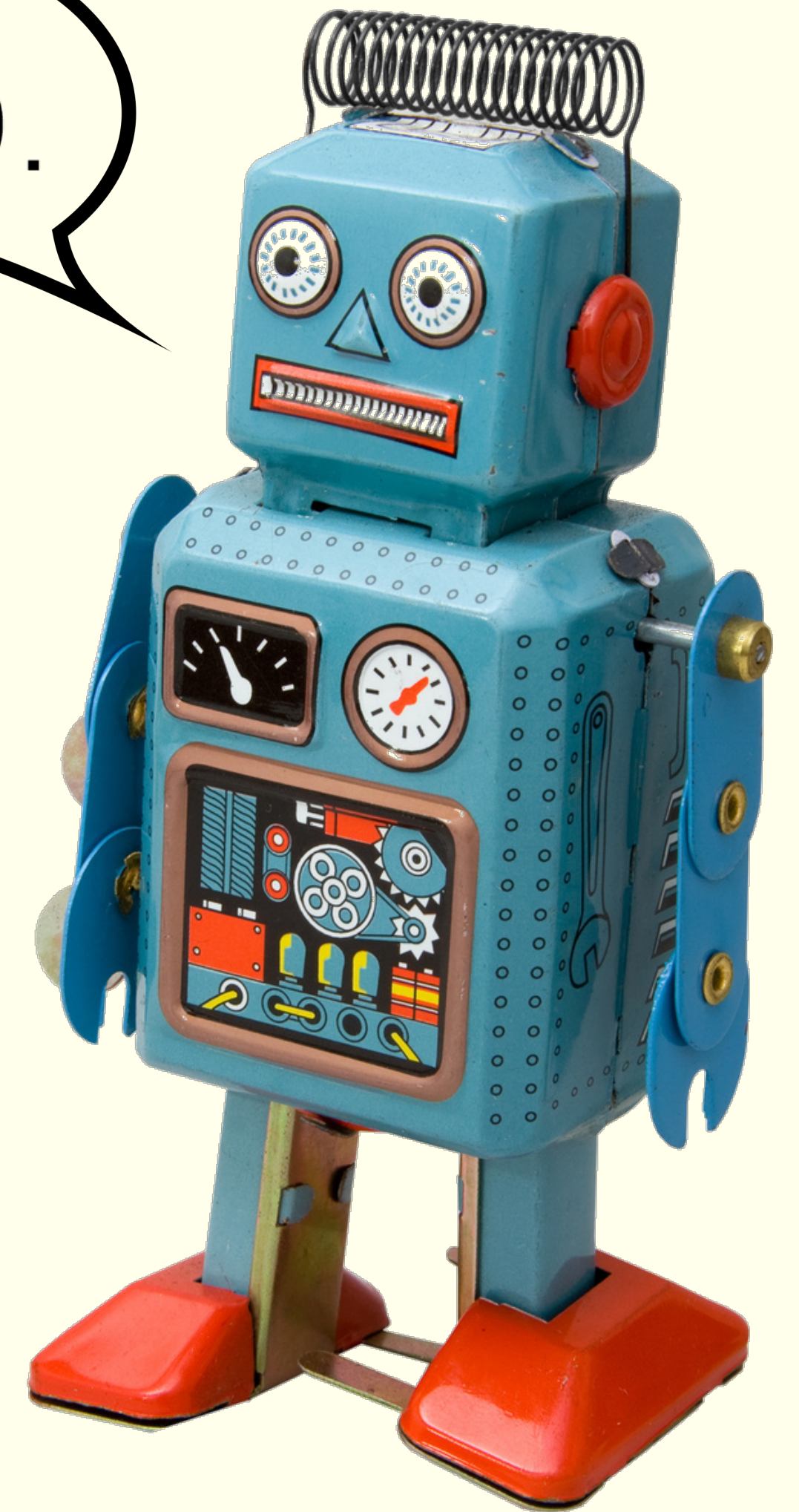


Hello,  
Sentient

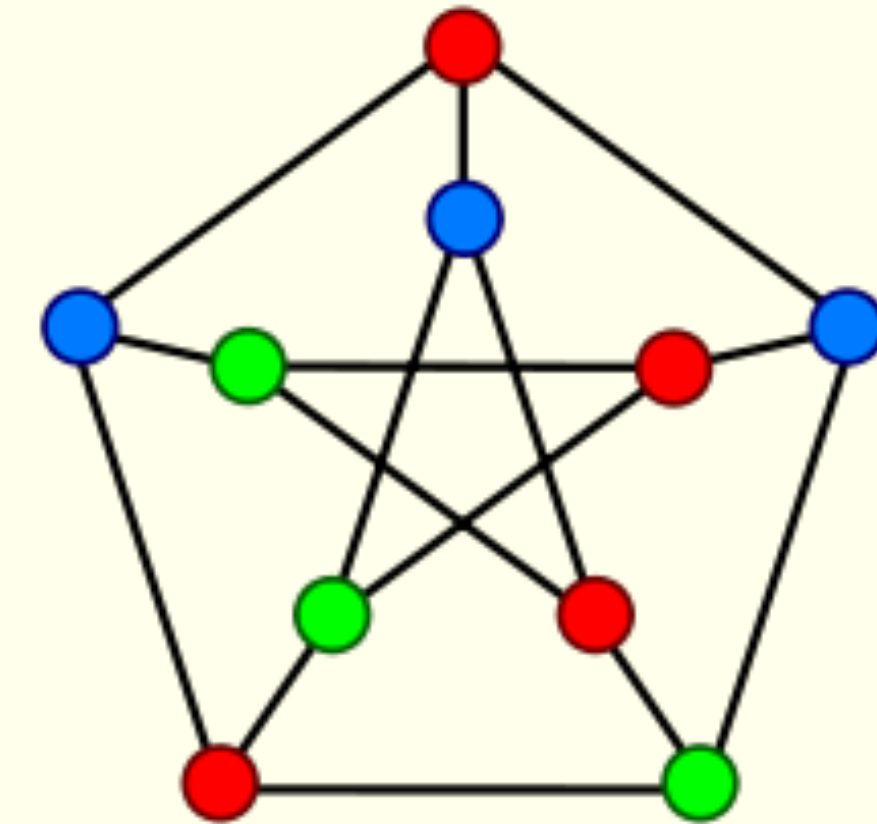
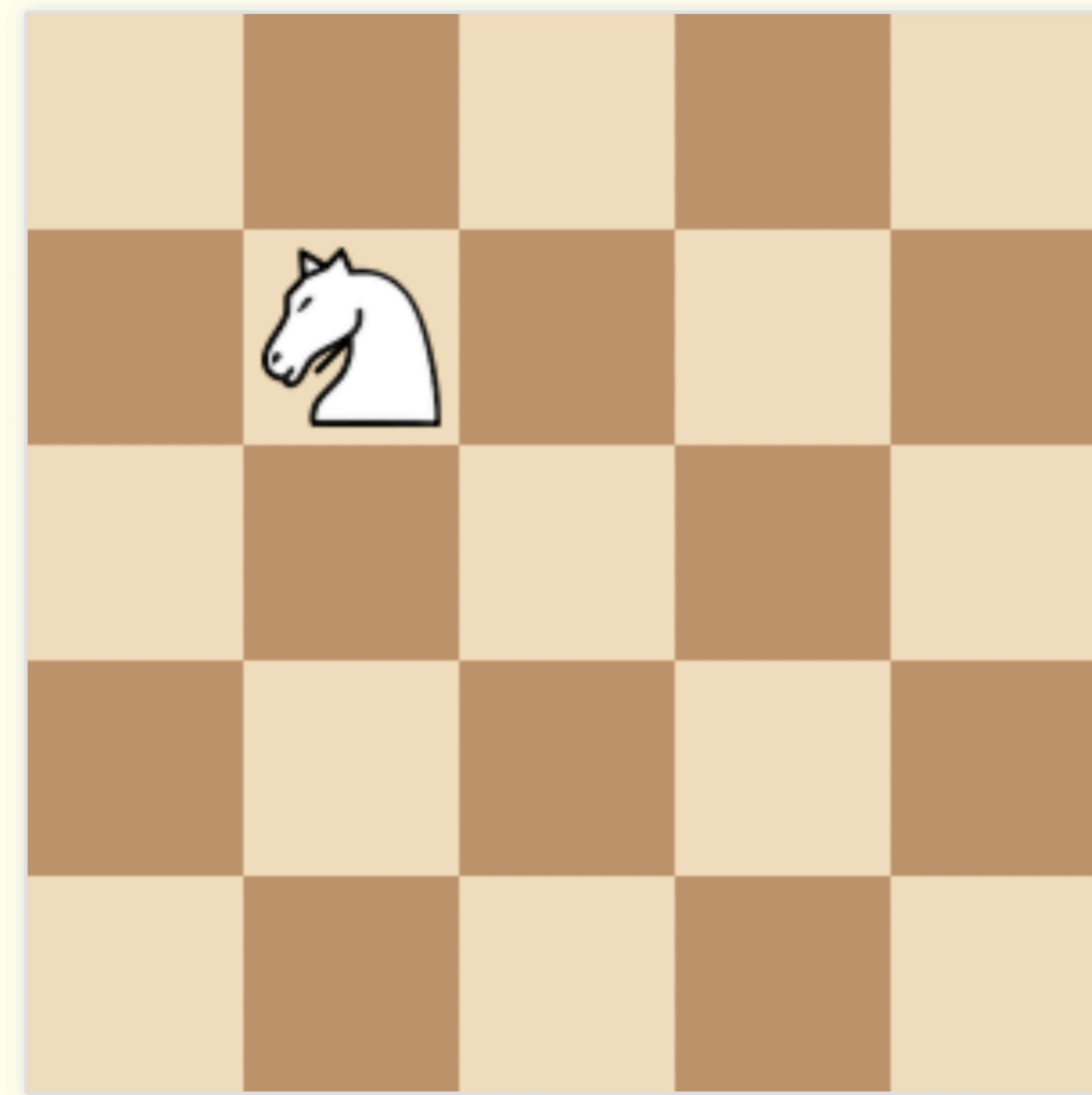
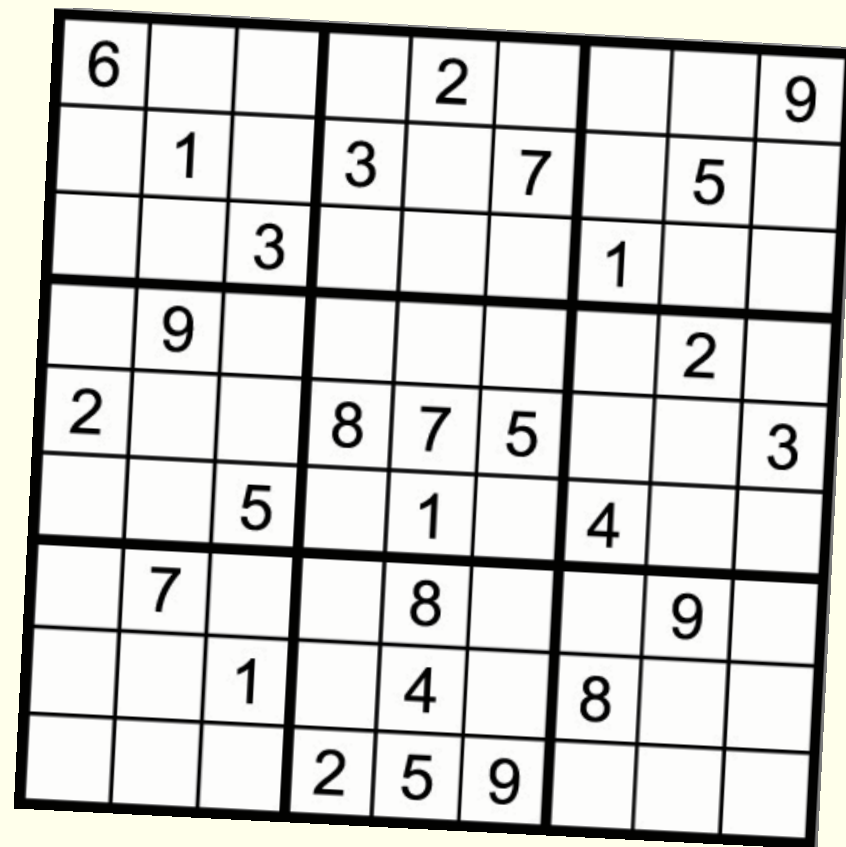
Sup.



