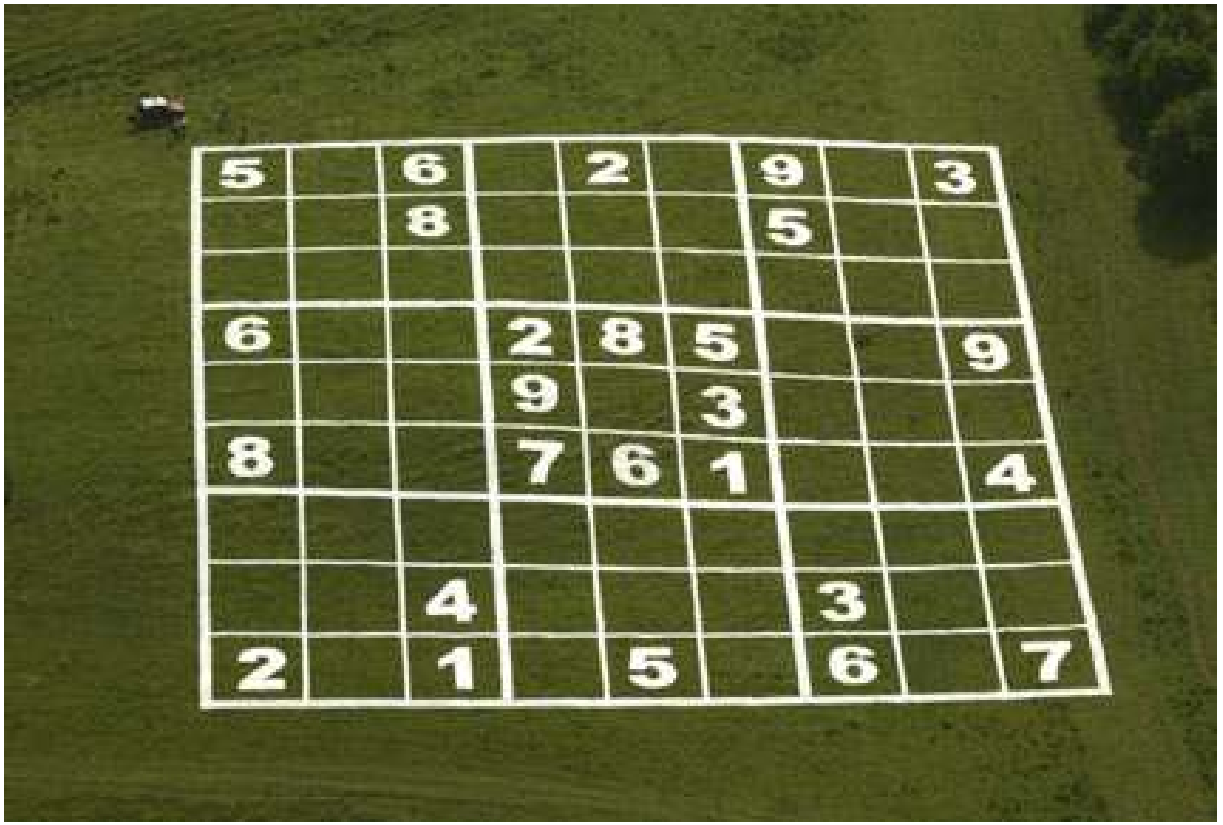
