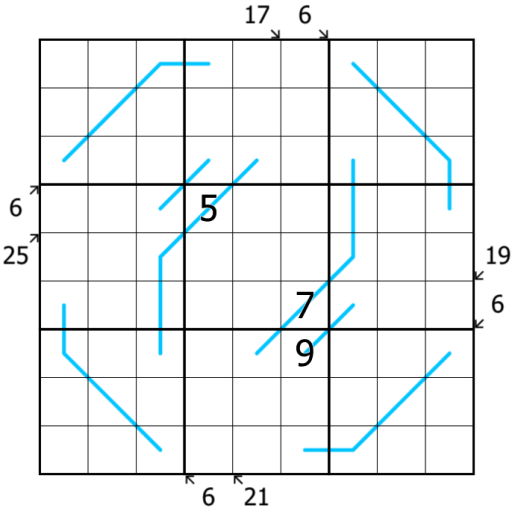
• *XV:* Digits separated by a V must sum to 5. Digits separated by an X must sum to 10. Not all Xs and Vs are necessarily given.

• *German Whispers:* Adjacent digits along a green German Whispers line differ by at least 5.

`https://sudokupad.app/2d9fib75h3`

Drain

by Bronze



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

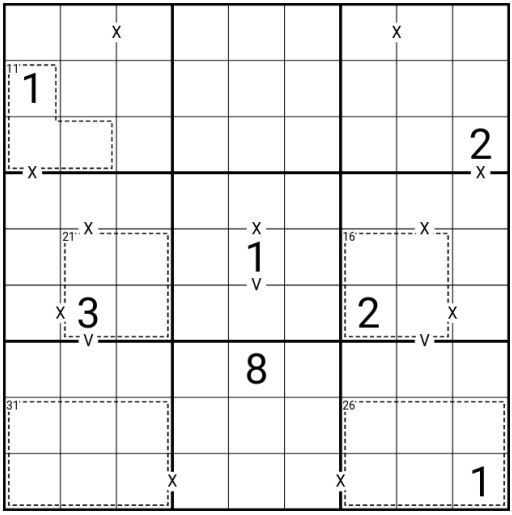
• *Little Killers:* Clues outside the grid give the sum of the digits along the indicated diagonal. Digits can repeat if allowed by other rules.

• *Region Sum Lines:* The sum of the digits along a blue Region Sum Line within a particular region must be the same for all of the regions the line passes through.

`https://sudokupad.app/hpv9o5z45z`

X-ecution Chamber

by CoreDump110010100



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

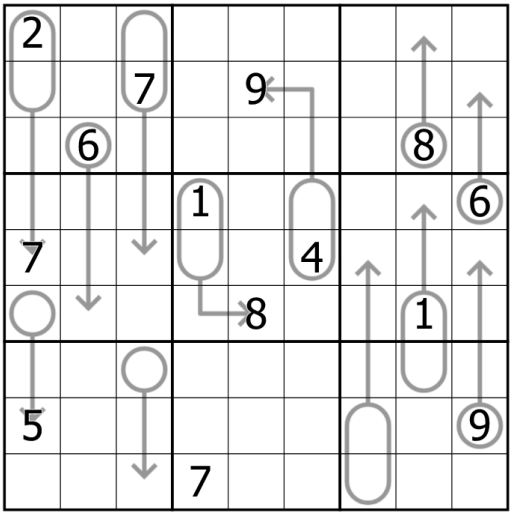
• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

• *XV:* Digits separated by a V must sum to 5. Digits separated by an X must sum to 10. Not all Xs and Vs are necessarily given.

`https://sudokupad.app/453lj72wi0`

Traffic Jam

by Falconi



Rules:

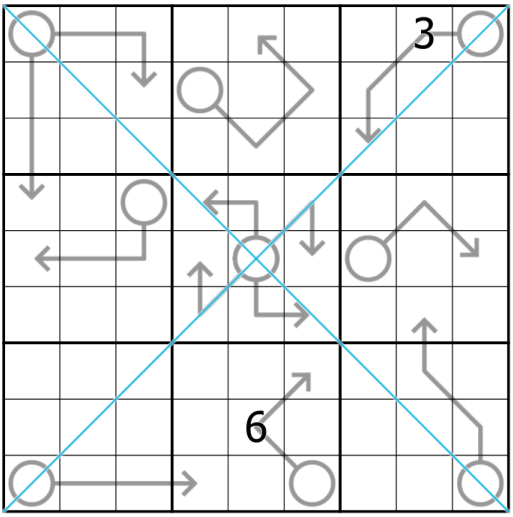
• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

• *Arrows:* Digits along an arrow must sum to the one- or two-digit number indicated in the pill from which the arrow emerges. Two-digit numbers are read top to bottom.

`https://sudokupad.app/yegjr4w0rx`

Misdirection

by Stuart



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

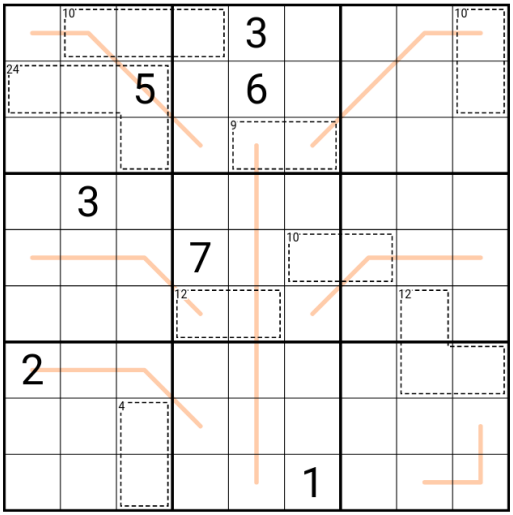
• *Arrows:* Digits along an arrow must sum to the number indicated in the circle from which the arrow emerges.

• *Diagonal:* Each of the indicated diagonals must contain a set of the digits 1-9 without repetition.

`https://sudokupad.app/tt9lzveml5`

Broken Rib

by ArkAngel0



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

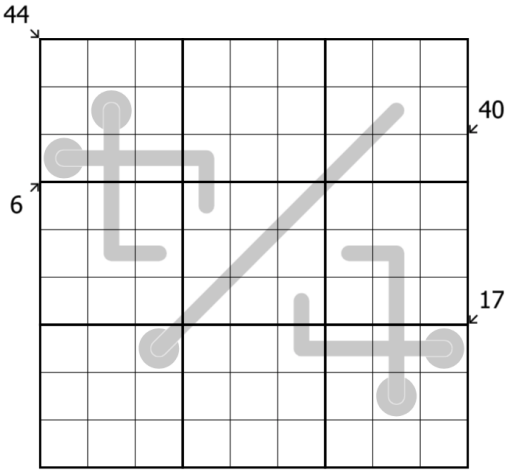
• *Entropic Lines:* Any set of three sequential cells along the beige Entropic Lines must contain a low digit (123), a middle digit (456), and a high digit (789). Digits may repeat on lines, if allowed by other rules.

• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

`https://sudokupad.app/pxqelaj5kn`

Pincers

by Ms. Peacock and Nash



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

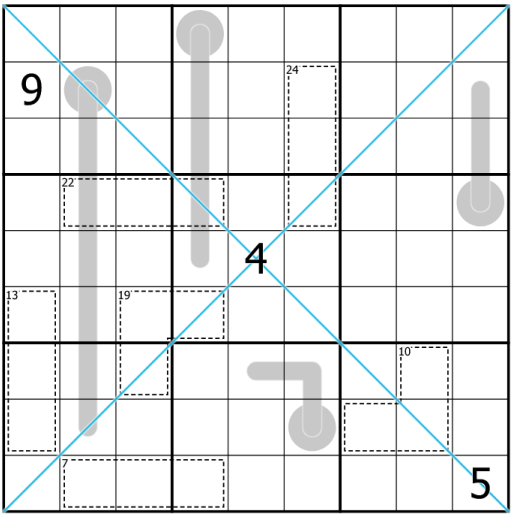
• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

• *Little Killers:* Clues outside the grid give the sum of the digits along the indicated diagonal. Digits can repeat if allowed by other rules.

`https://sudokupad.app/mc0v1wdly3`

X

by Chaos



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

• *Diagonal:* Each of the indicated diagonals must contain a set of the digits 1-9 without repetition.

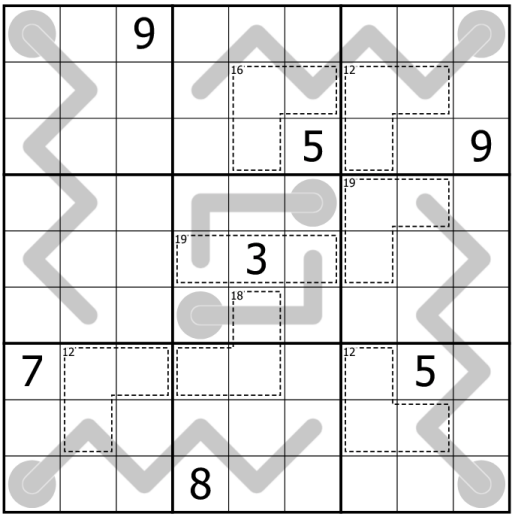
• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

`https://sudokupad.app/odj89hvta1`

Killer Pinwheel

by Adam



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

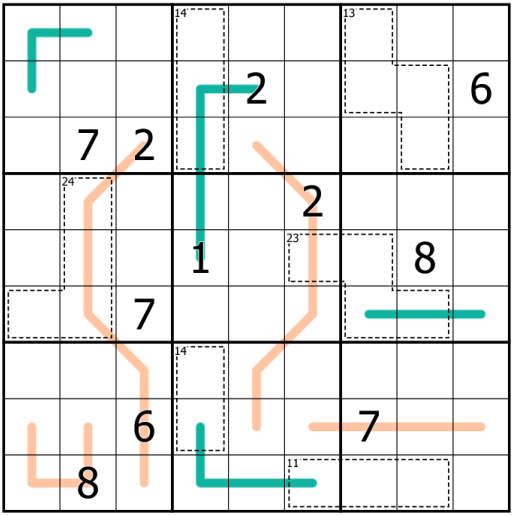
• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

`https://sudokupad.app/i8sojnbdyr`

Trainyard

by bitmask



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

• *Entropic Lines:* Any set of three sequential cells along the beige Entropic Lines must contain a low digit (123), a middle digit (456), and a high digit (789). Digits may repeat on lines, if allowed by other rules.

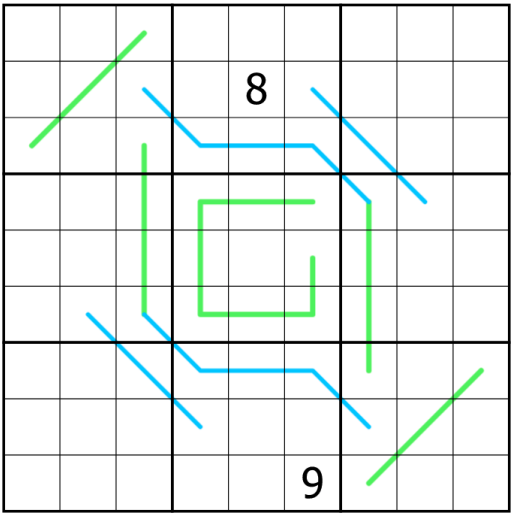
• *Modular Lines:* Any set of three sequential cells along a teal Modular Line must contain a complete set of residues modulo 3, i.e. one digit from (147), one from (258), and one from (369). Digits may repeat on a line if allowed by other rules.

• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

`https://sudokupad.app/28oumcmnrc`

Lantern

by Bronze



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

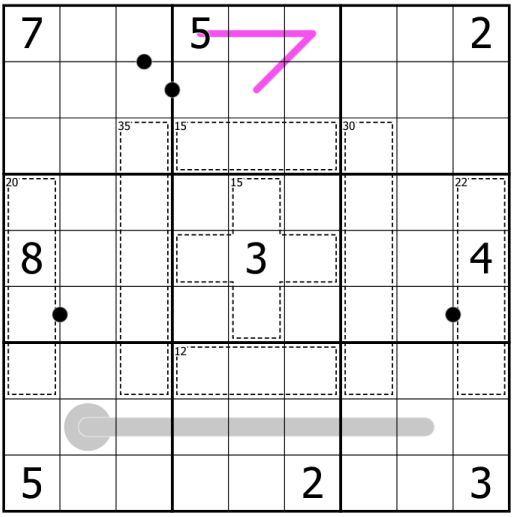
• *German Whispers:* Adjacent digits along a green German Whispers line differ by at least 5.

• *Region Sum Lines:* The sum of the digits along a blue Region Sum Line within a particular region must be the same for all of the regions the line passes through.

`https://sudokupad.app/b4gprbwyzx`

The Grinch

by Nash



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

• *Ratio Dots:* Digits separated by a black dot are in a 1 : 2 ratio. Not all dots are necessarily given.

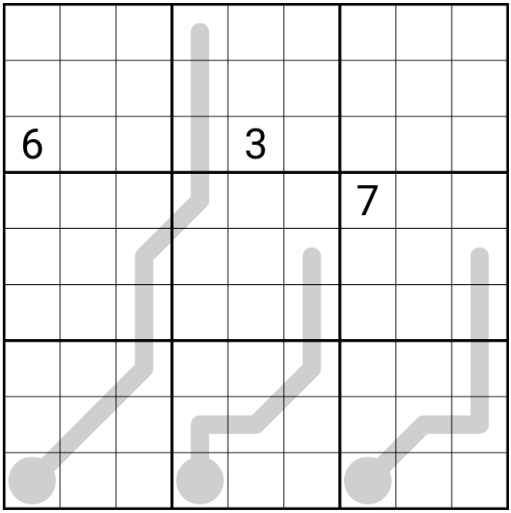
• *Renban Lines:* Digits placed on purple Renban Lines must be a set of consecutive, non-repeating digits, in any order.

