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THE REAL DISTRIBUTION OF MINIMAL PUZZLES

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Author	Message
eleven Joined: 10 Feb 2008 Posts: 349	<p> <input type="checkbox"/> Posted: Mon Jul 13, 2009 7:31 am Post subject: quote </p> <hr/> <p>I dont understand. Doesn't your formula tell the ratio of probabilities to get minimals in floor n and n+1 ?</p> <p>There are 4 minimals, 1 in floor 2 and 3 in floor 1. The probability to reach the one in floor 2 is 1/10, as you said, and the one for the other 3 is $(1-1/10)*(1/3)$.</p> <p>So the ratio is 1/3. Is that, what your formula also gets ?</p> <p>Back to top profile pm</p>
coloin Joined: 05 May 2005 Posts: 1037 Location: Devon UK	<p> <input type="checkbox"/> Posted: Mon Jul 13, 2009 7:56 am Post subject: quote </p> <hr/> <p>At level 77 [? 78]the only potential thing that might happen is that a clue can become "essential" if the 3 other preceding clues that are removed are part of a U4.....</p> <p>Does this change things if we have an essential clue ?</p> <p>Stat evaluation of my previous data [Secondary school maths [my limit too !]]</p> <p>Code:</p> <pre style="border: 1px solid #ccc; padding: 5px;"> P value and statistical significance: Chi squared equals 79.864 with 10 degrees of freedom. The two-tailed P value is less than 0.0001 By conventional criteria, this difference is considered to be extremely statistically significant.</pre> <p>Possibly program bias...I agree.....Presently repeating the trial with a morphed subgrid.....</p> <p>C</p> <p>Back to top profile pm</p>
denis_berthier Joined: 19 Jun 2007 Posts: 720 Location: Paris, France	<p> <input type="checkbox"/> Posted: Mon Jul 13, 2009 9:14 am Post subject: quote </p> <hr/> <p>eleven wrote:</p> <div style="border: 1px solid #ccc; padding: 5px;"> <p>I dont understand. Doesn't your formula tell the ratio of probabilities to get minimals in floor n and n+1 ?</p> </div> <p>Yes, it was supposed to do this.</p> <p>eleven wrote:</p> <div style="border: 1px solid #ccc; padding: 5px;"> <p>There are 4 minimals, 1 in floor 2 and 3 in floor 1. The probability to reach the one in floor 2 is 1/10, as you said,</p> </div> <p>OK</p> <p>eleven wrote:</p> <div style="border: 1px solid #ccc; padding: 5px;"> <p>and the one for the other 3 is $(1-1/10)*(1/3)$.</p> </div> <p>Yes, yes.</p>

Thanks to your example, I realise there's one aspect of the top-down generators I had neglected.

Part of the sons of the 9 non-minimal puzzles remaining at floor 2 are below the only minimal of floor 2. For the generator, this case corresponds to the following situation: being at a non-minimal at floor 2 and deleting a clue, the result is a multi-sol puzzle; in this case, the generator discards it (the heritage is lost). I had forgotten to include this case in the analysis.

My formula should therefore include another factor to renormalise the probabilities at each floor, in order to take into account the lost heritage. This factor would depend on how many minimals with n clues there are - which is unknown. This entails that any hope of an exact formula vanishes.

Nevertheless:

- the proof that all the valid puzzles with n clues (minimal or not) have the same chances of being reached is still valid;
- your mini example isn't completely faithful to the real situation, in which the percentage of minimal puzzles at each floor is very very small. I think the probability loss is therefore very small and my formula still holds as a very close approximation.

In particular, my estimation of the mean number of clues (25.39) should not be too far from the real one.

Last edited by denis_berthier on Tue Jul 14, 2009 6:08 pm; edited 2 times in total

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coloin

Posted: Mon Jul 13, 2009 3:49 pm Post subject:



Well **denis**..... you should learn from this.....sudoku has a nasty habit of proving what you think must be right - but isnt !