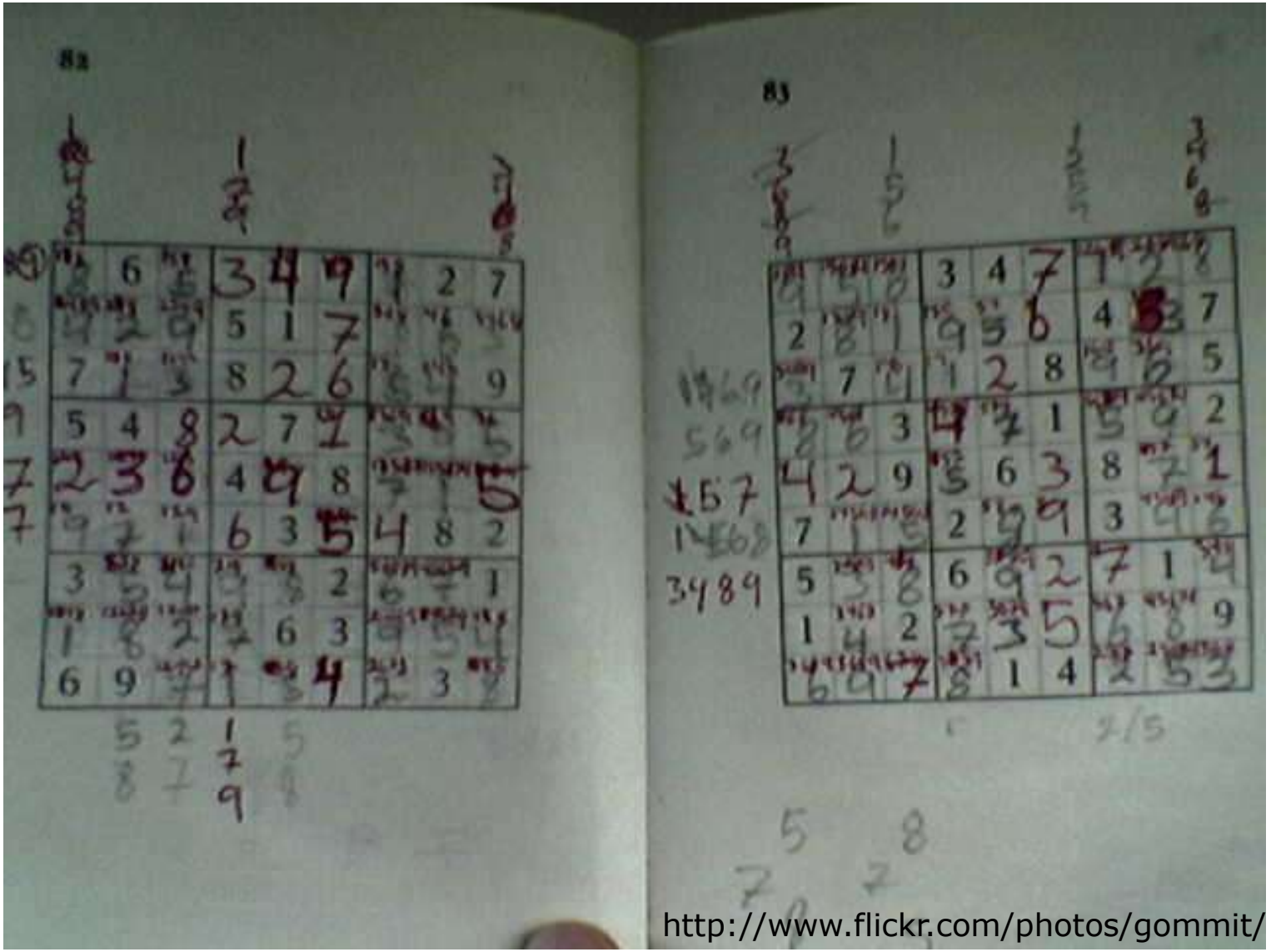
Extreme Sudoku solving with Ruby