by Chris Patuzzo  
Ember London, 2017-01-12  
@cpatuzzo

Firstly,

# What is Sentient?



5	1	9	15
9	5	1	15
1	9	5	15
15	15	15	15



# Most languages



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

## Some algorithm

For each empty square

Try a number that fits

If no numbers fit

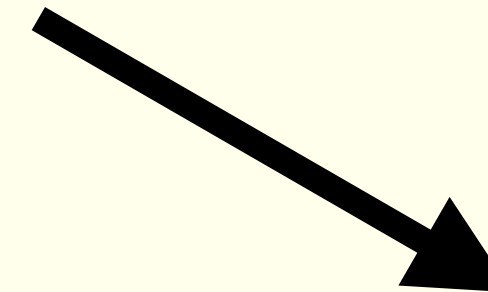
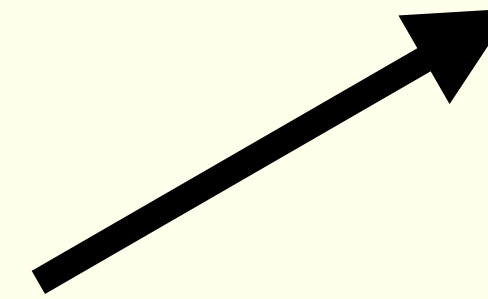
Backtrack

# Sentient

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



**Valid?**



# An example

5	1	9	15
9	5	1	15
1	9	5	15
15	15	15	15

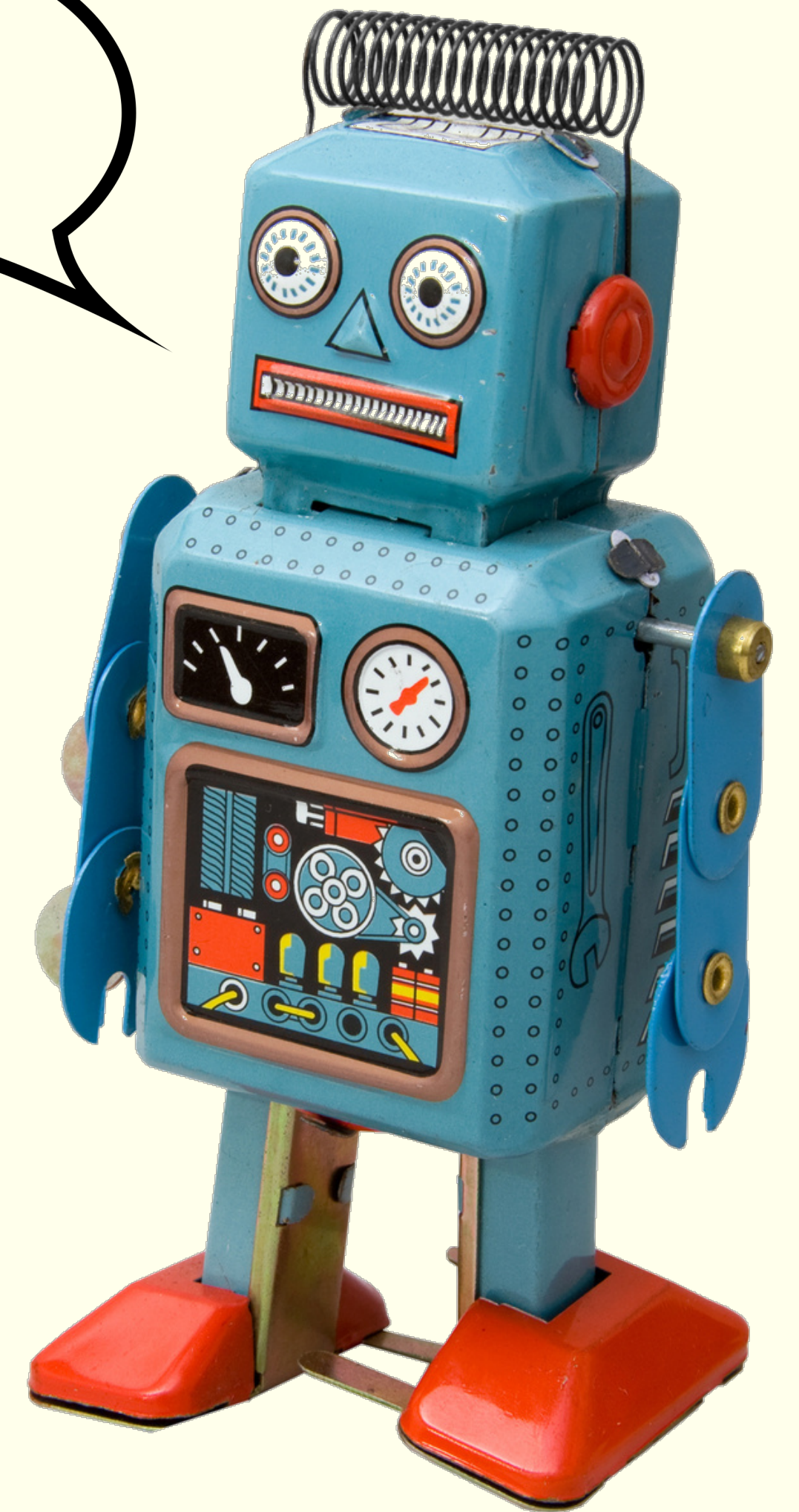
- 1) The **rows** must sum to the same target
- 2) The **columns** must sum to the same target
- 3) The **diagonals** must sum to the same target



Here's how to  
check a magic  
square

Now go  
find some!

OK





```
array3<array3<int>> magic_square;  
int target;  
  
magic_square.each(function^ (row) {  
  invariant row.sum == target;  
  invariant row.all?(*positive?);  
});  
  
magic_square.transpose.each(function^ (column) {  
  invariant column.sum == target;  
});  
  
left_diagonal = magic_square.map(function (row, index) {  
  return row[index];  
});  
  
right_diagonal = magic_square.map(function (row, index) {  
  return row.reverse[index];  
});  
  
invariant left_diagonal.sum == target;  
invariant right_diagonal.sum == target;  
  
expose magic_square, target;
```



```
array3<array3<int>> magic_square;  
int target;
```

```
magic_square.each(function^ (row) {  
  invariant row.sum == target;  
  invariant row.all?(*positive?);  
});
```

ROWS

```
magic_square.transpose.each(function^ (column) {  
  invariant column.sum == target;  
});
```

COLUMNS

```
left_diagonal = magic_square.map(function (row, index) {  
  return row[index];  
});
```

DIAGONALS

```
right_diagonal = magic_square.map(function (row, index) {  
  return row.reverse[index];  
});
```

```
invariant left_diagonal.sum == target;  
invariant right_diagonal.sum == target;
```

```
expose magic_square, target;
```

```
array3<array3<int>> magic_square;  
int target;
```

```
array3<array3<int>> magic_square;  
int target;
```

**magic\_square**

int	int	int
int	int	int
int	int	int

**target**

int
-----



```
array3<array3<int>> magic_square;  
int target;
```

```
magic_square.each(function^ (row) {  
    invariant row.sum == target;  
    invariant row.all?(*positive?);  
});
```

**magic\_square**

int	int	int
int	int	int
int	int	int

**target**

= 

int
-----

```
magic_square.transpose.each(function^ (column) {  
  invariant column.sum == target;  
});
```

**magic\_square**

int	int	int
int	int	int
int	int	int

**target**  
=  

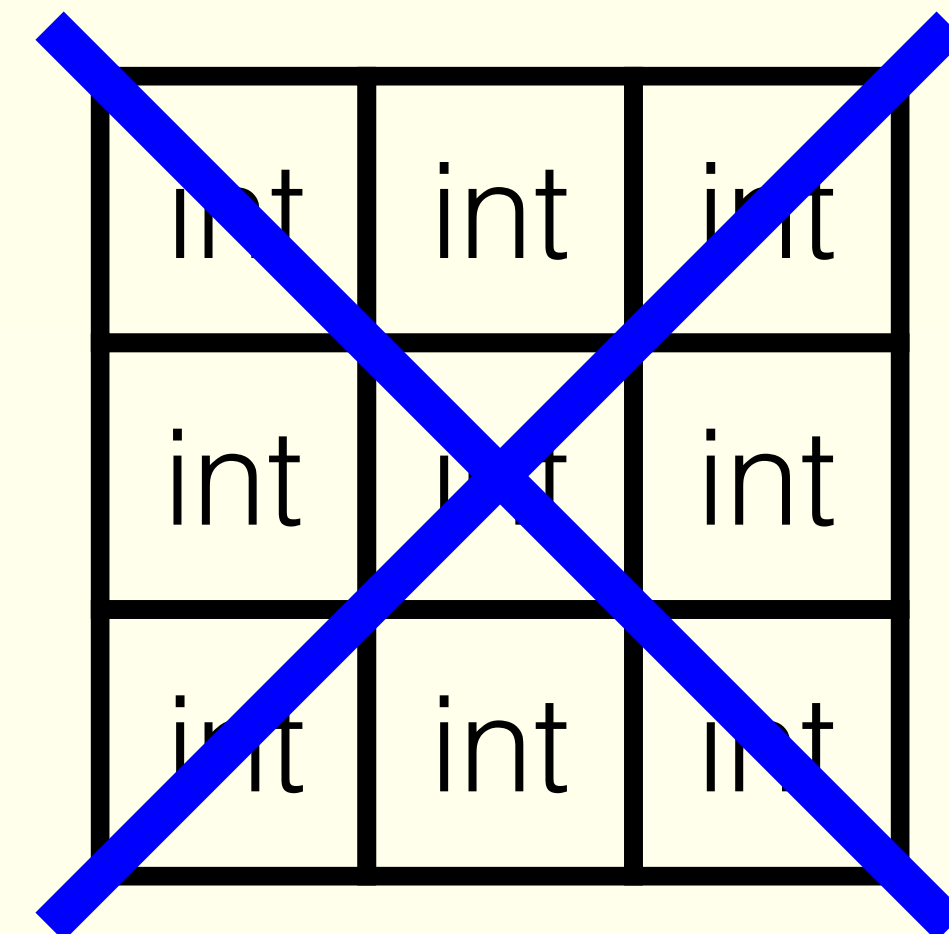
int
-----

```
left_diagonal = magic_square.map(function (row, index) {  
    return row[index];  
});
```

```
right_diagonal = magic_square.map(function (row, index) {  
    return row.reverse[index];  
});
```

```
invariant left_diagonal.sum == target;  
invariant right_diagonal.sum == target;
```

