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一、主要任务

比赛采用的数据为大量伪造的证书文档类图像。任务是通过提供的训练集学习出有效的检测算法，对测试集的伪造图像进行篡改定位。

二、算法思路

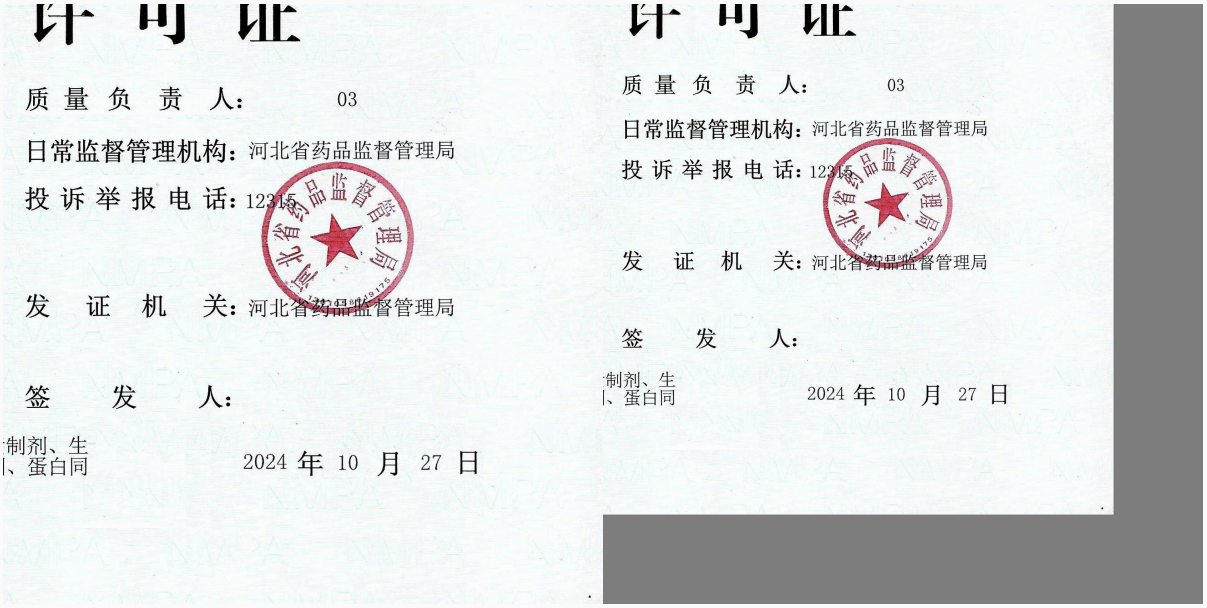
2.1 核心方法

转换为目标检测问题，将篡改区域定义目标类别class-cheat

2.2 数据处理

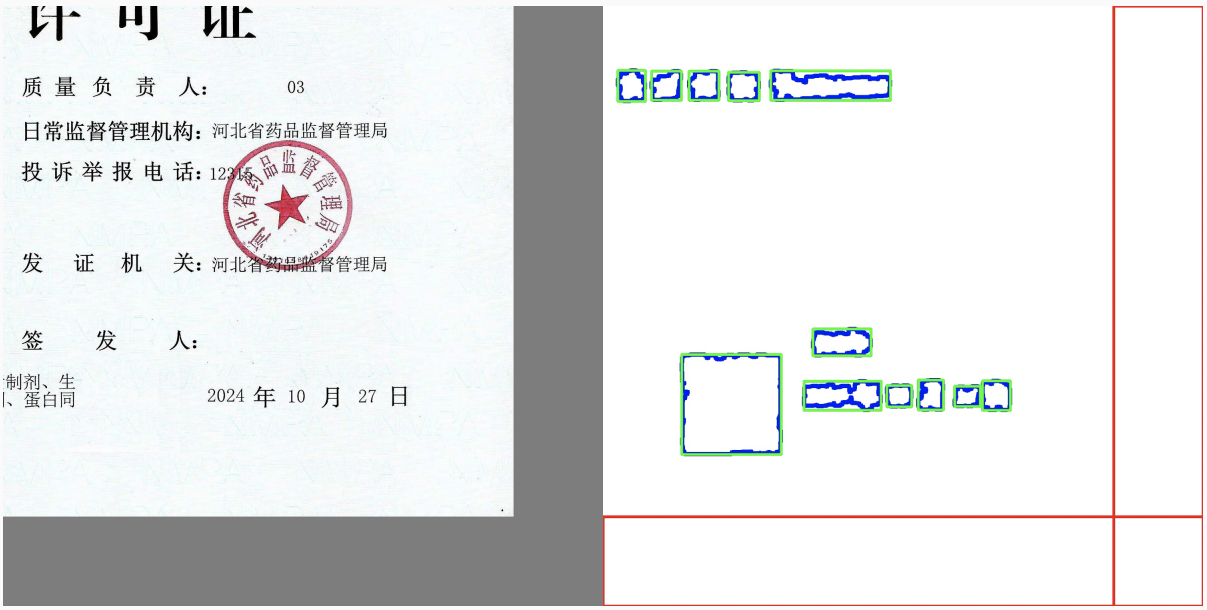