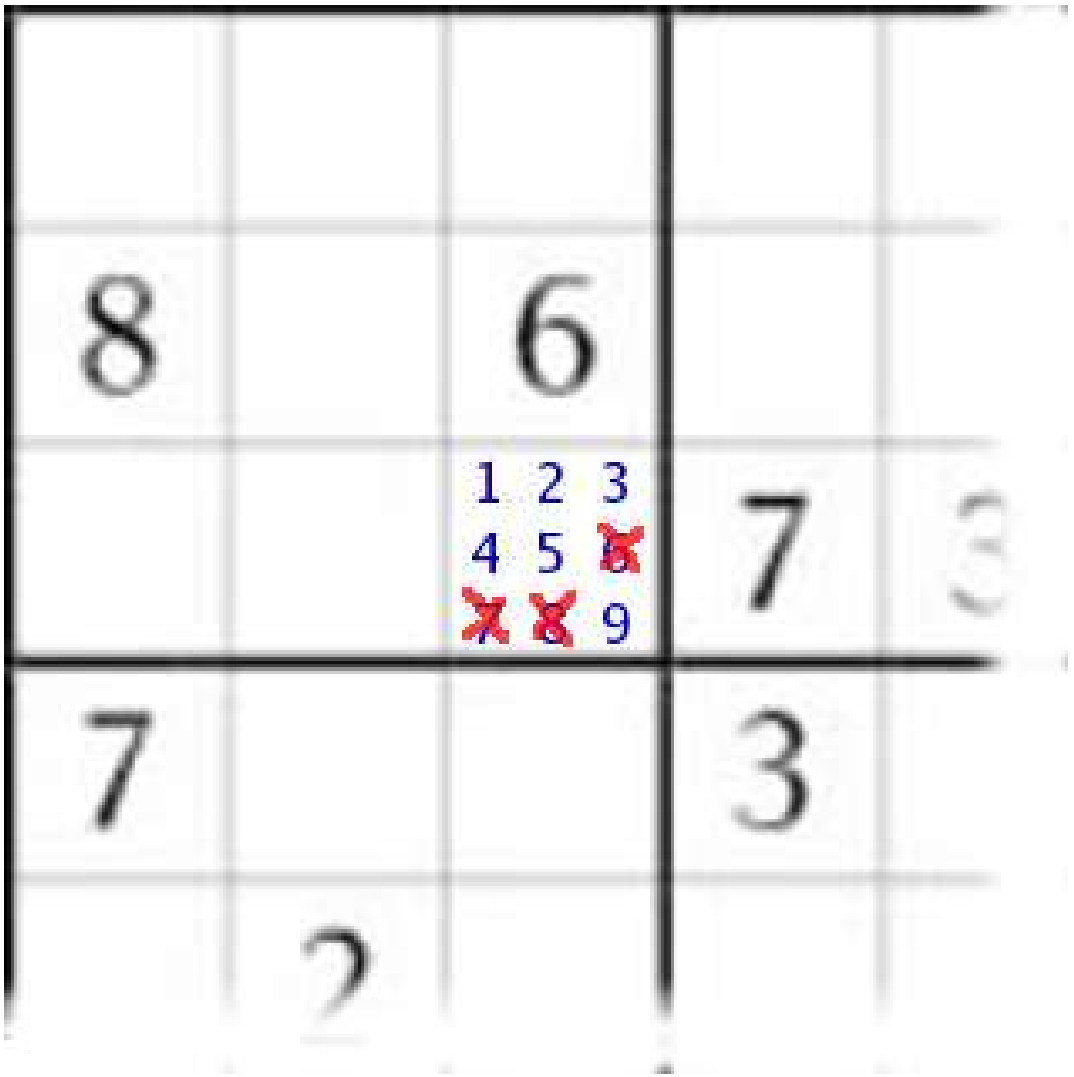
Matt Westcott

Why a sudoku solver?



