안과질환 진단 알고리즘의 소개

국가수리과학연구소
National Institute for Mathematical Sciences

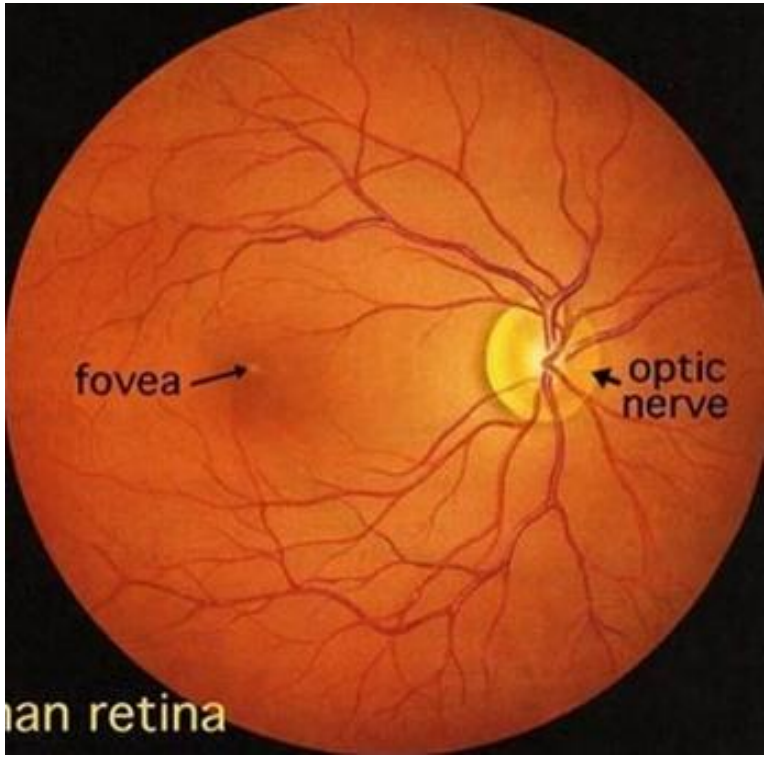
부산의료수학센터

안과질환 진단 플랫폼

안저촬영기

안저 사진

인공지능 SW



