Сегментация рукописного текста

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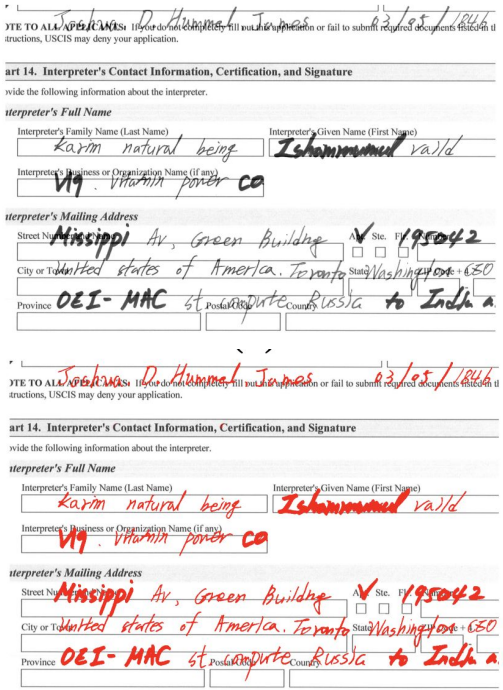
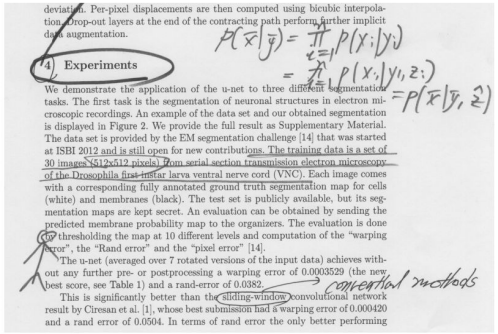
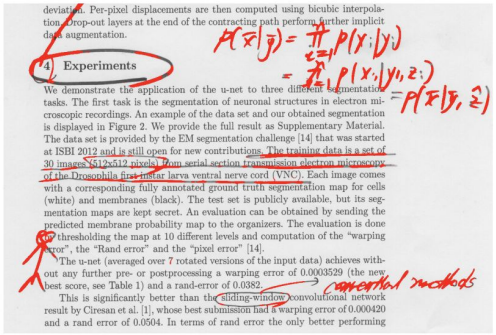
1 - Пояснение темы «Сегментация рукописного текста»







- оцифровка документов
- распознавание текстов
- рукописный текст
- коллизии
- сверточные нейронные сети
- данные

1 - Цель работы

Разработка системы для сегментации рукописного текста с использованием алгоритмов машинного обучения

Особое внимание уделяется подготовке данных для машинного обучения

1 - Задачи

1. Изучение литературы по теме

2. Изучение архитектуры нейронных сетей для сегментации изображений и функций потерь, выбор и реализация подходящих вариантов.

3. Определение алгоритма подготовки данных, реализация системы подготовки данных (фреймворка) и подготовка данных для обучения.

4. Обучение моделей (алгоритмов машинного обучения) и измерение качества.

5. Тестовое применение модели на реальных примерах и анализ результатов.

1 - Актуальность работы

- Улучшение детекции и распознавания рукописного текста
- Устранение артефактов при генерации рукописного текста с помощью GAN

- Отсутствие открытого исходного кода по теме
- Отсутствие примеров реального применения