**magic\_square**



int	int	int
int	int	int
int	int	int

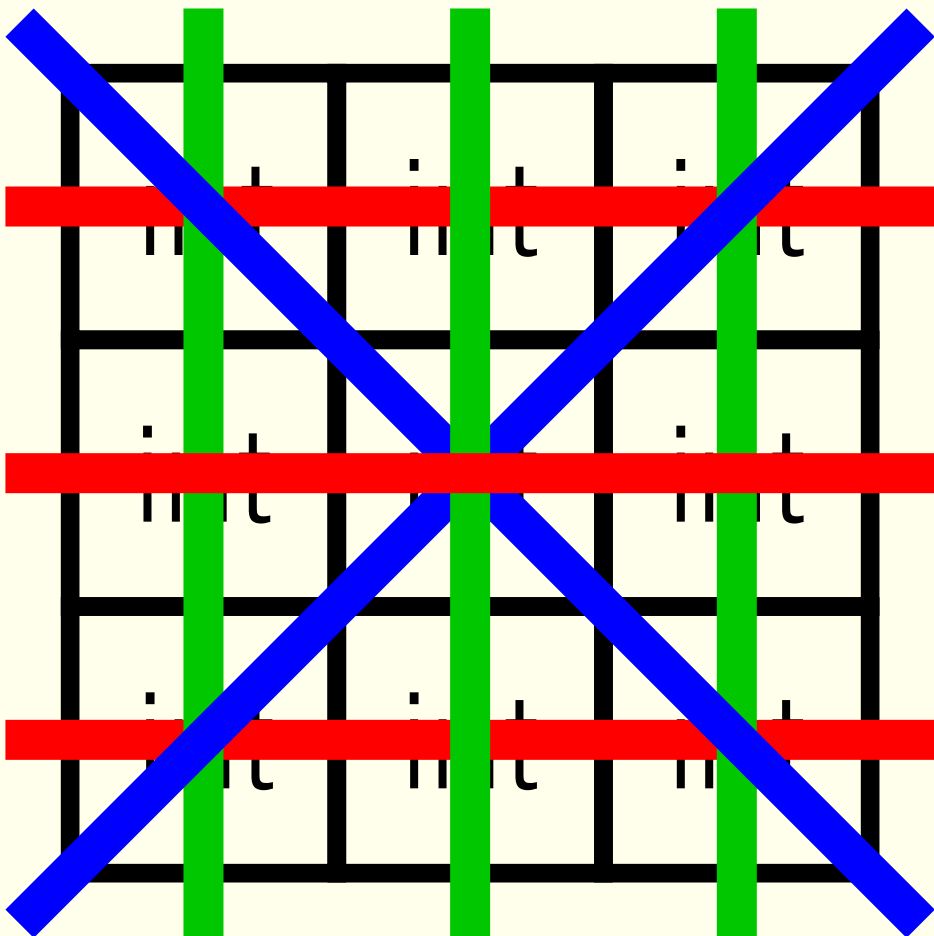
**target**  
= 

int
-----

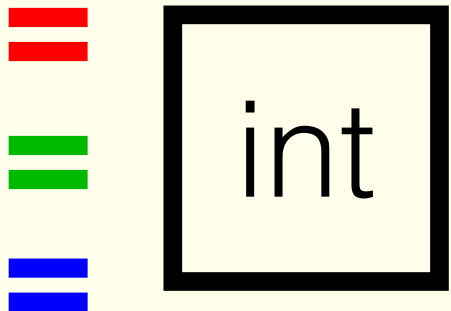


```
expose magic_square, target;
```

magic\_square



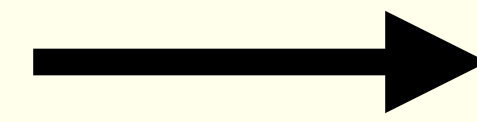
target



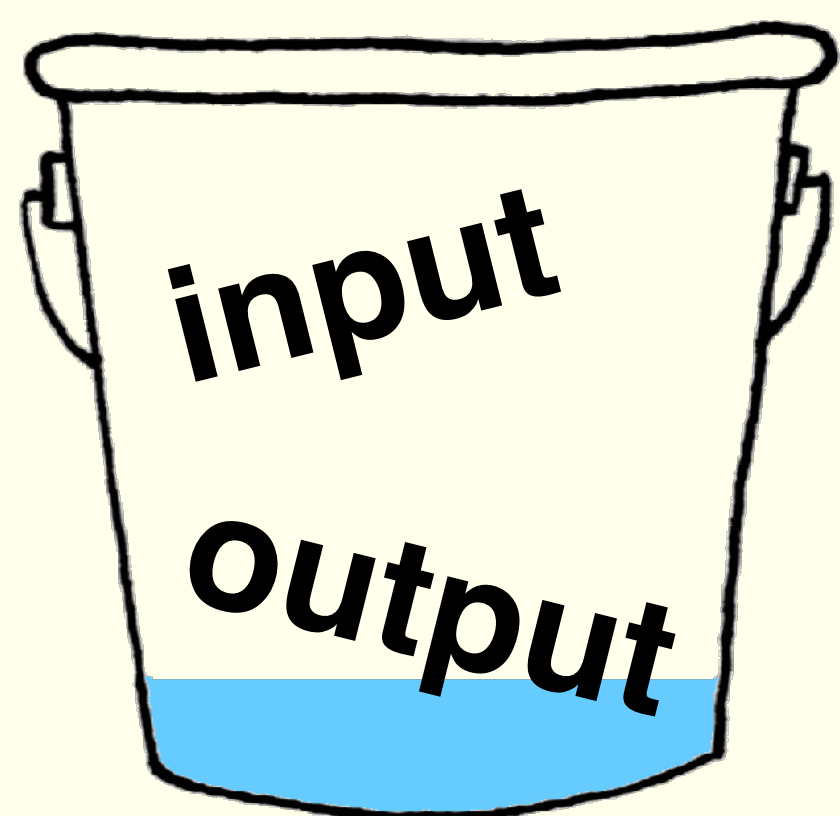
