

Sudoku Solver

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Sudoku: The Basics



- What is Sudoku? Sudoku is a game played on a 9 x 9 grid where each row, column, and 3 x 3 square needs to be filled in with numbers 1-9. Numbers cannot be repeated and some of the squares come pre-filled in.
- Sudoku is a game of logic and reasoning and is quite difficult to solve when utilizing the guessing technique.
- People often use an elimination strategy when solving sudoku puzzles as a way to check off numbers when going through the puzzle.

5	3			7				
6			1	9	5			
	9	8					6	
8				6				3
4			8		3			1
7				2				6
	6					2	8	
			4	1	9			5
				8			7	9

Human v. Machine

		9	2			
	4					5
		2			3	
2						7
		4	5	6		
6						9
	7				8	
	3					4
		2		7		

```
div class="container">
  div class="row">
    nav id="nav" role="navigation">
      <li><a href="index.html">Home</a></li>
      <li><a href="home-events.html">Home Events</a></li>
      <li><a href="multi-col-menu.html">Multiple Column Men
      <li class="has-children"> <a href="#" class="current">
        <ul>
          <li><a href="call-button-header.html">Call Bu
          <li><a href="image-logo.html">Image Logos</a>
          <li class="active"><a href="call-logo.html">Te
        </ul>
      </li>
      <li class="has-children"> <a href="#">Carousel</a>
      <li><a href="variable-width-slider.html">Variab
      <li><a href="variable-width-slider.html">Testimon
```



- On average it takes an ordinary person about 20 minutes to solve a sudoku puzzle. This number can be higher as the difficulty of the puzzle increases.
- When writing a code for a typical sudoku solver it can take less than 5 seconds for the computer to solve the puzzle.
- Computers are able to go through every combination of numbers quite quickly and can check if they work within the box that they have been assigned.
- The computer is also able to utilize a method of sudoku called backtracking that makes the process much simpler and fast for the algorithm to operate using.
- What is Backtracking?

Constraint

- Constraint satisfaction problems are “mathematical questions defined as a set of objects whose state must satisfy a number of constraints or limitations” (Wikipedia)
- For sudoku, every row column and 3x3 grid must exactly contain the numbers 1-9
- Accomplished this using a function with for loops, indexing, and boolean values

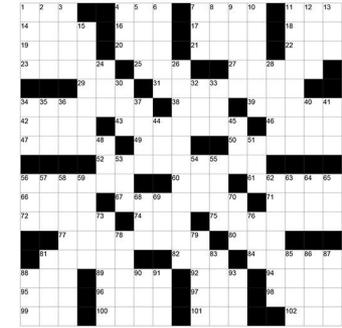
Chemistry or Not II Robert D. Pike

ACROSS

1. She bore you
4. Append
7. Amount of material or religious service
11. Plead
14. Poems of praise
16. Pike-like fish
17. Margerine
18. Sch. in Charlottesville
19. Conveyance for arriving in style
20. Galena or cobaltite, e.g.
21. Meum aloud
22. Back-talk
23. ___ Gay, A-bomb bomber
25. Computer key
27. Electron grouping or mollusk covering
29. Street in Italy
31. Homogeneous liquid mixture or the goal of this puzzle
34. "We interrupt this program..."
38. Companion of tuck
39. Together
42. Social science that relies on math, abbrev.
43. A result that replicates well
46. "___ my turn yet?"
47. "Inferno" writer
49. Boy band ___ Direction
50. Refill for printers
52. Voltage or unrealized ability
56. Weigh again
60. ___ talk
61. RCOOR'
66. Workplace rights agcy.
67. Oz city
71. Waste product, C2H4NO
72. Blood, minus cells & clotting factors
74. Drivers' grp.
75. Glare at
77. Chemical/physical characteristic or own's land
80. Immigrant course offering, abbr.
81. Composition of matter or developmental period
82. "___ Pray, Love"
84. Kind of natural pool
88. Self-proclaimed greatest boxer
89. Reach across
92. Old-style TV screen
94. Cry of the unsatisfied
95. Prevailed
96. Currency in 19 countries
97. Towel monogram
98. Sicilian volcano
99. Summer in Provence
100. Electron quantum property or public relations task
101. Type of quark
102. Instant lawn