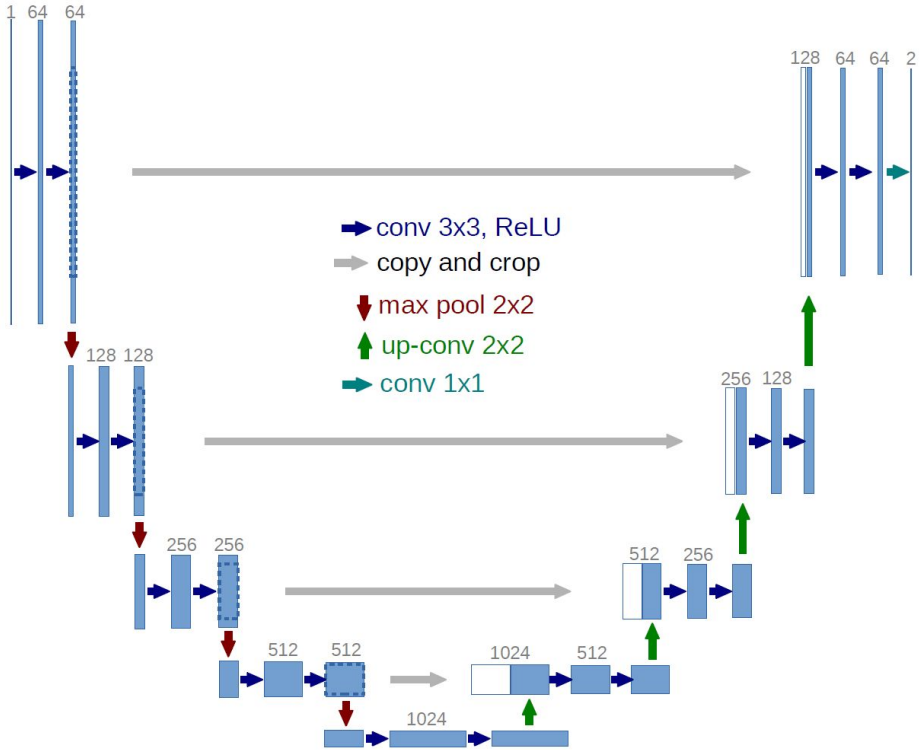
2 - Методы распознавания

Сверточные нейронные сети

Сегментация = попиксельная классификация

2 - Методы распознавания

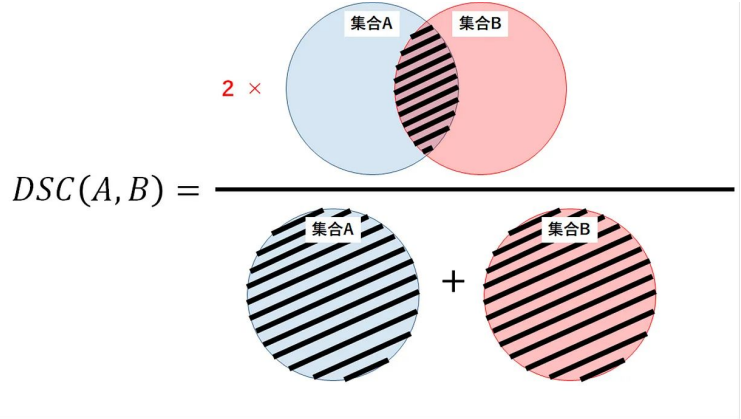
- U-Net
- Разная глубина сверток:
  - 16 - 32 - 64 -128
  - 32 - 64 - 128 - 256
  - 64 - 128 - 256 - 512
- Вход – 1 channel (grayscale)
- Выход – 1 channel (hwr mask)
  - sigmoid



2 - Методы распознавания

Dice loss

$$D_p = \frac{2\sum_{i,j} p_{i,j} m_{i,j}}{\sum_{i,j} p_{i,j} + \sum_{i,j} m_{i,j}}$$



где

- $p_{i,j}$ — это предсказанная вероятность для пикселя принадлежать к целевому классу (от 0 до 1)
- $m_{i,j}$ — значение маски в пикселе (от 0 до 1)

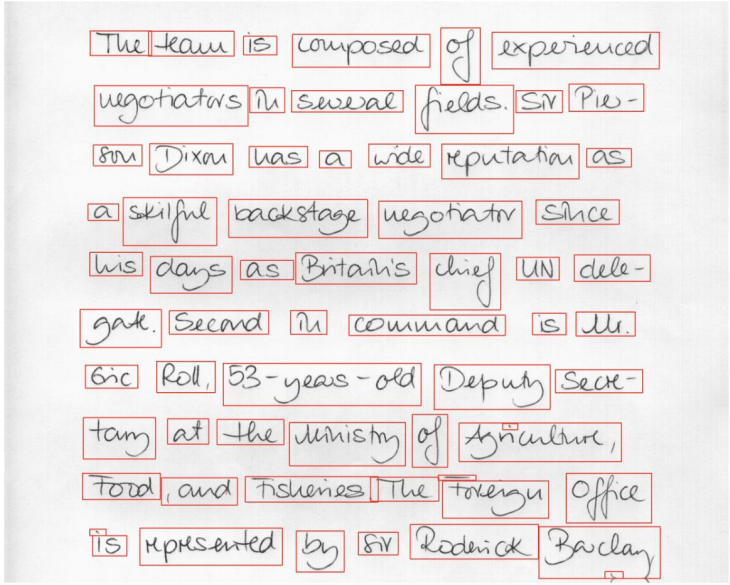
$$D_{binary} = F_1 = \frac{2 * TP}{2 * TP + FN + FP}$$

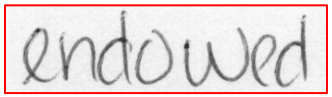
3 - Подготовка данных - подход

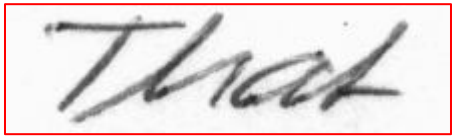
- Нет готовых наборов данных
- Можно сделать свой на основе рукописей и страниц печатного текста

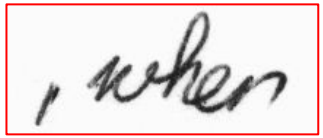
3 - Подготовка данных - выделение фрагментов

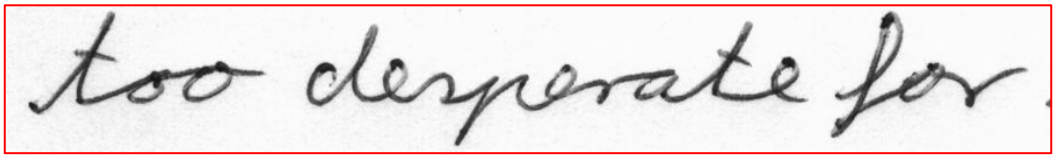
- Выделить слова и сохранить их как отдельные картинки
  - морфологические преобразования
  - findContours
  - отбрасывание выбросов
- Результат:
  - датасет IAM (2 100 страниц -> 47 000 фрагментов)
  - фреймворк для любых входных данных