http://www.flickr.com/photos/gommit/

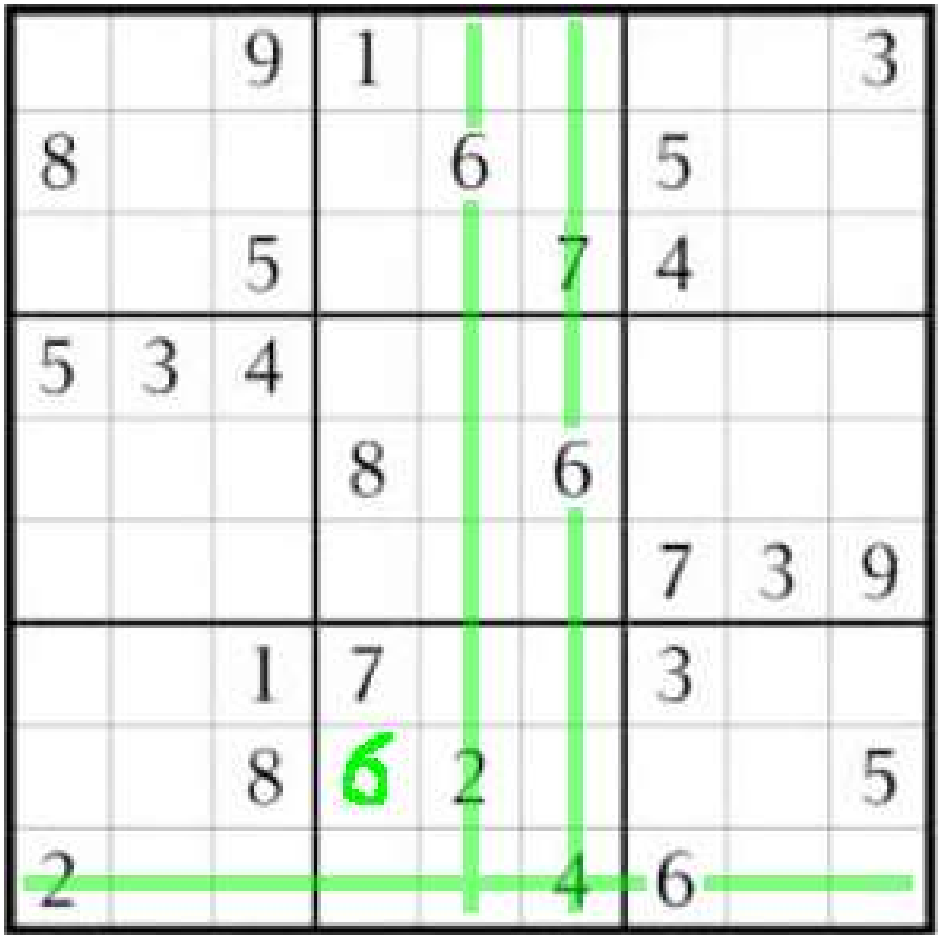
The general plan



First pass: Eliminating candidates

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

Second pass:
Finding unique positions



Doing it in Ruby

```
solved_square.value = 6
grid.each_in_row(solved_square.row) do |square|
   square.eliminate(6) unless square == solved_square
end

grid.each_in_column(solved_square.column) do |square|
   square.eliminate(6) unless square == solved_square
end
```

Iterators

```
Class Grid
    def each_in_row(y)
        0.upto(9) do |x|
            yield @squares[y][x]
        end
    end
    def each_in_square(n)
        (n/3 .. n/3+2).each do |y|
            (n%3 .. n%3+2).each do |x|
                yield @squares[y][x]
            end
        end
    end
end
```

Lookahead

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

Lookahead

```
def solve(grid)
   whittle_down!(grid) # do as much number-crossing-out
     as possible
   if grid.screwed_up?
      raise UnsolvableException
   elsif grid.solved?
      return grid
   else
      empty_square = grid.find{|square| square.empty?}
      empty_square.candidates.each { |candidate|
         backup_grid = grid.dup
         empty_square.fill_with(candidate)
         begin
```

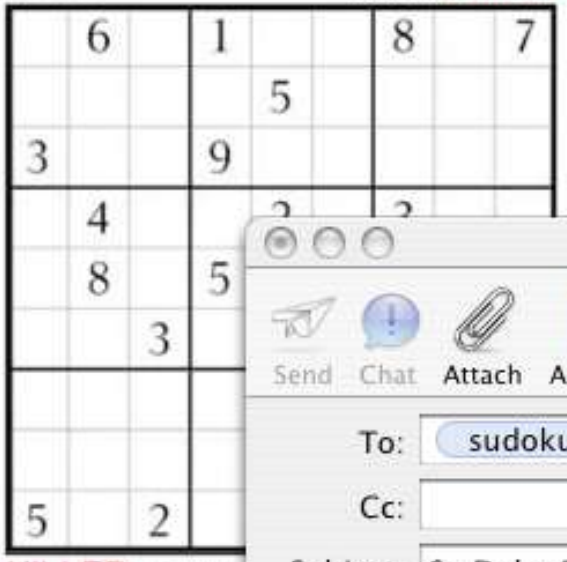
Lookahead

```
    else
        empty_square = grid.find{|square| square.empty?}
        empty_square.candidates.each { |candidate|
            backup_grid = grid.dup
            empty_square.fill_with(candidate)
            begin
                solution = solve(grid)
                return solution
            rescue UnsolvableException
                grid = backup_grid
            end
        }
        raise UnsolvableException
    end
end
```