Joined: 05 May 2005
Posts: 1037
Location: Devon UK

Unfortunately I was responsible for questioning the puzzle generation process....

coloin wrote:

You would think that statistically the chances of a [minimal] 24-puzzle being produced would be the same as any other [minimal] 24-puzzle - but I believe this is not the case. As the clue numbers reduce the pruning tree will be different [there will be an increasing number of "essential" "non-removable" clues as you advance] this will be specific to each of the many subpuzzles in the search tree.

Admittedly this bias towards certain puzzles wont really make much difference. Its been a job to show that this is significant.....and duplicate puzzles, lets be honest, wont happen in a lifetime of generating puzzles.

The subgridmorph which I examined gave similar results, I am sure there is a statistical test which confirms that the two distributions are probably similar.

Code:

```

.....94...8...7...35...2.....7.....7.914...5.....12.4.....6.9.5..1#69#62
....6...4..78.....9...54.2.....3.....91..75..1.....12...7.....6..35...#17#29
....6...4..78.....9...54.2...9.3.....9...75..1.....12...7.....6..35...#30#18
1.....9.5..8...23...4...3...5...91..7.....4.57..2.....6.9.5..1#26#30
1.....94...8...7...35...2.4...7...7.91...5.....2.4.....6.9.5..1#46#52
1.....94...8...7...235.....7.....7.914...5.....4.....2.....6.9.5..1#48#56
1...6...5.....9.23.4...4.9.3..6..57...7...1.....7..2.....9..4.1#31#38
1...6...5.7.....9.2..4...4.9.3..6..5.....7...1.....57..2.....3.42.#25#20
1...6...4..8...9...5...4.9.3...5..9...7...1.....2.4..7..2.....6...5..1#17#21
1...6...4..8...9.2.5.....9.3..6..5..9...75..1.....7..2.....9..4.1#23#13
1...6...4..8...9.2.5...4.9.3..6..5..9...7..1.....7..2.....9..4.1#21#10
    
```

and their SE ratings

```

2.6/1.2/1.2
2.0/1.2/1.2
1.5/1.2/1.2
2.0/1.2/1.2
2.5/1.2/1.2
2.0/1.2/1.2
4.5/1.2/1.2
9.6/9.6/2.6
7.1/1.2/1.2
6.6/1.2/1.2
6.6/1.2/1.2
    
```

maybe harder puzzles are disadvantaged !

Interestingly the subgrid was made from two disjoint 20-clue puzzles - one very hard the othe fairly easy.

Code:

```

1....6..945.78....7.9.2354.2.4.9.37.6..57.914.75..1.....12.4.57..2.....6.935421
    
```

Every clue in this 40-subgrid is superfluos.

Code:

```

+---+---+---+
| 1..|..6|...|
|.5.|7..|...|
|..9|.2|.4.|
+---+---+---+
|.4|.9.|3..|
|6..|5..|...|
|.7|..1|...|
+---+---+---+
|...|...|.57|
|.2|...|...|
|...|.3|.42.|
+---+---+---+ SE 9.6/9.6/2.6

from same grid, but excluding these clues

+---+---+---+
|...|...|..9|
|4..|.8.|...|
|7..|..3|5..|
+---+---+---+
|2..|...|.7.|
|...|.7.|914|
|..5|...|...|
+---+---+---+
|.1|2.4|...|
|...|...|...|
|.6|.9.5|.1|
+---+---+---+ SE 2.6/1.2/1.2

```

You still have to question the 25.39 value !

I wonder.....

Minimal sudoku puzzles are a funny breed.....

There are many,many unavoidable sets.....

That they can all be hit with less than 20 or so clues is a feat.

Maybe when a whole grid is considered the number of large puzzles that come out of the woodwork really does bump up the mean to >26.5 clues.

We shall see [I hope]

C

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denis_berthier

Posted: Mon Jul 13, 2009 8:32 pm Post subject:



coloin wrote:

At level 77 [? 78]the only potential thing that might happen is that a clue can become "essential" if the 3 other preceding clues that are removed are part of a U4.....
Does this change things if we have an essential clue ?

AFAIK, top-down generators don't take U4s into account.

I can't see any way they could do so without introducing a bias. If you forbid them a priori to delete the essential clue, it is similar to forbidding the deletion of some clues that would leave us with singles or naked pairs.