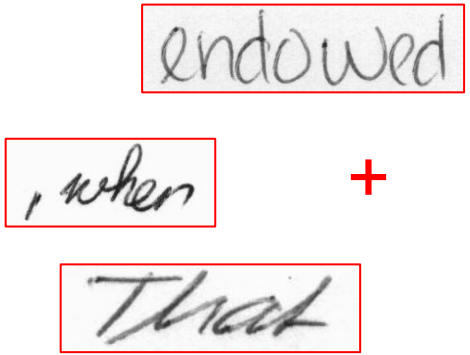






3 - Подготовка данных - размещение

- Разделяем данные train/val/test
- Размещаем на каждой «печатной» странице 300 случайно выбранных фрагментов
  - случайное положение
  - случайный масштаб
  - случайный поворот



Filaria Journal 2004, **3**:5 http://www.filariajournal.com/content/3/1/5

producing microfilariae of intermediate dimensions and periodicity [3]. (This is not to say that under natural conditions diurnally-periodic worms of human *Loa* are never transmitted to monkeys, but such events, if they do occur, appear to be rare).

Later, Belgian workers in the Mayumbe District in the south-western part of the Democratic Republic of the Congo (DRC), commented on the local human *Loa* infections in that area being particularly liable to give rise to cases of *Loa*-encephalopathy after treatment with diethylcarbamazine citrate (DEC). They also noted that out of 547 patients from this area, whose blood films were examined both by day and night, 197 showed *Loa* mf only by day, 322 showed them by day and by night; and 16 showed mf only at night. Although the latter cases, with a complete reversal of the normal periodicity, showed only light microfilarial loads (12 cases with 1–5 mf per examination, and 4 cases with 6–9 mf per examination), among those persons who showed *Loa* mf by day and by night, 62 showed microfilarial concentrations that were nearly as high by night as by day and 10 showed more mf by night than by day (two of them showing 500 – 1,000 mf by night as compared with 300 – 500 mf by day) [4-6]. As some of the cases of loiasis from Mayumbe were abnormal in displaying a primarily nocturnal periodicity of the microfilariae, it is possible that the local strain of *Loa* responsible for them may be closely related to the simian parasite.

Recently in the Republic of Cameroon, cases of *Loa*-encephalopathy have been reported following mass treatment with ivermectin by the African Programme for Onchocerciasis Control (APOC) in areas where loiasis is co-endemic with onchocerciasis [7-11]. A remarkable clustering of many of these cases was found in the Lékié Division, a forest and forest/savannah mosaic area some 80 km from the capital, Yaoundé. So far, the reason for this clustering has not become apparent but the occurrence of these cases of *Loa*-encephalopathy has had a deleterious effect on the popularity of the APOC campaign in that area [12]. Furthermore, at the end of 2003 in the Mayumbe area of the DRC, some 100,000 persons were treated with a standard single dose of ivermectin distributed as part of the activities of APOC, and 41 cases of serious adverse reactions (SAEs) were reported, of which 14 were fatal despite appropriate management of the patients. This is an incidence rate even higher than that reported in Lékié Division of Cameroon and has led to the establishment of a commission to examine the matter (Dr B. Thylefors, *personal communication*).

The patho-biological reasons for the occurrence of *Loa*-encephalopathy following treatment with DEC or with ivermectin, mainly seen in patients heavily infected with *Loa* microfilariae, are not well understood, and co-factors may exist that account for the fact that some patients do not develop SAEs despite having high *Loa* microfilaraemia. Experimental work by Dr Samuel Wanji using an animal model is currently trying to reproduce heavy microfilaraemic infections of human *L. loa* in experimentally infected monkeys (mainly *Mandrillus* spp) and to investigate the biochemical and pathological changes that accompany the development of any *Loa*-encephalopathy following ivermectin treatment.

In the original work at the HRU, Kumba, where it was relatively easy to infect young drills experimentally (either by inoculation of infective larvae or by transplantation of adult worms) with either the nocturnally-periodic simian *Loa* parasite or with the diurnally-periodic human parasite, it was obviously far more difficult to determine whether the nocturnally-periodic simian parasite could be transferred to man. Nevertheless, at that time, before the discovery of the potentially deadly viruses such as Ebola, Marburg and HIV that are believed to originate from monkeys, attempts to infect a human (the author) experimentally with a simian strain of the *Loa* parasite were undertaken. Today, such experiments would not only be viewed as unethical but also as potentially life-threatening.

In 1954 and 1955, the author (who at that time had no signs or symptoms of loiasis and who was not taking any medication, apart from 200 mg proguanil (Paludrine) daily as a prophylactic for malaria), took part in two such experiments, which have not been previously published but are relevant in the light of the localised occurrence of *Loa*-encephalopathy in some individuals following treatment with ivermectin. These attempts at experimental infection of a human being with simian *Loa* are as follows:

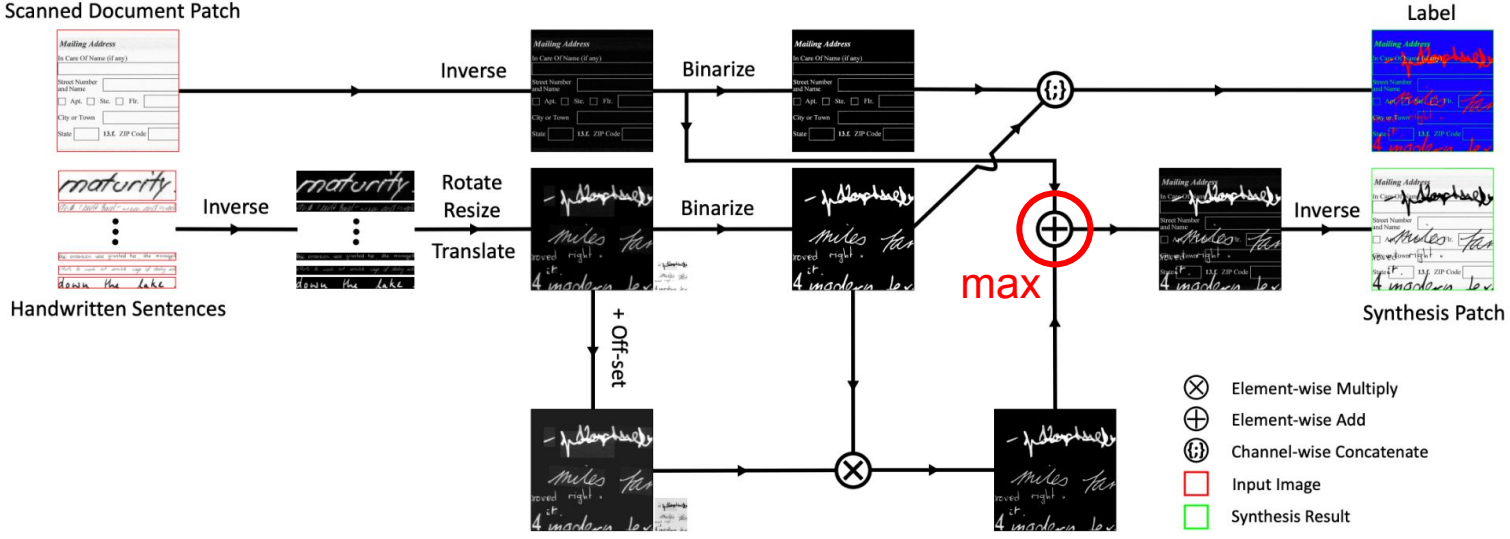
In July 1954, a large male drill, which had been shot in the forest near Kumba some 3–4 hours previously, was brought into the laboratory by the Unit's hunter. It was immediately dissected and a total of seven male and fifteen female mature simian *Loa* worms, all alive, undamaged and motile, were collected from the subcutaneous and intermuscular tissues. The worms were placed in sterile normal saline solution, along with a small quantity of merthiolate, in the same manner that had been used previously to transplant adult simian *Loa* worms successfully into other monkeys. Two and a half hours later, 12 of these live, motile, adult female worms and five males were inserted, under local anaesthesia, into the upper, anterior part of the right thigh of the author by the Medical Officer-in-Charge of the Kumba Medical Field Unit. After making a 3-inch, longitudinal incision through the skin and the superficial fascia, the simian *Loa* worms were inserted, some into the sub-cutaneous tissue and others under the

3 - Подготовка данных - наложение и маски

Способы наложения

- alpha-blending
- из статьи
- свой*

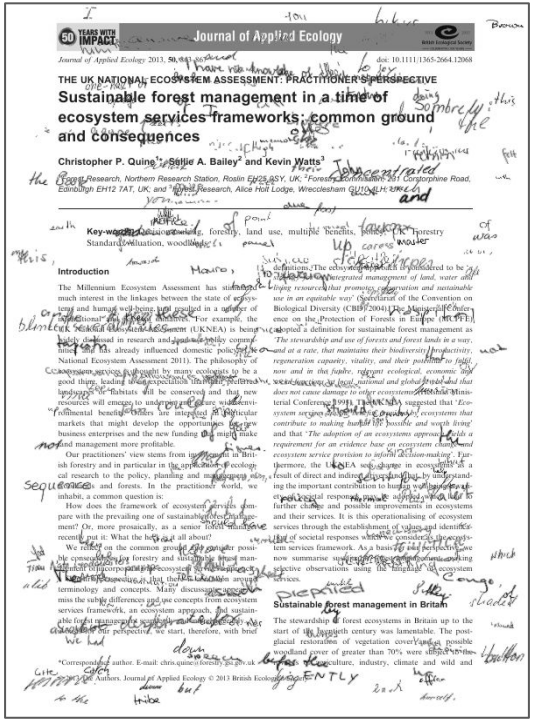
Handwritten Text Segmentation via End-to-End Learning of Convolutional Neural Networks, 2019 https://arxiv.org/pdf/1906.05229.pdf