Note from the Setter: This is a harder version of Presents, which appears earlier in the collection.

`https://sudokupad.app/6aj58y78gq`

Fahrenheits

by ArkAngel0



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

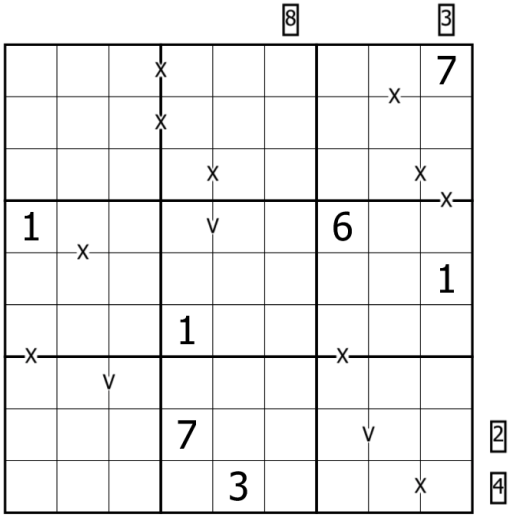
• *Antiking:* Cells that are a chess king's move apart cannot contain the same digit.

• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

`https://sudokupad.app/tnrq1tzbuv`

Busy City

by bitmask



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

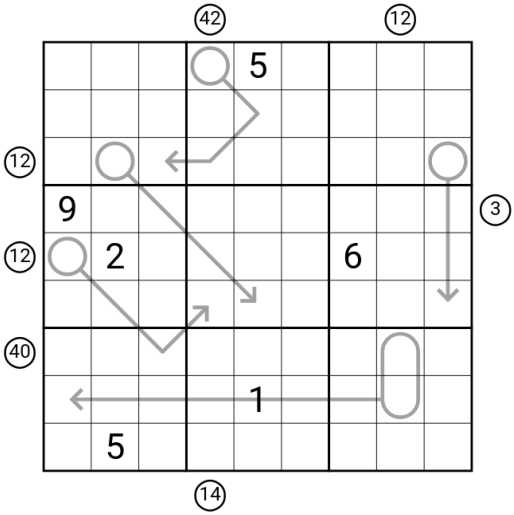
• *XV:* Digits separated by a V must sum to 5. Digits separated by an X must sum to 10. Not all Xs and Vs are necessarily given.

• *Skyscrapers:* Each cell represents a skyscraper whose height is the digit in that cell. Taller skyscrapers obscure the view of smaller ones. Clues outside the grid tell how many skyscrapers are visible looking across the row or column from the direction of the clue.

`https://sudokupad.app/69qq51u6lw`

Every Which Way

by Nash



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

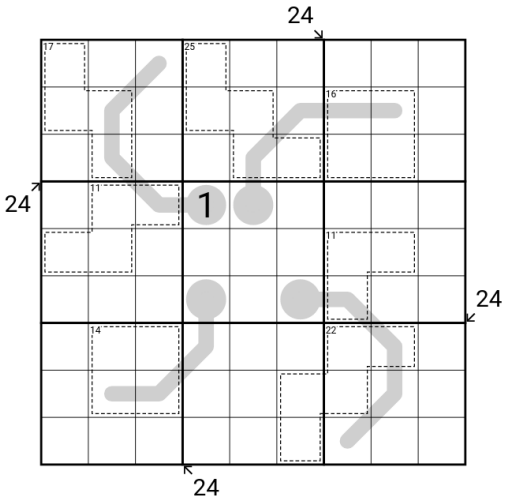
• *Arrows:* Digits along an arrow must sum to the one- or two-digit number indicated in the pill from which the arrow emerges. Two-digit numbers are read top to bottom.

• *X-Sums:* Numbers outside the grid indicate the sum of the first X digits in that row or column, where X is the first digit seen from the direction of the clue.

`https://sudokupad.app/fjdrz3l5gl`

Turbulence 2.0

by Ms. Peacock



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

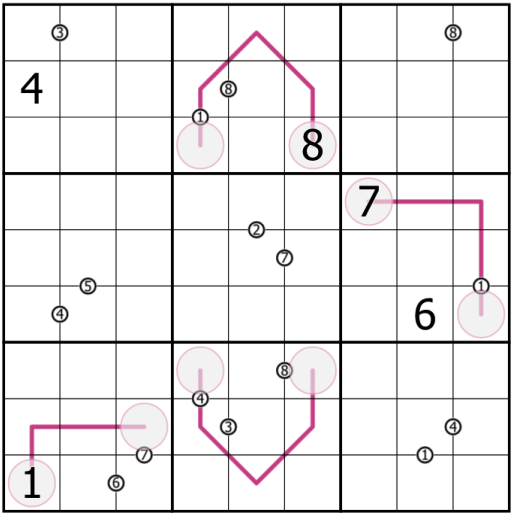
• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

• *Little Killers:* Clues outside the grid give the sum of the digits along the indicated diagonal. Digits can repeat if allowed by other rules.

`https://sudokupad.app/8pzz95h3hx`

Double Difference

by Adam



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

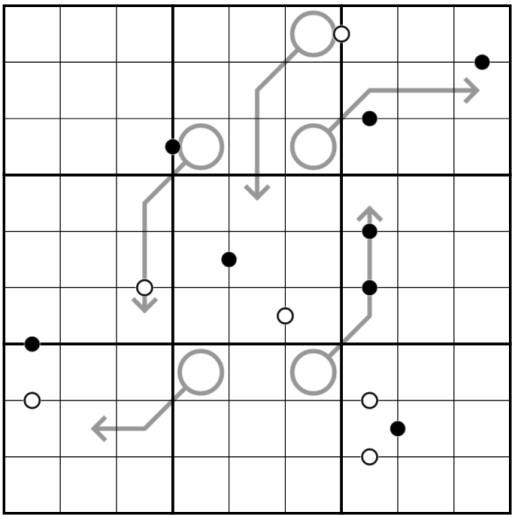
• *Double Arrows:* The sum of digits placed on a line must be equal to the sum of digits in the circles at each end of the line.

• *Difference Dots:* Digits in cells separated by a white dot must have a difference given by the number inside the dot.

`https://sudokupad.app/degc9ndt9r`

Running Man

by Scaly Griffon and Nash



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

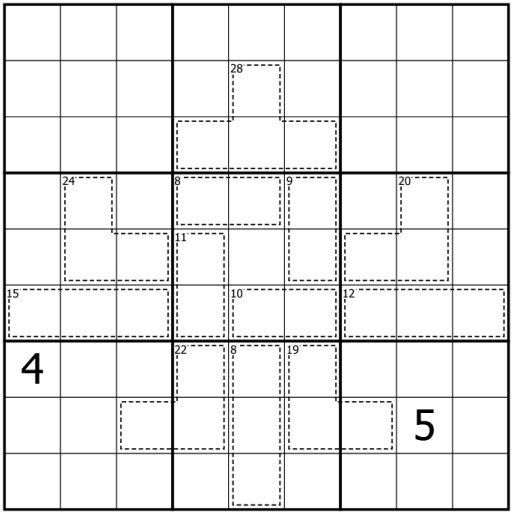
• *Arrows:* Digits along an arrow must sum to the number indicated in the circle from which the arrow emerges.