**input**



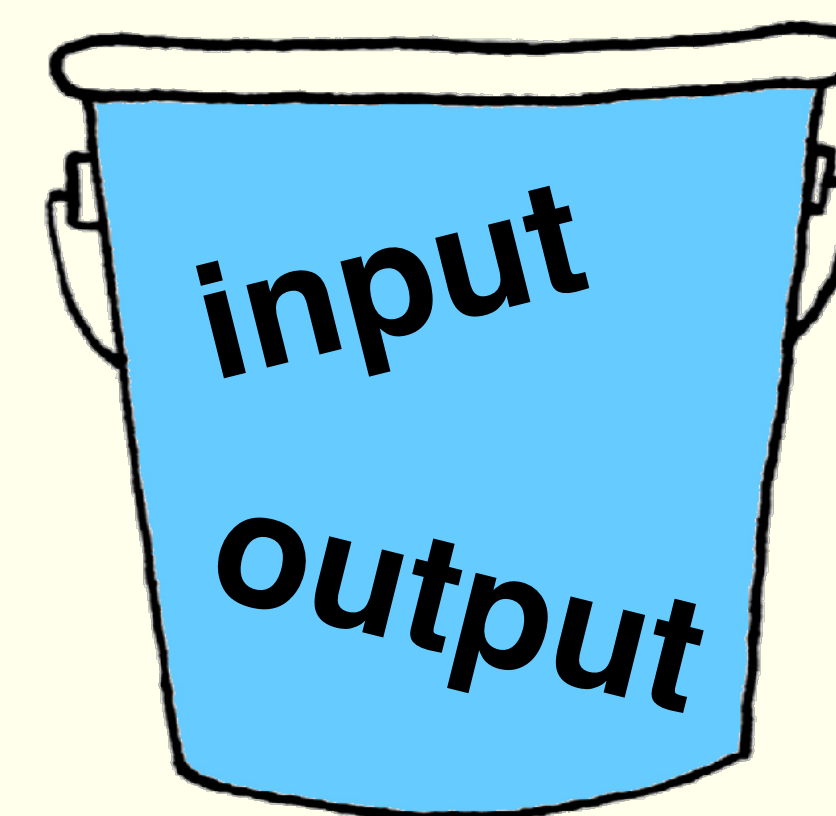
**Program**



**output**



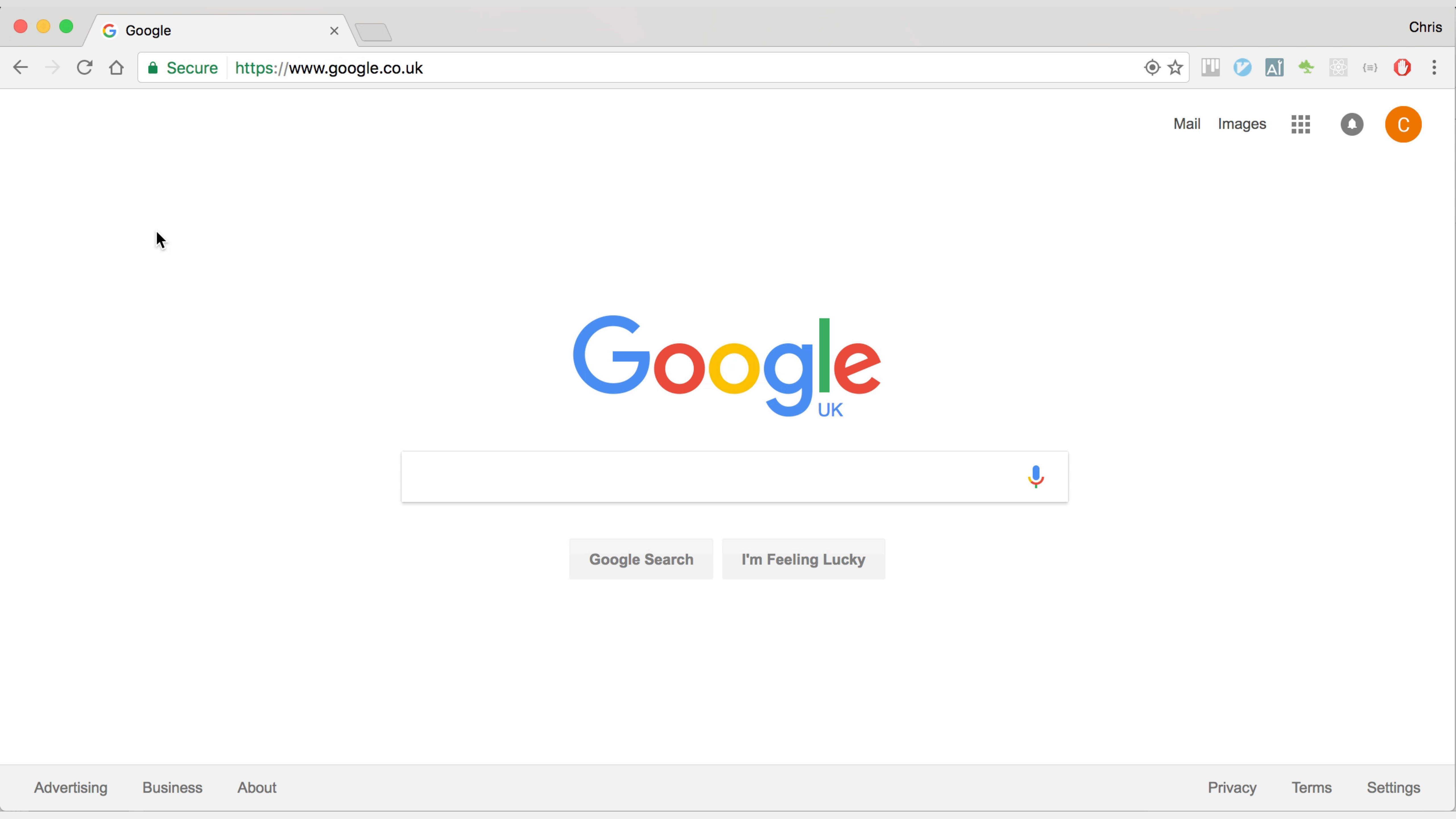
**Program**





chris:~ chris\$ █

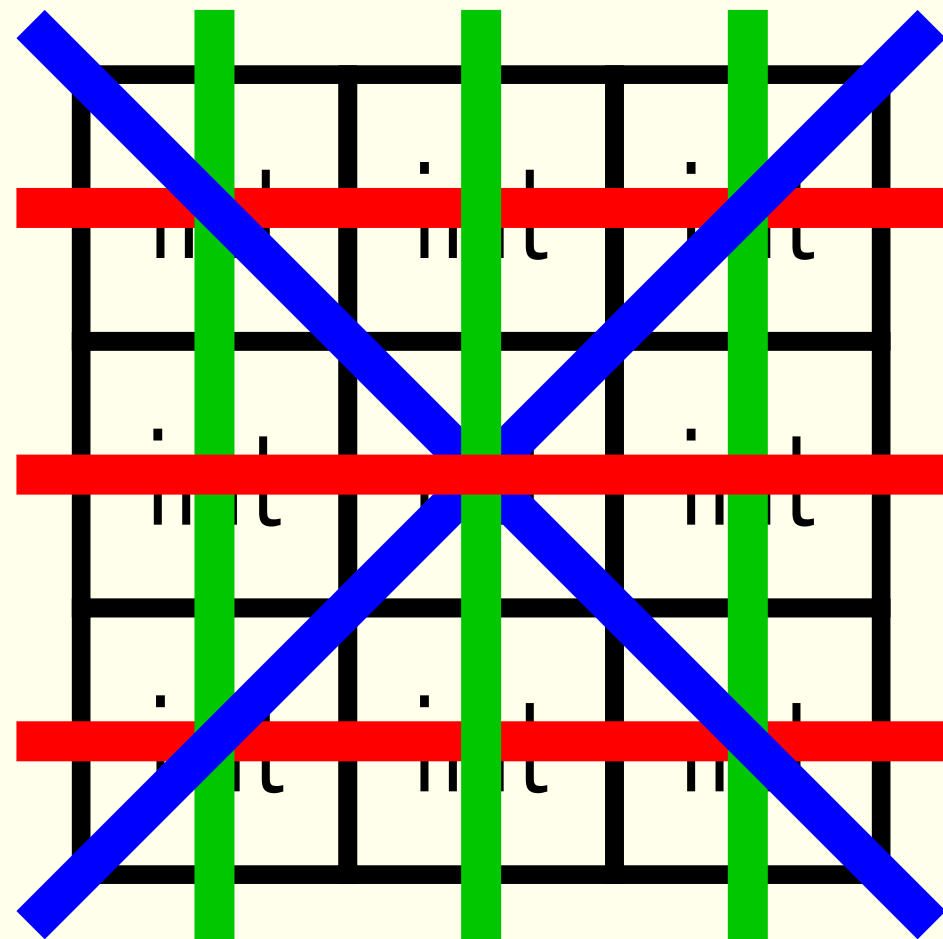
⌘



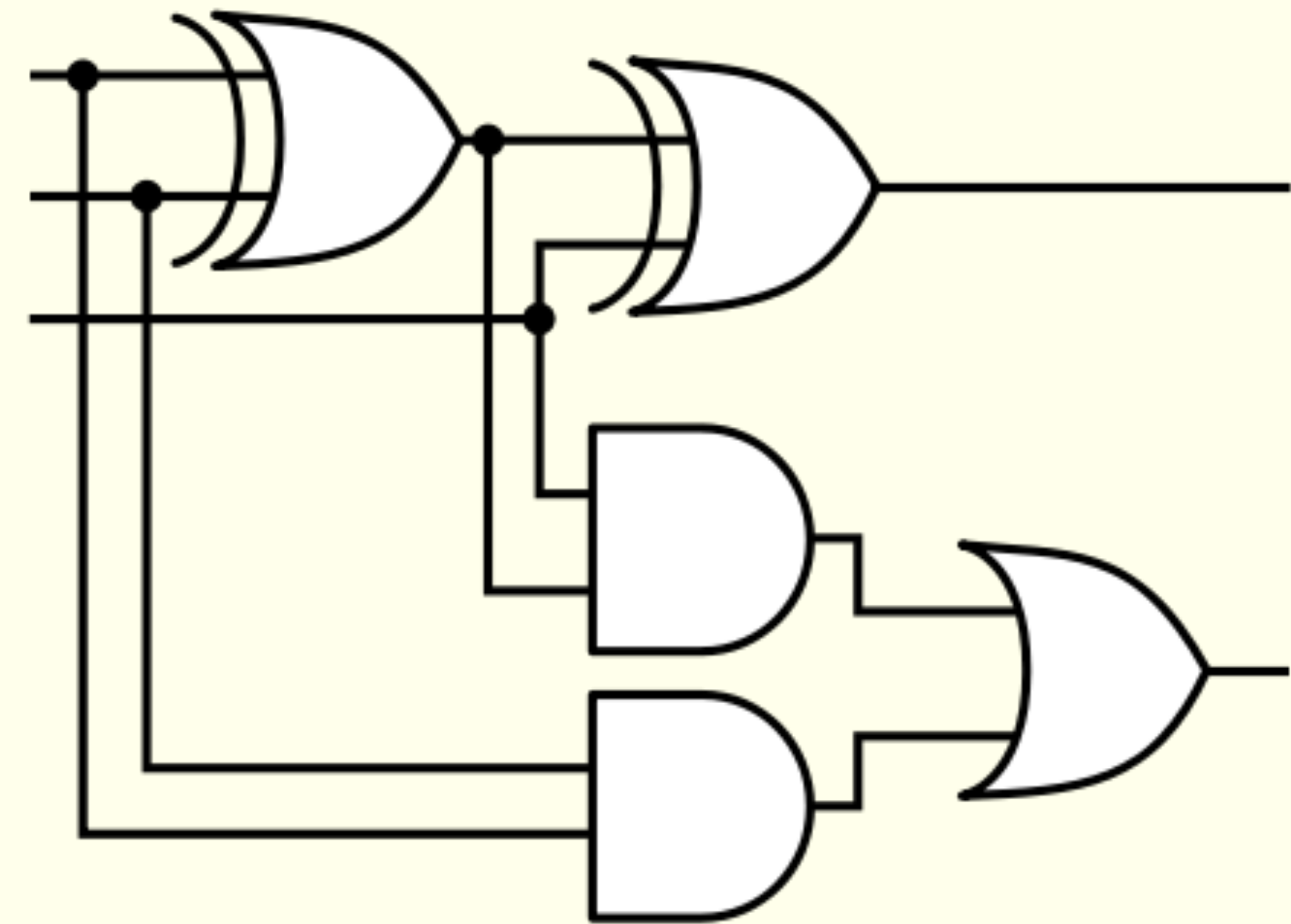
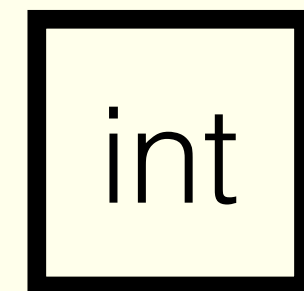
How does it work?



