

基于深度学习的靶区自动勾画

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目录

- 问题介绍
- 文献调研
- 方法设计
- 课题难点
- 预计目标
- 进度安排



问题介绍 – 靶区勾画

靶区勾画

- 临床放射治疗前进行癌变区域的部位进行勾画
- 依据不同部位局部复发和区域淋巴结转移几率定义勾画区域

- **GTV (Gross Target Volume) 肿瘤区**

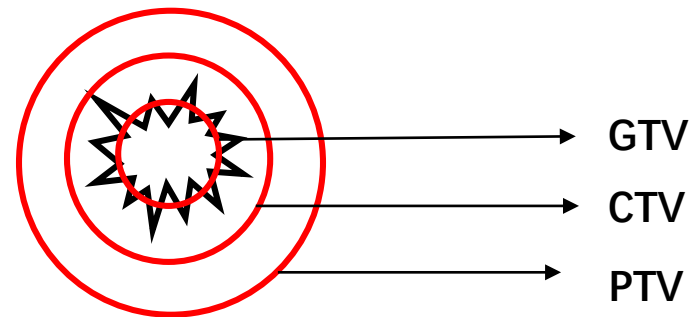
临床灶，为一般的诊断手段能够诊断出的可见的具有一定形状和大小的恶性病变的范围，包括转移地淋巴结和其它转移的病变

- **CTV (Clinical Target Volume) 临床靶区**

CTV指按一定的时间剂量模式给予一定剂量的肿瘤的临床灶 (GTV) 亚临床灶以及肿瘤可能侵犯的范围。

- **PTV (Planning Target Volume) 计划靶区**

PTV是指包括CTV本身、照射中患者器官运动，和由于日常摆位治疗中靶位置和靶体积变化等因素引起的扩大照射的组织范围，以确保CTV得到规定的治疗剂量。





问题介绍 – 语义分割

图像的语义分割

定义

- 将像素按照图像中表达语义含义的不同进行分组分割，相同类设定相同标签

传统方法

- Normalized cut [1]
- Histogram thresholding [2]
- Graph-Based methods [3]
- Grab cut [12]
- ...

使用场合

- 无人机
- 自动驾驶
- 机器人
- ...





问题介绍 - 深度学习

深度学习应用

- 图像分类
- 人脸识别
- 物体检测
- 图像分割
- 语音识别
- ...