原始图像尺寸参差不齐，统一使用**颜色125**填充至1550*1550。

举例：



颜色125部分定义为第二类别class-pmiss

对mask进行解析，如下红色为class-pmiss，蓝绿色为class-cheat。

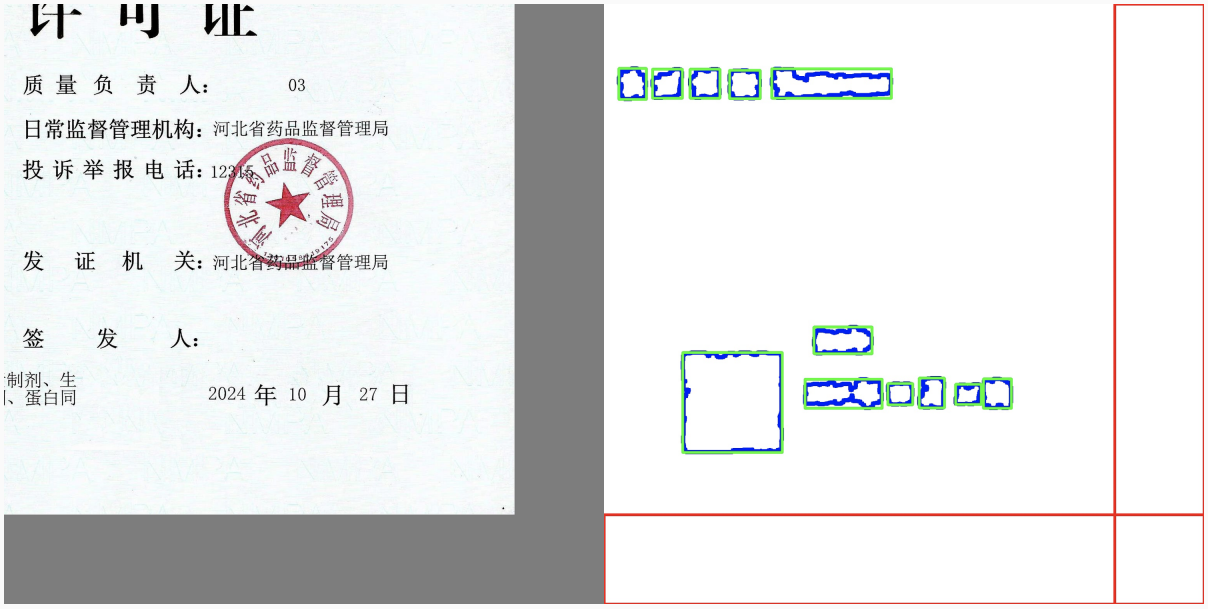


据此构建COCO数据集，用于mmdetection目标检测。

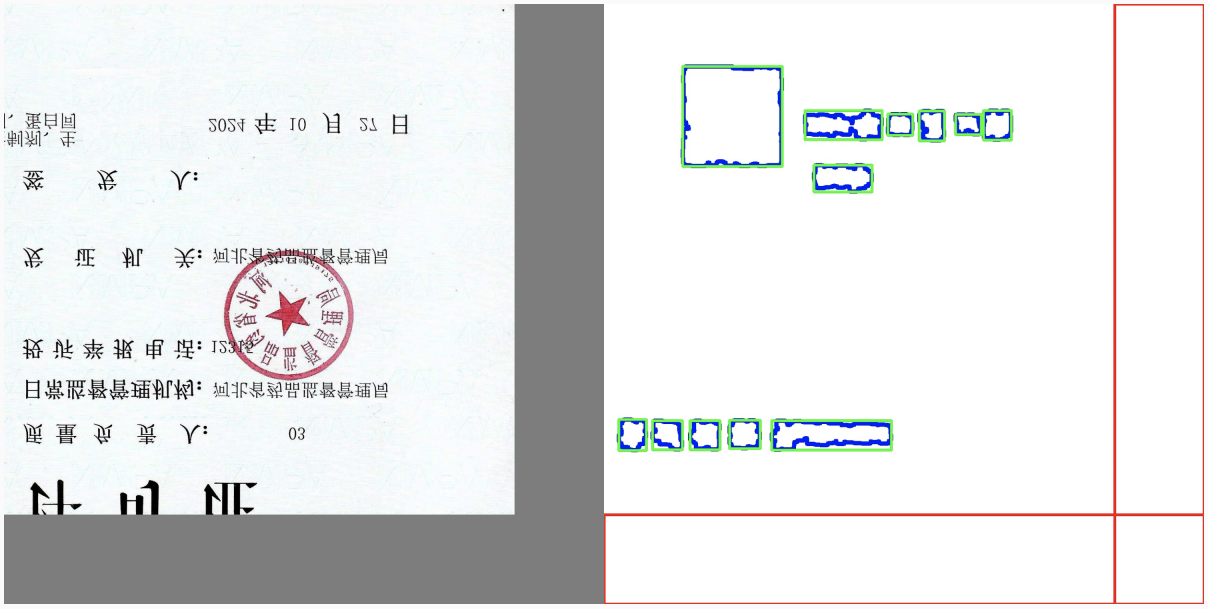
2.3 数据增强