Su Doku 863 and 864; Killer S

http://www.timesonline.co.uk/article/0,,182

No 864 **RATING: FIENDISH**



KILLER No 259 Tim

Classic Su Doku © Puzz

Fill the grid so that
every 3x3 box con

Play interactive Su

Default Session

```
Last login: Sat Jul 22 23:10:36 on ttyp2
Welcome to Darwin!
woodstock:~ matthew$ cd Development/ruby/sudoku/
woodstock:~/Development/ruby/sudoku matthew$ ruby sudoku.rb
9 6 5   1 4 2   8 3 7
4 1 8   7 5 3   6 9 2
3 2 7   9 6 8   1 5 4

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

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

woodstock:~/Development/ruby/sudoku matthew$
```

Send Chat Attach Address Fonts

To: sudoku@thetimes.c

Cc:

Subject: Su Doku 21/07/2006

Bcc:

Account: Matthew Westcott <matthew@west.co.tt>

Solution:

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

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

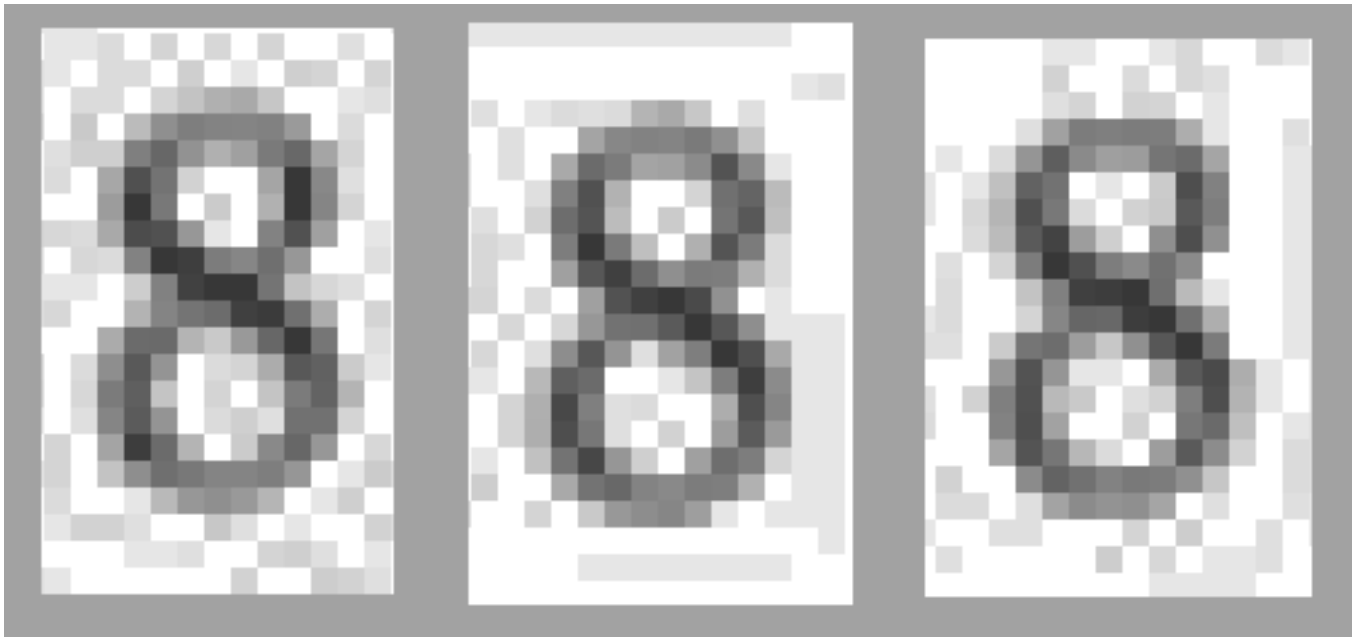
8 3 6   4 1 5   2 7 9
1 9 4   2 8 7   5 6 3
5 7 2   3 9 6   4 1 8
```

Screen scraping

```
require 'net/http'
# step 1: fetch redirector page
h = Net::HTTP.new('www.timesonline.co.uk', 80)
response = h.get('/sudoku')
find_meta = response.body.scan(/<META HTTP-
  EQUIV=Refresh CONTENT=\'10;
  URL=\"http:\/\/www\.timesonline\.co\.uk([^\"]+)
  \"\'>/)
homepage_url = find_meta[0][0]

# step 2: look for puzzle link on homepage
response = h.get(homepage_url)
link_text = today.strftime("Su Doku: %B %d, %Y");
find_puzzle_url = response.body.scan(/<a href=\'(
  [^\']+)\' class=\'sectionhead\'>#{link_text}
  <\/a>/)
puzzle_url = find_puzzle_url[0][0]
```

JPEG artifacts 'Я' us



OCR processing