问题介绍

目的

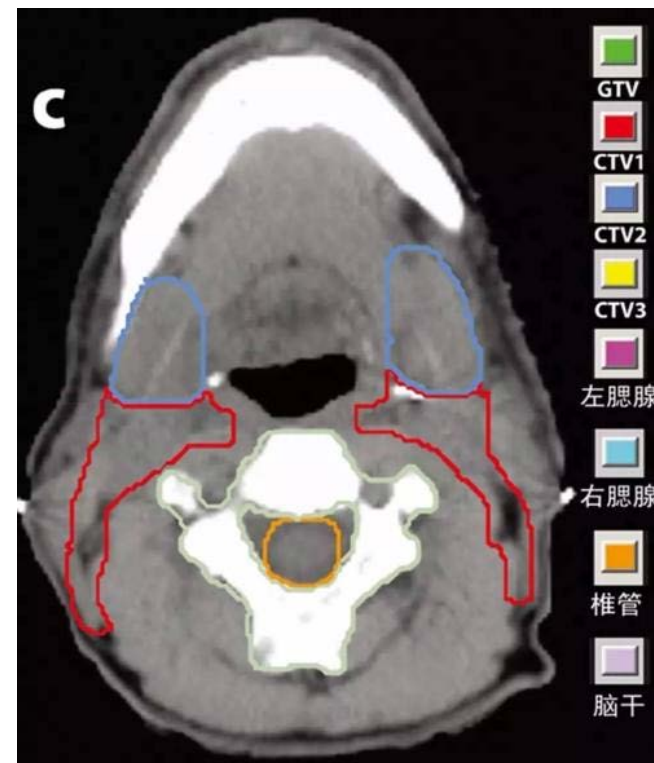
- 可使用的自动化的靶区勾画系统

方法

- 深度学习的语义分割方法

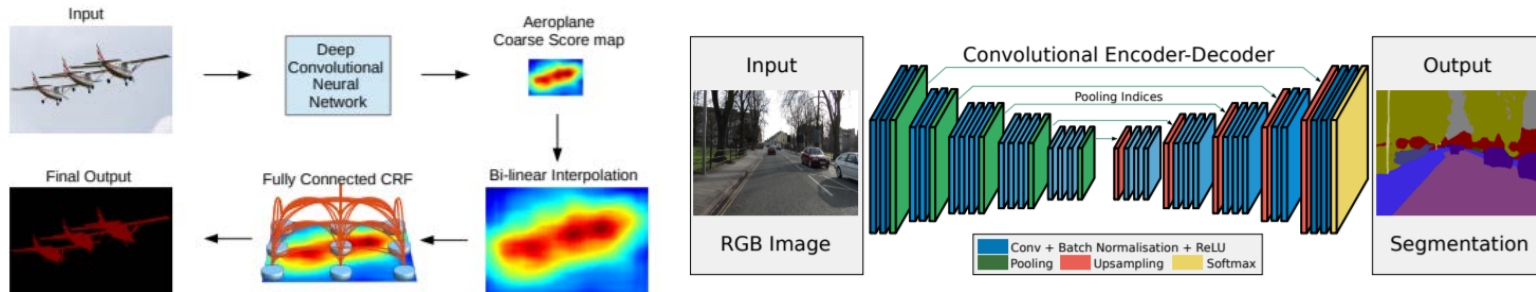
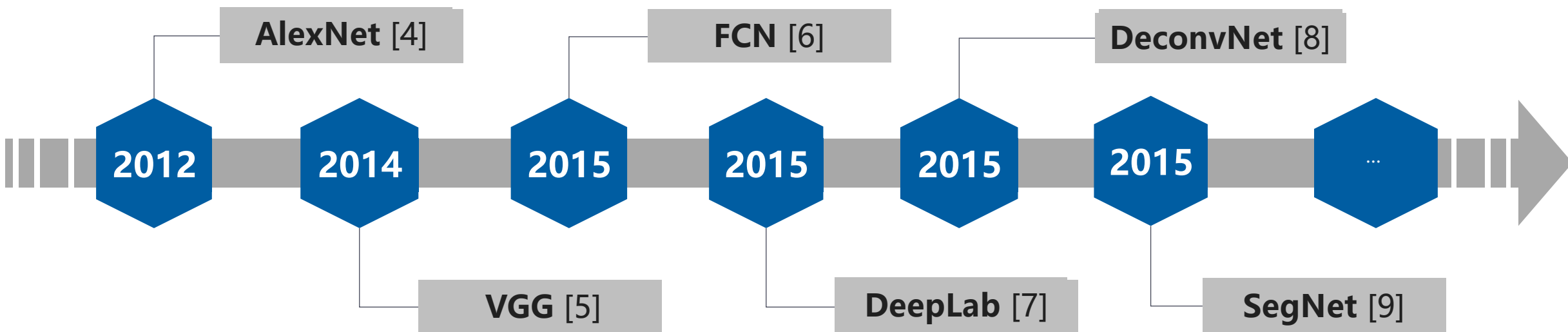
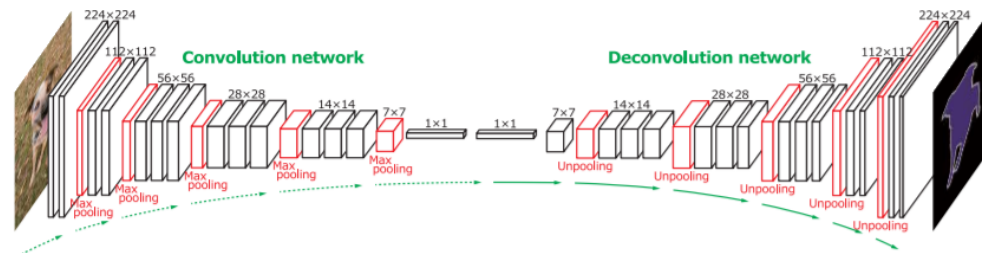
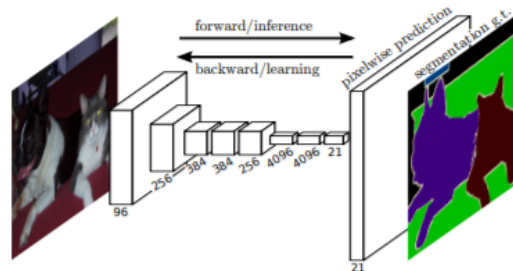
意义

