
Cosmos Segmentation

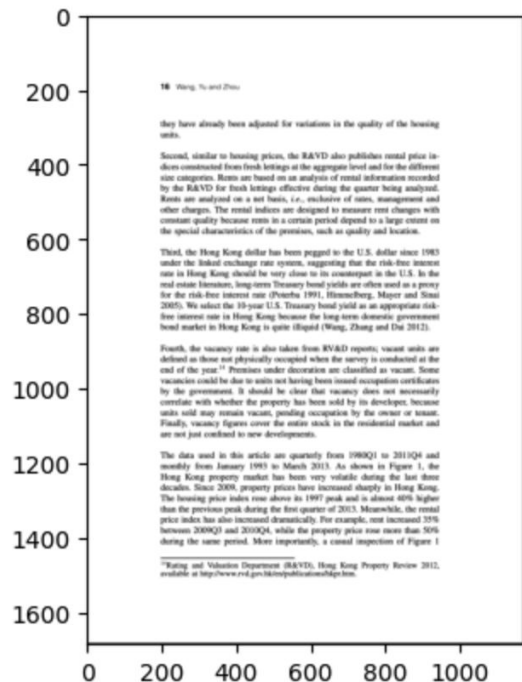
— by Keshav Balaji —

Balancing Margins

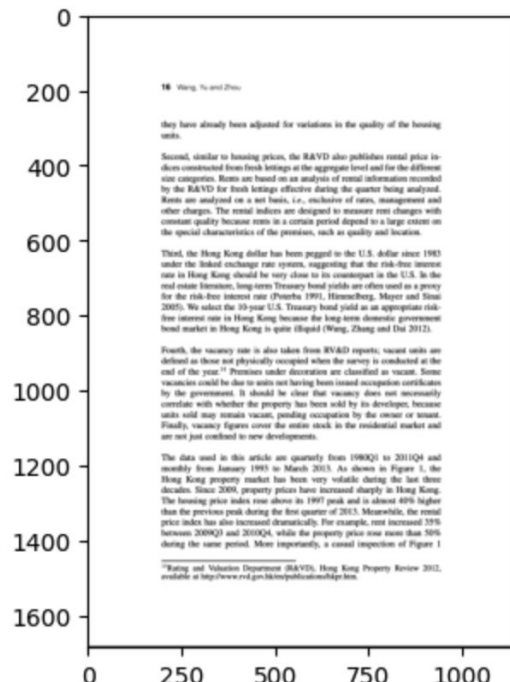
- Takes in input binary map and map of original image, and balance possibly unequal margins
- Two pointers (left margin at column i and right margin at column width - i)
 - Move each margin boundary inward while it contains only whitespace
- Checks absolute difference between left and right margin boundaries
 - If left margin width is less than right margin width, slices image and bmap to include only the columns from first column till the column at index width - diff
 - Otherwise, slices image and bmap to include only the columns from first column till the column at index width - diff

Balancing Margins Example

Before balancing margins: **width = 1166**



After balancing margins: **width = 1140**



Get Blank Rows

- Objective: create list of blank rows that mark the end of a region (ie. the beginning of another region)
- Defines a blank row (array of 0's) of size img's width (# columns)
- Defines curr_top and curr_bot variables to track top and bottom of current row
- Iterates with curr_bot from row 0 to row img_height - 1 (top to bottom)
 - If current row (row from curr_top to curr_bot) is equal to the blank row:
 - If list is empty, adds curr row to list and set curr_top and curr_bot to next row
 - If row index of the last white row in the list is greater than the current row's top index, set the last white row's bottom index to curr_bot (finding white row closest to end of region)
 - Otherwise, append curr_bot to list
 - If curr_top is first row, or if curr_bot is last row, adds the row to the list

Get Blank Rows Example

16 Wang, Xu and Zhou

they have already been adjusted for variations in the quality of the housing units.

Second, similar to housing prices, the RAVD also publishes rental price indices constructed from fresh lettings at the aggregate level and for the different size categories. Rents are based on an analysis of rental information recorded by the RAVD for fresh lettings effective during the quarter being analysed. Rents are analysed on a net basis, i.e., exclusive of rates, management and other charges. The rental indices are designed to measure rent changes with constant quality because rents in a certain period depend to a large extent on the special characteristics of the premises, such as quality and location.