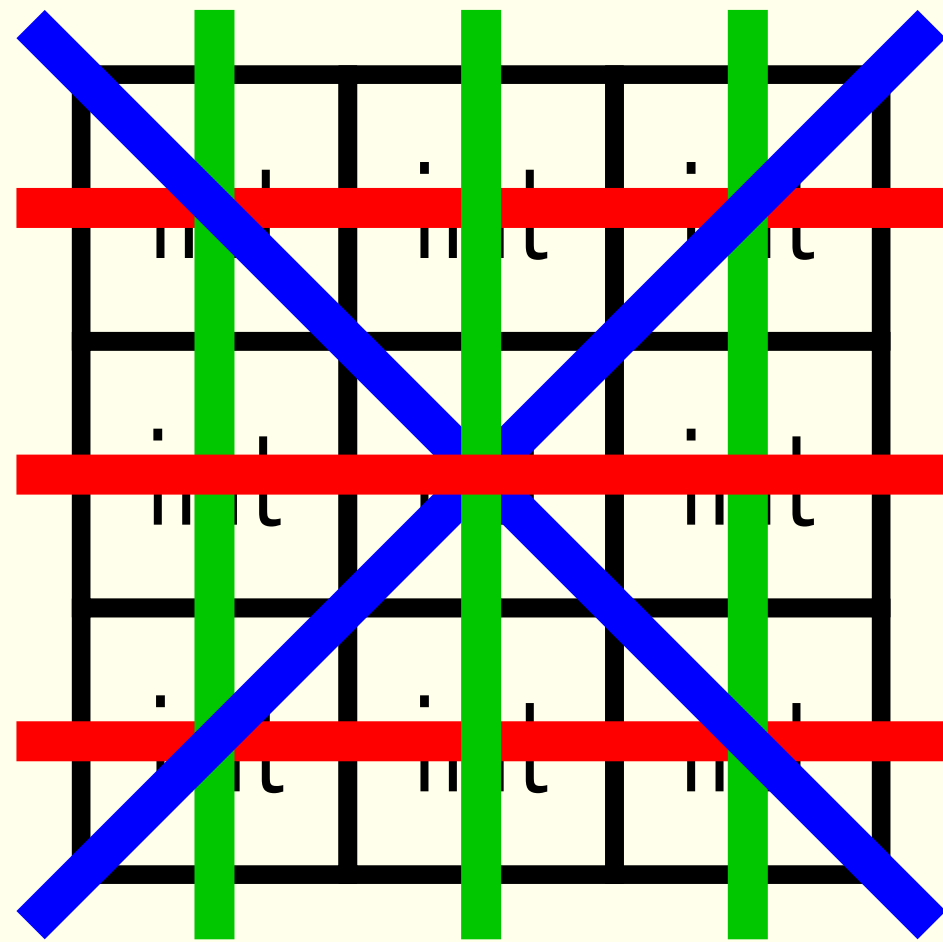
**magic\_square**



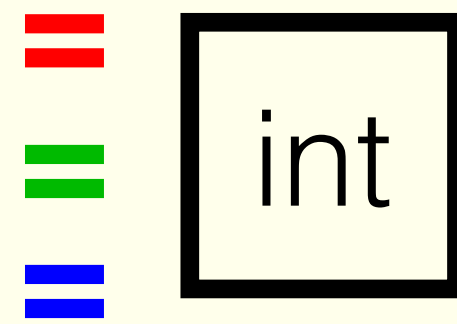
**target**



**magic\_square**



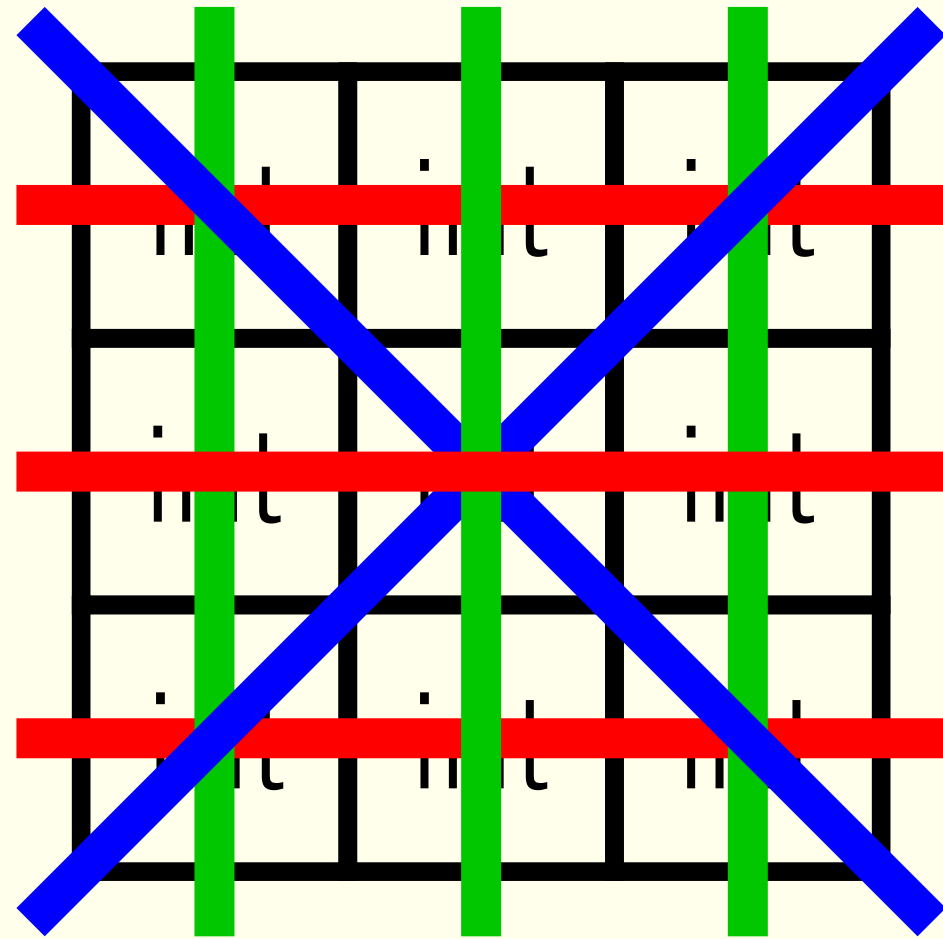
**target**



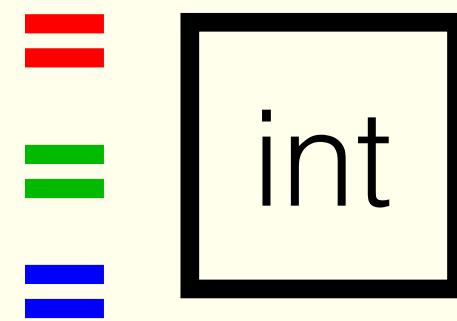
$(a \parallel b) \&\& (!a \parallel !c) \&\& (a \parallel !d)$   
 $\&\& (b \parallel c) \&\& (c \parallel !d)$

\* This process is called a “Tseitin” transform which is how “Sentient” gets its name

**magic\_square**

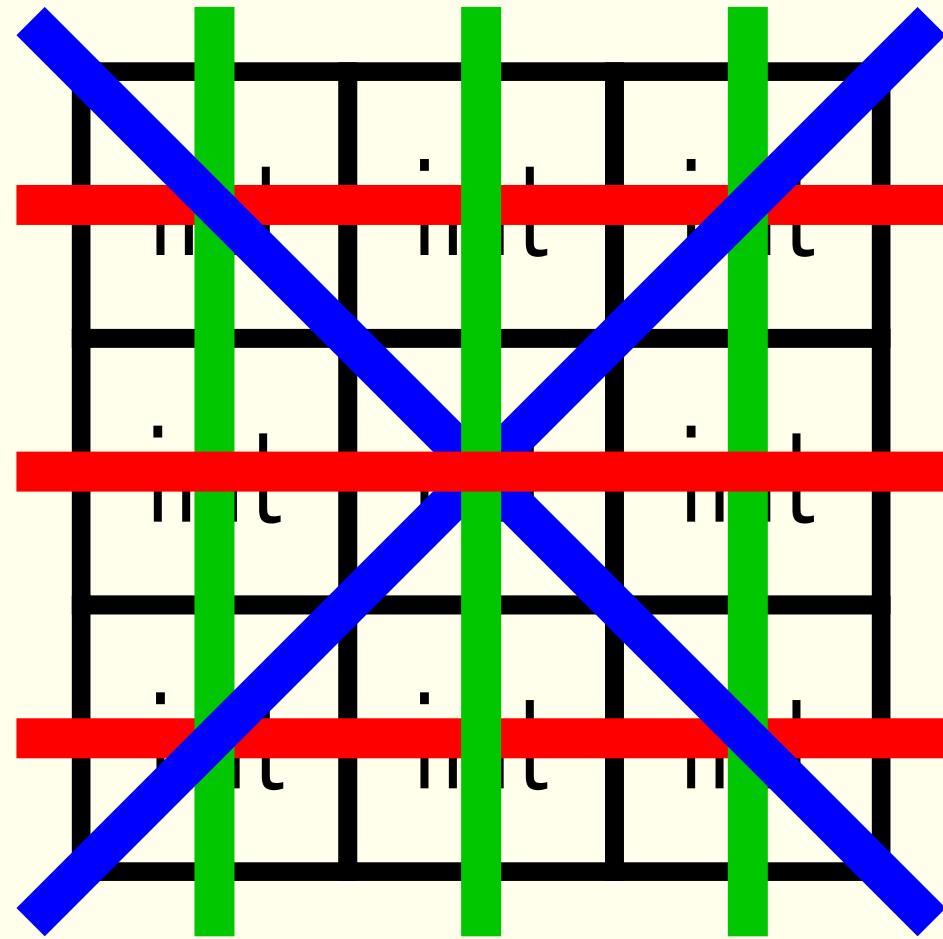


**target**

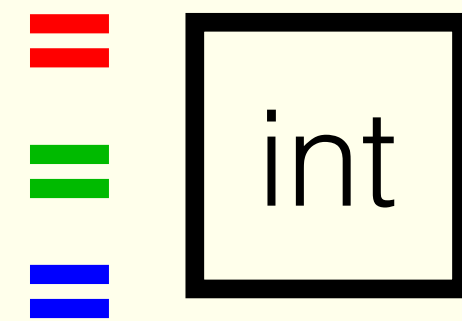


$(a \parallel b) \ \&\& \ (!a \parallel !c) \ \&\& \ (a \parallel !d)$   
 $\&\& \ (b \parallel c) \ \&\& \ (c \parallel !d) \ == \text{true}$

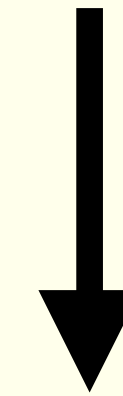
**magic\_square**



**target**



$(a \parallel b) \&\& (!a \parallel !c) \&\& (a \parallel !d)$   
 $\&\& (b \parallel c) \&\& (c \parallel !d) == \text{true}$