```
require 'RMagick'

include Magick

img = img.negate

img.resize!
  (100,100,LanczosFilter, 4)

mass = 0; com_x = 0; com_y = 0

(0...100).each do |y|

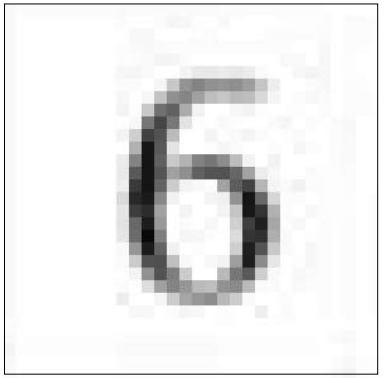
   (0...100).each do |x|

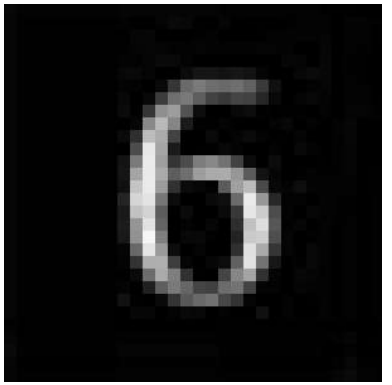
      pix = img.pixel_color(x,y).
        intensity

      mass += pix

      com_x += x * pix

      com_y += y * pix
```





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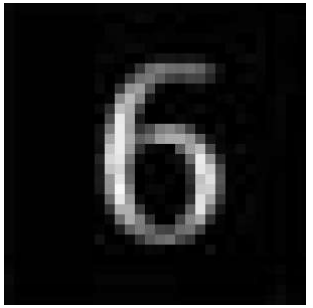

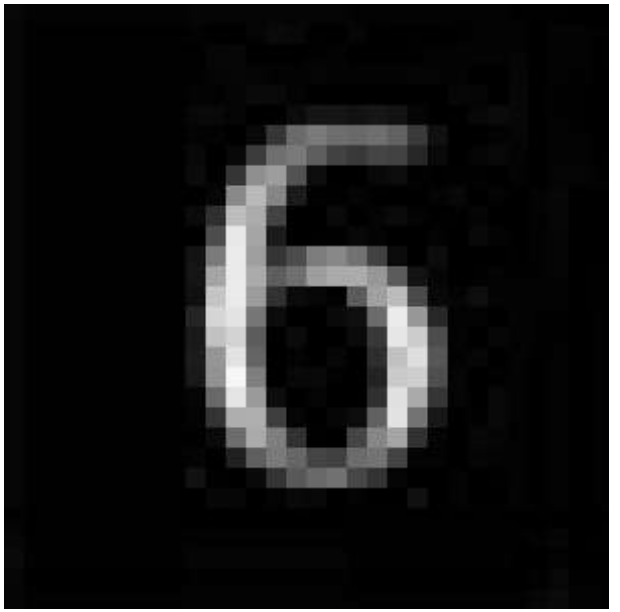

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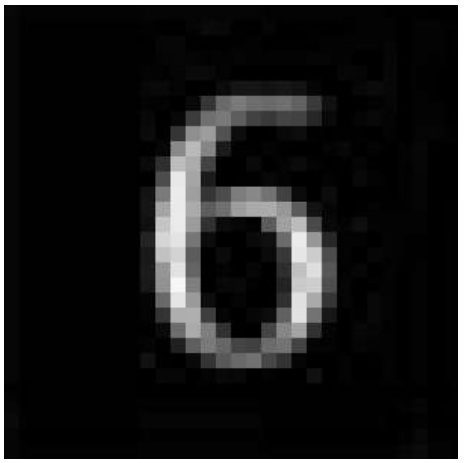
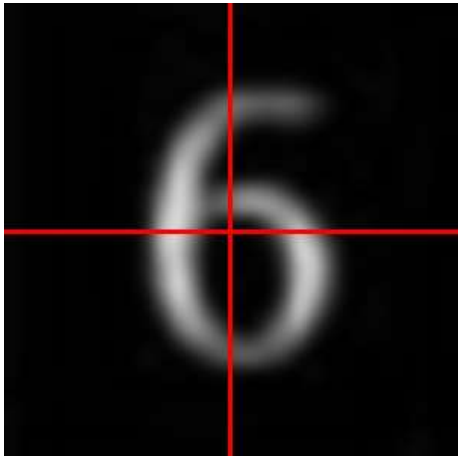
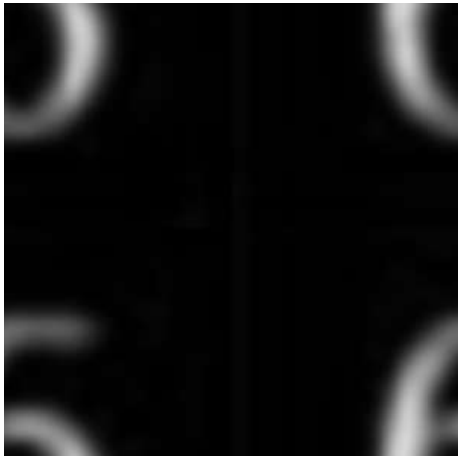
```