原有训练数据集较少，且部分图像来自同一张图像，为避免过拟合。使用了以下方法以数据增强。

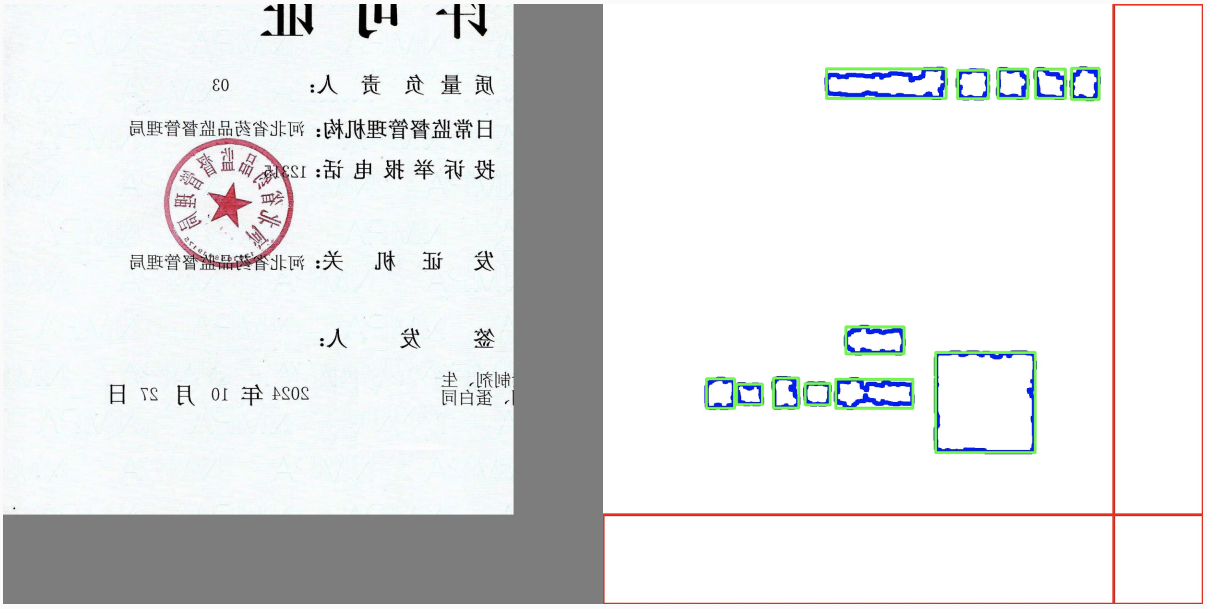
- 原始


质量负责人：03
日常监督管理机构：河北省药品监督管理局
投诉举报电话：12331
发证机关：河北省药品监督管理局
签发人：
2024 年 10 月 27 日

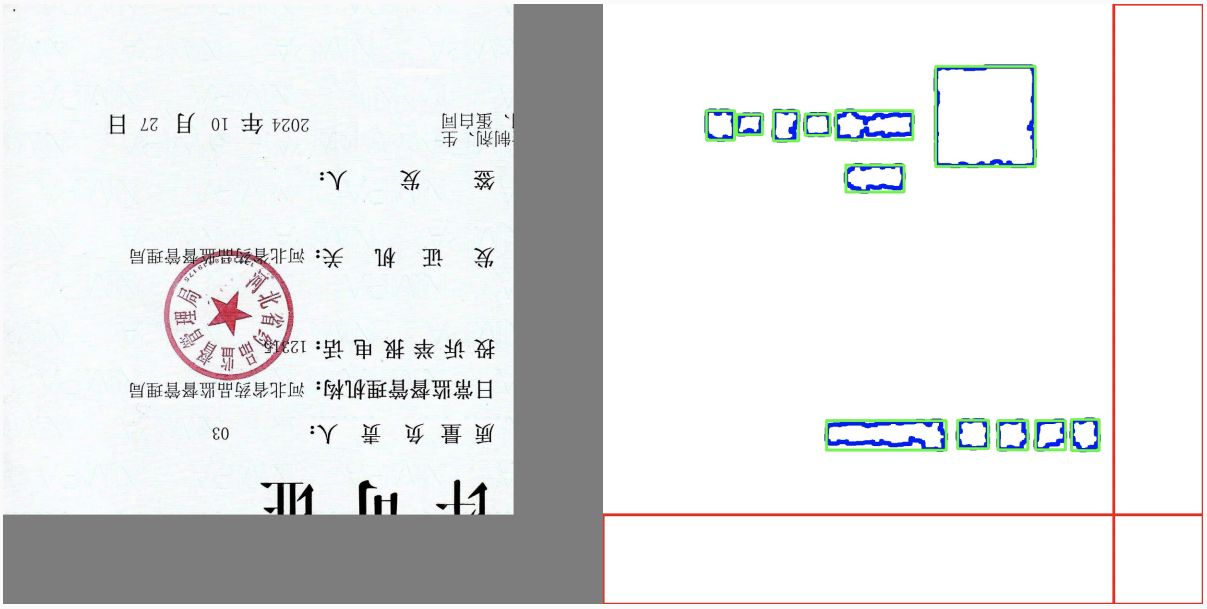
- cv旋转0



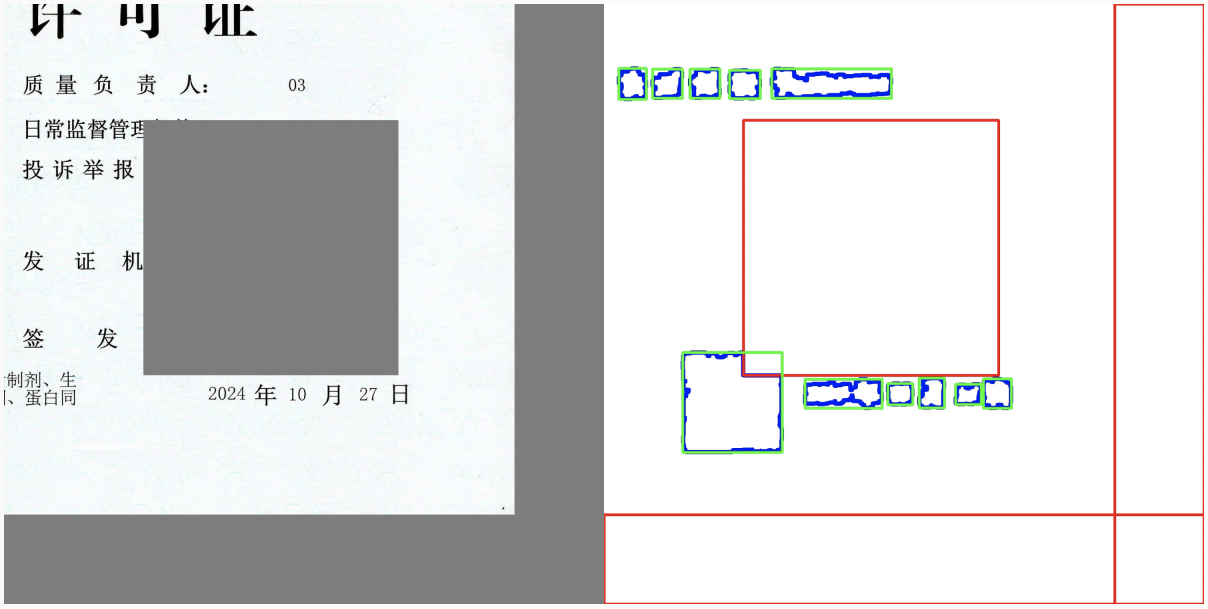