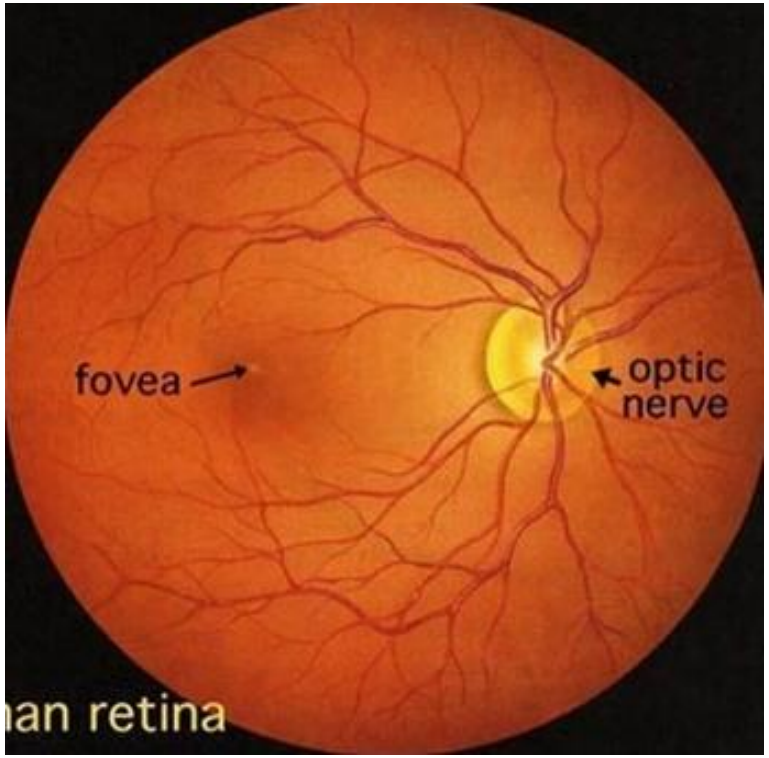
진단 결과 출력

안과질환 진단 플랫폼

안저촬영기

안저 사진

인공지능 SW



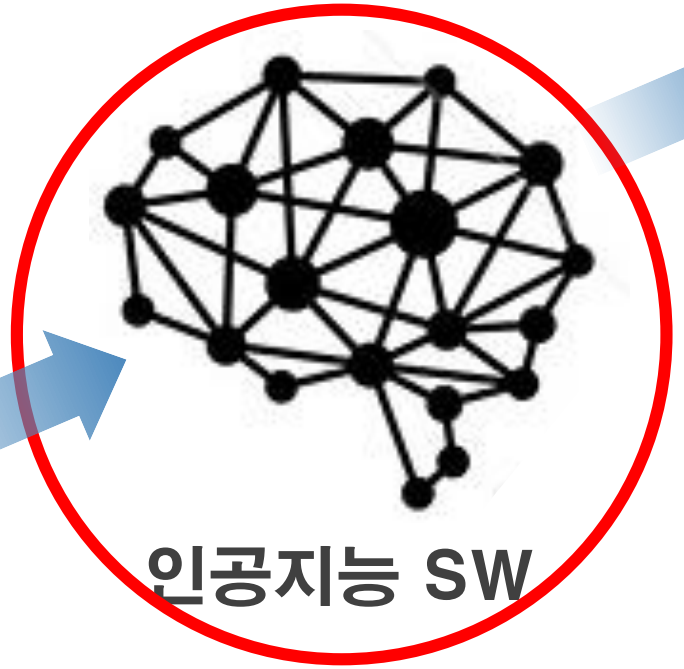
진단 결과 출력

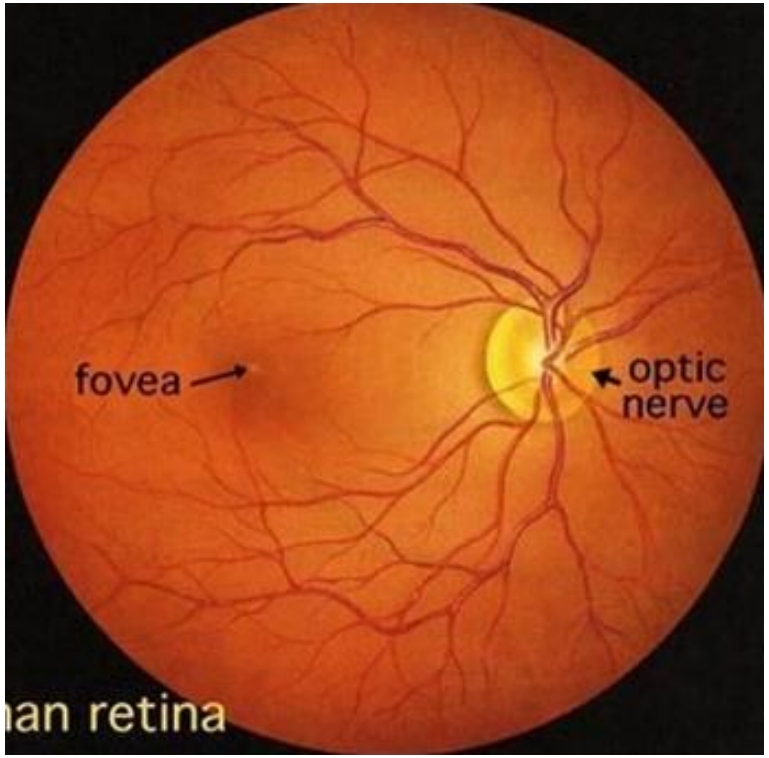