- 极大程度减少医生勾画工作量
- 对于不同的靶区类别的高维特征提取进行类别间聚类分析



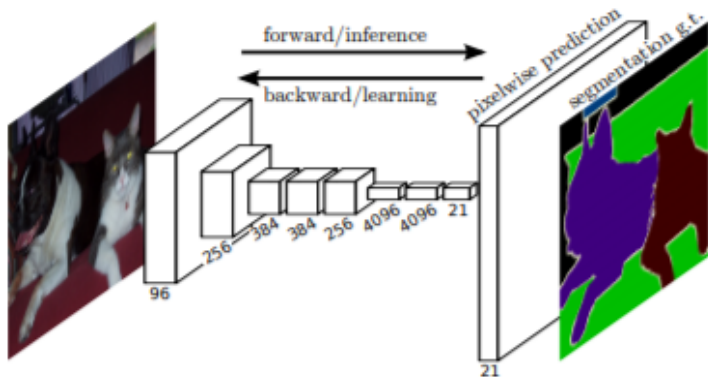


文献调研 – 深度学习的图像分割方法

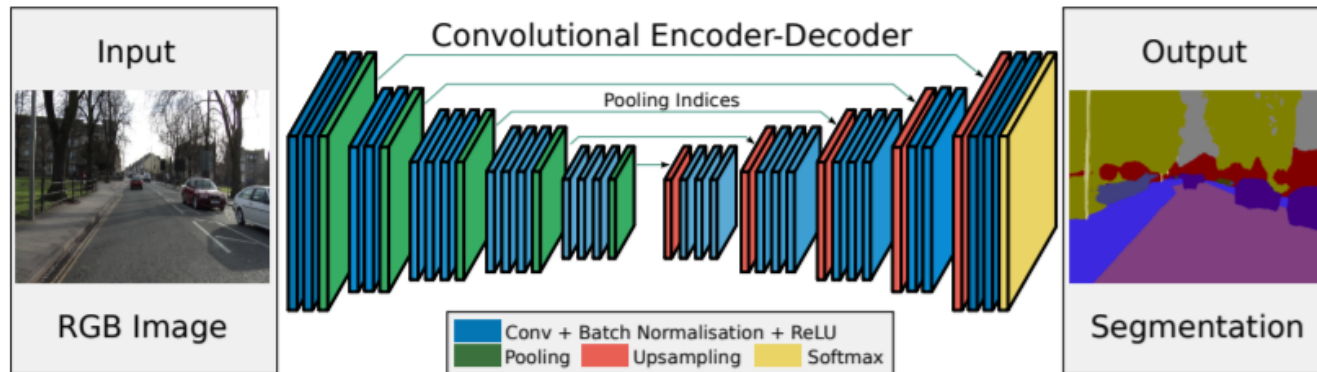




文献调研 – SegNet & FCN



FCN网络结构

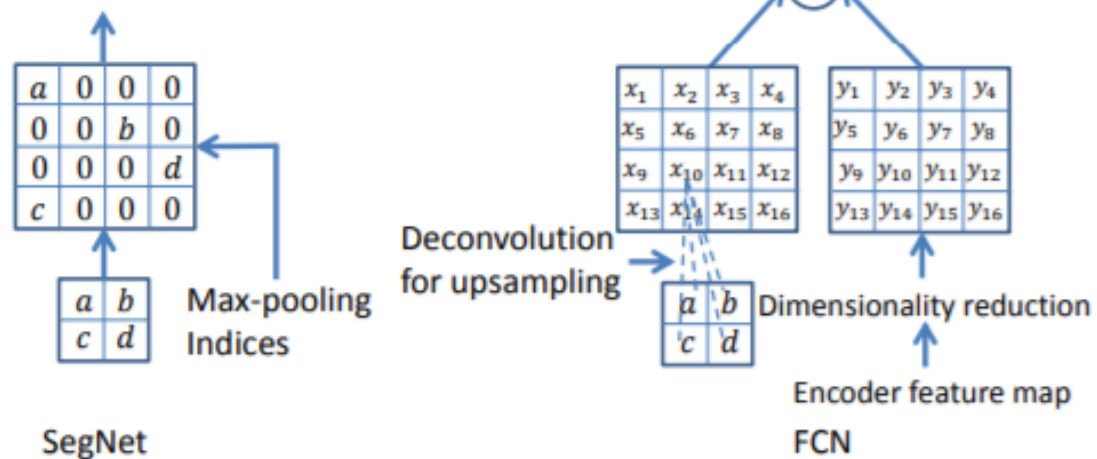


SegNet网络结构

SegNet的改进

- 多层decoder结构
- 池化脚标转移
- Decoder中引入encoder信息

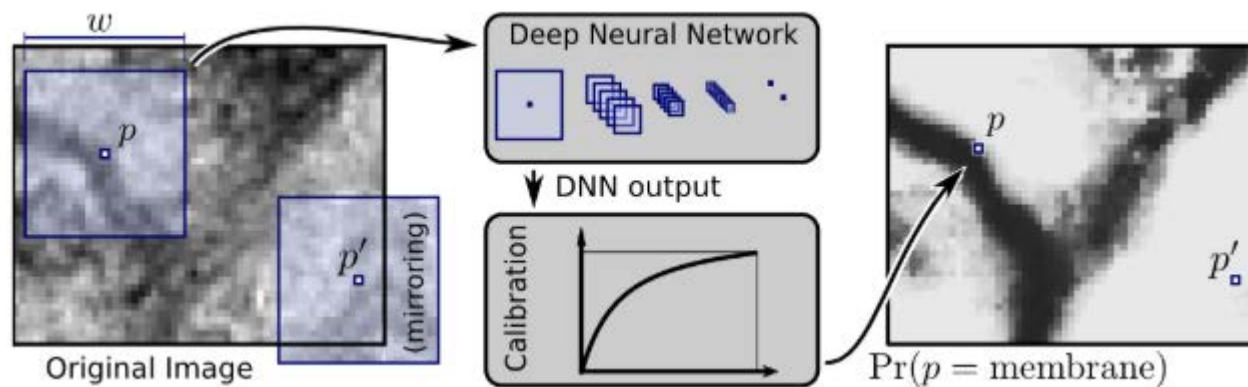
Convolution with trainable decoder filters