- cv旋转1



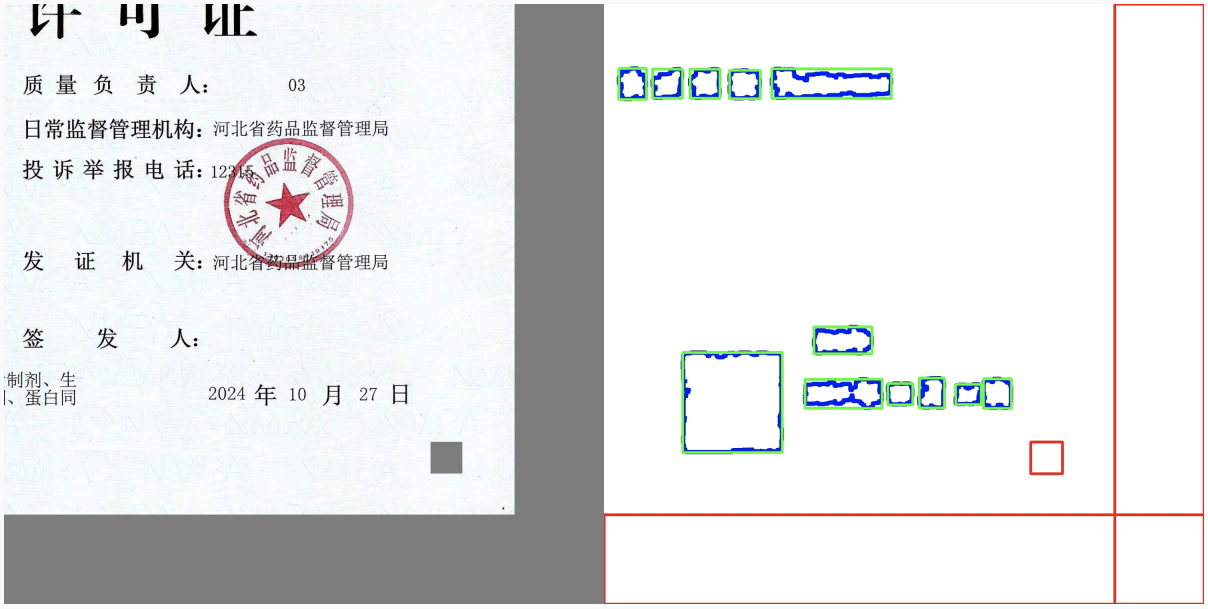
- cv旋转-1



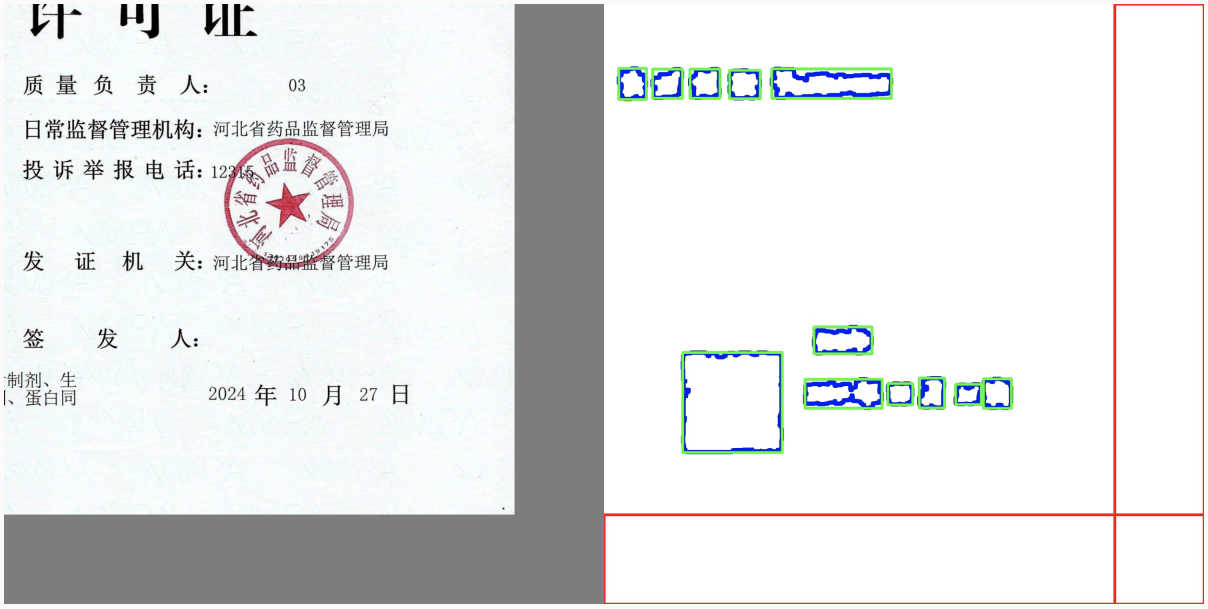
- M2（随机生成1/2边长正方形作为遮挡，遮挡部分定义为class-pmiss）



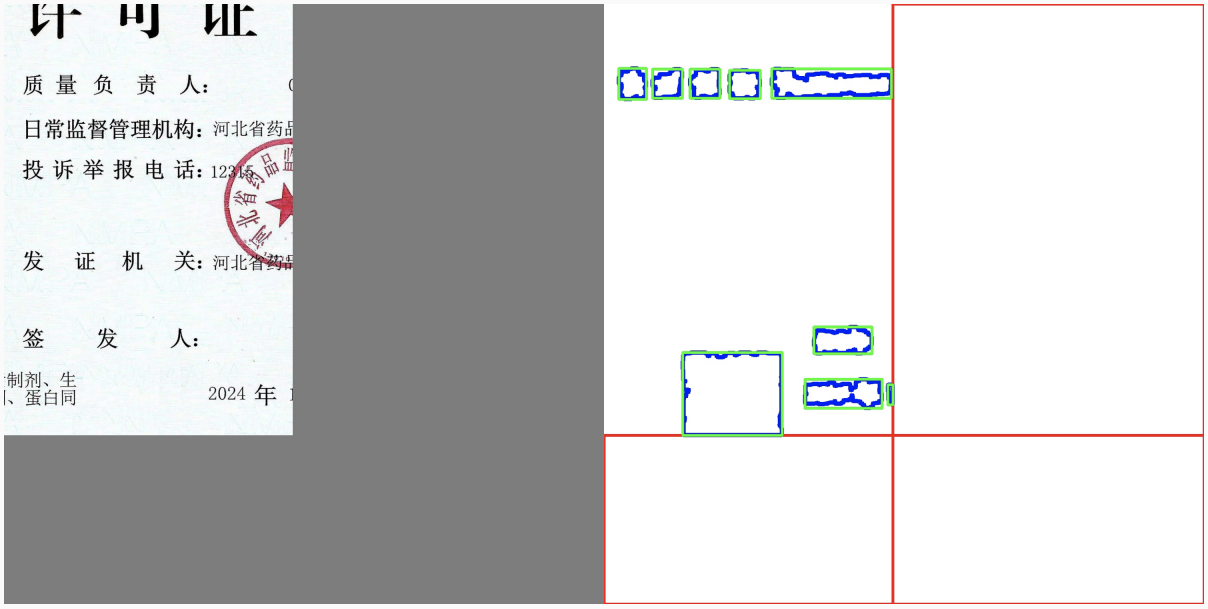
- MF（随机生成1/16边长正方形作为遮挡，遮挡部分定义为class-pmiss）