• *Kropki Dots:* Digits separated by a black dot are in a $1:2$ ratio. Digits separated by a white dot are consecutive. Not all dots are necessarily given.

`https://sudokupad.app/zf6hd99umb`

Dreamliner

by Stuart and Roundout



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

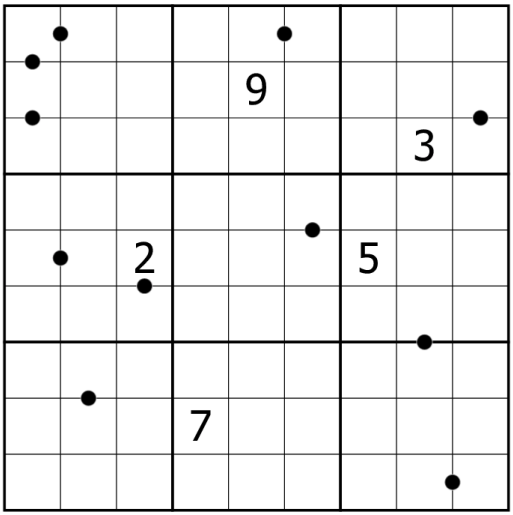
• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

• *Antiknight:* Cells that are a chess knight's move apart cannot contain the same digit.

`https://sudokupad.app/3hsaxoh5k2`

Odd Ball

by Adam



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

• *Ratio Dots:* Digits separated by a black dot are in a $1 : 2$ ratio. Not all dots are necessarily given.

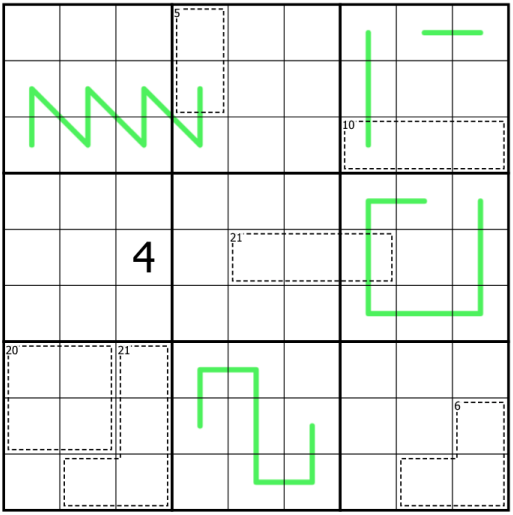
• *Antiknight:* Cells that are a chess knight's move apart cannot contain the same digit.

• *Antiking:* Cells that are a chess king's move apart cannot contain the same digit.

`https://sudokupad.app/dvet4fjt9z`

SBD

by Stuart



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

• *German Whispers:* Adjacent digits along a green German Whispers line differ by at least 5.

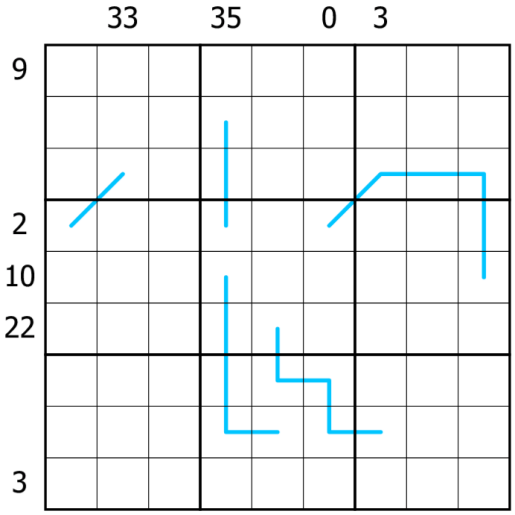
• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

`https://sudokupad.app/p91k25an3s`

Hard Puzzles

These are the hardest puzzles set by the students this semester. Although some of the deductions may take time to spot, each puzzles is solvable by humans, without guessing. In addition to center- and corner-marking, you might need to use colours to spot ways in which the geometry of the grid moves the solution forward. You may have to think carefully about where the puzzle is under the most pressure in order to spot a key deduction. You may have to think four or five steps ahead to spot why a particular digit cannot go in a particular cell. Having to look ahead further than that starts gets into the "guessing" category, so if you can't spot a contradiction within that many logical steps, try looking elsewhere in the puzzle.

Dancing Crane by Scaly Griffon and Glitch Horse



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

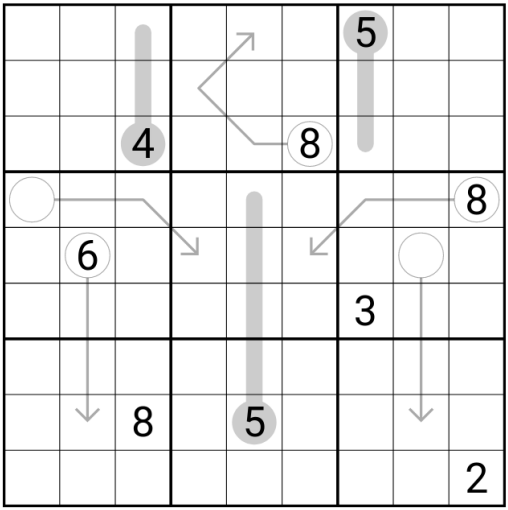
• *Region Sum Lines:* The sum of the digits along a blue Region Sum Line within a particular region must be the same for all of the regions the line passes through.

• *Sandwich:* Numbers outside the grid indicate the sum of the digits between 1 and 9 in that row or column.

`https://sudokupad.app/pfo21ljx4u`

Taxiways

by Roundout



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

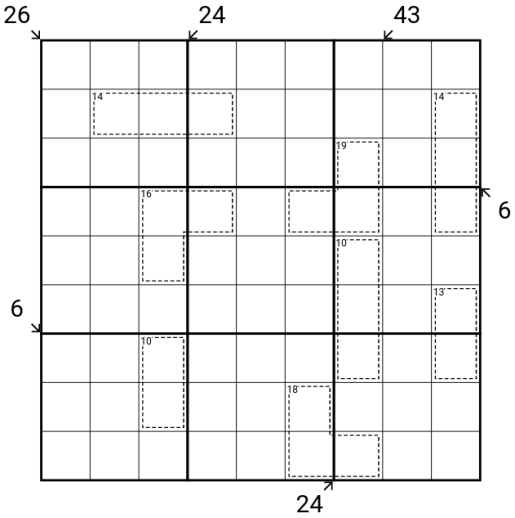
• *Thermometers:* Digits on a grey Thermo must strictly increase from bulb to tip.

• *Arrows:* Digits along an arrow must sum to the number indicated in the circle from which the arrow emerges.

