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Sudoku

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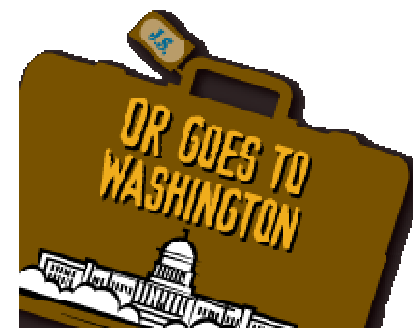
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Sudoku

Address <http://www.dailysudoku.com/sudoku/index.shtml>

Daily SuDoku



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Welcome to the Daily SuDoku!

Today's SuDoku is shown on the right. Click the grid to download a printable version of the puzzle. Visit [the archive](#) for previous daily puzzles and solutions. Play online, print a Sudoku, solve and get hints using the new improved **Draw/Play** function.

But how do I do it?

The object is to insert the numbers in the boxes to satisfy only one condition: each row, column and 3x3 box must contain the digits 1 through 9 exactly once. What could be simpler?

The rules of the new **Monster Sudokus** are exactly the same, but more numbers and letters are needed.

Classic

Monster

Kids

Squiggly

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

Daily SuDoku: Thu 2-Nov-2006

very hard



Christmas tree Sudoku

Address <http://www.dailysudoku.com/sudoku/archive.shtml?year=2005&month=12&day=23&type=seasonal>

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Daily Seasonal Sudoku: Fri 23-Dec-2005 [\[instructions\]](#)

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

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Christmas tree Sudoku: Fri 23-Dec-2005 very hard



Demo: Basic Sudoku (*su1*)

Basic model
su1 computes
solution to
given Sudoku

```

IDE File Edit Search Windows Utilities Model Libraries Help
[Icons] [a] [Print] [Run] gdx=su1
su1.gms
$title SUDOKU model 1

* Define SUDOKU grid and basic relationships
Sets  r  rows      / r1*r9 /
      c  columns   / c1*c9 /
      b  blocks    / b1*b9 /
      v  values    / v1*v9 /
br(b,r) / b1*b3 .r1*r3, b4*b6 .r4*r6, b7*b9 .r7*r9 /
bc(b,c) / (b1,b4,b7).c1*c3, (b2,b5,b8).c4*c6, (b3,b6,b9).c7*c9 /
brc(b,r,c) block definitions ;

brc(b,r,c) = br(b,r) *bc(b,c) ;

Table problem(r,c) Hard problem with non-unique solution
      c1  c2  c3  c4  c5  c6  c7  c8  c9
r1    2           6  7
r2           6           2
r3    4           8           1
r4    5           9  3
r5           3           5
r6           2  8           7
r7           1
r8    7           8           6
r9           5  3           8 ;

```

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Demo: Find other solutions ($su1 \rightarrow su2$)

- Is the solution unique?
- If not, how many solutions exist?
- Edits for $su1 \rightarrow su2$:
 - Implement binary cuts to exclude known solution
 - Use GDXdiff to inspect differences between solutions
 - Use loop to find and store solutions



Demo: Infeasible Sudoku ($su1 \rightarrow su3$)

- What should we do with an infeasible Sudoku?
 - Not enough to just report the infeasibility
 - Here, repair the data to make the model feasible
- Edits for going from $su1 \rightarrow su3$
 - Use random generation to get bogus data
 - Remove X.fx for fixed cells
 - Add binary variable UNDO (relaxes fixed cells)
 - Add equation fix using the UNDO variables
 - Add new objective function: Minimize sum over all UNDOs
 - Write short report

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Demo: Samurai model (su3 → su4)

- Add puzzle index p to all variables/equations
- Add linking constraints
- Use random data to test
- Fix undo variables initially to 0
 - If the model is feasible, it will solve quickly
 - If infeasible, we unfix undo and resolve



Demo: Excel in charge (samurai_vb)

- Existing Samurai model with Excel GUI
- Look at data communication between model and GUI

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

Samurai 1	Samurai 2
Samurai 3	Samurai 4
Solve	

GAMS Directory:	c:\program files\gams22.8\
Working Directory:	c:\tmp2\

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Demo: Samurai data input ($su4 \rightarrow su5$)

- Prepare our Samurai model $su4$ to plug in to spreadsheet
- Import 21x21 data from GUI (via GDX)
- Use mappings from map1 to map 21x21 \rightarrow 5x9x9
- Export 21x21 solution to GDX



Demo: Clean up (su5 → su6)

- Create text file for display in GUI

```
Solver: CPLEX  
equations: 1945 variables: 3646  
model status: 1 OPTIMAL  
solver status: 1 NORMAL COMPLETION  
iterations: 0 solve time: 0.08
```



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