Moreover, I suspect that testing for U4s would take more time than taking the risk of finding a multi-solution puzzle later in the standard search tree.

As you may know, my main interest is not in the number of clues itself but in the complexity of puzzles. I became interested in the number of clues after we noticed a trend (more clues => harder) in the range 21-29 clues (for top-down generators). This trend is small and the 2 variables (#clues, complexity) have a very small correlation.

Is there any indication that the trend is still present beyond 30?

Just taking the first 3 puzzles I can think of in the top-something:

EasterMonster: 21 clues

GoldenNugget: 21 clues

SilverPlate: 21 clues

Do you know any **random** collection of minimal 35- or 40- clue puzzles?

Joined: 19 Jun 2007
Posts: 720
Location: Paris, France

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m_b_metcalf

Posted: Mon Jul 13, 2009 9:48 pm Post subject:



Joined: 15 May 2006
Posts: 2216
Location: Berlin

denis_berthier wrote:

Moreover, I suspect that testing for U4s would take more time than taking the risk of finding a multi-solution puzzle later in the standard search tree.

For what it's worth, in my programs I have found a clear advantage when using tests on unavoidable 4- and 6-sets in the following situations:

- 1) Top down: test these sets are covered *before* calling any solver.
- 2) Bottom up: if a puzzle has multiple solutions (the usual case), it is faster to find a first solution and then to check the cover, than to find a second solution.

Note: it is not necessary to find all the sets -- they can be found and tested for cover one at a time and the routine exited as soon as any set is found uncovered.

Regards,

Mike Metcalf

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denis_berthier

Posted: Mon Jul 13, 2009 10:04 pm Post subject:



Joined: 19 Jun 2007
Posts: 720
Location: Paris, France

m_b_metcalf wrote:

denis_berthier wrote:

Moreover, I suspect that testing for U4s would take more time than taking the risk of finding a multi-solution puzzle later in the standard search tree.

For what it's worth, in my programs I have found a clear advantage when using tests on unavoidable 4- and 6-sets in the following situations:

By "advantage", I suppose you mean in computation times.

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m_b_metcalf

Posted: Mon Jul 13, 2009 10:18 pm Post subject:



Joined: 15 May 2006
Posts: 2216
Location: Berlin

denis_berthier wrote:

By "advantage", I suppose you mean in computation times.

Yes.

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eleven

Posted: Mon Jul 13, 2009 11:31 pm Post subject:



Joined: 10 Feb 2008
Posts: 349

Coloin,

since i could not explain it, i ran sudogen overnight and can confirm now a clear bias in finding the 20 clues of your subgrid (last column, sum is 4787)

Code:

```

.....94...8...7...35...2.....7.....7.914...5.....12.4.....6.9.5...1#69#62#1039
.....6...4..78.....9...54.2.....3.....91..75..1.....12...7.....6..35...#17#29#280
.....6...4..78.....9...54.2...9.3.....9...75..1.....12...7.....6..35...#30#18#281
1.....9.5..8.....23.....4...3.....5...91..7.....4.57..2.....6.9.5...1#26#30#401
1.....94...8...7...35...2.4...7...7.91...5.....2.4.....6.9.5...1#46#52#656
1.....94...8...7...235.....7...7.914...5.....4.....2.....6.9.5...1#48#56#652
1...6...5.....9.23.4...4.9.3..6..57...7...1.....7...2.....9...4.1#31#38#418
1...6...5.7.....9.2..4...4.9.3..6..5...7...1.....57..2.....3.42.#25#20#320
1...6...4..8.....9...5...4.9.3...5..9...7...1.....2.4..7..2.....6...5...1#17#21#304
1...6...4...8.....9.2.5.....9.3..6..5..9...75..1.....7..2.....9...4.1#23#13#212
1...6...4...8.....9.2.5...4.9.3..6..5..9...7...1.....7..2.....9...4.1#21#10#225
    
```

So i missed something yesterday. But now i have -5 hours to think about it 😊

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David P Bird

Posted: Tue Jul 14, 2009 1:20 am Post subject:

[quote](#)

Joined: 16 Sep 2008

Posts: 63

Location: Middle
England

Having followed the mathematical arguments on this thread to the best of my ability, I wonder if these concepts have any merit:

For a solution grid we map all the unconditional sets - here I think only those containing two or three digits are significant but I'm ready to be educated.