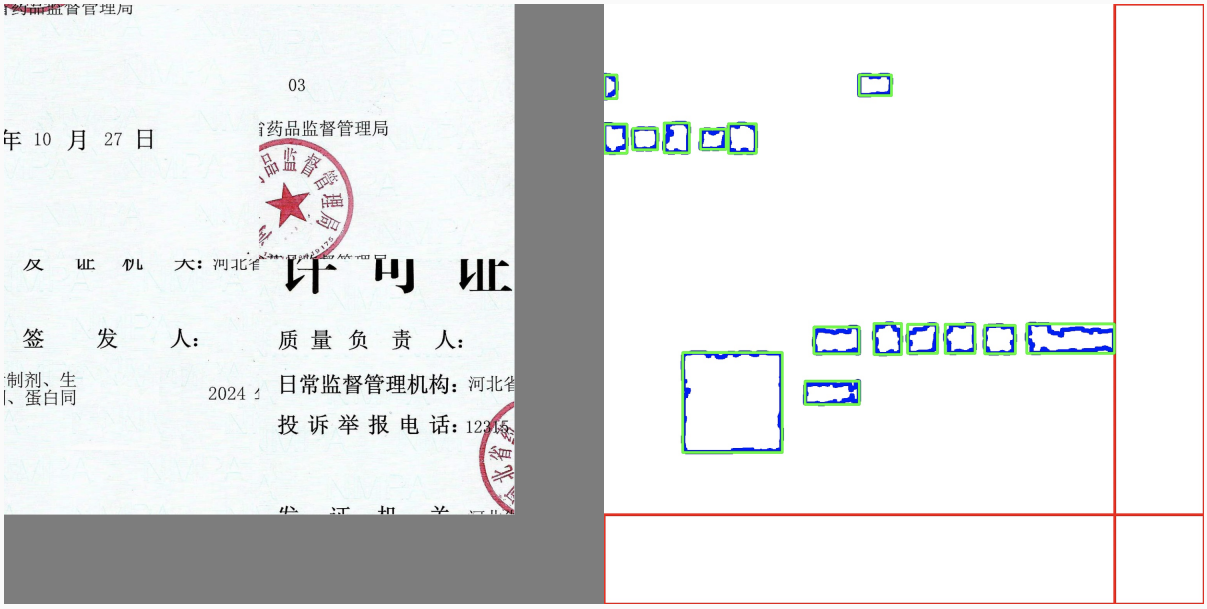
- ~~blur（调整蓝色色调，肉眼不可见）~~



- chicken（逛超市看到鸡块想到的鸡块法，也就是随机删减）



- jely（知名设计师jely提出的1/4随机拼凑）



时间有限，未逐一验证是否都有效，**但本方案最终使用了除blur外全部。**

> 详见 clean_data_code.py

2.4 数据分配

```
1 _n = random.choice(list("0000000012"))
```

随机分配，训练：测试：验证 = 8：1：1.

> 详见 clean_data_code.py

三、复现流程

3.1 环境依赖

3.1.1 docker依赖

```
1 FROM registry.cn-shanghai.aliyuncs.com/tcc-public/pytorch:1.1.0-cu
  da10.0-py3
```

- 核心参数：cuda10.0
- 其他参数同此docker镜像

3.1.2 pip依赖

```
##
RUN apt-get update
RUN apt-get install libglib2.0-dev libsm6 libxrender1 libxext-dev
 -y

## 在构建镜像时安装依赖包
RUN pip install -i https://mirrors.aliyun.com/pypi/simple -r requi
rements/build.txt
RUN pip install -i https://mirrors.aliyun.com/pypi/simple -r requi
rements/runtime.txt
```

- requirements/build.txt

```
pip==20.2.4
cython
pillow>=6.2.0
```

- requirements/runtime.txt

```
torch==1.3.1
torchvision==0.4.2
pandas
tqdm
opencv-python==4.2.0.34
pycocotools
```

3.1.3 mmdetection依赖

```
WORKDIR code/train/env/
RUN pip install mmcv_full-2.3.0+torch1.3.0+cu100-cp36-cp36m-manyli
nux1_x86_64.whl
WORKDIR mmdetection-master
RUN pip install -r requirements/build.txt
WORKDIR ../cocoapi-master/pycocotools/
RUN python setup.py build
RUN python setup.py install --user
WORKDIR ../../mmdetection-master
RUN pip install --no-cache-dir -e . --user
```

核心版本为mmcv_full-2.3.0+torch1.3.0+cu100-cp36-cp36m-manylinux1_x86_64.whl

3.1.4 Dockfile

完整Dockfile如下：

```
# Base Images
## 从天池基础镜像构建
FROM registry.cn-shanghai.aliyuncs.com/tcc-public/pytorch:1.1.0-cuda10.0-py3

## 把当前文件夹里的文件构建到镜像的根目录下
ADD . /

## 指定默认工作目录为根目录（需要把run.sh和生成的结果文件都放在该文件夹下，提交后才能运行）
WORKDIR /

##
RUN apt-get update
RUN apt-get install libglib2.0-dev libsm6 libxrender1 libxext-dev -y

## 在构建镜像时安装依赖包
RUN pip install -i https://mirrors.aliyun.com/pypi/simple -r requirements/build.txt
RUN pip install -i https://mirrors.aliyun.com/pypi/simple -r requirements/runtime.txt

##
WORKDIR code/train/env/
RUN pip install mmcv_full-2.3.0+torch1.3.0+cu100-cp36-cp36m-manylinux1_x86_64.whl
WORKDIR mmdetection-master
RUN pip install -r requirements/build.txt
WORKDIR ../cocoapi-master/pycocotools/
RUN python setup.py build
RUN python setup.py install --user
WORKDIR ../../mmdetection-master
RUN pip install --no-cache-dir -e . --user

```

```
WORKDIR /
## 镜像启动后统一执行 sh run.sh
CMD ["sh", "run.sh"]
```

3.2 代码结构

```
project
    |--README.md             # 解决方案及算法介绍文件，必选
    |--requirements.txt      # Python环境依赖，必选
    |--s2_data
        |--data
            |--test
                |--1.jpg
                |--2.jpg
                ...
                |--1500.jpg
            |--train
                |--1.jpg
                |--2.jpg
                ...
                |--1500.jpg
            |--train_mask
                |--1.png
                |--2.png
                ...
                |--1500.png
    |--user_data
        |--model_data        # 模型文件夹示例，可自行组织
            |--model.pth
        |--tmp_data          # 临时存储文件夹示例，可自行组织
            |--tmp.dat
        |-- 计算的中间文件
        |-- 临时存储目录
    |--prediction_result
        |-- images
            |-- 1.png
            |-- 2.png
            ...
            |--1500.png
```

```
    |--code
        |--train            # 训练代码文件夹示例，可自行组织
        |--test             # 预测代码文件夹示例，可自行组织
        |--run.sh           # 预测执行脚本，必选
        |--train.sh         # 训练执行脚本，必选
        |--clean_data_code.cpp(.py, .java) # 数据清洗代码，可自行取舍
```