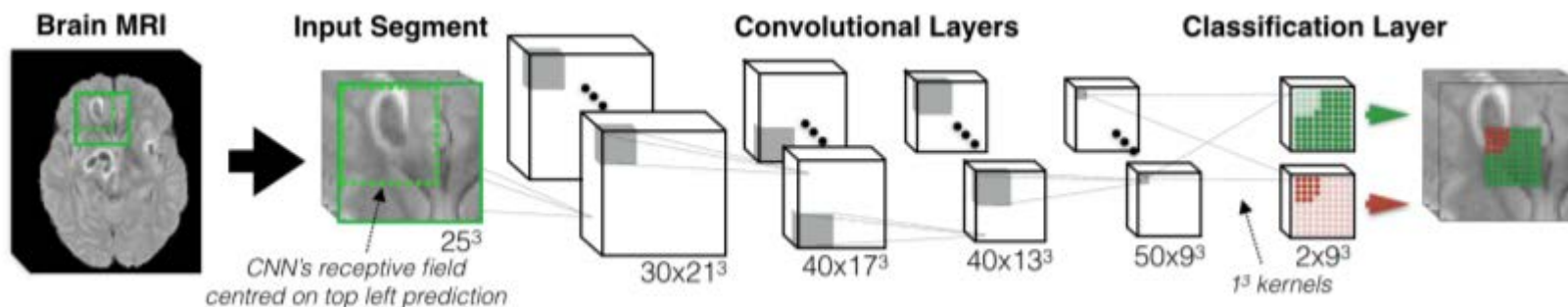


文献调研 – FCN

- Deep Neural Networks Segment Neuronal Membranes in Electron Microscopy Image (NIPS2014)



- Efficient Multi-Scale 3D CNN with fully connected CRF for Accurate Brain Lesion Segmentation (MIA)

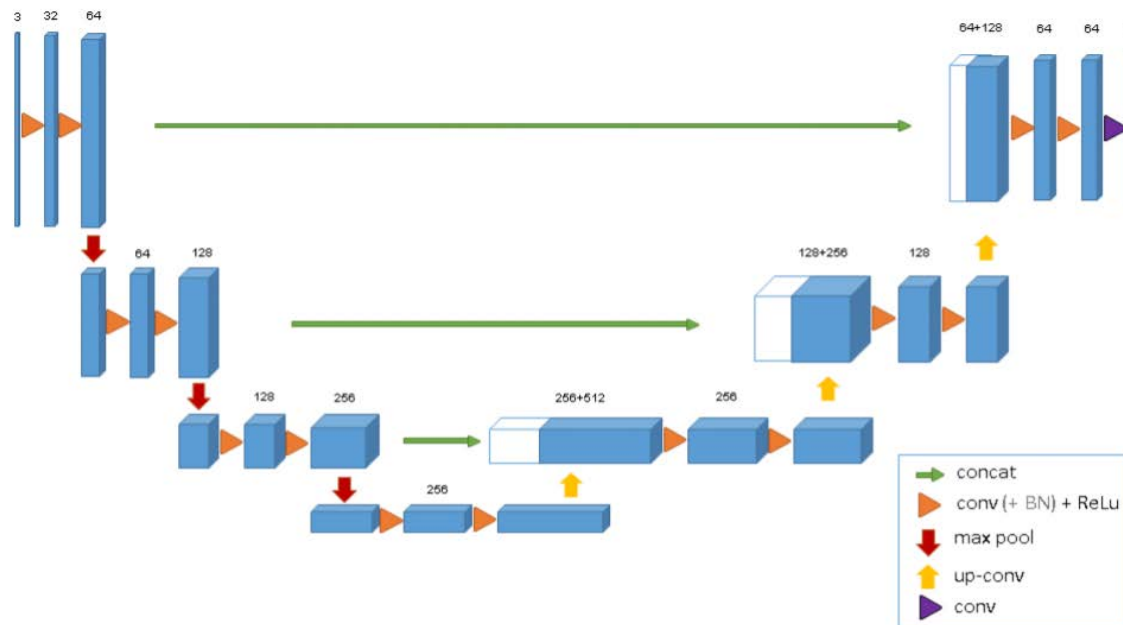
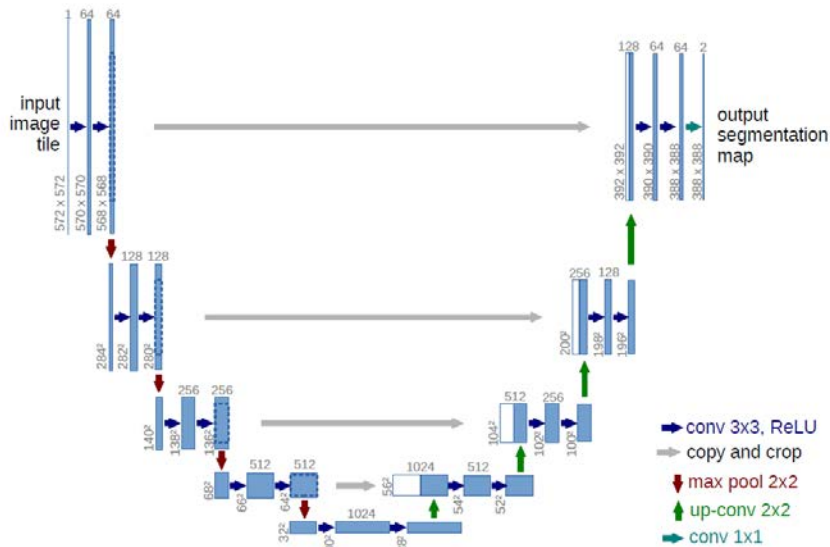