`https://sudokupad.app/72tvi6a4m9`

Caged Wisdom

by Scaly Griffon, Ms. Peacock, and Nash



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

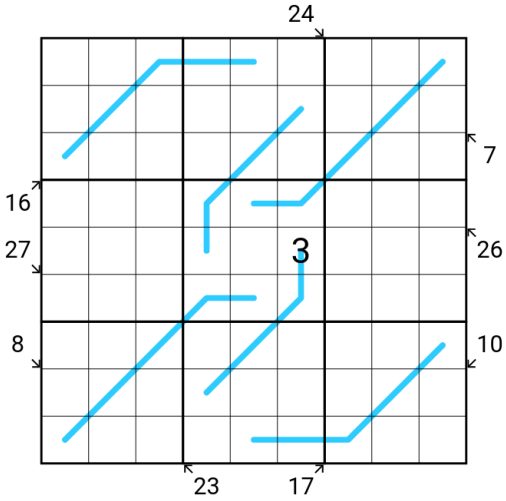
• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

• *Little Killers:* Clues outside the grid give the sum of the digits along the indicated diagonal. Digits can repeat if allowed by other rules.

`https://sudokupad.app/c694nh80lq`

3 Carats

by Bronze



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

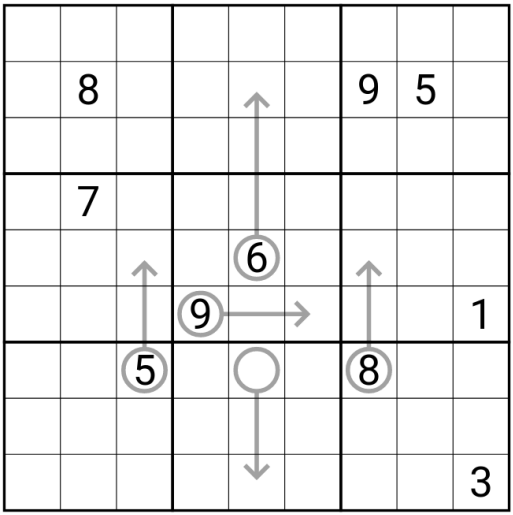
• *Little Killers:* Clues outside the grid give the sum of the digits along the indicated diagonal. Digits can repeat if allowed by other rules.

• *Region Sum Lines:* The sum of the digits along a blue Region Sum Line within a particular region must be the same for all of the regions the line passes through.

`https://sudokupad.com/0zgqmw0clp`

Excalibur 2.0

by Roundout



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

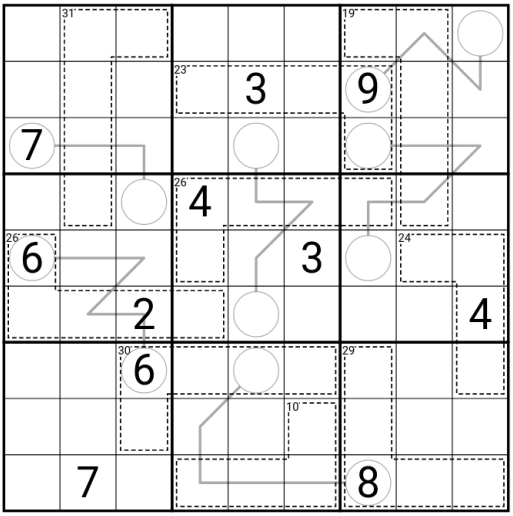
• *Antiknight:* Cells that are a chess knight's move apart cannot contain the same digit.

• *Arrows:* Digits along an arrow must sum to the number indicated in the circle from which the arrow emerges.

`https://sudokupad.com/an8mrr6s3l`

Connecting the Pieces

by CoreDump110010100



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

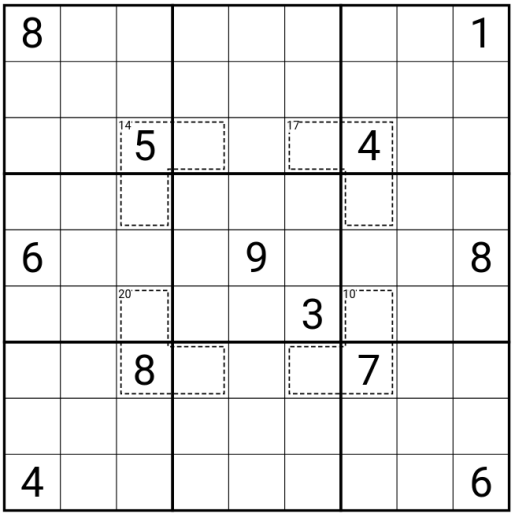
• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

• *Double Arrows:* The sum of digits placed on a line must be equal to the sum of digits in the circles at each end of the line.

`https://sudokupad.app/gte0jlfeom`

The Round Table

by Roundout



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

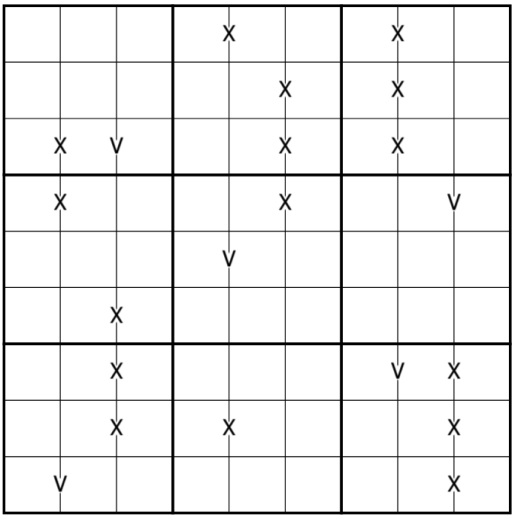
• *Antiknight:* Cells that are a chess knight's move apart cannot contain the same digit.

• *Killer Cages:* Digits add to the total in the top left corner of the cage, if the sum is given. Digits cannot repeat in cages.

`https://sudokupad.com/kyxdcxvv0f`

Bad Neighbors

by Chaos



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

• *Non-consecutive:* Digits in orthogonally adjacent cells may not be consecutive.

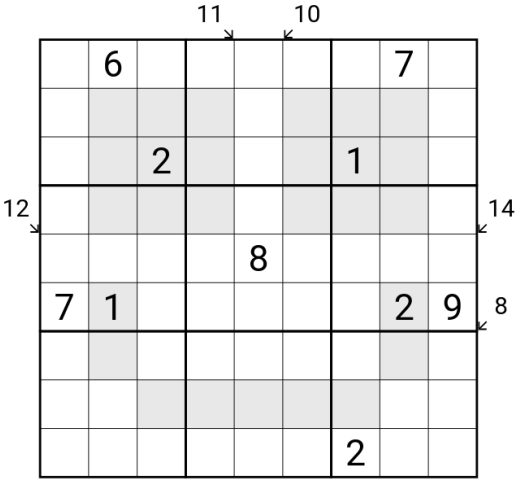
• *Antiknight:* Cells that are a chess knight's move apart cannot contain the same digit.

• *XV:* Digits separated by a V must sum to 5. Digits separated by an X must sum to 10. Not all Xs and Vs are necessarily given.