Third, the Hong Kong dollar has been pegged to the U.S. dollar since 1983 under the linked exchange rate system, suggesting that the risk-free interest rate in Hong Kong should be very close to its counterpart in the U.S. In the real estate literature, long-term Treasury bond yields are often used as a proxy for the risk-free interest rate (Poterba 1991, Hansmberg, Mayer and Sinai 2005). We select the 10-year U.S. Treasury bond yield as an appropriate risk-free interest rate in Hong Kong because the long-term domestic government bond market in Hong Kong is quite illiquid (Wang, Zhang and Dai 2012).

Fourth, the vacancy rate is also taken from RAVD reports; vacant units are defined as those not physically occupied when the survey is conducted at the end of the year.¹⁴ Premises under decoration are classified as vacant. Some vacancies could be due to units not having been issued occupation certificates by the government. It should be clear that vacancy does not necessarily correlate with whether the property has been sold by its developer, because units sold may remain vacant, pending occupation by the owner or tenant. Finally, vacancy figures cover the entire stock in the residential market and are not just confined to new developments.

The data used in this article are quarterly from 1980Q1 to 2011Q4 and monthly from January 1993 to March 2013. As shown in Figure 1, the Hong Kong property market has been very volatile during the last three decades. Since 2009, property prices have increased sharply in Hong Kong. The housing price index rose above its 1997 peak and is almost 40% higher than the previous peak during the first quarter of 2013. Meanwhile, the rental price index has also increased dramatically. For example, rent increased 35% between 2009Q1 and 2010Q4, while the property price rose more than 50% during the same period. More importantly, a casual inspection of Figure 1

¹⁴Rating and Valuation Department (RAVD), Hong Kong Property Review 2013, available at <http://www.rvd.gov.hk/mis/publications/qlp.htm>.

16 Wang, Xu and Zhou

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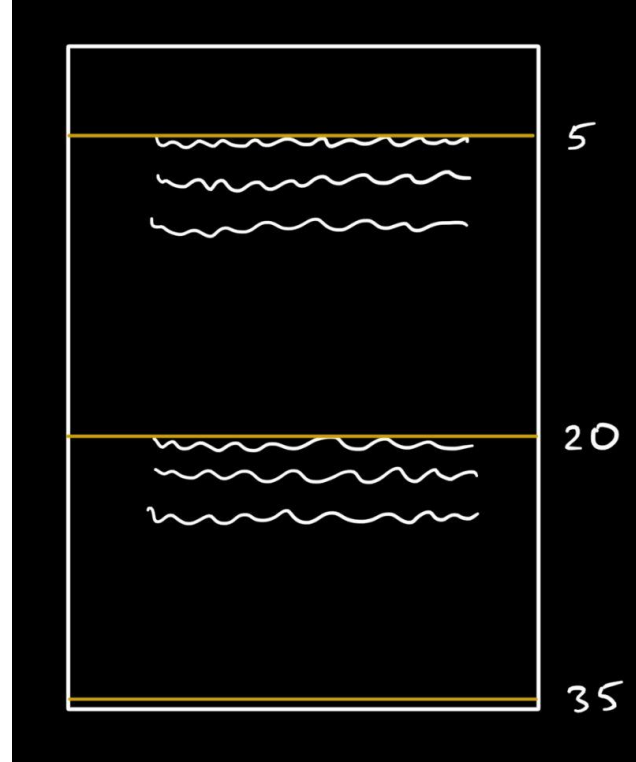
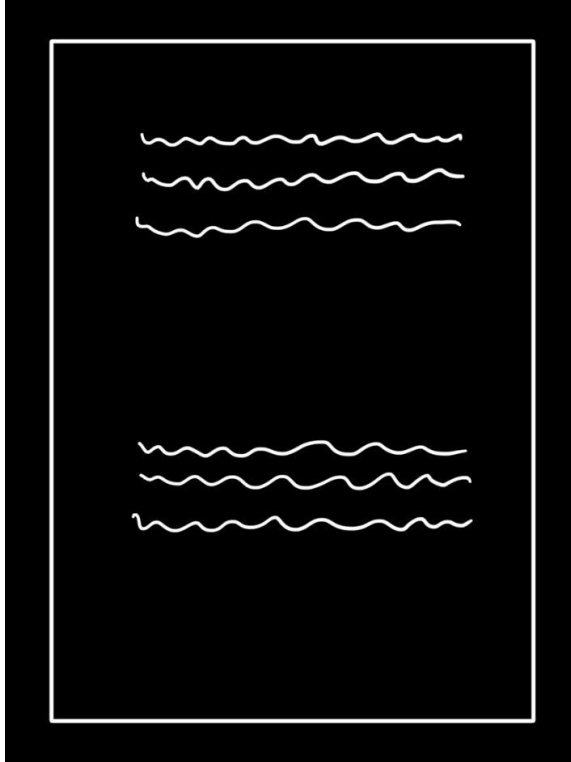
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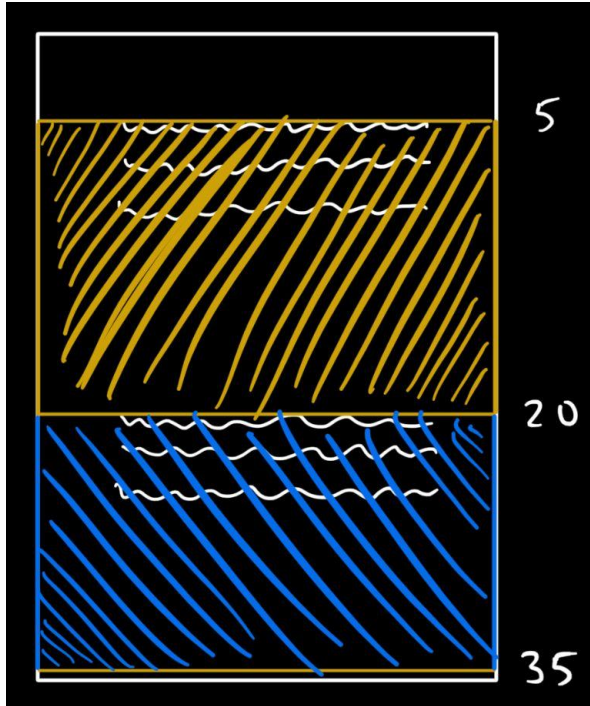
Get Proposals