For a top down generator, as we randomly exclude cells we make a running check that each unconditional set still has two or more surviving cells. If not we slap a protection order on any sole survivors as being essential to the solution and continue until every surviving cell is protected.

As Red Ed has pointed out, we need to start this check only after the first three exclusions, but from floor 30 downwards I guess there will be a significant proportion of the remaining cells which would be protected.

For a random bottom up generator, as cells are added the unconditional sets containing them are marked as being satisfied and the list of candidate cells for inclusion is updated to contain the members of all the unsatisfied sets.

Again this process would have little influence on the early choices but this would ramp up steadily in the later stages and would obviate having to check for superfluous givens (I think).

For a deterministic bottom up generator we can add the size of the unconditional sets as an extra measure. Totalling these for the sets satisfied by a cell gives a measure of its potential contribution to the solution. For a start I would favour a strategy that at any stage prioritised cells with the highest unsatisfied set count and the lowest contribution, which I hope would lead to tougher puzzles.

Last edited by David P Bird on Tue Jul 14, 2009 1:50 am; edited 1 time in total

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m_b_metcalf

Posted: Tue Jul 14, 2009 3:52 am Post subject:

[quote](#)

Joined: 15 May 2006

Posts: 2216

Location: Berlin

David P Bird wrote:

For a solution grid we map all the unconditional sets - here I think only those containing two or three digits are significant but I'm ready to be educated.

For your information, here is the 4- and 6-set hit count and cover information for four random grids. I don't have much time left for further contributions.

Code:

```

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

```

```

4 0 8 6 6 4 12 4 0
6 0 6 0 6 10 10 6 0
4 4 4 6 6 6 8 4 0
6 6 12 6 12 12 6 12 0
10 10 6 6 12 6 10 10 0
10 6 4 10 16 12 10 4 0
12 0 0 24 0 10 10 18 0
6 0 6 16 4 4 8 16 0
12 0 0 12 6 6 4 22 0

```

Zero hits: 18 Number of sets: 20

```

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

```

```

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

```

```

0 4 0 12 12 16 8 4 4
4 8 0 0 4 8 10 6 10
6 6 0 0 0 0 6 6 0
12 6 0 12 6 6 0 6 0
6 0 6 6 0 12 6 12 0
0 4 10 12 6 0 6 6 0
10 8 22 0 16 10 6 6 18
0 6 12 6 12 6 6 12 0
12 12 12 6 24 6 4 10 12

```

Zero hits: 21 Number of sets: 18

```

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

```

```

10 6 6 4 6 0 6 0 0
10 4 8 6 6 10 14 4 8
8 0 4 10 0 10 0 0 4
6 6 12 12 0 12 12 12 0
12 0 10 10 18 6 6 6 6
6 4 8 4 10 4 4 10 12
0 18 6 6 6 6 6 12 0
0 12 6 0 4 16 12 6 0
12 18 12 18 6 6 4 6 10

```

Zero hits: 15 Number of sets: 20

```

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

```

```

22 0 16 12 18 12 18 6 24
24 12 30 0 0 18 18 16 16
18 12 18 6 12 12 18 12 24
6 6 18 4 4 4 12 10 12
22 12 12 4 8 6 0 8 6
12 4 10 0 0 6 12 10 6
18 0 6 10 6 10 18 12 18
12 24 18 4 4 6 12 4 10
10 10 12 0 12 0 18 6 0

```

Zero hits: 10 Number of sets: 28

Regards,

Mike Metcalf

Last edited by m_b_metcalf on Tue Jul 14, 2009 6:04 am; edited 2 times in total

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David P Bird

Posted: Tue Jul 14, 2009 4:51 am Post subject:

[quote](#)

Joined: 16 Sep 2008
Posts: 63
Location: Middle
England

Mike, thanks for your response, but I'm a relative newbie to this topic and you give me credit for more knowledge than I have!