`https://sudokupad.app/u1jci9m8o5`

Poison

by Adam



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

• *Little Killers:* Clues outside the grid give the sum of the digits along the indicated diagonal. Digits can repeat if allowed by other rules.

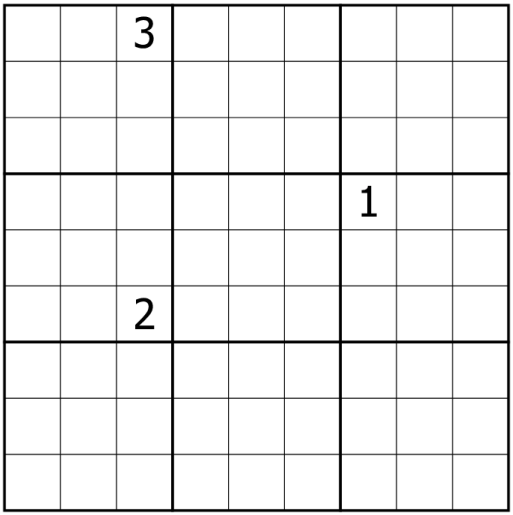
• *Extra Regions:* Each extra region indicated in the grid must contain a complete set of the digits 1-9 without repetition.

Each of the contiguous sets of grey cells forms an extra region. The "smile" in the grid also forms an extra region.

`https://sudokupad.app/3rixqonfzh`

1, 2, 3 ...

by Chaos



Rules:

• *Normal* 9×9 *sudoku:* Every row, column, and box must contain a complete set of the digits 1-9.

• *Non-consecutive:* Digits in orthogonally adjacent cells may not be consecutive.

• *Antiknight:* Cells that are a chess knight's move apart cannot contain the same digit.

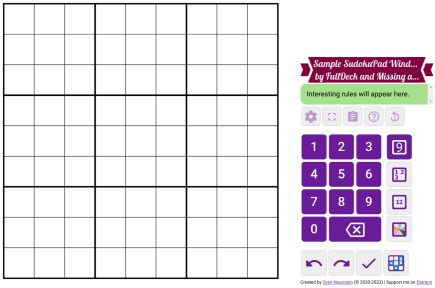
• *Antiking:* Cells that are a chess king's move apart cannot contain the same digit.

`https://sudokupad.app/xdhjlv2uf7`

Solving Online

There are a number of online tools for setting and solving variant sudoku. Our favorite platform for solving is Sven Neumann's SudokuPad. It is browser independent but works better on a laptop or tablet than on a cell phone. Online solving allows for a variety of annotations to the grid which enable the solver to keep track of information and deductions. It also allows the solver to backtrack, check digits, and get confirmation of a correct solution. Each puzzle in this book provides a short link to play online in SudokuPad. Sven is constantly improving SudokuPad, so the images we provide below may be slightly different than what you see, but the functionality will be similar.

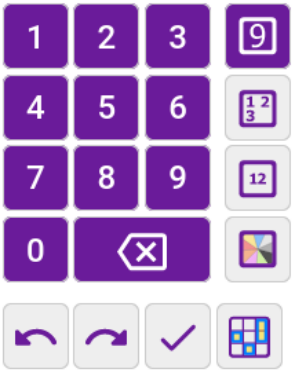
When you open a puzzle in SudokuPad you'll see a browser window with the puzzle grid on the left.



On the right you will find several panels. The top panel includes information about the puzzle: title, author, and rules. Below are tools for interacting with the grid. To the right of a number pad are four options: a large digit (for placing digits in the grid), a set of three small digits in corners (for corner marking digits), a set of two small digits in the center (for center marking digits), and a colour wheel (for colouring cells in the grid). These tools can help you keep track of information you have deduced about possible values. Below the number pad are arrows for backtracking (and then moving forward again) and a checkmark for seeing whether digits you have placed so far are correct or not. Above the number pad, to the left, is a cog button that opens the settings window where you can customize your solving experience. Below, we talk more about how to use these features to improve your solving experience.

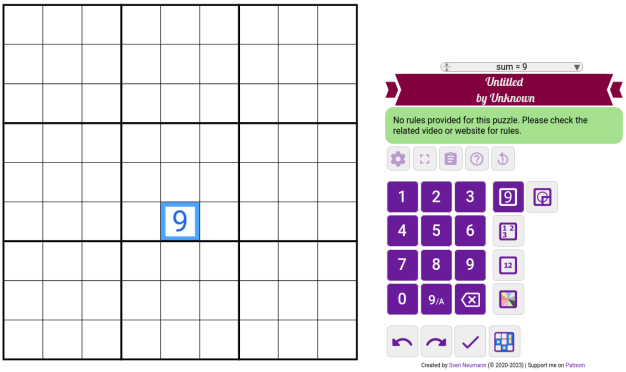
Placing digits

The most basic task in solving a sudoku puzzle is entering correct digits. This is done by clicking on the place digits button



then clicking on a cell in the grid and either typing a digit or clicking on the appropriate digit in the number pad. We some-

times refer to digits placed in this way as “big digits.”



Centermarks and Cornermarks

When you are solving a sudoku puzzle, whether online or on paper, it’s often helpful to ask yourself two important questions:

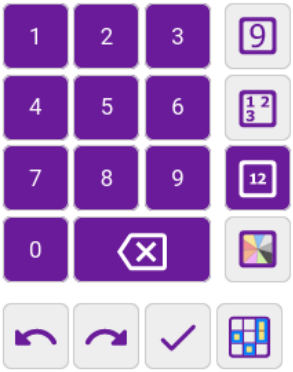
What values can possibly be placed in this cell?

Where can digit X possibly be placed in this box?

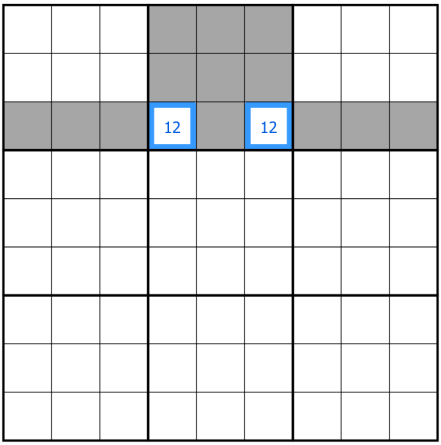
There are lots of other good questions, but these are the two that correspond to using center and corner marks.

Centermarks

If you can narrow down the values which can be placed in a single cell to just a couple of choices, it is useful to keep track of this by centermarking those values in the cell. Select the centermark button (the one with two small digits in the center):

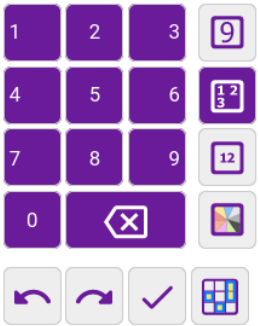


then enter the digits. Sometimes you will find that you have two cells in a box with the the same two digits center marked: this is useful because it rules out those digits from anywhere else in the box. Similarly two cells with the same pair of centermarks in a row, or in a column, rule out those digits in the rest of that row or column. In this grid, none of the shaded cells can be 1 or 2 because the 1 and 2 are used up in box 2 and in row 3.