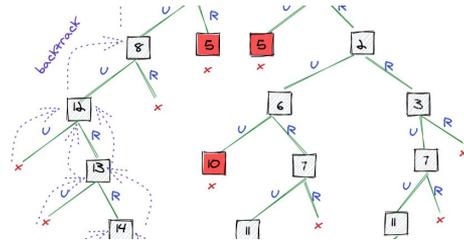
DOWN

1. Avogadro's number
2. One-eyed Norse deity
3. Written office communication
4. A long time ___
5. Anti-narcotics/gangs campaign
6. Put on clothing
7. Cut the grass
8. Full-bodied brew
9. Takes notice of, King James style
10. Woman's name from the Greek for wisdom
11. Rounded counter top edge style
12. Austin's Powers' Dr. ___
13. When riding the tube, be sure to mind this
15. Part of 31 across or financially okay
24. Found between ready & fire
26. Decrease the volume of 31 across or think hard
28. Red fluorescent dye for staining proteins
30. Phone program
32. Year in Claudius' reign as Roman emperor
33. Package deliverers
34. Referring to the foot
35. Company with dog & gramophone logo
36. A big slice of time
37. Between walk and center
40. A spectral sub-region, abbrev.
41. SAT org.
44. Double-bonded compound ending
45. When you plan to get there, abbrev.
46. Graphics file type
51. Builtright about
53. Chemical suffix for a sugar
54. Potable for two
55. Monty Python's Eric
56. ___ isa laquair
57. Big shoes to fill
58. Opiate named for the god of sleep
59. Luxury Japanese car nameplate
62. Convert directly from solid to gas or wonderful
63. ___ la
64. Unagi fish
65. N.C. capital, abbrev.
68. Bawdy film star West
69. Piercing site
70. Chemical colorant
73. Sources of peat
76. Winter hours in 65 down
78. Energize
79. Ship of drools
81. Grave or graph
83. The Jonas Brothers, e.g.
85. Points on 81 down
86. Tuscan river
87. Ahead or Pb
88. It accompanies shock
90. Onassis, Gold, or Shafiq
91. Meaning-reversing prefix
93. Small ingredient amt.



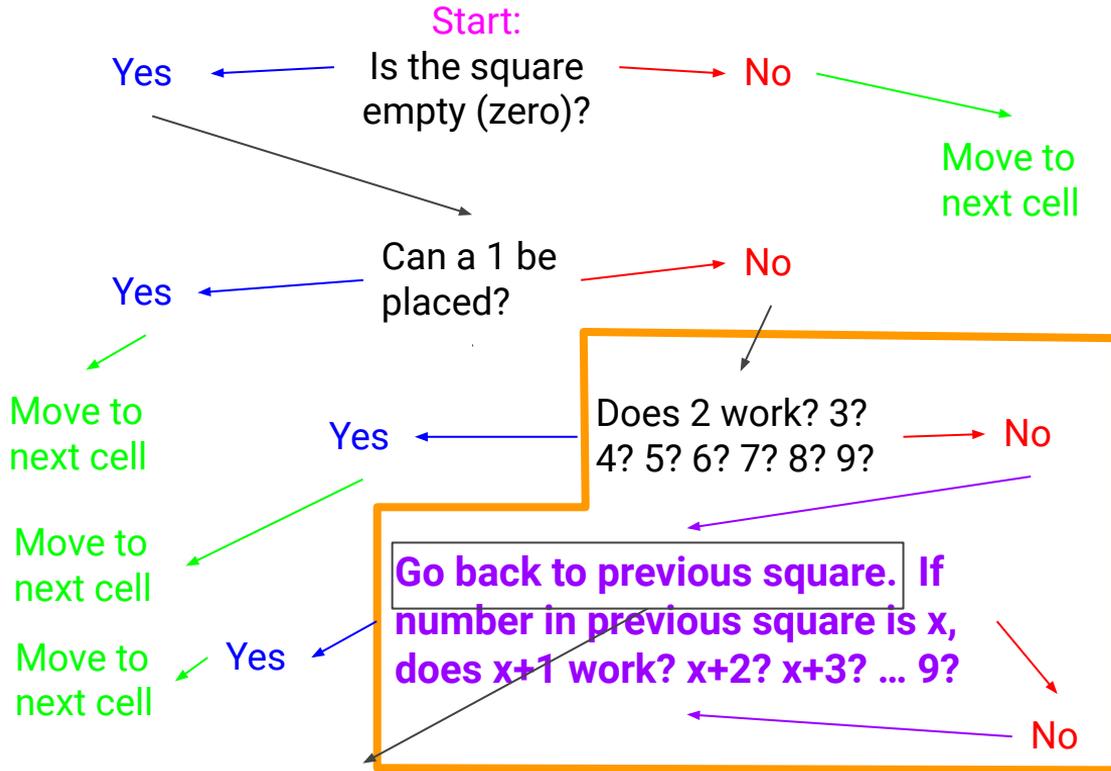
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Backtracking (The Basics)



- What is Backtracking?
- Backtracking is a form of recursion that looks for a solution to a problem by running through a system of possibilities, in this case, numbers 1 through 9
- When the computer finds that one piece of the sequence no longer works with the code, it will “backtrack” by abandoning the solution that it has used.
- Once the computer abandons a solution, it will try the next solution possible in the sequence until this also can no longer be a viable solution.
- The computer will repeat this process until it has filled out the Sudoku grid or it has run out of possible solutions.
- Backtracking is a great method of recursion that is able to successfully complete a Sudoku grid.