文献调研 - UNet

生物医学图像分割

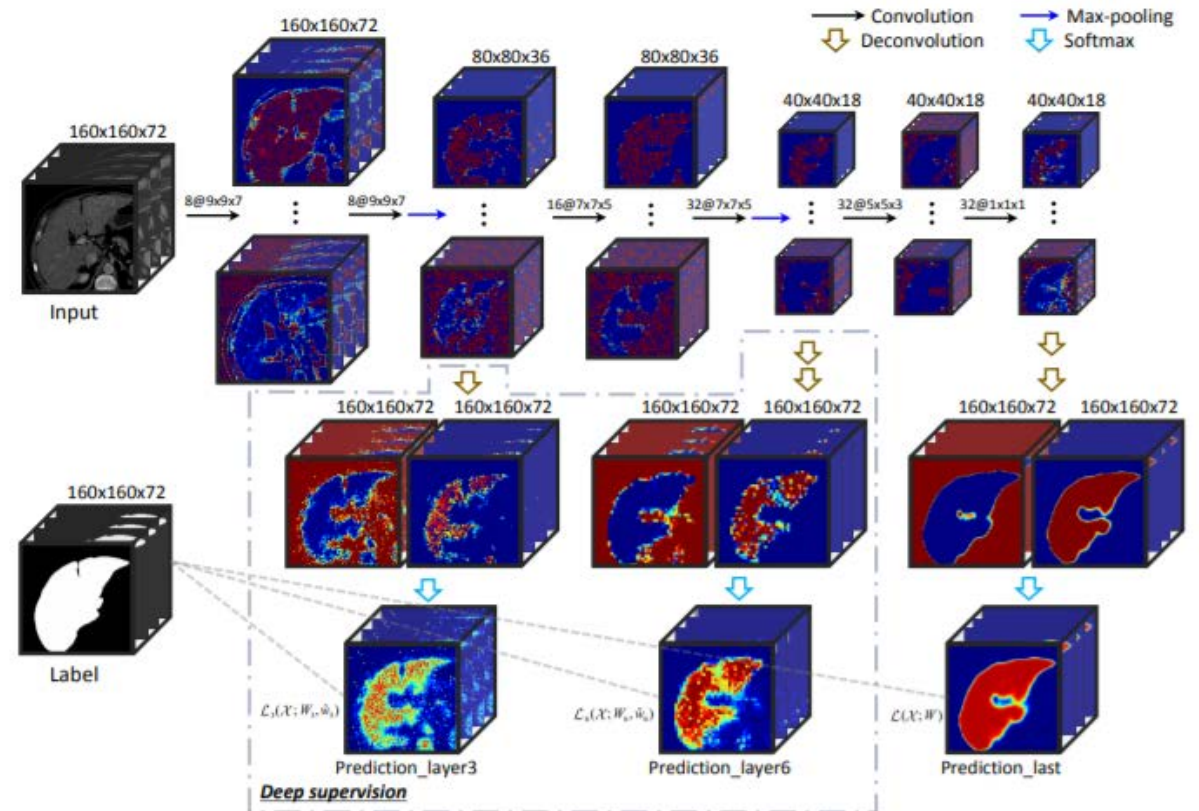
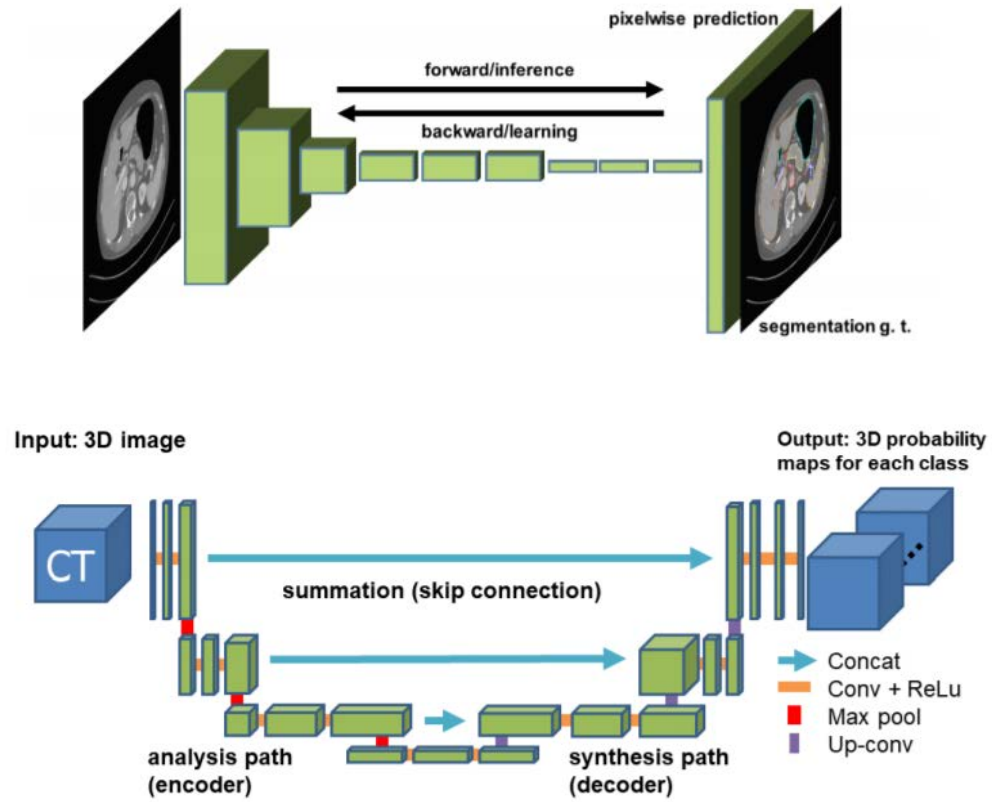
- Unet[11]
 - 第一个为生物医学图像分割特别设计的网络结构
 - 解码器使用编码器传递的信息进行解码
- 3D Unet[12]
 - Unet的3D扩充版