3 - Подготовка данных - Результат

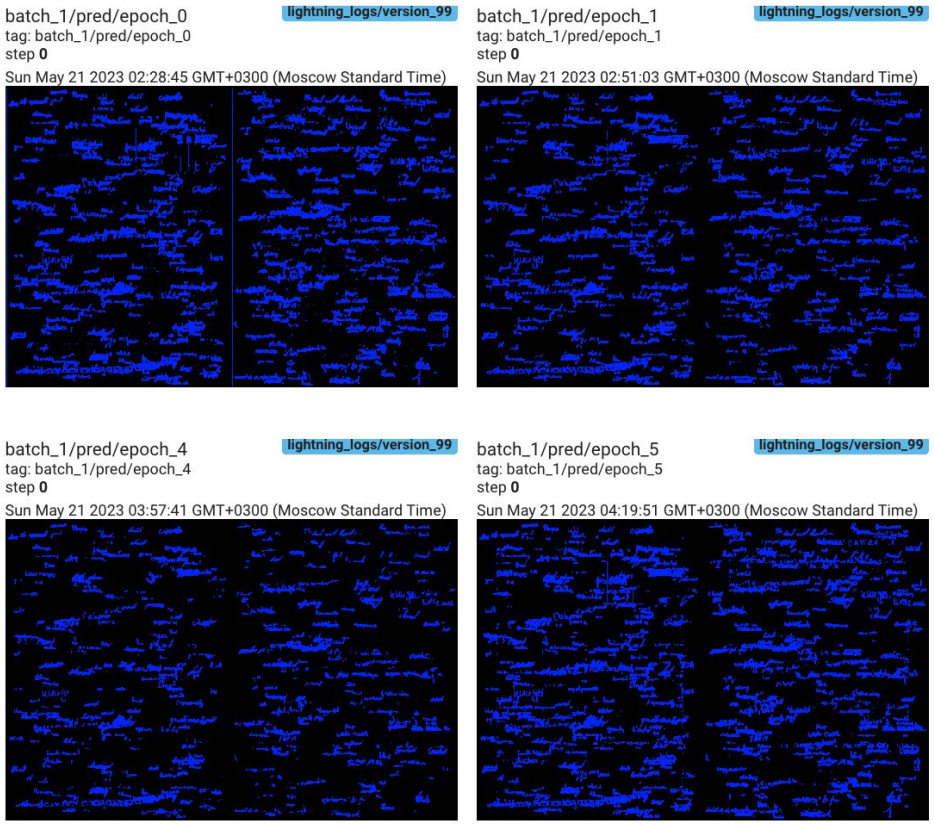
Результат:

- PubLayNet (10k) + фрагменты (47k) = MixDataset (10k)
- фреймворк для любых входных данных



4 - Процесс обучения - Подход

- Аугментации
  - случайный поворот
  - случайное отражение по горизонтали и вертикали
- Оптимизируем DiceLoss с помощью Adam
  - Динамически уменьшаем lr на плато
- 2080 ti
- Torch / Pytorch Lightning / Tensorboard



4 - Процесс обучения - Валидационные метрики

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

$$Precision = \frac{TP}{TP + FP}$$

$$Recall = \frac{TP}{TP + FN}$$

$$F1 - score = \frac{2 * Recall * Precision}{Recall + Precision} = \frac{2 * TP}{2 * TP + FP + FN}$$

4 - Процесс обучения - Результаты

25 эпох

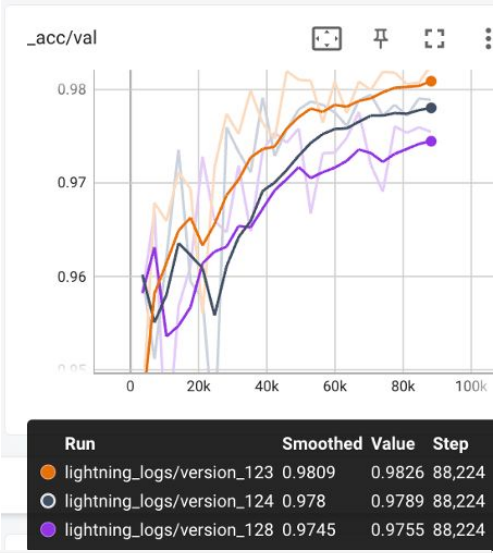
Модель	Кол-во параметров	Accuracy	Precision	Recall	F1-score
Unet 16-32-64-128 (128)	**1.9 M**	**0.976**	**0.942**	**0.892**	**0.916**
Unet 32-64-128-256 (124)	**7.8 M**	**0.979**	**0.949**	**0.910**	**0.929**
Unet 64-128-256-512 (123)	31.0 M	**0.983**	**0.959**	**0.924**	**0.941**

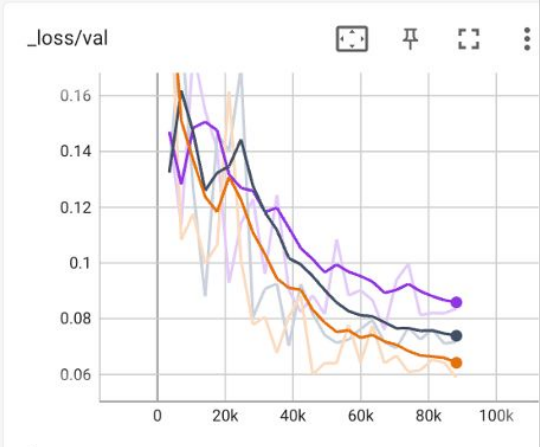
$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