When you say a 4-set, does the 4 refer to the number of cells or the number of digits? I would also like to know what the row and column headers would be for your tables! One of the random grids used would also help if you've got the time.

To make sure we are not at cross purposes, for me an unconditional set is one where every candidate it contains occurs

twice in every house it occupies. For the 36 digit pairs there will be between 1 and 4 unconditional sets in a grid. I'd guess that most grids would contain less than 80 two-digit sets.

For three-digit sets certain Braiding (travelling pairs and singles) constraints must be met and I'd say that most grids would have less than 10.

From my very limited experience gained by working manually I've never found a set with more than 3 digits has come into play, but perhaps that's just luck. I've concluded that they arise because of the way the 2- and 3- digit sets overlap, and by looking after these, the likelihood that one of the bigger sets will survive is either nil or remote.

Consequently I believe that in computing terms, watching something in the order of 90 unconditional sets should be manageable, and although it would be a pain during the early stages, it would come into it's own towards the end because there wouldn't be the need to do so much checking.

Your earlier post on the "A crazy generator" thread provided me with some brain food. My suggested prioritising system for the deterministic bottom-up generator attempts to satisfy all the required sets as quickly as possible but at the same time minimise the influence exerted on the rest of the grid by the givens and so restrict the opportunities of making a big advance from a single deduction. It would therefore be distinctly biased, but I don't think the random schemes I described would be.

I'm far from sure I've grasped all the essentials here however, so I post my ideas in the hope that even if they are flawed, they'll provide food for thought for something better.

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m_b_metcalf

Posted: Tue Jul 14, 2009 5:45 am Post subject:

 [quote](#)

David P Bird wrote:

To make sure we are not at cross purposes, for me an unconditional set is one where every candidate it contains occurs twice in every house it occupies. For the 36 digit pairs there will be between 1 and 4 unconditional sets in a grid. I'd guess that most grids would contain less than 80 two-digit sets.

Always a good idea. I mean [unavoidable sets](#). If we're talking about the same thing I have all the compnents in place to program your suggestions, but I will have no time to do so before September. [Edit:] See the grids in my previous posting.

Regards,

Mike Metcalf

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coloin

Posted: Tue Jul 14, 2009 8:34 am Post subject:

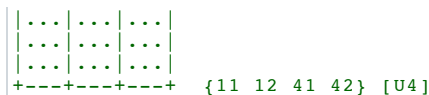
 [quote](#)

Not sure where to start here.

I perhaps need to restate that there are MANY MANY unavoidable sets in a complete solution grid. So many in fact that no-one has ever got near writing a "set-cover" program.

Code:

```
+---+---+---+
| 126 | 347 | 598 |
| 458 | 169 | 732 |
| 379 | 285 | 461 |
+---+---+---+
| 213 | 478 | 659 |
| 584 | 692 | 317 |
| 697 | 513 | 824 |
+---+---+---+
| 732 | 851 | 946 |
| 845 | 926 | 173 |
| 961 | 734 | 285 |
+---+---+---+
+---+---+---+
| 12. | ... | ... |
| ... | ... | ... |
| ... | ... | ... |
+---+---+---+
| 21. | ... | ... |
| ... | ... | ... |
| ... | ... | ... |
+---+---+---+
```



Here are the co-ordinates of a few more unavoidable sets in this random grid. Remove all the clues in a set and you get a "puzzle" with > 1 sol. Note these are the unavoidable which are specific to r1c1 clue. There are many more sets with more than 27 clues. There are many more involving other clues. I am not sure that mikes grids are helpful at all !