- Balances margins of image by calling `balance_margins()`
- Gets the row indices of each start of region with `get_blank_rows()`
- Stores `bmap`'s horizontal slices (areas between consecutive starts of regions) in a list 'rows' (setting top boundary)
- Iterates through 'rows' list
 - Performs same white row detection on transpose of each row (column)
 - Sweeps sideways to get vertical slices of the horizontal slices, stores each vertical slice in a variable `spl`, whose transpose is then added to the list 'blocks'
 - Iterates through 'blocks' list, and adds its horizontal slices to list 'rows2'
 - Iterates through `rows2` list, and establishing right and bottom boundary for each region with `np.argwhere()`, which retains only non-white pixels
 - Adjusts coordinates of final bounding box to page's absolute coordinates

Detecting White Rows (Visual Representation)



Forming 'rows' List



- Top boundary of regions set

rows = { slice from (5,20) , slice from (20,35) }

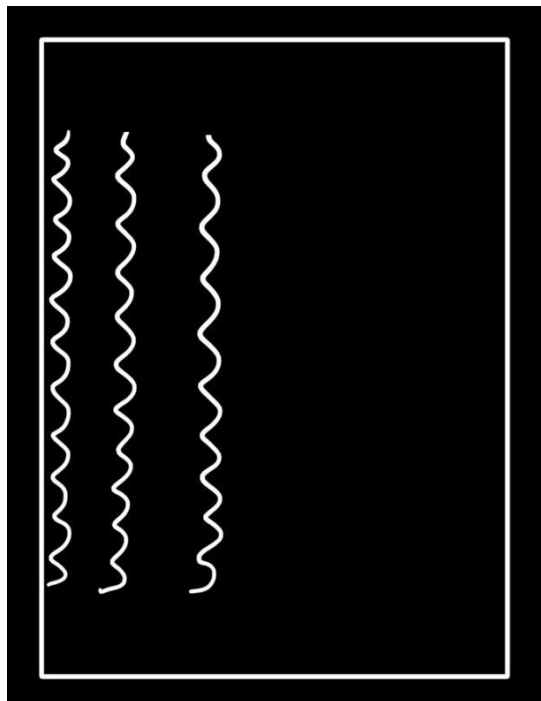
$$\text{rows}[0] = \begin{bmatrix} 0 & a & b & c & d & 0 \\ 0 & e & f & g & h & 0 \\ 0 & i & j & k & l & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\text{rows}[1] = \begin{bmatrix} 0 & m & n & p & q & 0 \\ 0 & r & s & t & u & 0 \\ 0 & v & w & x & y & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Column Detection