同此结构。

3.3 训练复现

3.3.1 训练参数

训练模型为FasterRCNN（resnet50-19c8e357.pth, faster_rcnn_r50_fpn_1x_coco）
获取官方文件后，我们做了部分修改，完整如下：

```
model = dict(
    type='FasterRCNN',
    pretrained='torchvision://resnet50',
    backbone=dict(
        type='ResNet',
        depth=50,
        num_stages=4,
        out_indices=(0, 1, 2, 3),
        frozen_stages=1,
        norm_cfg=dict(type='BN', requires_grad=True),
        norm_eval=True,
        style='pytorch'),
    neck=dict(
        type='FPN',
        in_channels=[256, 512, 1024, 2048],
        out_channels=256,
        num_outs=5),
    rpn_head=dict(
        type='RPNHead',
        in_channels=256,
        feat_channels=256,
        anchor_generator=dict(
            type='AnchorGenerator',
            scales=[8],
            ratios=[0.5, 1.0, 2.0],
```

```
            strides=[4, 8, 16, 32, 64]),
        bbox_coder=dict(
            type='DeltaXYWHBBoxCoder',
            target_means=[0.0, 0.0, 0.0, 0.0],
            target_stds=[1.0, 1.0, 1.0, 1.0]),
        loss_cls=dict(
            type='CrossEntropyLoss', use_sigmoid=True, loss_weig
ht=1.0),
        loss_bbox=dict(type='L1Loss', loss_weight=1.0)),
    roi_head=dict(
        type='StandardRoIHead',
        bbox_roi_extractor=dict(
            type='SingleRoIExtractor',
            roi_layer=dict(type='RoIAlign', output_size=7, sampl
ing_ratio=0),
            out_channels=256,
            featmap_strides=[4, 8, 16, 32]),
        bbox_head=dict(
            type='Shared2FCBBoxHead',
            in_channels=256,
            fc_out_channels=1024,
            roi_feat_size=7,
            num_classes=2,
            bbox_coder=dict(
                type='DeltaXYWHBBoxCoder',
                target_means=[0.0, 0.0, 0.0, 0.0],
                target_stds=[0.1, 0.1, 0.2, 0.2]),
            reg_class_agnostic=False,
            loss_cls=dict(
                type='CrossEntropyLoss', use_sigmoid=False, loss
_weight=1.0),
            loss_bbox=dict(type='L1Loss', loss_weight=1.0))))
train_cfg = dict(
    rpn=dict(
        assigner=dict(
            type='MaxIoUAssigner',
            pos_iou_thr=0.7,
            neg_iou_thr=0.3,
            min_pos_iou=0.3,
            match_low_quality=True,
```

```
            ignore_iof_thr=-1),
        sampler=dict(
            type='RandomSampler',
            num=256,
            pos_fraction=0.5,
            neg_pos_ub=-1,
            add_gt_as_proposals=False),
        allowed_border=-1,
        pos_weight=-1,
        debug=False),
    rpn_proposal=dict(
        nms_across_levels=False,
        nms_pre=2000,
        nms_post=1000,
        max_num=1000,
        nms_thr=0.7,
        min_bbox_size=0),
    rcnn=dict(
        assigner=dict(
            type='MaxIoUAssigner',
            pos_iou_thr=0.5,
            neg_iou_thr=0.5,
            min_pos_iou=0.5,
            match_low_quality=False,
            ignore_iof_thr=-1),
        sampler=dict(
            type='RandomSampler',
            num=512,
            pos_fraction=0.25,
            neg_pos_ub=-1,
            add_gt_as_proposals=True),
        pos_weight=-1,
        debug=False))
test_cfg = dict(
    rpn=dict(
        nms_across_levels=False,
        nms_pre=1000,
        nms_post=1000,
        max_num=1000,
        nms_thr=0.7,
```

```
        min_bbox_size=0),
    rcnn=dict(
        score_thr=0.05,
        nms=dict(type='nms', iou_threshold=0.5),
        max_per_img=100))
dataset_type = 'CocoDataset'
data_root = 'data/coco/'
img_norm_cfg = dict(
    mean=[123.675, 116.28, 103.53], std=[58.395, 57.12, 57.375],
to_rgb=True)
train_pipeline = [
    dict(type='LoadImageFromFile'),
    dict(type='LoadAnnotations', with_bbox=True),
    dict(type='Resize', img_scale=(1550, 1550), keep_ratio=True)
,
    dict(type='RandomFlip', flip_ratio=0.5),
    dict(
        type='Normalize',
        mean=[123.675, 116.28, 103.53],
        std=[58.395, 57.12, 57.375],
        to_rgb=True),
    dict(type='Pad', size_divisor=32),
    dict(type='DefaultFormatBundle'),
    dict(type='Collect', keys=['img', 'gt_bboxes', 'gt_labels'])
]
test_pipeline = [
    dict(type='LoadImageFromFile'),
    dict(
        type='MultiScaleFlipAug',
        img_scale=(1550, 1550),
        flip=False,
        transforms=[
            dict(type='Resize', keep_ratio=True),
            dict(type='RandomFlip'),
            dict(
                type='Normalize',
                mean=[123.675, 116.28, 103.53],
                std=[58.395, 57.12, 57.375],
                to_rgb=True),
            dict(type='Pad', size_divisor=32),
```

```
            dict(type='ImageToTensor', keys=['img']),
            dict(type='Collect', keys=['img'])
        ])
]
data = dict(
    samples_per_gpu=2,
    workers_per_gpu=2,
    train=dict(
        type='CocoDataset',
        ann_file='code/train/env/mmdetection-master/data/coco/annotations/annotations_trai.json',
        img_prefix='code/train/env/mmdetection-master/data/coco/img/',
        pipeline=[
            dict(type='LoadImageFromFile'),
            dict(type='LoadAnnotations', with_bbox=True),
            dict(type='Resize', img_scale=(1550, 1550), keep_ratio=True),
            dict(type='RandomFlip', flip_ratio=0.5),
            dict(
                type='Normalize',
                mean=[123.675, 116.28, 103.53],
                std=[58.395, 57.12, 57.375],
                to_rgb=True),
            dict(type='Pad', size_divisor=32),
            dict(type='DefaultFormatBundle'),
            dict(type='Collect', keys=['img', 'gt_bboxes', 'gt_labels'])
        ]),
    val=dict(
        type='CocoDataset',
        ann_file='code/train/env/mmdetection-master/data/coco/annotations/annotations_test.json',
        img_prefix='code/train/env/mmdetection-master/data/coco/img/',
        pipeline=[
            dict(type='LoadImageFromFile'),
            dict(
                type='MultiScaleFlipAug',
                img_scale=(1550, 1550),
```

```
                flip=False,
                transforms=[
                    dict(type='Resize', keep_ratio=True),
                    dict(type='RandomFlip'),
                    dict(
                        type='Normalize',
                        mean=[123.675, 116.28, 103.53],
                        std=[58.395, 57.12, 57.375],
                        to_rgb=True),
                    dict(type='Pad', size_divisor=32),
                    dict(type='ImageToTensor', keys=['img']),
                    dict(type='Collect', keys=['img'])
                ])
        ]),
    test=dict(
        type='CocoDataset',
        ann_file='code/train/env/mmdetection-master/data/coco/annotations/annotations_vals.json',
        img_prefix='code/train/env/mmdetection-master/data/coco/img/',
        pipeline=[
            dict(type='LoadImageFromFile'),
            dict(
                type='MultiScaleFlipAug',
                img_scale=(1550, 1550),
                flip=False,
                transforms=[
                    dict(type='Resize', keep_ratio=True),
                    dict(type='RandomFlip'),
                    dict(
                        type='Normalize',
                        mean=[123.675, 116.28, 103.53],
                        std=[58.395, 57.12, 57.375],
                        to_rgb=True),
                    dict(type='Pad', size_divisor=32),
                    dict(type='ImageToTensor', keys=['img']),
                    dict(type='Collect', keys=['img'])
                ])
        ]))
evaluation = dict(interval=1, metric='bbox')
```

```
optimizer = dict(type='SGD', lr=0.02, momentum=0.9, weight_decay=0.0001)
optimizer_config = dict(grad_clip=None)
lr_config = dict(
    policy='step',
    warmup='linear',
    warmup_iters=500,
    warmup_ratio=0.001,
    step=[8, 11])
total_epochs = 1
checkpoint_config = dict(interval=1)
log_config = dict(interval=50, hooks=[dict(type='TextLoggerHook')])
dist_params = dict(backend='nccl')
log_level = 'INFO'
load_from = None
resume_from = None
workflow = [('train', 2), ('val', 1)]
work_dir = 'code/train/env/mmdetection-master/work_dirs'
gpu_ids = range(0, 1)
```

