Bouygues Floor Plan Detection

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1. Project Task

The goal of this project is to develop a machine learning model to estimate the surface area for each room in an apartment, given its floor plan. More precisely, the objectives are:

- Create a model that reads a PDF floor plan, then detects the number of rooms in this apartment (see Fig 1.).
- Implement a model calculates the surface area of each room.
- Design an algorithm to detects the type of each room, such as living room, kitchen, and bedroom.
- Output all predictions and saves them in a CSV file (see Table 1.).

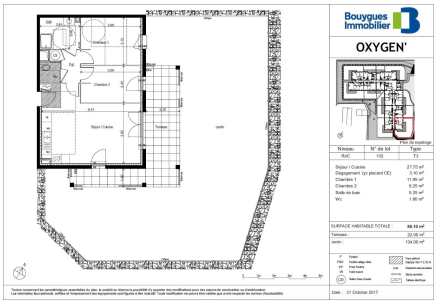

Figure 1. Input PDF Floor Plan

ID	Building Name	Unit Num	Num of Rooms	Living Room	… ...
1	oxygen	102	5	27.75 m^2	… ...

Table 1. Output Table Template

2. Related Work

Some previous works used deep neural network geometric and semantic information into a set of junctions [1] [3]. Then they implemented an integer programming aggregated junctions into a set of simple primitives (which are the contour of the floor plan). However, we would like to try a different approach. For room type detection, previous works mainly had two strategies: one way is using neural network with a set of primitives [1]; the other way is creating a text layer and extracting text information from the input image [4].

3. Dataset and Metric

Bouygues Group provided total 133 training floor plans, which contain two buildings “Eko” and “Equation” with 49 and 84 pdf floor plan files, respectively, along with the training dataset ground truth table. The testing dataset contains 139 floor plans from the “Oxygen” building. The template table for the testing dataset result is provided, however, the table requires us to manually fill in the floor plan information (Number of Rooms, Surface Areas, etc) for each apartment. Note that all words and labels in the training and testing floor plans are in French, Bouygues Group also provided a reference room type chart, which translates French (some with abbreviations) to English. For example, (see Table 2.).

French	Chambre	ch	ch1
English	Bedroom	Bedroom	Bedroom

Table 2. French Reference Table

Besides, Bouygues Group provided a template for the output of floor detection, where 29 types of rooms are mandatory targets and 20 room’s types are optional tasks.

3.1 Metrics

For surface area detection, we calculate Intersection Over Union (IOU) as the accuracy of each room surface area and set the distance to be $1 - IOU$, as previously introduced in [1]. For room type labeling, we simply check whether our prediction room name matches with the ground truth (GT) label, The accuracy function is defined:

$$Accuracy(Room\ labeling) = \frac{Number\ of\ correct\ predictions}{GT\ number\ of\ rooms} \quad (m1)$$

In addition, the accuracy function of the number of main rooms is defined:

$$Accuracy(Room\ numbers) = \frac{Predicted\ number\ of\ rooms}{GT\ number\ of\ rooms} \quad (m2)$$

Note that IOU accuracy is an independent metric. While m1 and m2 are correlated, if m1 equals to 1 then m2 equals to 1. If m2 does not equal to 1, m1 must not equal to 1. We hope our model can achieve accuracies higher than 80% on surface area, room type labeling, and the number of rooms predictions.

4. Approach

Our approach integrates a contour detector via OpenCV, and a classifier model to predict the type of each room, where we would like to implement a Convolutional Neural Network(CNN) model.

First, the contour detector extracts each room from the input PDF file and calculates the surface area by using erode and dilate method in OpenCV [5]. Second, our CNN model uses a multiclass softmax regression and its loss layer uses cross entropy loss, where the hypothesis and the loss function defined as follow [6]:

$$p(y^{(i)} = j|x^{(i)}; \theta) = \frac{e^{\theta_j^T x^{(i)}}}{\sum_{l=1}^{k} e^{\theta_l^T x^{(i)}}}$$

F1. Hypothesis Function

$$J(\theta) = -\frac{1}{m}\sum_{i=1}^{m}\sum_{j=1}^{k}[1\ \{y^{(i)} = j\}\ log(\frac{e^{\theta_j^T x^{(i)}}}{\sum_{l=1}^{k} e^{\theta_l^T x^{(i)}}})]$$

F2. Loss Function without regularization

Note that in F2, 1{.} is the indicator function, so that 1{a true statement} = 1, and 1{a false statement} = 0.

For the CNN room's type model, we cogitate on two approaches: scanning the important objects in each room, (for example, the hotplates in the kitchen); and extracting the room type words from the input floor plan.

5. Preliminary Results

We used erode and dilate methods in OpenCV to extract the contour of a floor plan from a given image:

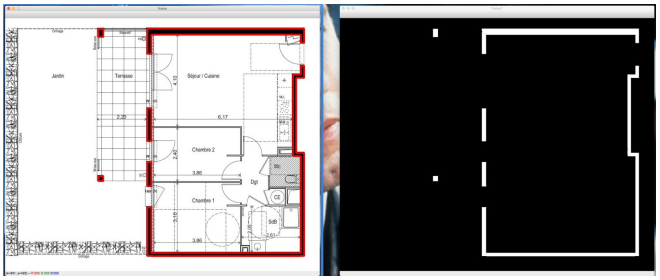

Figure 2. Input Floor plan (left), Erode Result with iteration = 3 (right)

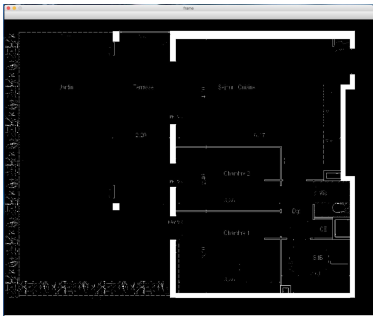

Figure 3. Erode Result with Iteration = 1

6. Timeline and Roles

Task	Deadline	Leader
Implement contour detection model	11/06/2018	Qitong Wang
Detect each room and calculate its surface area	11/11/2018	Chi Zhang
Using CNN model to detect the type of each room, by scanning the important objects in each room	12/01/2018	Kaihong Wang
Using CNN model to detect the type of each room, by extracting the word from the given room floor plan	11/21/2018	Jiangshan Luo
Prepare report and presentation	12/06/2018	all

Leaders are responsible for their tasks, however, others may also contribute to these tasks.

References

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3. *Ahmed, S., Liwicki, M., Weber, M., & Dengel, A. (2011). Improved Automatic Analysis of Architectural Floor Plans. 2011 International Conference on Document Analysis and Recognition. doi:10.1109/icdar.2011.177*
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5. *Image Filtering¶. (n.d.). Retrieved October 29, 2018, from https://docs.opencv.org/2.4/modules/imgproc/doc/filtering.html?highlight=erode#erode*
6. *Softmax Regression. (n.d.). Retrieved October 29, 2018, from http://ufldl.stanford.edu/wiki/index.php/Softmax_Regression*