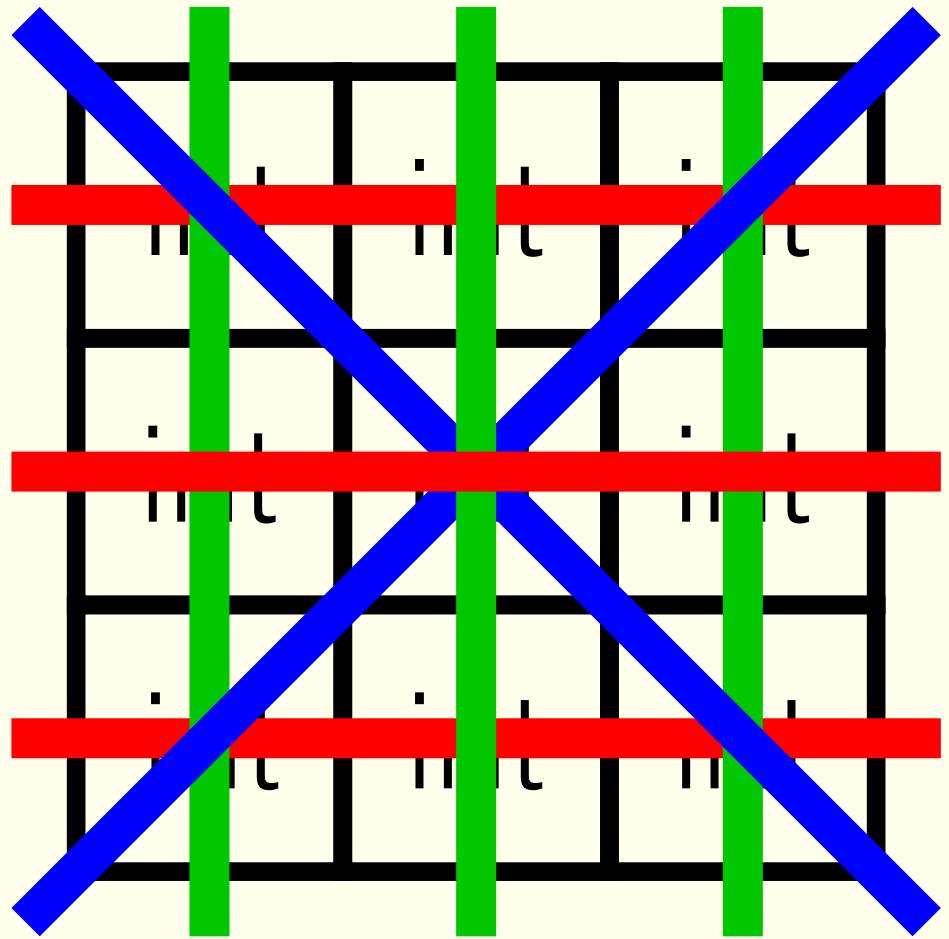


1) **a=true**, **b=true**, **c=false**, **d=false**

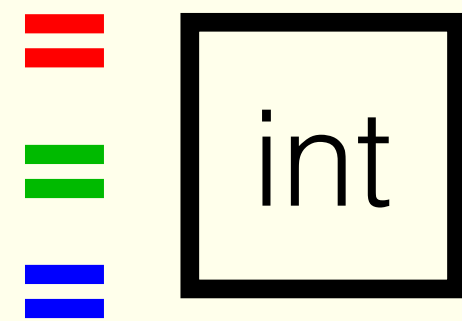
2) **a=false**, **b=true**, **c=true**, **d=false**

⋮

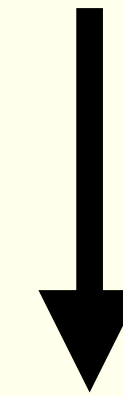
**magic\_square**



**target**



$(a \parallel b) \ \&\& \ (!a \parallel !c) \ \&\& \ (a \parallel !d)$   
 $\&\& \ (b \parallel c) \ \&\& \ (c \parallel !d) == \text{true}$



1) **a=true**, **b=true**, **c=false**, **d=false**

2) **a=false**, **b=true**, **c=true**, **d=false**

⋮

5	1	9
9	5	1
1	9	5

= 15





(!x49) && (!x33) && (!x17) && (!x73) && (!x65) && (!x1) && (!x41) && (!x57) && (!x9) && (!x25) && (x8 ll x16 ll x81) && (x8 ll x16 ll !x81) && (!x8 ll x16 ll x81) && (!x8 ll !x16 ll x82) && (x8 ll !x82) && (x16 ll !x82) && (x7 ll !x15 ll x83) && (x7 ll x15 ll !x83) && (!x7 ll !x15 ll !x83) && (!x7 ll x15 ll x83) && (!x82 ll x83 ll x84) && (x82 ll x83 ll !x84) && (!x82 ll !x83 ll !x84) && (x82 ll !x83 ll x84) && (x6 ll !x14 ll x86) && (x6 ll x14 ll !x86) && (!x6 ll !x14 ll !x86) && (!x6 ll x14 ll x86) && (!x85 ll x86 ll x87) && (x85 ll x86 ll !x87) && (!x85 ll !x86 ll !x87) && (x85 ll !x86 ll x87) && (x5 ll !x13 ll x89) && (x5 ll x13 ll !x89) && (!x5 ll !x13 ll !x89) && (!x5 ll x13 ll x89) && (!x88 ll x89 ll x90) && (x88 ll x89 ll !x90) && (!x88 ll !x89 ll !x90) && (x88 ll !x89 ll x90) && (x4 ll !x12 ll x92) && (x4 ll x12 ll !x92) && (!x4 ll !x12 ll !x92) && (!x4 ll x12 ll x92) && (!x91 ll x92 ll x93) && (x91 ll x92 ll !x93) && (!x91 ll !x92 ll !x93) && (x91 ll !x92 ll x93) && (x3 ll !x11 ll x95) && (x3 ll x11 ll !x95) && (!x3 ll !x11 ll !x95) && (!x3 ll x11 ll x95) && (!x94 ll x95 ll x96) && (x94 ll x95 ll !x96) && (!x94 ll !x95 ll !x96) && (x94 ll !x95 ll x96) && (!x94 ll !x95 ll x97) && (x95 ll !x97) && (x94 ll !x97) && (!x10 ll x98) && (x2 ll x10 ll !x98) && (!x2 ll x98) && (!x98 ll x99) && (!x2 ll !x10) && (!x24 ll x80 ll x81) && (x24 ll !x80 ll x81) && (!x24 ll !x80 ll !x81) && (x24 ll x80 ll !x81) && (!x24 ll !x81 ll x100) && (x81 ll !x100) && (x24 ll !x100) && (!x23 ll x84 ll x101) && (x23 ll x84 ll !x101) && (!x23 ll !x84 ll !x101) && (x23 ll !x84 ll x101) && (x79 ll !x100 ll x101) && (!x79 ll x100 ll x101) && (!x79 ll !x100 ll !x101) && (x79 ll x100 ll !x101) && (!x22 ll x87 ll x103) && (x22 ll x87 ll !x103) && (!x22 ll !x87 ll !x103) && (x22 ll !x87 ll x103) && (x78 ll !x102 ll x103) && (!x78 ll x102 ll x103) && (!x78 ll !x102 ll !x103) && (x78 ll x102 ll !x103) && (!x21 ll x90 ll x105) && (x21 ll x90 ll !x105) && (!x21 ll !x90 ll !x105) && (x21 ll !x90 ll x105) && (x77 ll !x104 ll x105) && (!x77 ll x104 ll x105) && (!x77 ll !x104 ll !x105) && (x77 ll x104 ll !x105) && (!x20 ll x93 ll x107) && (x20 ll x93 ll !x107) && (!x20 ll !x93 ll !x107) && (x20 ll !x93 ll x107) && (x76 ll !x106 ll x107) && (!x76 ll x106 ll x107) && (!x76 ll !x106 ll !x107) && (x76 ll x106 ll !x107) && (!x19 ll x96 ll x109) && (x19 ll x96 ll !x109) && (!x19 ll !x96 ll !x109) && (x19 ll !x96 ll x109) && (x75 ll !x108 ll x109) && (!x75 ll x108 ll x109) && (!x75 ll !x108 ll !x109) && (x75 ll x108 ll !x109) && (!x108 ll !x109 ll x110) && (x109 ll !x110) && (x108 ll !x110) && (!x18 ll x111) && (x18 ll !x99 ll !x111) && (!x99 ll x111) && (x74 ll !x111) && (!x18 ll !x99) && (x32 ll !x40 ll x112) && (x32 ll x40 ll !x112) && (!x32 ll !x40 ll !x112) && (!x32 ll x40 ll x112) && (!x32 ll !x40 ll x113) && (x32 ll !x113) && (x40 ll !x113) && (x31 ll !x39 ll x114) && (x31 ll x39 ll !x114) && (!x31 ll !x39 ll !x114) && (!x31 ll x39 ll x114) && (!x113 ll x114 ll x115) && (x113 ll x114 ll !x115) && (!x113 ll !x114 ll !x115) && (x113 ll !x114 ll x115) && (x30 ll !x38 ll x117) && (x30 ll x38 ll !x117) && (!x30 ll !x38 ll !x117) && (!x30 ll x38 ll x117) && (!x116 ll x117 ll x118) && (x116 ll x117 ll !x118) && (!x116 ll !x117 ll !x118) && (x116 ll !x117 ll x118) && (x29 ll !x37 ll x120) && (x29 ll x37 ll !x120) && (!x29 ll !x37 ll !x120) && (!x29 ll x37 ll x120) && (!x119 ll x120 ll x121) && (x119 ll x120 ll !x121) && (!x119 ll !x120 ll !x121) && (x119 ll !x120 ll x121) && (x28 ll !x36 ll x123) && (x28 ll x36 ll !x123) && (!x28 ll !x36 ll !x123) && (!x28 ll x36 ll x123) && (!x122 ll x123 ll x124) && (x122 ll x123 ll !x124) && (!x122 ll !x123 ll !x124) && (x122 ll !x123 ll x124) && (x27 ll !x35 ll x126) && (x27 ll x35 ll !x126) && (!x27 ll !x35 ll !x126) && (!x27 ll x35 ll x126) && (!x125 ll x126 ll x127) && (x125 ll x126 ll !x127) && (!x125 ll !x126 ll !x127) && (x125 ll !x126 ll x127) && (!x27 ll !x35 ll x128) && (x27 ll !x128) && (x35 ll !x128) && (!x34 ll x129) && (x26 ll x34 ll !x129) && (!x26 ll x129) && (!x129 ll x130) && (!x26 ll !x34) && (!x48 ll x80 ll x112) && (x48 ll !x80 ll x112) && (!x48 ll !x80 ll !x112) && (x48 ll x80 ll !x112) && (!x48 ll !x112 ll x131) && (x112 ll !x131) && (x48 ll !x131) && (!x47 ll x115 ll x132) && (x47 ll x115 ll !x132) && (!x47 ll !x115 ll !x132) && (x47 ll !x115 ll x132) && (x79 ll !x131 ll x132) && (!x79 ll x131 ll x132) && (!x79 ll !x131 ll !x132) && (x79 ll x131 ll !x132) && (!x46 ll x118 ll x134) && (x46 ll x118 ll !x134) && (!x46 ll !x118 ll !x134) && (x46 ll !x118 ll x134) && (x78 ll !x133 ll x134) && (!x78 ll x133 ll x134) && (!x78 ll !x133 ll !x134) && (x78 ll x133 ll !x134) && (!x45 ll x121 ll x136) && (x45 ll x121 ll !x136) && (!x45 ll !x121 ll !x136) && (x45 ll !x121 ll x136) && (x77 ll !x135 ll x136) && (!x77 ll x135 ll x136) && (!x77 ll !x135 ll !x136) && (x77 ll x135 ll !x136) && (!x44 ll x124 ll x138) && (x44 ll x124 ll !x138) && (!x44 ll !x124 ll !x138) && (x44 ll !x124 ll x138) && (x76 ll !x137 ll x138) && (!x76 ll x137 ll x138) && (x76 ll !x137 ll !x138) && (x76 ll x137 ll !x138) && (!x43 ll x127 ll x140) && (x43 ll x127 ll !x140) && (!x43 ll !x127 ll !x140) && (x43 ll !x127 ll x140) && (x75 ll !x139 ll x140) && (!x75 ll x139 ll x140) && (!x75 ll !x139 ll !x140) && (x75 ll x139 ll !x140) && (!x139 ll !x140 ll x141) && (x140 ll !x141) && (x139 ll !x141) && (!x42 ll x142) && (x42 ll x130 ll !x142) && (!x130 ll x142) && (x74 ll !x142) && (!x42 ll !x130) && (x56 ll !x64 ll x143) && (x56 ll x64 ll !x143) && (!x56 ll !x64 ll !x143) && (!x56 ll x64 ll x143) && (!x56 ll !x64 ll x144) && (x56 ll !x144) && (x64 ll !x144) && (x55 ll !x63 ll x145) && (x55 ll !x63 ll !x145) && (!x55 ll !x63 ll !x145) && (!x55 ll x63 ll x145) && (!x144 ll x145 ll x146) && (x144 ll x145 ll !x146) && (!x144 ll !x145 ll !x146) && (x144 ll !x145 ll x146) && (x54 ll !x62 ll x148) && (x54 ll x62 ll !x148) && (!x54 ll !x62 ll !x148) && (!x54 ll x62 ll x148) && (!x147 ll x148 ll x149) && (x147 ll x148 ll !x149) && (!x147 ll !x148 ll !x149) && (x147 ll !x148 ll x149) && (x53 ll !x61 ll x151) && (x53 ll x61 ll !x151) && (!x53 ll !x61 ll !x151) && (!x53 ll x61 ll x151) && (!x150 ll x151 ll x152) && (x150 ll x151 ll !x152) && (!x150 ll !x151 ll !x152) && (x150 ll !x151 ll x152) && (x52 ll !x60 ll x154) && (x52 ll x60 ll !x154) && (!x52 ll !x60 ll !x154) && (!x52 ll x60 ll x154) && (!x153 ll x154 ll x155) && (x153 ll x154 ll !x155) && (!x153 ll !x154 ll !x155) && (x153 ll !x154 ll x155) && (x51 ll !x59 ll x157) && (x51 ll x59 ll !x157) && (!x51 ll !x59 ll !x157) && (!x51 ll x59 ll x157) && (!x156 ll x157 ll x158) && (x156 ll x157 ll !x158) && (!x156 ll !x157 ll !x158) && (x156 ll !x157 ll x158) && (!x51 ll !x59 ll x159) && (x51 ll !x159) && (x59 ll !x159) && (!x58 ll x160) && (x50 ll x58 ll !x160) && (!x50 ll x160) && (!x160 ll x161) && (!x50 ll !x58) && (!x72 ll x80 ll x143) && (x72 ll !x80 ll x143) && (!x72 ll !x80 ll !x143) && (x72 ll x80 ll !x143) && (!x72 ll !x143 ll x162) && (x143 ll !x162) && (x72 ll !x162) && (!x71 ll x146 ll x163) && (x71 ll x146 ll !x163) && (!x71 ll !x146 ll !x163) && (x71 ll !x146 ll x163) && (x79 ll !x162 ll x163) && (!x79 ll x162 ll x163) && (!x79 ll !x162 ll !x163) && (x79 ll x162 ll !x163) && (!x70 ll x149 ll x165) && (x70 ll x149 ll !x165) && (!x70 ll !x149 ll !x165) && (x70 ll !x149 ll x165) && (x78 ll !x164 ll x165) && (!x78 ll x164 ll x165) && (!x78 ll !x164 ll !x165) && (x78 ll x164 ll !x165) && (!x69 ll x152 ll x167) && (x69 ll x152 ll !x167) && (!x69 ll !x152 ll !x167) && (x69 ll !x152 ll x167) && (x77 ll !x166 ll x167) && (!x77 ll x166 ll x167) && (!x77 ll !x166 ll !x167) && (x77 ll x166 ll !x167) && (!x68 ll x155 ll x169) && (x68 ll x155 ll !x169) && (!x68 ll !x155 ll !x169) && (x68 ll !x155 ll x169) && (x76 ll !x168 ll x169) && (!x76 ll x168 ll x169) && (!x76 ll !x168 ll !x169) && (x76 ll x168 ll !x169) && (!x67 ll x158 ll x171) && (x67 ll x158 ll !x171) && (!x67 ll !x158 ll !x171) && (x67 ll !x158 ll x171) && (x75 ll !x170 ll x171) && (!x75 ll x170 ll x171) && (!x75 ll !x170 ll !x171) && (x75 ll x170 ll !x171) && (!x67 ll !x158 ll x172) && (x158 ll !x172) && (x67 ll !x172) && (!x66 ll x173) && (x66 ll x161 ll !x173) && (!x161 ll x173) && (x74 ll !x173) && (!x66 ll !x161) && (x8 ll !x32 ll x174) && (x8 ll x32 ll !x174) && (!x8 ll !x32 ll !x174) && (!x8 ll x32 ll x174) && (!x8 ll !x32 ll x175) && (x8 ll !x175) && (x32 ll !x175) && (x7 ll !x31 ll x176) && (x7 ll x31 ll !x176) && (!x7 ll !x31 ll !x176) && (!x7 ll x31 ll x176) && (!x175 ll x176 ll x177) && (x175 ll x176 ll !x177) && (!x175 ll !x176 ll !x177) && (x175 ll !x176 ll x177) && (x6 ll !x30 ll x179) && (x6 ll x30 ll !x179) && (!x6 ll !x30 ll !x179) && (!x6 ll x30 ll x179) && (!x178 ll x179 ll x180) && (x178 ll x179 ll !x180) && (!x178 ll !x179 ll !x180) && (x178 ll !x179 ll x180) && (x5 ll !x29 ll x182) && (x5 ll x29 ll !x182) && (!x5 ll !x29 ll !x182) && (!x5 ll x29 ll x182) && (!x181 ll x182 ll x183) && (x181 ll x182 ll !x183) && (!x181 ll !x182 ll 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x247) && (x55 ll !x247) && (x55 ll x247 ll !x247) && (x55 ll !x247 ll x247) && (!x55 ll x247 ll x248) && (x55 ll x248 ll !x248) && (!x55 ll !x248 ll !x248) && (x55 ll x248 ll x248) && (!x55 ll x248 ll x249) && (x55 ll !x249) && (x55 ll x249 ll !x249) && (x55 ll !x249 ll x249) && (!x55 ll x249 ll x250) && (x55 ll x250 ll !x250) && (!x55 ll !x250 ll !x250) && (x55 ll x250 ll x250) && (!x55 ll x250 ll x251) && (x55 ll !x251) && (x55 ll x251 ll !x251) && (x55 ll !x251 ll x251) && (!x55 ll x251 ll x2