11 12 13 14 16 17 18 19 22 23 24 25 26 27 28 29 31 35 38 39
 11 12 13 14 16 18 19 22 23 24 25 26 28 29 31 32 35 36 38 39
 11 12 13 14 15 17 19 21 22 23 24 25 27 29 31 32 34 37
 11 12 13 14 15 16 17 19 21 23 24 25 29 31 32 34 36 37
 11 12 14 15 17 19 22 27 31 32 34 35 37 39
 11 12 14 15 16 17 19 31 32 34 35 36 37 39
 11 12 13 14 15 16 18 19 21 22 23 24 25 26 28 29 32 36
 11 12 13 14 15 16 18 19 21 22 23 25 26 28 29 31 32 34 36 39
 11 12 13 14 15 16 17 18 19 21 22 23 24 25 26 27 28 29
 11 12 13 14 15 16 17 18 19 21 22 23 25 26 27 28 29 31 34 39
 11 13 14 15 16 17 18 21 23 24 25 26 27 28 33 35 36 37
 11 13 14 15 18 21 22 23 24 25 26 27 28 32 33 35 36 37
 11 15 19 21 25 28 31 35 38 39
 11 12 14 15 16 18 19 21 22 23 24 25 26 28 29 32 33 35 36 38
 11 12 14 15 16 18 19 21 24 26 27 28 32 34 35 37 39
 11 12 14 15 16 17 18 19 21 22 23 24 25 26 27 28 29 33 35 38
 11 12 13 31 33 42 43 61 63 71 72 73 91 93
 11 13 31 33 41 43 61 63 71 73 91 93
 11 15 21 24 29 34 37 42 44 53 58 65 68 69 73 78 82 87 93 97
 11 15 21 24 42 44 53 56 58 65 68 82 85 87 93 96 97
 11 17 22 24 34 36 39 42 48 51 56 58 64 68 83 87 93 99
 11 17 22 24 36 39 41 42 48 51 56 64 65 68 73 76 83 85 87 93 99
 11 17 22 24 36 39 41 42 48 51 56 64 65 68 73 76 85 87 93 97 99
 11 17 22 24 36 39 42 48 51 58 64 65 73 75 76 85 87 93 97 99
 11 17 22 24 36 39 42 48 51 56 58 64 65 68 73 76 83 85 87 93 99
 11 12 13 38 39 42 47 56 58 61 65 68 73 76 79 85 87 92 97
 11 12 13 25 29 34 38 39 42 47 54 56 58 61 65 73 76 79 85 87 92 97
 11 13 25 29 34 38 41 42 47 54 56 61 68 73 79 85 86 92 93 97
 11 13 24 25 29 34 38 41 42 47 54 58 61 65 68 73 79 92 93 97
 11 13 38 39 42 47 56 58 61 65 68 76 79 85 86 87 92 93
 11 13 25 29 34 38 39 42 47 54 56 58 61 65 76 79 85 86 87 92 93
 11 13 25 29 34 38 39 42 47 54 56 58 61 65 73 76 79 85 87 92 93 97
 11 16 24 27 29 32 39 42 45 56 59 63 65 68 71 73 76 85 88 93 94
 11 12 19 23 24 35 39 41 46 52 56 58 65 67 74 76 81 87 93 98
 11 19 23 24 34 35 39 73 74 81 85 87 93 97
 11 12 41 42
 11 18 26 29 33 34 39 42 49 56 58 62 65 68 76 77 84 85 87 91 93
 11 14 15 24 28 31 39 42 44 53 58 65 69 72 76 78 82 89 93 96
 11 15 21 24 28 31 39 42 44 53 58 65 69 72 76 78 82 89 93 96
 11 14 22 24 31 36 42 48 51 58 64 66
 11 14 17 31 36 39 64 66 83 87 93 99
 11 14 17 22 24 28 42 48 51 57 58
 11 17 22 24 36 39 42 43 48 51 58 64 65 66 72 75 76 83 87 89 95 99
 11 17 22 28 31 39 43 48 51 57 72 75 83 87 89 93 95 99
 11 13 24 25 38 39 42 43 47 54 58 61 65 66 72 79 86 87 89 92 93 95
 11 13 14 24 25 28 31 38 39 43 47 54 57 58 61 66 72 76 79 86 87 92 95
 11 14 24 27 28 31 39 87 88 89
 11 14 24 28 31 39 58 59 88 89
 11 16 24 27 32 39 42 45 57 59 63 65 71 76 87 89 93 94
 11 16 24 27 28 32 39 42 45 57 58 59 63 65 71 76 93 94