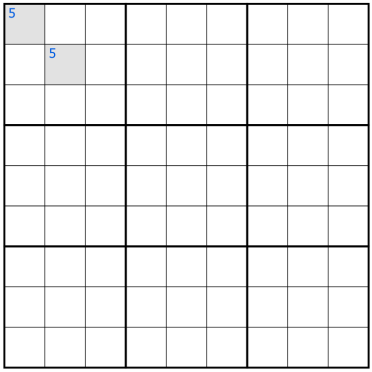


Cornermarks

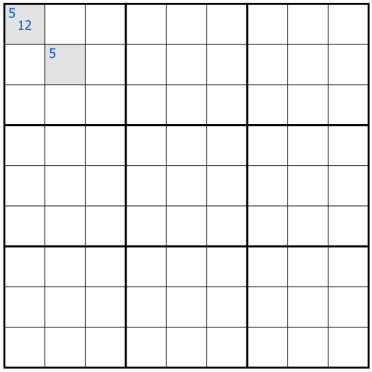
If you can narrow down the possible positions of a particular digit in a box, you can place that digit as a cornermark in those cells. Select the cornermark option (the one with three small digits in corners):



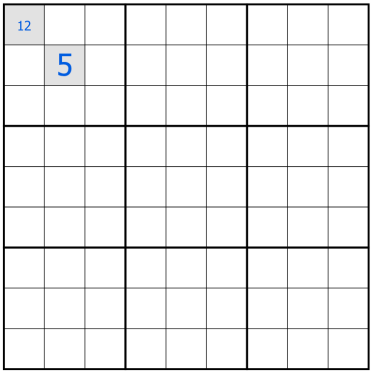
then place the digits in the possible locations within the box. We usually only do this if the digit is restricted to two, or occasionally three, possible positions. This is useful because of the interaction between center- and cornermarks. For example, if you've been able to cornermark 5's in r1c1 and r2c2, (so that those are the only cells in box 1 where 5's could possibly go)



and subsequently can centermark 1 and 2 as the only digits which can possibly be placed in r1c1



then the elimination of the centermarked 5 in that cell means that r2c2 *must* be a 5.



Check digits

If the puzzle you are solving has an embedded solution (as is the case for all of the puzzle in this book) and you have placed "big digits," you can reassure yourself that you have not made

a mistake by clicking on the check mark below the number pad:

A window will pop up telling you that the puzzle is not finished, but that the digits you have placed are correct. Of course, if they are *not* correct, it will tell you that, too!

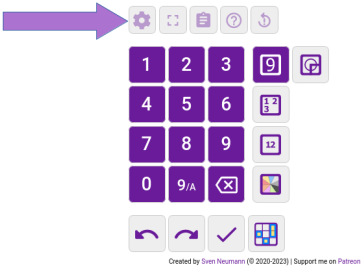
Undo and Redo

If you do discover that you have made an error, you may wish to rewind your work in the puzzle until you reach a point where you know your work is correct. SudokuPad makes that easy! Under the number pad, there are "Undo" and "Redo" buttons.

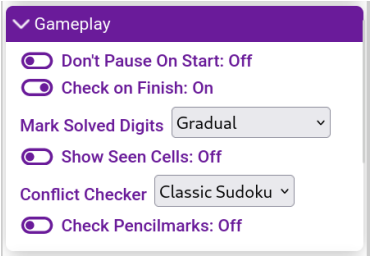
Each click of the "Undo" button (counter-clockwise arrow) goes back one step in the puzzle state. Each click of the "Redo" button advances the puzzle state one step to the furthest point in your solve. Watch out, though! If you undo to an earlier point in the puzzle, then make a new deduction, you will be starting a new branch in the timeline and will only be able to go back and forth along that branch.

Conflict Checking

In SudokuPad, you can customize how much help you want in spotting errors and eliminations in your pencilmarks. To change these settings, click the cog button above the number pad.

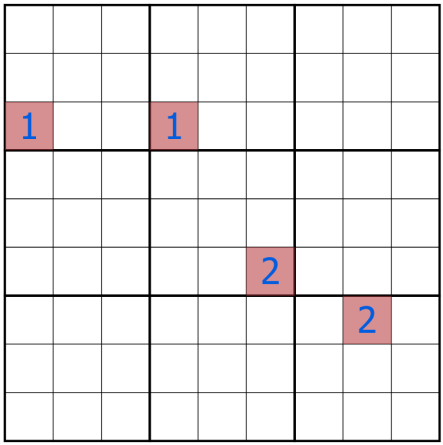


Under the "Game Play" tab, there are three settings for the Conflict Checker: *On*, *Classic Sudoku*, and *Off*.

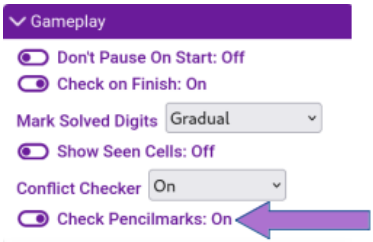


If either *On* or *Classic Sudoku* is selected and you try placing a big digit in a cell which conflicts with other big digits already placed in the same row, column, or box, the conflicting digits will be highlighted. This can be particularly helpful if you accidentally mistype a digit and fail to notice it at the time. The *Classic Sudoku* setting only checks for conflicts in rows, columns, and boxes. The *On* setting also checks for conflicts arising from added constraints. For example, in a puzzle with an antiknight constraint, the grid below would show conflicting digits for both the 1's (same row) and 2's (antiknight) if conflict checking is set

to *On* but would only show the conflict with 1's (same row) if conflict checking is set to *Classic Sudoku*.



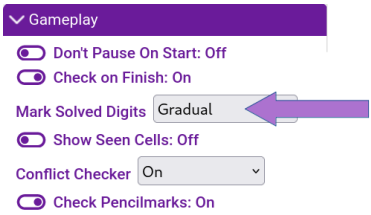
Still under the "Game Play" tab, you can also toggle between having "Check Pencilmarks" on or off:



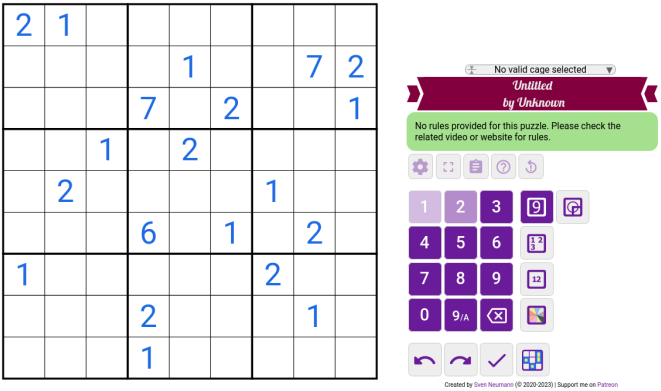
With "Check Pencilmarks" set to *Off*, only big digits are checked for conflicts. With "Check Pencilmarks" set to *On*, centermarks and cornermarks are also checked.