文献调研 – CT图中深度学习学习方法

- Deep learning and its application to medical image segmentation (Medical Image Technology 2018)
- 3D Deeply Supervised Network for Automatic Liver Segmentation from CT Volumes (MICCAI 2016)





方法设计

• 数据准备与预处理 [已实现]

- 项目目标

- 帮助医生自动根据CT图像生成靶区部位，减少医生工作量

- 数据来源

- CT横断扫描腰部图像序列组**498**组，**340**组可用
- 数据体积在[**0, 2072**]区间内
- 数值分布在[**48x512x512, 125x512x512**]区间内

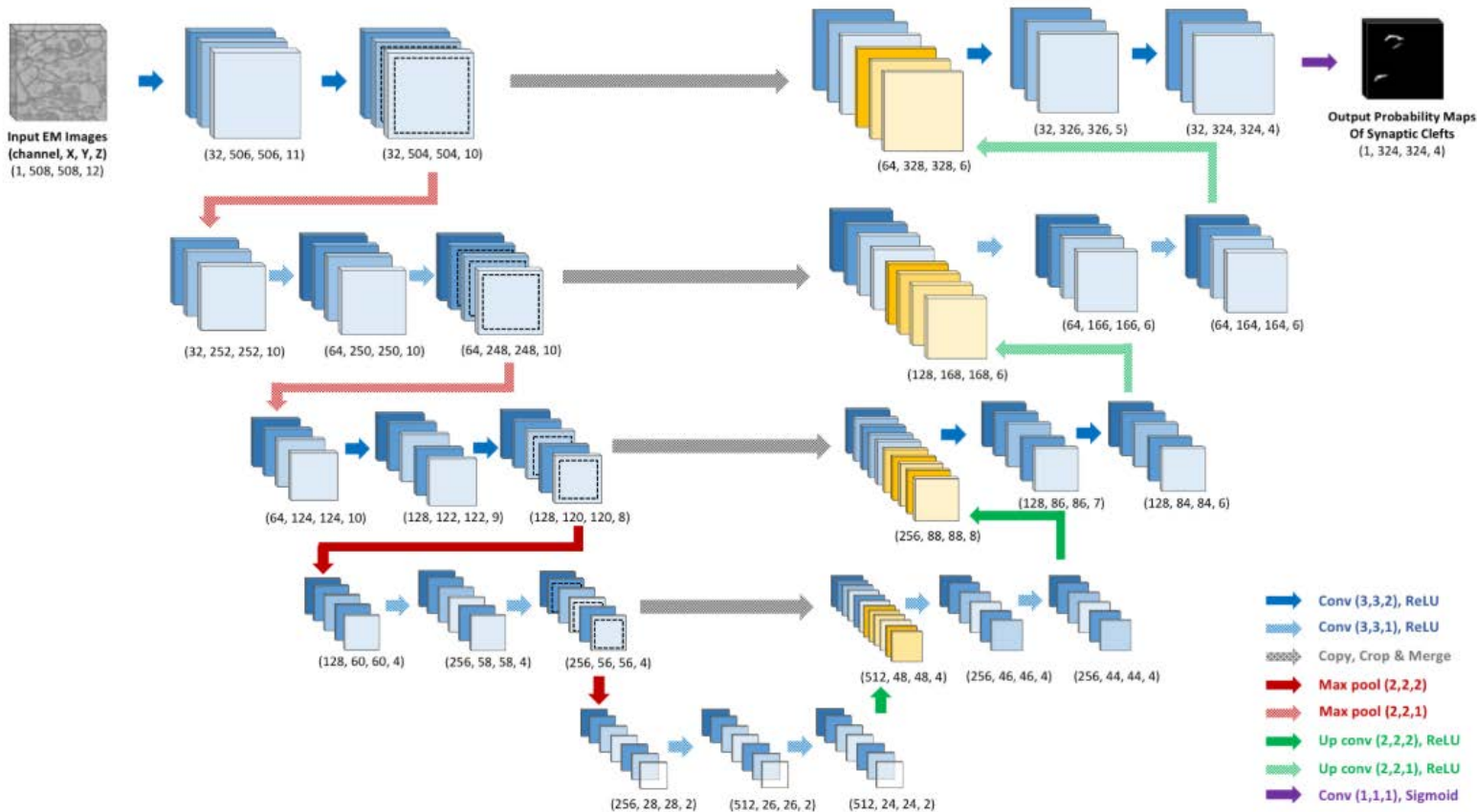
- 数据预处理

- 取数值为[**0, 1600**]间的部分，超出1600部分取1600，并归一化到0-1
- 数据重新设置为**72x256x256**的大小
- 数据增强
 - 最大偏移8像素的随机移动和15°的随机转动
 - 随机翻折、翻转、伸缩与旋转