 11 14 23 24 31 35 43 46 52 57 58 66 67 72 74 81 87 93 95 98
 11 14 19 23 24 28 57 58 81 87 89 93 98
 11 14 24 28 31 39 57 58 87 89
 11 14 24 26 28 31 33 39 42 43 49 55 57 58 62 65 66 72 77 84 89 91 93 95
 11 14 18 24 26 28 33 39 43 49 55 57 58 62 66 72 77 84 87 89 91 93 95
 11 13 15 21 24 25 42 44 47 53 54 58 61 65 69 76 78 79 82 86 87 93 96
 11 13 15 21 24 25 37 38 42 44 47 61 65 69 78 79 92 93
 11 13 15 21 24 25 37 39 42 44 47 61 65 69 76 79 86 87 92 93
 11 15 21 24 37 38 39 44 47 54 58 65 69
 11 13 24 25 37 38 42 47 54 58 61 65 76 78 82 87 92 93 96
 11 13 24 25 37 38 39 42 44 53 54 61 65 76 78 79 82 87 93 96
 11 13 15 21 24 25 38 39 53 54 58 61 65 69 78 79
 11 15 21 24 37 39 42 44 53 58 65 69 76 78 82 87 93 96
 11 15 21 24 42 44 49 62 65 69
 11 15 18 21 24 26 33 37 42 44 53 55 62 65 77 78 82 84 91 96
 11 17 22 24 25 36 39 42 48 51 54 58 61 65 75 76 83 87 93 99
 11 13 17 22 24 36 38 39 42 47 48 54 58 61 64 65 75 76 79 83 86 87 92 93 99
 11 16 17 22 24 27 42 45 48 51 59 63 65 71 76 83 88 93 94 99
 11 17 22 27 32 39 42 48 51 58 59 83 87 88 93 99


```

11 16 22 24 32 36 42 45 63 64 65 71 75 76 93 94
11 16 17 32 36 39 42 45 48 51 58 63 64 71 75 83 87 93 94 99
11 17 22 23 24 35 36 39 46 48 51 52 64 65 67 81 87 93 98 99
11 17 22 23 24 36 39 46 48 51 52 64 67 74 76 81 87 93 98 99
11 17 19 22 24 35 36 39 42 46 48 51 52 58 64 65 67 98 99
11 17 19 22 24 36 39 42 46 48 51 52 58 64 67 74 76 98 99
11 17 19 23 24 35 39 64 65 74 75 81 83 87 93 99
11 17 19 23 24 35 36 39 74 75 76 81 83 87 93 99
11 19 22 23 24 35 39 42 46 48 51 58 65 67 74 76 81 83 87 93 98
11 19 22 23 24 35 39 42 48 51 58 64 65 74 75 81 83
11 19 22 23 24 35 36 39 42 48 51 58 74 75 76 81 83
11 17 22 24 36 39 42 48 51 58 64 65 75 76 83 87 93 99
11 13 42 47 52 58 61 67 81 87 92 93 98
11 13 24 25 52 54 58 61 65 67 81 87 92 93 98
11 13 24 25 42 46 52 54 61 65 74 76 92 93
11 13 19 23 24 35 39 42 46 47 61 65 67 74 76 92 93
11 13 19 23 25 35 38 42 46 47 52 54 58 74 79 81 86 87 93 98
11 13 19 23 24 25 35 38 46 47 54 58 65 67 74 79 81 86 87 93 98
11 13 19 23 24 25 35 38 42 46 47 61 65 67 74 76 79 81 86 92 93 98
11 19 23 24 25 35 38 39 42 46 52 54 61 65 74 76 79 81 86 92 93 98
11 19 23 24 35 38 39 46 47 54 58 65 67 74 79 81 86 87 93 98
11 19 23 24 35 38 39 42 46 47 61 65 67 74 76 79 81 86 92 93 98
11 13 24 25 38 39 42 47 54 58 61 65 76 79 86 87 92 93
11 13 18 33 39 42 49 55 58 61 62 65 92 93
11 18 24 25 33 38 39 42 47 54 58 61 65 76 79 86 87 91 92 93
11 16 24 27 32 39 42 45 58 59 63 65 71 76 87 88 93 94
11 16 24 27 32 39 42 49 55 58 59 62 63 65 71 76 87 88 93 94
11 18 32 33 39 42 45 49 55 58 63 65 91 93
11 19 23 24 35 39 42 46 52 58 65 67 74 76 81 87 93 98
11 18 33 39 42 49 55 58 62 65 91 93