Marking Solved Digits

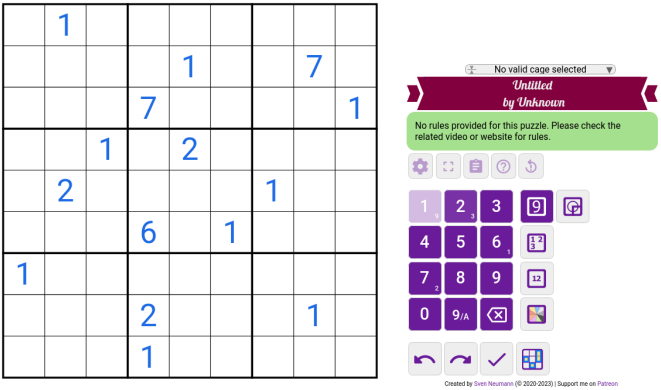
Near the end of the puzzle, it can be useful to know which digits are left to place. Under the Gameplay tab you can turn on "Mark Solved Digits."



This tool has four settings: *On*, *Gradual*, *Count*, and *Off*. When set to *On*, digits are greyed out on the number pad once all instances of that digit have been placed (correctly or incorrectly) in the grid. When set to *Gradual*, digits are greyed out proportional to how many remain to be placed.

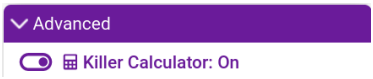


When set to *Count*, digits are greyed out once all instances have been placed. In addition, a small number in the lower right corner of each digit on the number pad tells you how many of that digit have already been placed in the grid:



Cage Calculator

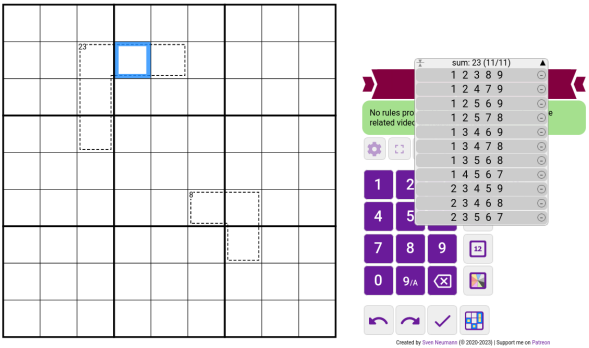
In "killer cages" the number in the corner of the top left cell of the cage indicates the sum of the digits in the cage. If you would prefer not to have to keep mental track of all the possible combinations for a particular sum, you can choose to use the built-in cage calculator in SudokuPad. Under the "Advanced" tab in the settings window you can turn on a Killer Calculator:



The Killer Calculator enables a pulldown list of all the possible combinations of digits that sum to a given total. Until you click on a cage in the puzzle, the calculator shows up above the puzzle title as "No Valid Cage Selected."

Once you click on a cell within a cage, the cage calculator shows you how many combinations of digits are possible; clicking on

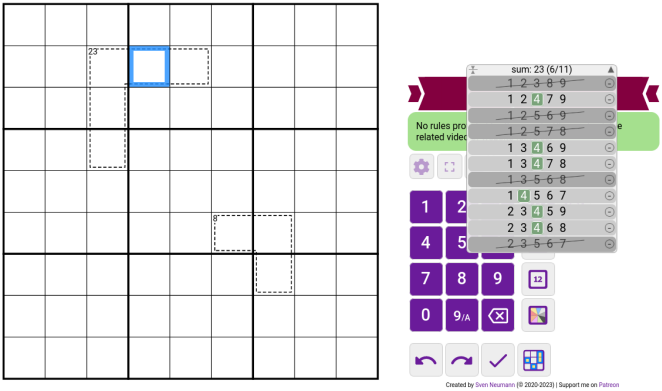
the arrow in the cage calculator panel drops down a list of all possible combinations.



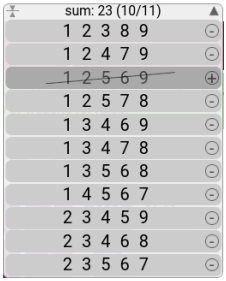
Clicking on a single digit in the list toggles through three states:

The digit MUST be in the cage.
The digit CANNOT be in the cage.
We don't know whether the digit is in the cage.

With each option, the list of possible combinations will be updated. For example, if we know 4 MUST BE in the 23-cage in this grid, we click on "4" once in the list and discover that we now have only six possible combinations.



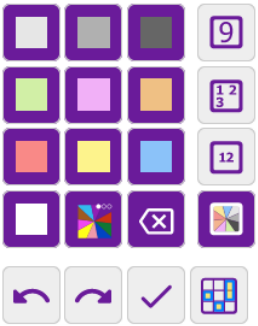
You can also click on the "−" sign to the right of a possible combination to eliminate it from the list; it will be greyed out and struck through. To rule that combination back into contention, just click on the "+" sign.



Sometimes the calculator automatically eliminates choices. For example, if you have placed a digit in the cage, all combinations that do not contain that digit are eliminated.

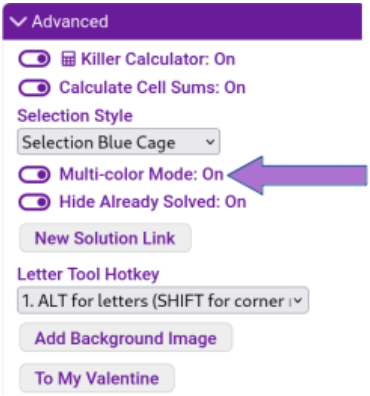
Colours

The colour wheel lets you add colour to cells as an aide to keeping track of intermediate deductions.



This is particularly helpful if a puzzle is built around keeping

track of parity (which cells contain even digits and which contain odd digits), entropy (low, middle, and high digits), or 3-modularity (remainder when a digit is divided by 3). With German Whispers, for example, it is very common to keep track of whether digits along a whisper line are low (1234) or high (6789). If you need to keep track of multiple colours within a single cell, you can select that option in the "Advanced" section of the Settings menu.



Other Options

Other advanced options we frequently use include letter mode (allowing both upper and lower case letters in the grid) and a pen tool. These can be toggled on/off in the settings window. Sven Neumann is actively developing SudokuPad and often introduces new features. Explore and enjoy!

Acknowledgements

We are grateful to be part of a worldwide community of sudoku enthusiasts: people who have welcomed us, and our students, and helped everyone learn to enjoy this hobby. This is a partial list, in alphabetical order, of those to whom we are indebted. To those we've left off, we apologize profusely.

BremSter

Cracking the Cryptic
(Simon Anthony and Mark Goodliffe)

f-puzzles.com
(Eric Fox and subsequently AfrayedKnot)

GAS Team
(Clover, Philip Newman, Bill Murphy, Sam Cappleman-Lynes)

James W. Sinclair and Artisanal Sudoku

Rangsk

Rockratzero

Sirxemic and sudokumaker.app

Skunkworks
(and Riffclown in particular)

SudokuCon

Sven Neumann and SudokuPad

Zetamath

We are also grateful to the Teagle Foundation for support for our course.

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