OCR processing

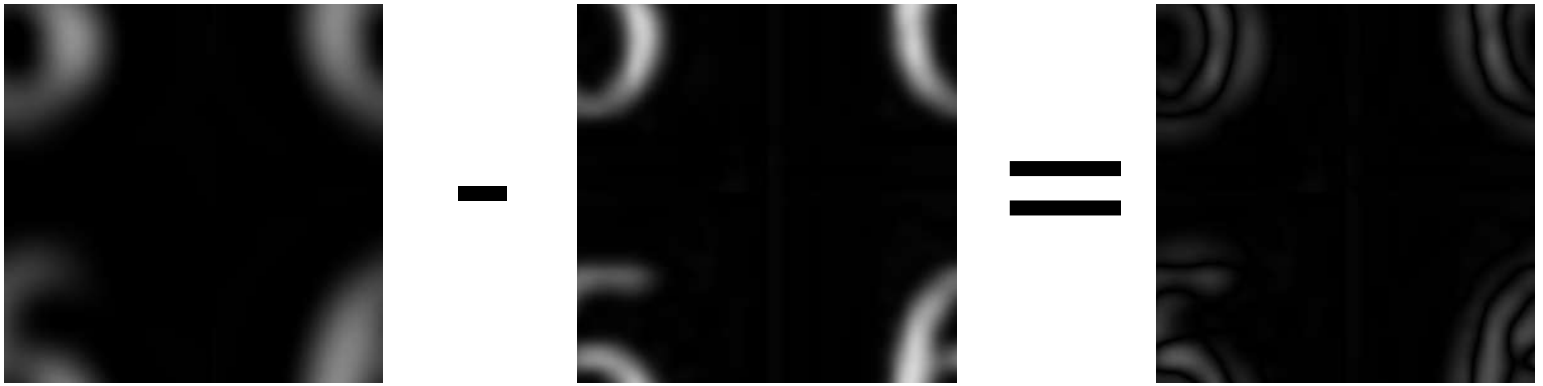
```
mass = 0; com_x = 0; com_y = 0
(0...100).each do |y|
   (0...100).each do |x|
      pix = img.pixel_color(x,y).
        intensity
      mass += pix
      com_x += x * pix
      com_y += y * pix
   end
end
com_x /= mass
com_y /= mass
img = img.roll(-com_x, -com_y)
```





OCR processing

```
def difference(img1, img2)
    total_diff = 0;
    (0...100).each do |y|
        (0...100).each do |x|
            total_diff += (
                img1.pixel_color(x,y).intensity -
                img2.pixel_color(x,y).intensity).abs
        end
    end
    total_diff
end
```

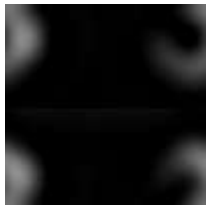


Success...

Digit: 0
Error: 58575

Digit: 1
Error: 43923

Digit: 2
Error: 42246



Digit: 3
Error: 33617

Digit: 4
Error: 39996

Digit: 5
Error: 28413

Digit: 6
Error: 2397 (92% certainty)

Digit: 7
Error: 37606

Digit: 8
Error: 32810

Digit: 9
Error: 38262


http://www.flickr.com/photos/ingopics/