```

.....

To confirm the extent of these, try running [unav27.exe](#) from **dukuso** over a valid 81-text grid.

You need at least one clue in every unavoidable set [PERIOD]

Code:

```

To make sure we are not at cross purposes, for me an unavoidable [edited] set is
one where every candidate it contains occurs twice in every house it occupies. For
the 36 digit pairs there will be between 1 and 4 unconditional sets in a grid. I'd
guess that most grids would contain less than 80 two-digit sets.

```

Code:

```

+---+---+---+
|. . . | . . 1 | . . 2 |
|. . 2 | . . . | . 1 . |
|. 1 . | . 2 . | . . . |
+---+---+---+
|. . . | . . 2 | 1 . . |
|. 2 . | 1 . . | . . . |
| 1 . . | . . . | . 2 . |
+---+---+---+
|. . . | . 1 . | 2 . . |
|. . 1 | 2 . . | . . . |
| 2 . . | . . . | . 1 . |
+---+---+---+ 2-perm 2-digit pattern [ U18 actually] [no U4, noU6, noU8 etc]

+---+---+---+
|. . . | . . . | . 1 2 |
|. . . | . 1 2 | . . . |
|. 1 2 | . . . | . . . |
+---+---+---+
|. . . | . . . | . 2 1 |
|. . . | . 2 1 | . . . |
|. 2 1 | . . . | . . . |
+---+---+---+
|. . . | 1 . . | 2 . . |
| 1 . . | 2 . . | . . . |
| 2 . . | . . . | 1 . . |
+---+---+---+ 16-perm 2-digit pattern [3xU4 and 1xU6] [4 unavoidables]

```

Absolutely correct. **RW** studied these 2-digit unavoidables [with 18 clues] There are 36 pairs in a grid, there are only 181 essentially different pairs. They have either 2,4,8 or 16 perms depending on thir structure. The most that a grid was found to have was 78 2-digit unavoidables. Grids with 36 pairs of 2 perms were found too[fully entwined grids][36 2-digit unavoidables[U18s]].

A top down generator , by removing a clue and checking for sol>1 is actually verifying that an unavoidable set is not covered.

The problem for random "puzzles" is dependant on the clue numbers

Above 39 - all non-minimal
 31-39 - nearly all non-minimal, some >1 sol.
 29,30 - mostly non-minimal, most >1sol
 below 29 - almost all >1sol
 below 17 - all >1 sol.

So prospects are hopeful only for 29 and 30 clue minimal puzzles !

As yet no-one has published a truely random puzzle !

I cant see a way of generating puzzles randomly with either a top down or a bottom up method !

It would be possible to generate randomly subgrids with 40 clues where all the clues are superfluous ! 🤔

C

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David P Bird

📅 Posted: Tue Jul 14, 2009 9:28 am Post subject:

[🗉 quote](#)

Joined: 16 Sep 2008
 Posts: 63
 Location: Middle
 England

Mike thanks for your second response and I'm working on your first grid right now. However my time is booked for the rest of today and all tomorrow so I'll have to get back to it on Thursday.

Colin I won't have time to do anything with the sets you so kindly posted either. However, we must be careful that we are actually disagreeing about anything! What I'm saying (or hoping) is if we make sure the 90 odd 2 and 3 digit unavoidable sets in a grid have at least one cell included (or covered) in the set of givens, the sets with 3+ digits will also be covered. To see if this hypothesis is right or not we can either go to some mathematical analysis that will be above me, or more simply, look for a counter example.

Even if I'm wrong, the schemes I suggest might still be practical, but would entail a final run through a fast solver such as the dancing links one to catch any instances of a big set that had managed to slip through.

Of course all this is still conditional on me having got hold of the right end of the right stick!

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