- [ ] 可以换用其他更高版本。

完整训练代码见`code/train.sh`，一共分三步：

（1）clean_data_code训练数据处理；

（2）mmdetection初始化，主要导入模型、创建路径、修改文件；

（3）开始训练；

```
# Train
# data
cd /
python code/clean_data_code.py train

# model
mmdetn=1
mmdet=code/train/env/mmdetection-master

mkdir -p /root/.cache/torch/checkpoints
cp user_data/model_data/resnet50-19c8e357.pth /root/.cache/torch/
```

```
checkpoints/resnet50-19c8e357.pth

mkdir -p $mmdet/data/coco
ln -s /user_data/tmp_data/work $mmdet/data/coco/annotations
ln -s /user_data/tmp_data/work $mmdet/work_dirs

cp code/train/coco$mmdetn.py $mmdet/mmdet/datasets/coco.py
cp code/train/class_names$mmdetn.py $mmdet/mmdet/core/evaluation/class_names.py

# 示例total_epochs = 1, 复现需修改
python $mmdet/tools/train.py code/train/faster_rcnn_r50_fpn_1x_coco.py --gpus 1 --work-dir $mmdet/work_dirs
```

其中，

- coco.py需修改：

```
@DATASETS.register_module()
class CocoDataset(CustomDataset):

    # CHANGE BY IVAN
    CLASSES = ('000', '001')
    # CHANGE BY IVAN
```

- class_names.py需修改：

```
# CHANGE BY IVAN
def coco_classes():
    return [
        '000',
        '001'
    ]
# CHANGE BY IVAN
```

3.3.2 训练复现

```
cd /
```

```
sh code/train.sh
```

但应修改`code/train/faster_rcnn_r50_fpn_1x_coco.py`内训练次数（现为1）

3.4 预测复现

3.4.1 预测步骤

（1）clean_data_code预测数据处理，主要修改尺寸；

```
# test
nnn = 0
test_ot = f"{ot}/temp3"
for i in tqdm(os.listdir(f"{dt}/test")):
    if ".jpg" in i:
        i = i.replace(".jpg", "")
        img0 = np.random.randint(0, 1, size=(N,N,3), dtype=np.uint8)
        img0[:, :] = P

        imgb = cv.imread(f"{dt}/test/{i}.jpg")
        i_y, i_x, _ = imgb.shape

        img0[:i_y, :i_x] = imgb
        cv.imwrite(f"{test_ot}/_{i}.jpg", img0)

        nnn += 1
        if nnn > 9999:
            break
```

（2）导入模型-S499、S488、S477，这里的4XX值模型线上分数；

```
#
import os
import cv2 as cv
import numpy as np
import pandas as pd
from tqdm import tqdm
from mmdet.apis import init_detector, inference_detector
```

```
8
9  config_file = "code/train/faster_rcnn_r50_fpn_1x_coco.py"
10 checkpoint_file = "user_data/model_data/S499.pth"
11 model1 = init_detector(config_file, checkpoint_file, device="cud
   a:0")
12 print("M1", model1.CLASSES)
13
14 checkpoint_file = "user_data/model_data/S488.pth"
15 model2 = init_detector(config_file, checkpoint_file, device="cud
   a:0")
16 print("M2", model2.CLASSES)
17
18 checkpoint_file = "user_data/model_data/S477.pth"
19 model3 = init_detector(config_file, checkpoint_file, device="cud
   a:0")
20 print("M3", model3.CLASSES)
```

（3）调用模型，分别获取预测结果；

```
1  #
2  N = 9999
3  p5 = "user_data/tmp_data/temp3/"
4  p6 = "s2_data/data/test/"
5  p7 = "prediction_result/images/"
6
7  dresult1, dresult2, dresult3 = {}, {}, {}
8
9  nnn = 0
10 for _img in tqdm(os.listdir(f"{p5}")):
11     # print(_img)
12     if ".jpg" in _img:
13         _img = _img.replace(".jpg", "").replace("_", "")
14
15         result = inference_detector(model1, f"{p5}_{_img}.jpg")
16         _result = [ij for i, j in enumerate(result) if i == 0 and
   j.shape != (0,5) for ij in j]
17         dresult1[_img] = _result
18
19         result = inference_detector(model2, f"{p5}_{_img}.jpg")
```

```
        _result = [ij for i, j in enumerate(result) if i == 0 and
    j.shape != (0,5) for ij in j]
        dresult2[_img] = _result

        result = inference_detector(model3, f"{p5}_{_img}.jpg")
        _result = [ij for i, j in enumerate(result) if i == 0 and
    j.shape != (0,5) for ij in j]
        dresult3[_img] = _result

        nnn += 1
        if nnn > N:
            break
```