方法设计

• Baseline – Unet 3D



网络参数

- 下采样5次，通道数分别为 16、32、64、96、128
- 卷积核大小3x3x3

评价指标

- dice ratio

$$d = \frac{2 \times Intersection(V_{pred}, V_{gt})}{V_{pred} + V_{gt}}$$

Baseline average dice ratio – 0.747



课题难点

• 数据量少

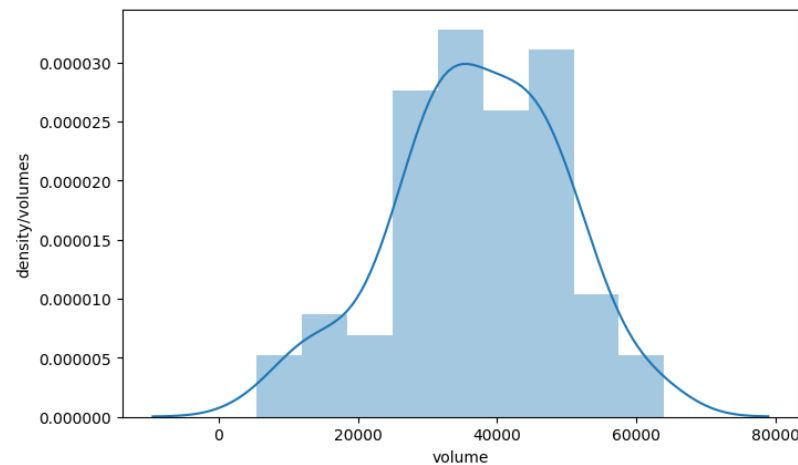
- 训练+测试一共498组数据
- 可使用标注的一共340组数据

• 靶区没有清晰边界

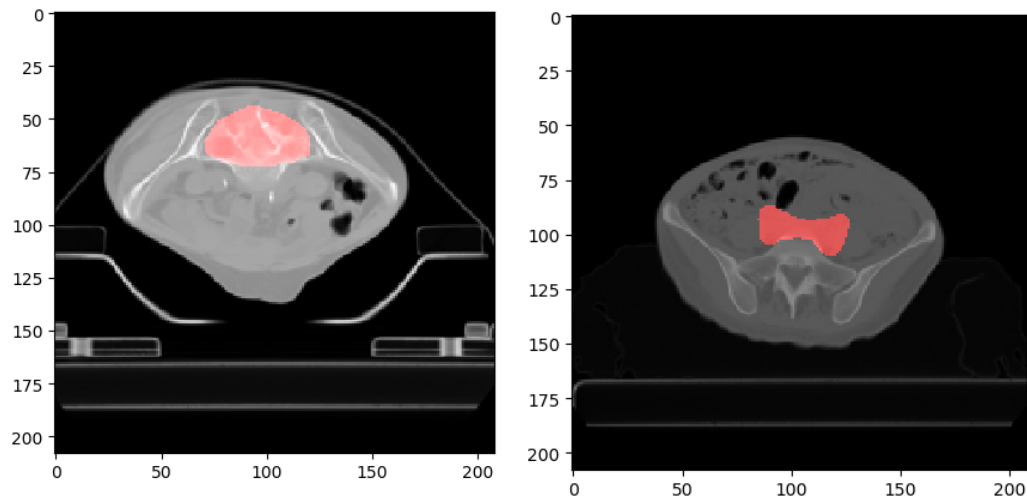
- 靶区 \neq 病灶
- 体内部位灰度差异值极小，易受噪声影响

• 标注标准不统一

- 外延距离标注标准不同
- 标注习惯与部位不同



标注像素值的分布

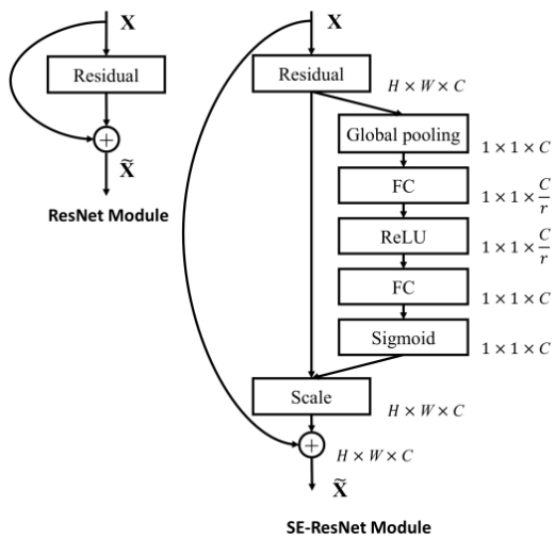