Backtracking Applied To Sudoku Solving

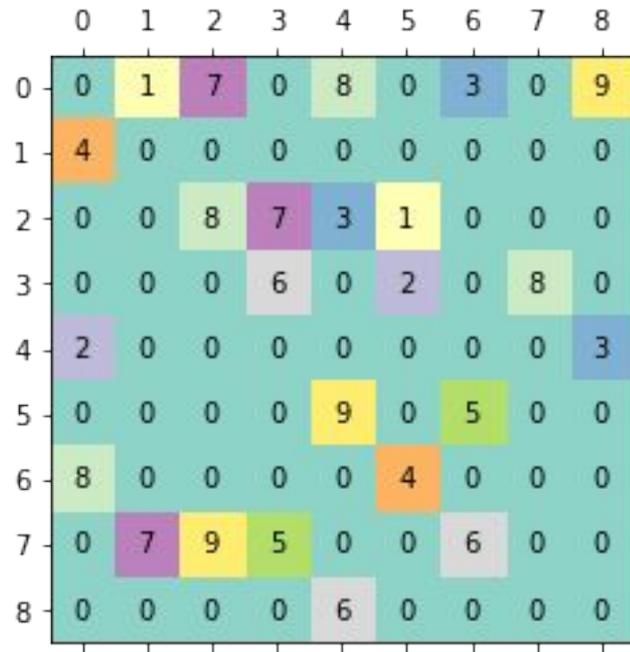


7	1	8	4	5	9	3	6	2
			2		1			
5								
	4						2	6
3				8				
			1				9	
	9		6					4
				7		5		

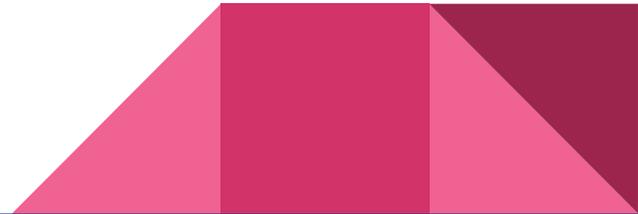
How do you go back to the previous square? **Backtracking**
Use an implicit return statement to break out of the current function and go back a step in the recursion.

Displaying Plots and Animations

- Displaying the sudoku grid as a numpy colormap
 - `matplotlib.pyplot.matshow()`
- Adjusting the colormap to display numbers
 - `numpy.ndenumerate()`
- Animating the Sudoku solver
 - `matplotlib.pyplot.savefig()`

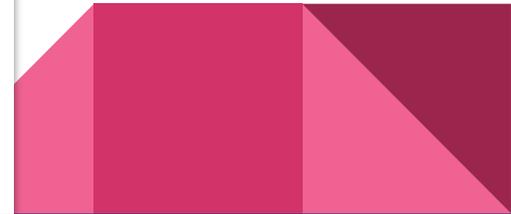


DEMO



Results

	0	1	2	3	4	5	6	7	8
0	4	2	7	5	8	6	9	1	3
1	6	8	3	1	7	9	2	5	4
2	9	1	5	3	2	4	6	7	8
3	8	7	1	9	6	2	3	4	5
4	3	4	9	8	1	5	7	2	6
5	2	5	6	4	3	7	8	9	1
6	1	9	2	6	5	8	0	0	0
7	5	0	8	7	4	3	0	6	0
8	7	6	0	0	0	1	0	0	0



Results: Odd End Behaviour of the Program

- Is it un-solving the Sudoku?
- In the notebook it outputs the solved Sudoku, why does it keep going in the video?

	0	1	2	3	4	5	6	7	8
0	4	2	7	5	8	6	9	1	3
1	6	8	3	1	7	9	2	5	4
2	9	1	5	3	2	4	6	7	8
3	8	7	1	9	6	2	3	4	5
4	3	4	9	8	1	5	7	2	6
5	2	5	6	4	3	7	8	9	1
6	1	9	2	6	5	8	0	0	0
7	5	0	8	7	4	3	0	6	0
8	7	6	0	0	0	1	0	0	0

References and Citations

- Backtracking (Geeks for Geeks)
 - <https://www.geeksforgeeks.org/sudoku-backtracking-7/>
- Sudoku Constraints (Stack Overflow)
 - <https://stackoverflow.com/questions/1697334/algorithm-for-solving-sudoku>
- Displaying Values on Plots (Stack Overflow)
 - <https://stackoverflow.com/questions/33828780/matplotlib-display-array-values-with-imshow>

ME AFTER 10 LINES OF CODING



Enough For Today!