$$Precision = \frac{TP}{TP + FP}$$

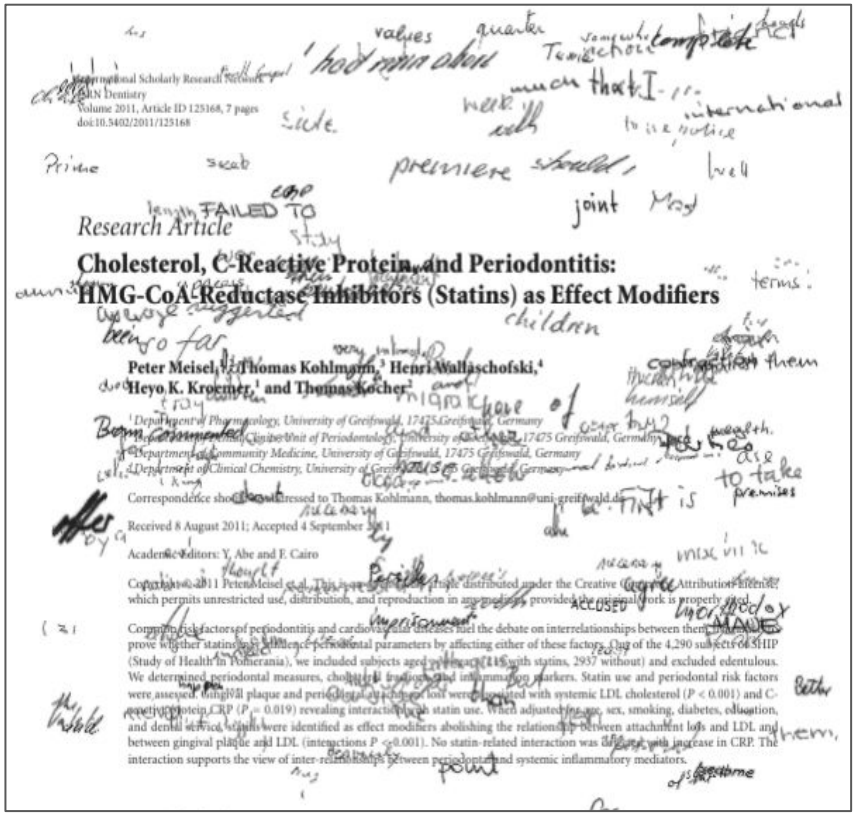
$$Recall = \frac{TP}{TP + FN}$$

$$F1 - score = \frac{2 * Recall * Precision}{Recall + Precision} = \frac{2 * TP}{2 * TP + FP + FN}$$





4 - Процесс обучения - Результаты



Research Article

Cholesterol, C-Reactive Protein, and Periodontitis: HMG-CoA-Reductase Inhibitors (Statins) as Effect Modifiers

Peter Meisel,[1,2] Thomas Kohlmann,[3] Henri Wallaschofski,[4] Heyo K. Kroemer,[1] and Thomas Kocher[2]

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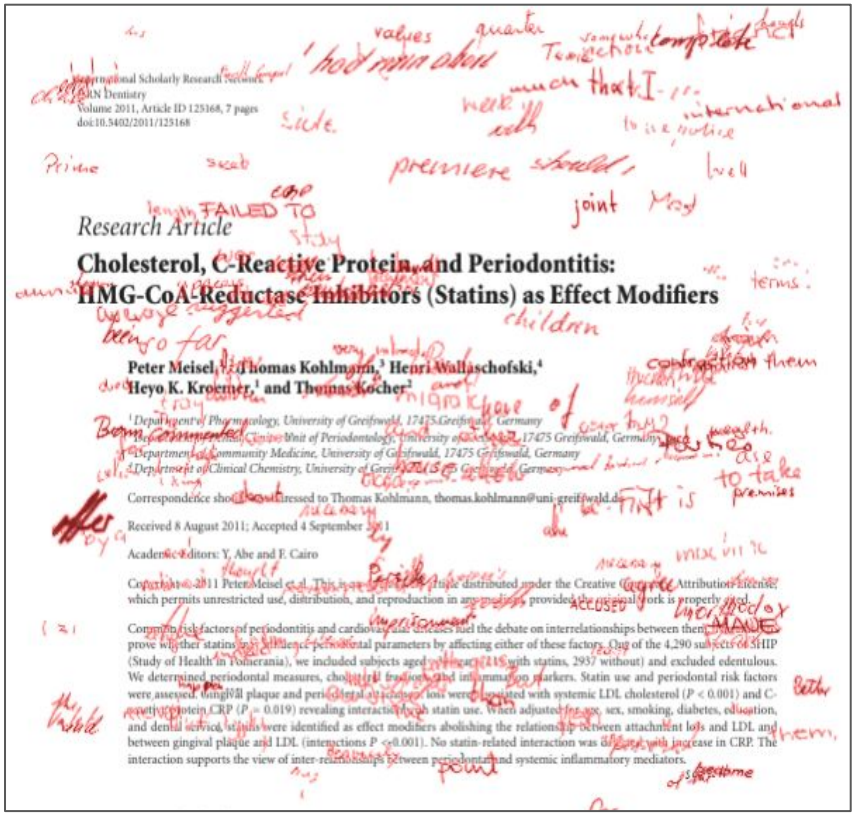
Common risk factors of periodontitis and cardiovascular diseases fuel the debate on interrelationships between them. We approve whether statins as influence periodontal parameters by affecting either of these factors. Out of the 4,290 subjects of SHIP (Study of Health in Pomerania), we included subjects aged ≥ 45 years (1,415 with statins, 2937 without) and excluded edentulous. We determined periodontal measures, cholesterol fractions, and inflammation markers. Statin use and periodontal risk factors were assessed. Gingival plaque and periodontal attachment loss were correlated with systemic LDL cholesterol ($P < 0.001$) and C-reactive protein CRP ($P = 0.019$) revealing interaction with statin use. When adjusted for age, sex, smoking, diabetes, education, and dental service, results were identified as effect modifiers abolishing the relationship between attachment loss and LDL and between gingival plaque and LDL (interactions $P < 0.001$). No statin-related interaction was detected with increase in CRP. The interaction supports the view of inter-relationships between periodontal and systemic inflammatory mediators.