For now, let's focus on row[0] as row

row.T : Visual representation

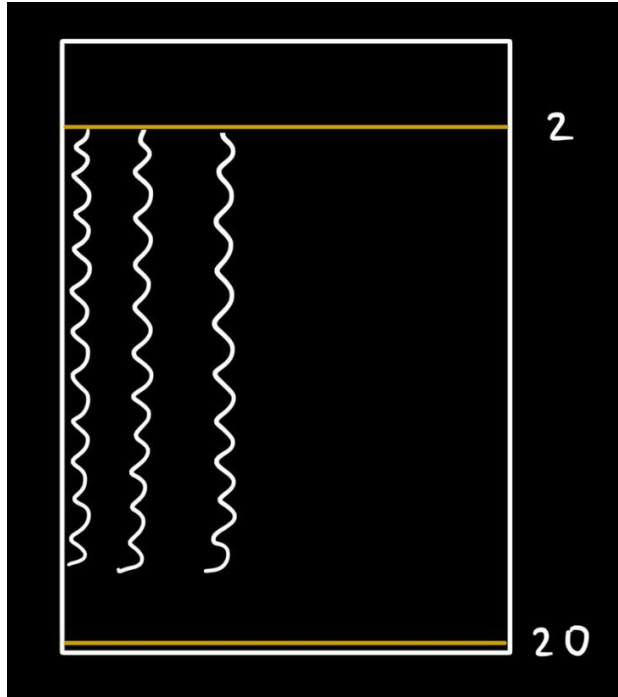


row.T : Visual representation

row T =
$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ a & e & i & 0 & 0 \\ b & f & j & 0 & 0 \\ c & g & k & 0 & 0 \\ d & h & l & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

(6 x 5)

Getting white_cols



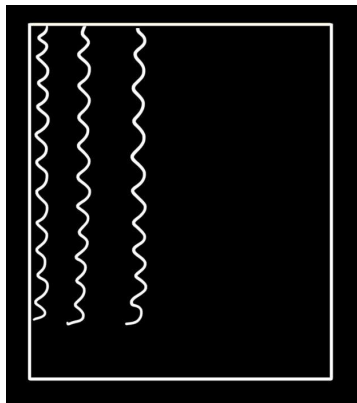
$$\text{row } T = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ a & e & i & 0 & 0 \\ b & f & j & 0 & 0 \\ c & g & k & 0 & 0 \\ d & h & l & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

(6 x 5)

Setting left boundary

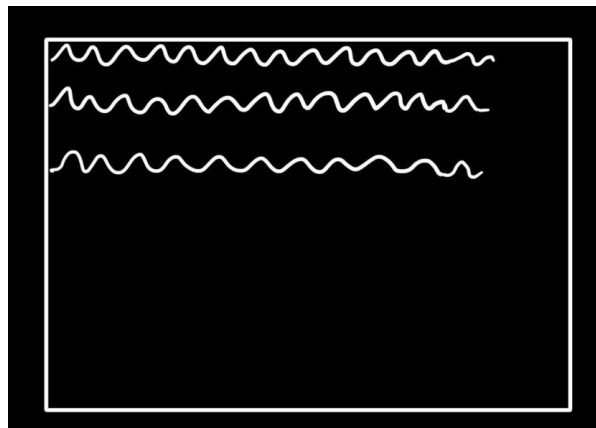
$$\text{Spl} = \begin{pmatrix} a & e & i & 0 & 0 \\ b & f & j & 0 & 0 \\ c & g & k & 0 & 0 \\ d & h & l & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

(5x5)



$$\text{Spl} = \text{Spl}^T = \begin{pmatrix} a & b & c & d & 0 \\ e & f & g & h & 0 \\ i & j & k & l & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

(5x5)
(left boundary set)



Finishing Bounding Box Creation

Adding to blocks and rows2 lists

$$\text{blocks} = \text{rows2} = \left\{ \begin{bmatrix} a & b & c & d & 0 \\ e & f & g & h & 0 \\ i & j & k & l & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix} \right\}$$

Finishing Box Creation by Finding Nonzero Elements

Finding Nonzero Elements with `argwhere()`

```
one_inds = { [0,0], [0,1], [0,2],  
             [0,3], [1,0], [1,1], [1,2], [2,0], [2,1],  
             [2,2], [2,3] }
```

Splitting coordinates by axis (row vs. col)
using `hsplit()`

```
h_one_inds = { { [0], [0], [0], [0],  
                 [1], [1], [1], [1], [2], [2], [2], [2] },  
               { [0], [1], [2], [3], [0], [1], [2], [3] } }
```

Bounding Box Coordinate Generation

- Taking minimum x and y coordinates of nonzero elements for top left corner
- Taking maximum x and y coordinates of nonzero elements for bottom right corner

```
x1 = np.min(h_one_inds[1]) = 0  
y1 = np.min(h_one_inds[0]) = 0  
x2 = np.max(h_one_inds[1]) = 3  
y2 = np.max(h_one_inds[0]) = 2
```

- Relative Coordinates