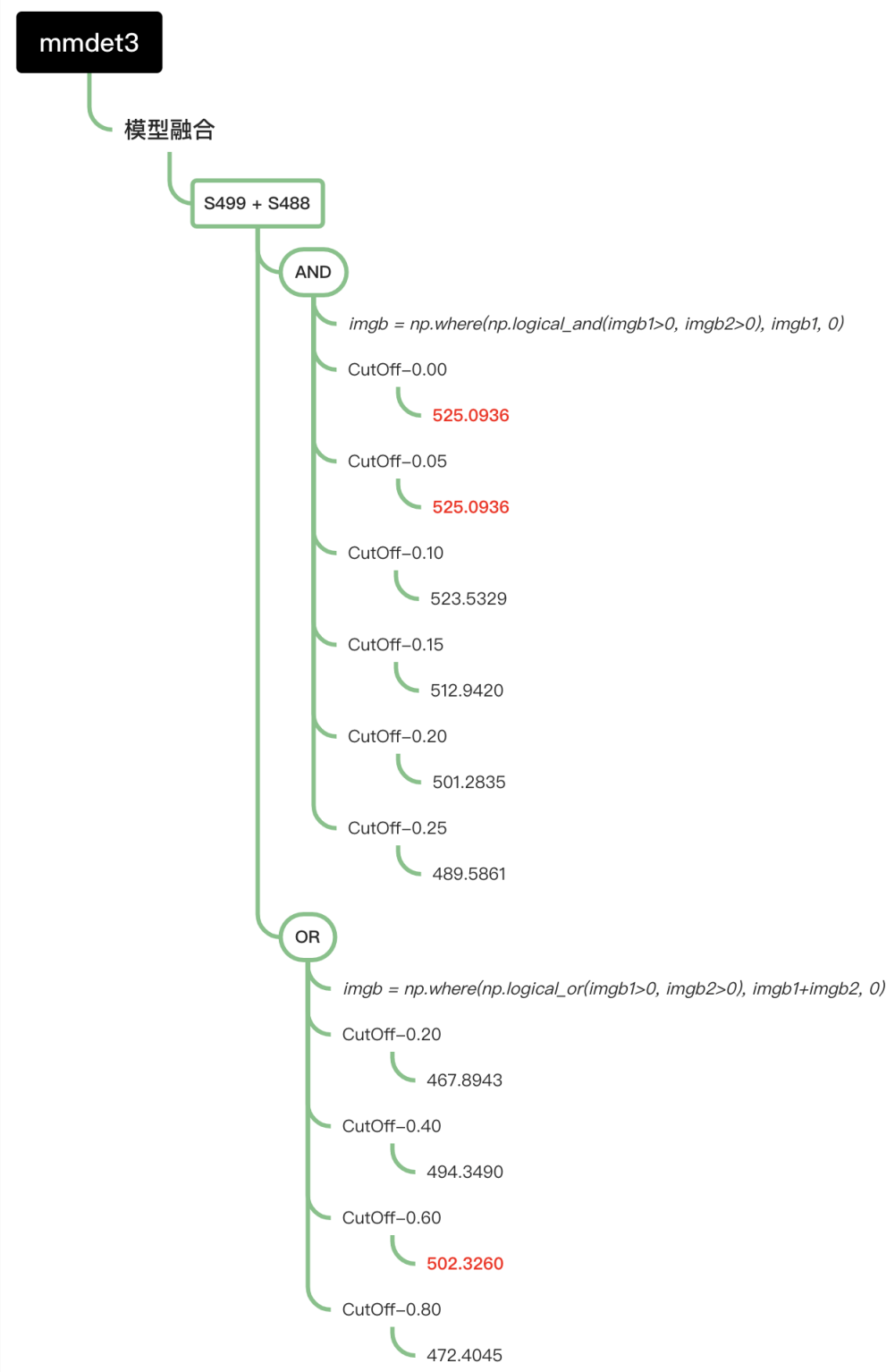
（4）结果输出

这里我们在训练集上做了大量探索，引入模型融合概念。

调整方法有三：

- 预测概率阈值，小icut即放弃；
- 大小限制，预测框过大或过小即放弃；
- 不同合并方式，取三个模型预测mask的并集或交集或其他；

对不同阈值、不同合并方式，线上情况如下：



可提高50分左右。

最终选定预测概率阈值为0，限定预测框大小300-90000，并取三个模型预测mask交集（**最小化、最精确化**）。

```
#
icut = 0.00
```

```
high1, high2 = 90000, 300 # 90000, 300
logs = "and"
r1, r2, r3 = [], [], []

nnn = 0
for _img in tqdm(os.listdir(f"{p5}")):
    if ".jpg" in _img:
        _img = _img.replace(".jpg", "").replace("_", "")



        #
        imgb1 = cv.imread(f"{p6}{_img}.jpg")
        imgb1[:] = 0
        for _iresult in dresult1[_img]:
            ymin, ymax, xmin, xmax = int(_iresult[1]), int(_iresu
lt[3]), int(_iresult[0]), int(_iresult[2])
            if _iresult[4] >= icut and (high1 >= (ymax-ymin)*(xma
x-xmin) >= high2):
                r1.append((ymax-ymin)*(xmax-xmin))
                imgb1[ymin:ymax, xmin:xmax] = bads

        #
        imgb2 = cv.imread(f"{p6}{_img}.jpg")
        imgb2[:] = 0
        for _iresult in dresult2[_img]:
            ymin, ymax, xmin, xmax = int(_iresult[1]), int(_iresu
lt[3]), int(_iresult[0]), int(_iresult[2])
            if _iresult[4] >= icut and (high1 >= (ymax-ymin)*(xma
x-xmin) >= high2):
                r2.append((ymax-ymin)*(xmax-xmin))
                imgb2[ymin:ymax, xmin:xmax] = bads

        #
        imgb3 = cv.imread(f"{p6}{_img}.jpg")
        imgb3[:] = 0
        for _iresult in dresult3[_img]:
            iymin, ymax, xmin, xmax = int(_iresult[1]), int(_ires
ult[3]), int(_iresult[0]), int(_iresult[2])
            if _iresult[4] >= icut and (high1 >= (ymax-ymin)*(xma
x-xmin) >= high2):
```

```
                r3.append((ymax-ymin)*(xmax-xmin))
                imgb3[ymin:ymax, xmin:xmax] = bads


        if logs == "and":
            imgb = np.where(np.logical_and(imgb1>0, imgb2>0, imgb3>0), imgb1, 0)
        if logs == "or":
            imgb = np.where(np.logical_or(imgb1>0, imgb2>0, imgb3>0), imgb1+imgb2+imgb3, 0)

        cv.imwrite(f"{p7}{_img}.png", imgb)

        nnn += 1
        if nnn > N:
            break
```

3.4.1 预测复现

```
# Tests
# data
cd /
python code/clean_data_code.py test

# model
python code/test/result.py
```

```
cd /
sh code/run.sh
```