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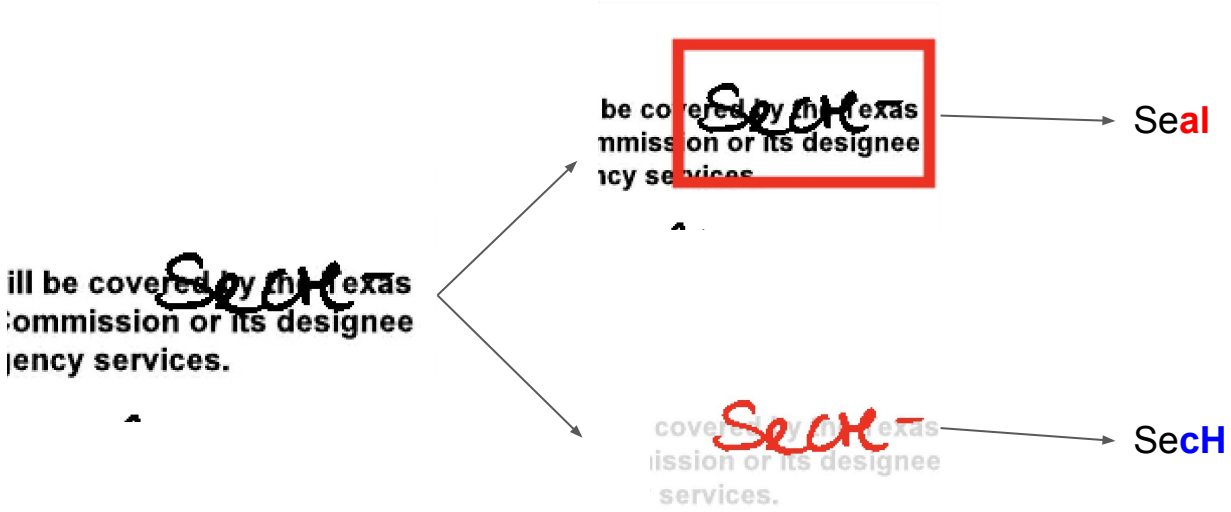
5 - Проверка на реальных данных - Способы

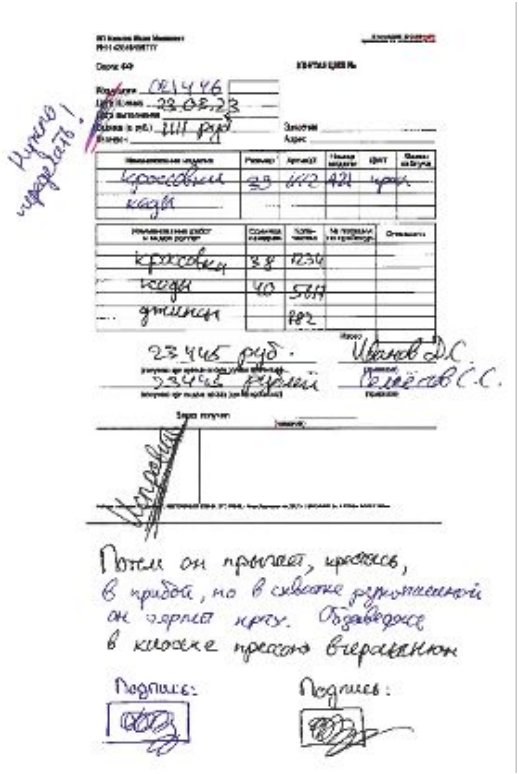
Количественно

Качественно

Handwritten detector + Handwritten reco **VS** Handwritten segmenter + Handwritten reco



5 - Проверка на реальных данных - Примеры



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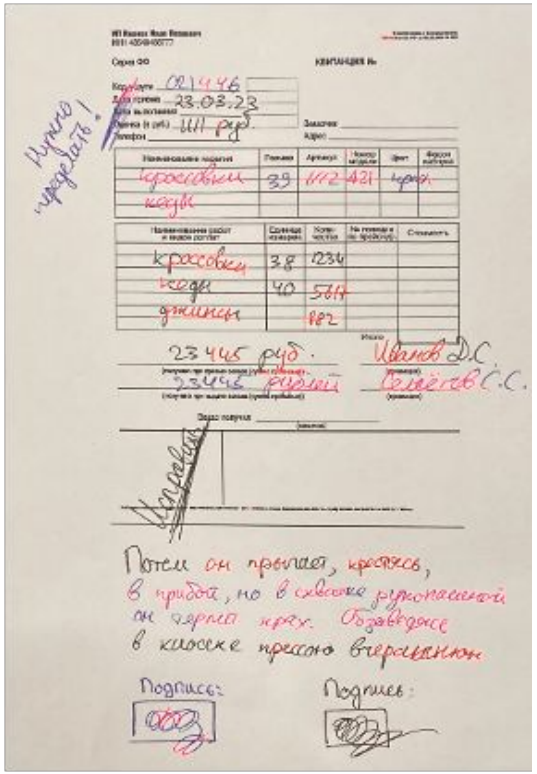