My favourite puzzle

This pangram contains \_\_\_\_ a's, \_\_\_\_ b's, \_\_\_\_ c's,  
\_\_\_\_ d's, \_\_\_\_ e's, \_\_\_\_ f's, \_\_\_\_ g's, \_\_\_\_ h's, \_\_\_\_ i's,  
\_\_\_\_ j's, \_\_\_\_ k's, \_\_\_\_ l's, \_\_\_\_ m's, \_\_\_\_ n's, \_\_\_\_ o's,  
\_\_\_\_ p's, \_\_\_\_ q's, \_\_\_\_ r's, \_\_\_\_ s's, \_\_\_\_ t's, \_\_\_\_ u's,  
\_\_\_\_ v's, \_\_\_\_ w's, \_\_\_\_ x's, \_\_\_\_ y's and \_\_\_\_ z's.

This pangram contains **four** a's, **two** b's, **one** c,  
\_\_\_\_ d's, \_\_\_\_ e's, \_\_\_\_ f's, \_\_\_\_ g's, \_\_\_\_ h's, \_\_\_\_ i's,  
\_\_\_\_ j's, \_\_\_\_ k's, \_\_\_\_ l's, \_\_\_\_ m's, \_\_\_\_ n's, \_\_\_\_ o's,  
\_\_\_\_ p's, \_\_\_\_ q's, \_\_\_\_ r's, \_\_\_\_ s's, \_\_\_\_ t's, \_\_\_\_ u's,  
\_\_\_\_ v's, \_\_\_\_ w's, \_\_\_\_ x's, \_\_\_\_ y's and \_\_\_\_ z's.