不同医生的标注

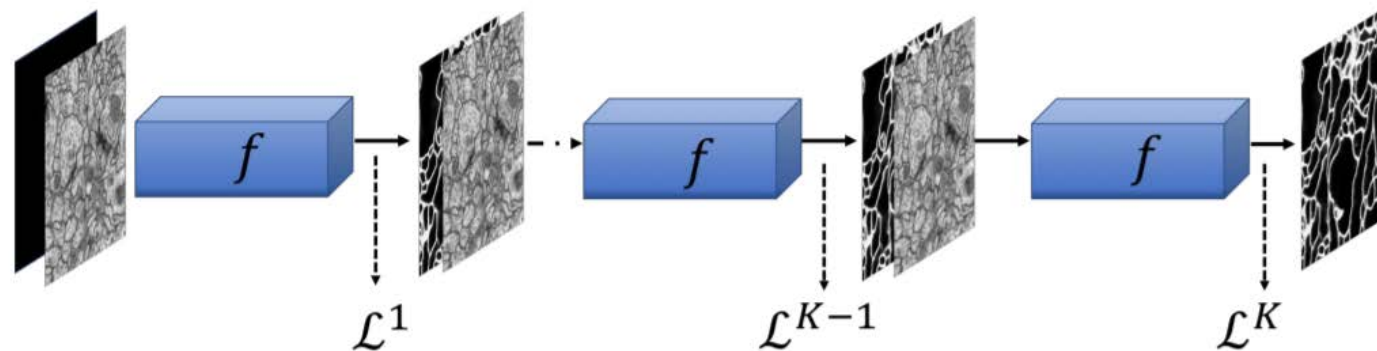


预计目标

- **Refine** – 通过修改网络结构等方式，提升性能
 - - 网络结构提升
 - - 多个模型进行组合
 - - 损失函数的进一步优化和尝试
 - - 循环生成



SE-ResNet结构



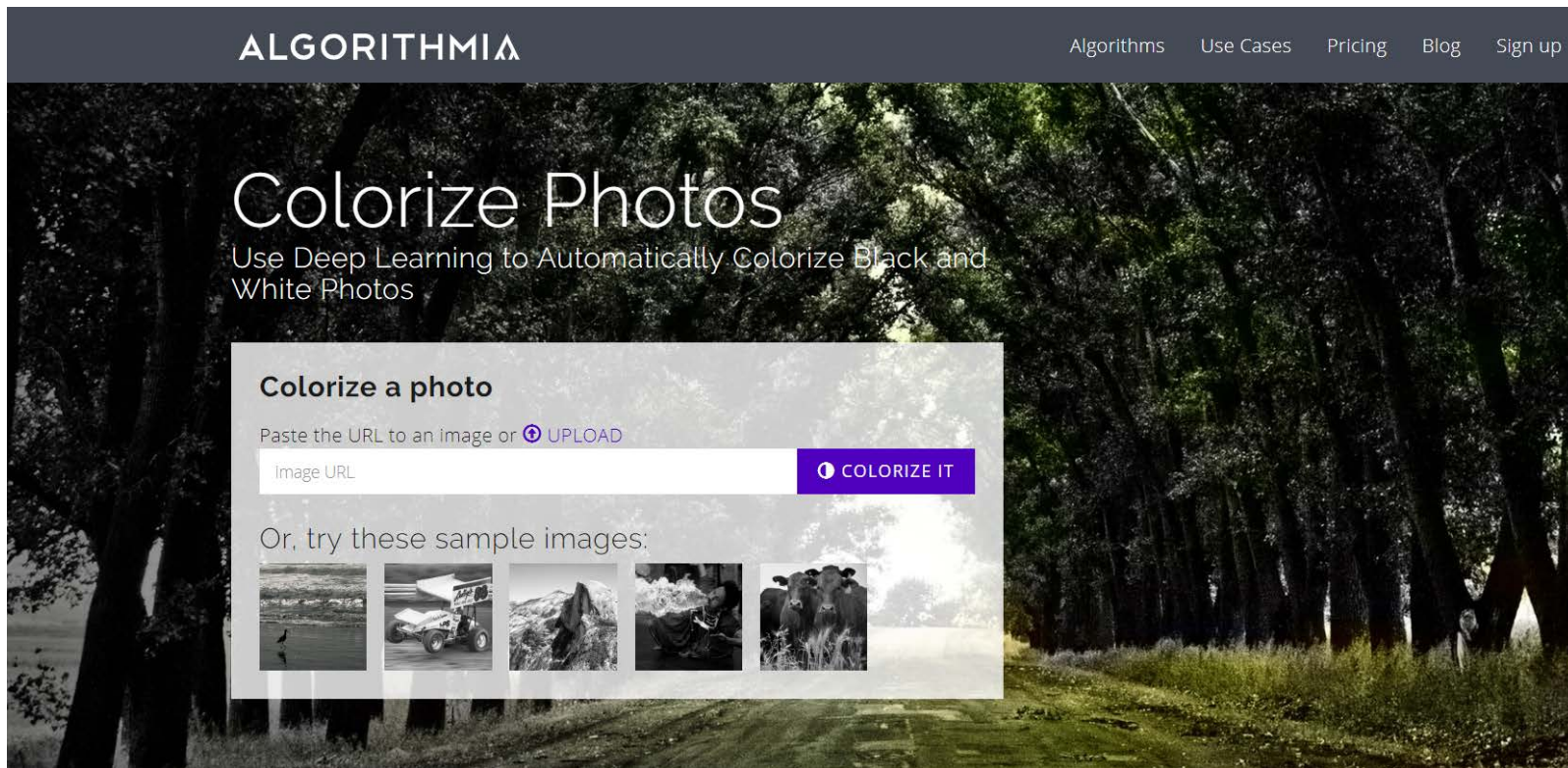
Cycle loss结构



预计目标

- **Demo** – 在线demo可以提供使用

- 上传CT图像
- 在线自动生成勾画结果
- 可视化工具设计
- 提供结果下载





进度安排

- ~2018.12 文献调研
- ~2018.1 数据准备与算法实现
- ~2019.4 算法改进与提升
- ~2019.5 系统设计与demo展示
- ~2019.6 材料准备 毕业答辩



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