фото

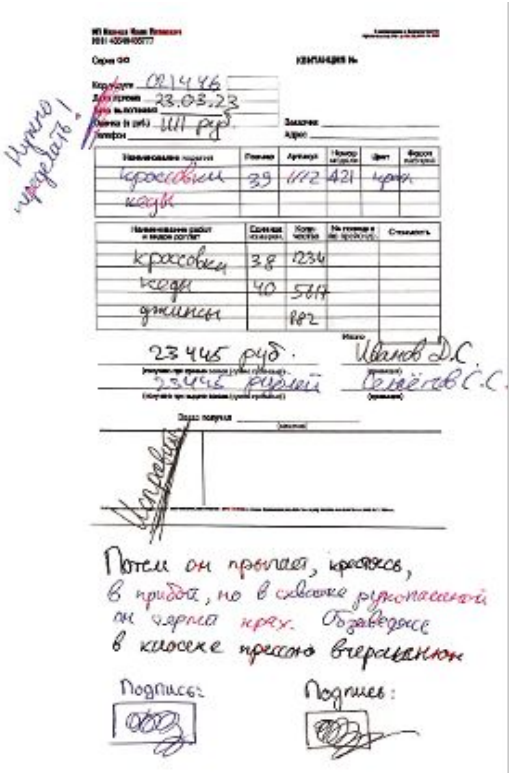

фото + фильтр

5 - Проверка на реальных данных - Примеры

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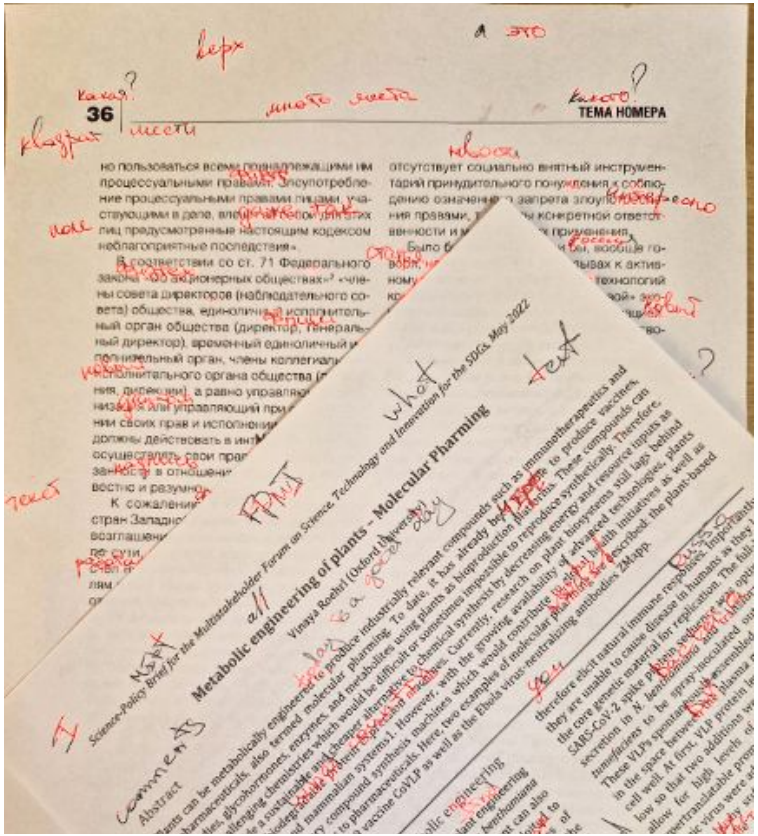

5 - Проверка на реальных данных - Выводы

- На сканах работает плохо, но на фотографиях удовлетворительно
- Одинаково хорошо распознаются рукописи разной контрастности (синие — менее контрастные, черные — более)
- Если пример похож на обучающие данные, то работает значительно лучше
- Чем меньше в модели параметров, тем лучше она распознает тестовые примеры

6 - Заключение - Выводы

1. Был создан фреймворк для создания смешанных (рукописи поверх печатных текстов) наборов данных и сгенерирован датасет с 10 тыс. сэмплами
2. С помощью машинного обучения моделей типа U-net был получен алгоритм, который хорошо показал себя на обучающем датасете
3. Было продемонстрировано реальное применение и сделаны выводы о результатах попытки применения

6 - Заключение - Дальнейшее исследование

1. Проверить гипотезы недостаточно хорошей работы модели на реальных данных
    - брать рукописи из сканов
    - расширить за счет аугментаций разнообразие рукописей
    - попробовать другие способы наложения рукописей на печатные страницы
2. Провести качественную оценку на более разнообразных данных
3. Реализовать алгоритм количественной оценки
4. Поэкспериментировать с архитектурой модели
    - глубины сверток в слоях U-Net
    - другие архитектуры