$$40^{26} =$$

450,359,962,737,049,600,000,  
000,000,000,000,000,000,000



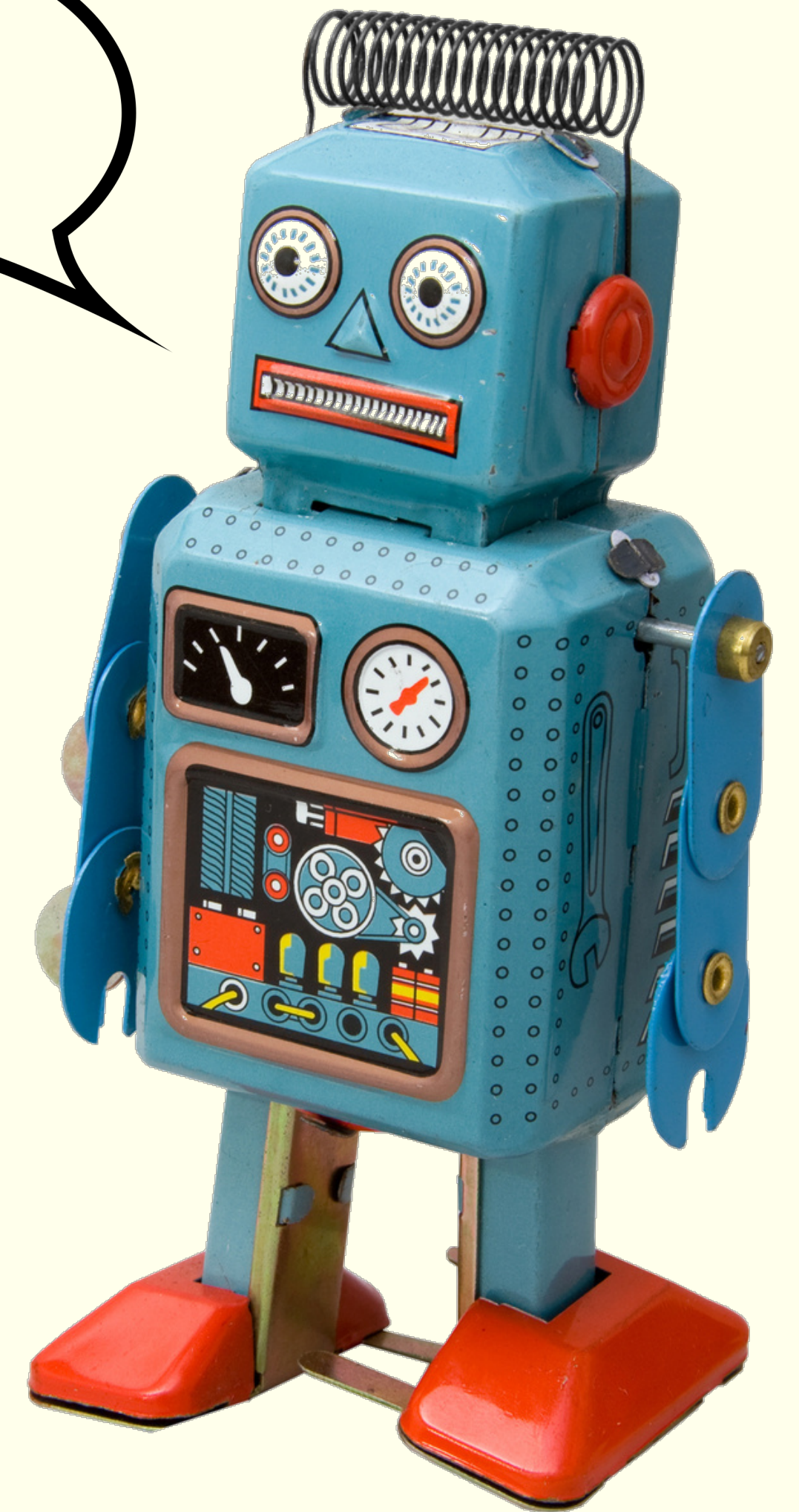


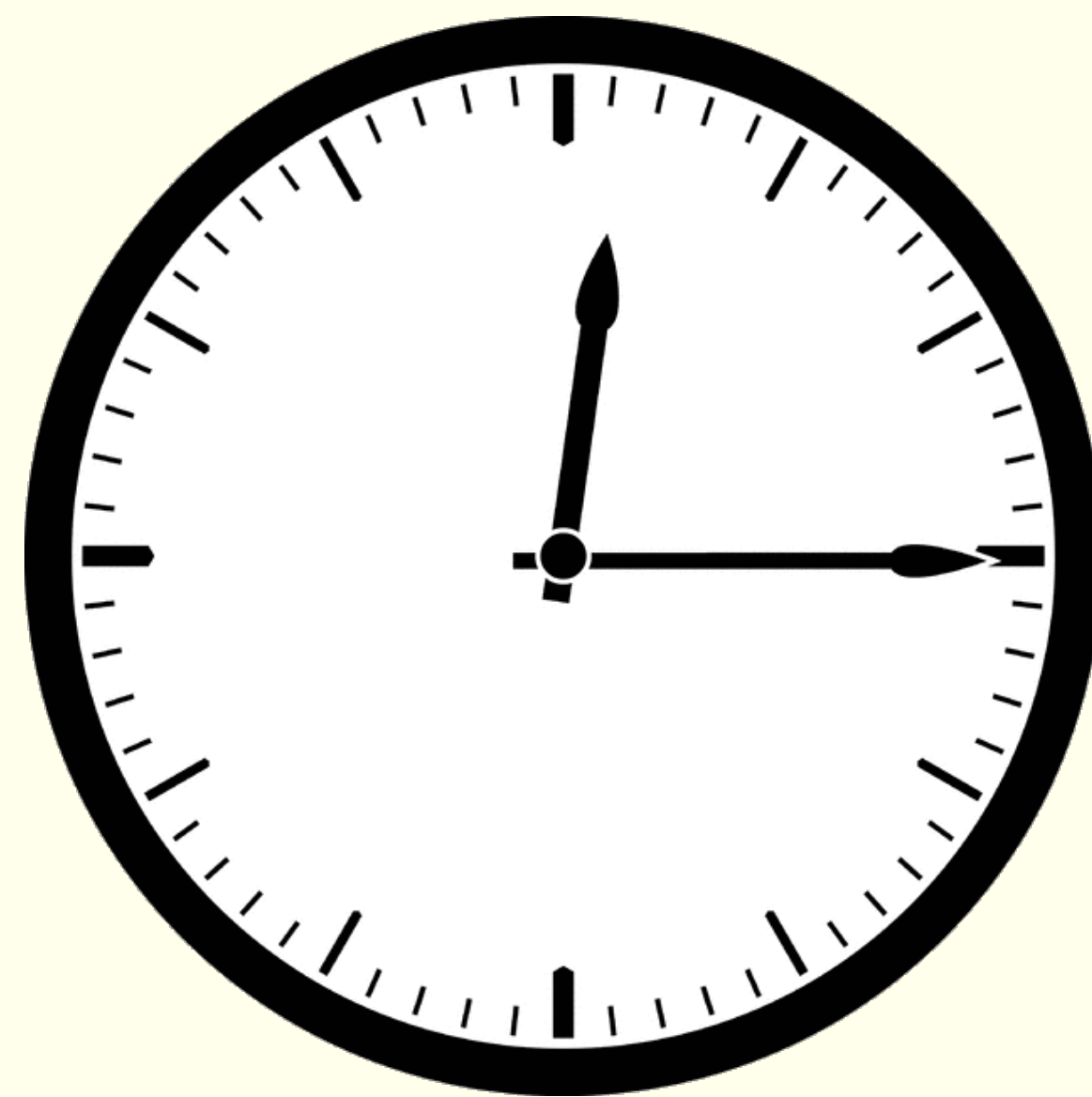
This pangram contains \_\_\_\_ a's, \_\_\_\_ b's, \_\_\_\_ c's,  
\_\_\_\_ d's, \_\_\_\_ e's, \_\_\_\_ f's, \_\_\_\_ g's, \_\_\_\_ h's, \_\_\_\_ i's,  
\_\_\_\_ j's, \_\_\_\_ k's, \_\_\_\_ l's, \_\_\_\_ m's, \_\_\_\_ n's, \_\_\_\_ o's,  
\_\_\_\_ p's, \_\_\_\_ q's, \_\_\_\_ r's, \_\_\_\_ s's, \_\_\_\_ t's, \_\_\_\_ u's,  
\_\_\_\_ v's, \_\_\_\_ w's, \_\_\_\_ x's, \_\_\_\_ y's and \_\_\_\_ z's.

Here's how  
to check a  
pangram

Now go  
find some!

OK





2 minutes

This sentence is dedicated to Ember London and it contains five a's, two b's, four c's, seven d's, thirty-four e's, eight f's, four g's, eight h's, sixteen i's, one j, one k, two l's, two m's, twenty-three n's, eighteen o's, one p, one q, nine r's, thirty s's, twenty-four t's, five u's, seven v's, seven w's, two x's, five y's and one z.

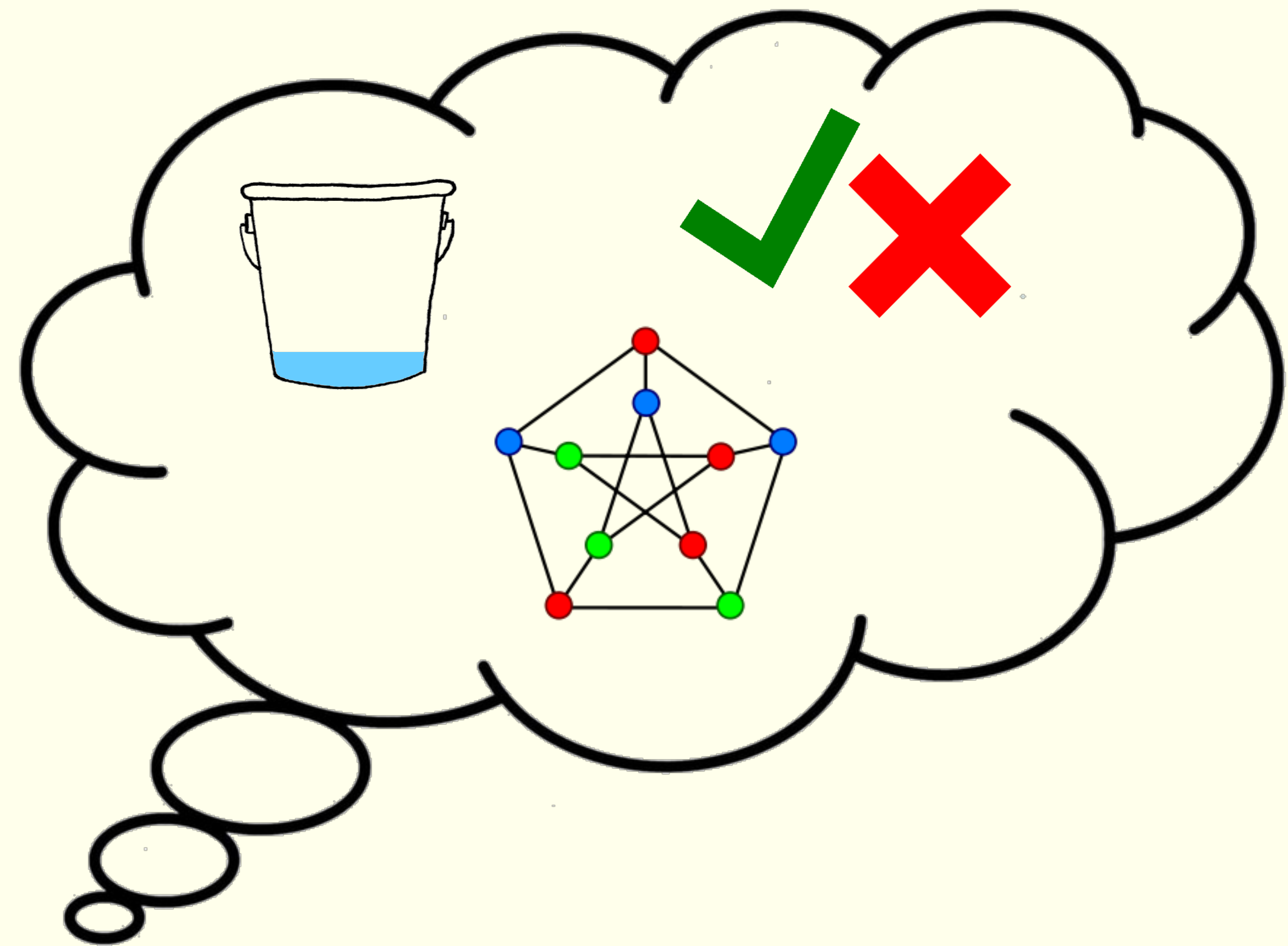


This sentence is dedic**a**ted to Ember London  
**a**nd it cont**a**ins five **a**'s, two b's, four c's, seven  
d's, thirty-four e's, eight f's, four g's, eight h's,  
sixteen i's, one j, one k, two l's, two m's,  
twenty-three n's, eighteen o's, one p, one q,  
nine r's, thirty s's, twenty-four t's, five u's, seven  
v's, seven w's, two x's, five y's **a**nd one z.



This sentence is dedicated to Emb**b**er London and it contains five a's, two **b**'s, four c's, seven d's, thirty-four e's, eight f's, four g's, eight h's, sixteen i's, one j, one k, two l's, two m's, twenty-three n's, eighteen o's, one p, one q, nine r's, thirty s's, twenty-four t's, five u's, seven v's, seven w's, two x's, five y's and one z.

To wrap up



[sentient-lang.org](http://sentient-lang.org)

[whyarecomputers.com/4](http://whyarecomputers.com/4)

[github.com/sentient-lang](https://github.com/sentient-lang)

# Thanks!

by Chris Patuzzo  
Ember London, 2017-01-12  
@cpatuzzo