녹내장, 당뇨, 황반변성 등

안과질환 진단 플랫폼

안저촬영기

안저 사진



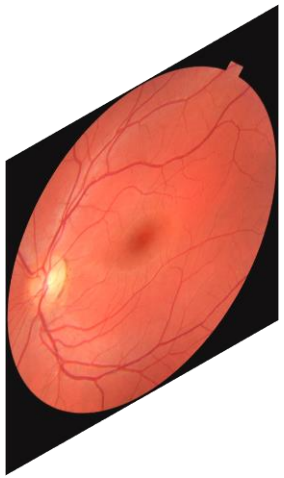


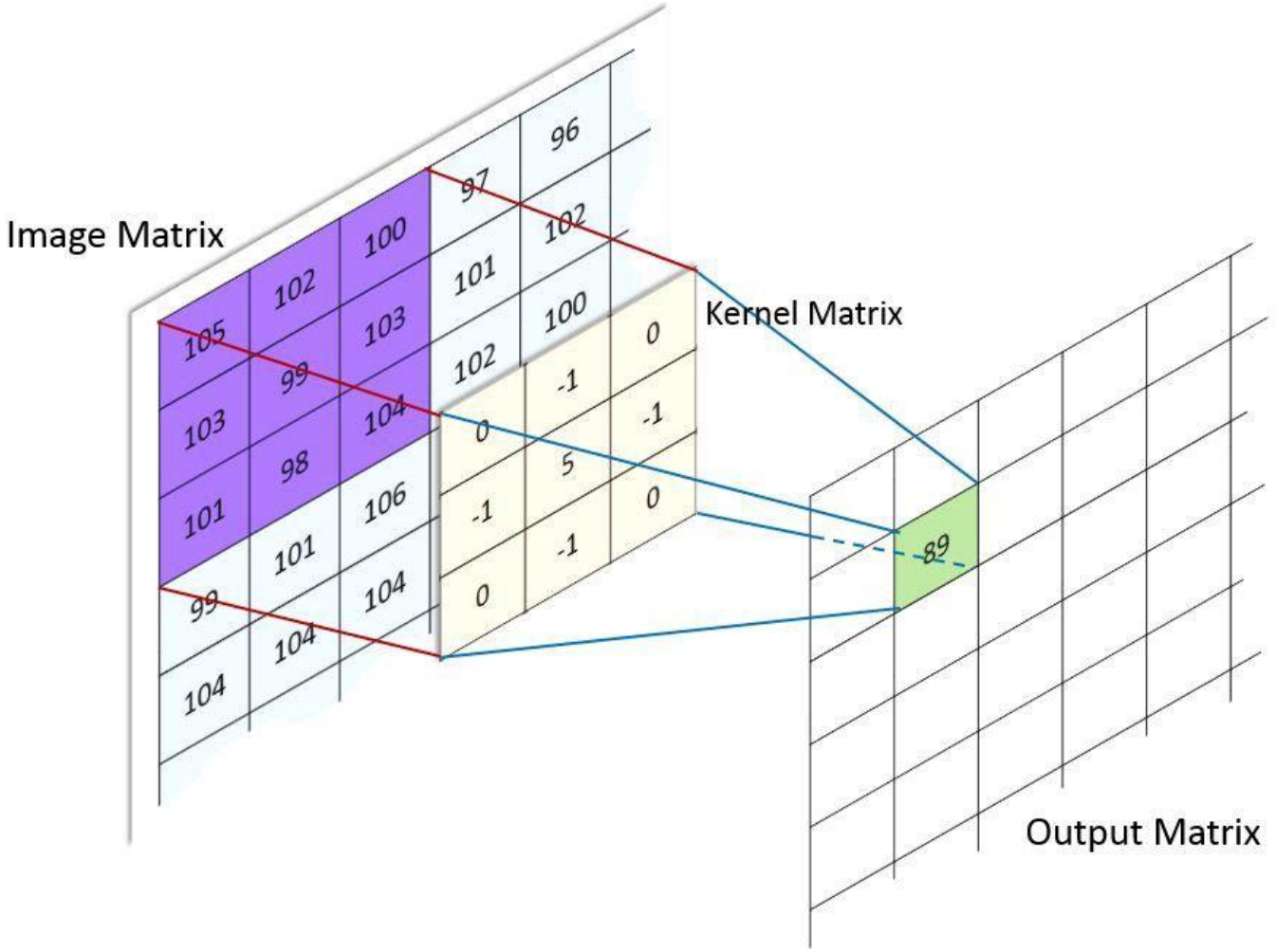
진단 결과 출력

녹내장, 당뇨, 황반변성 등

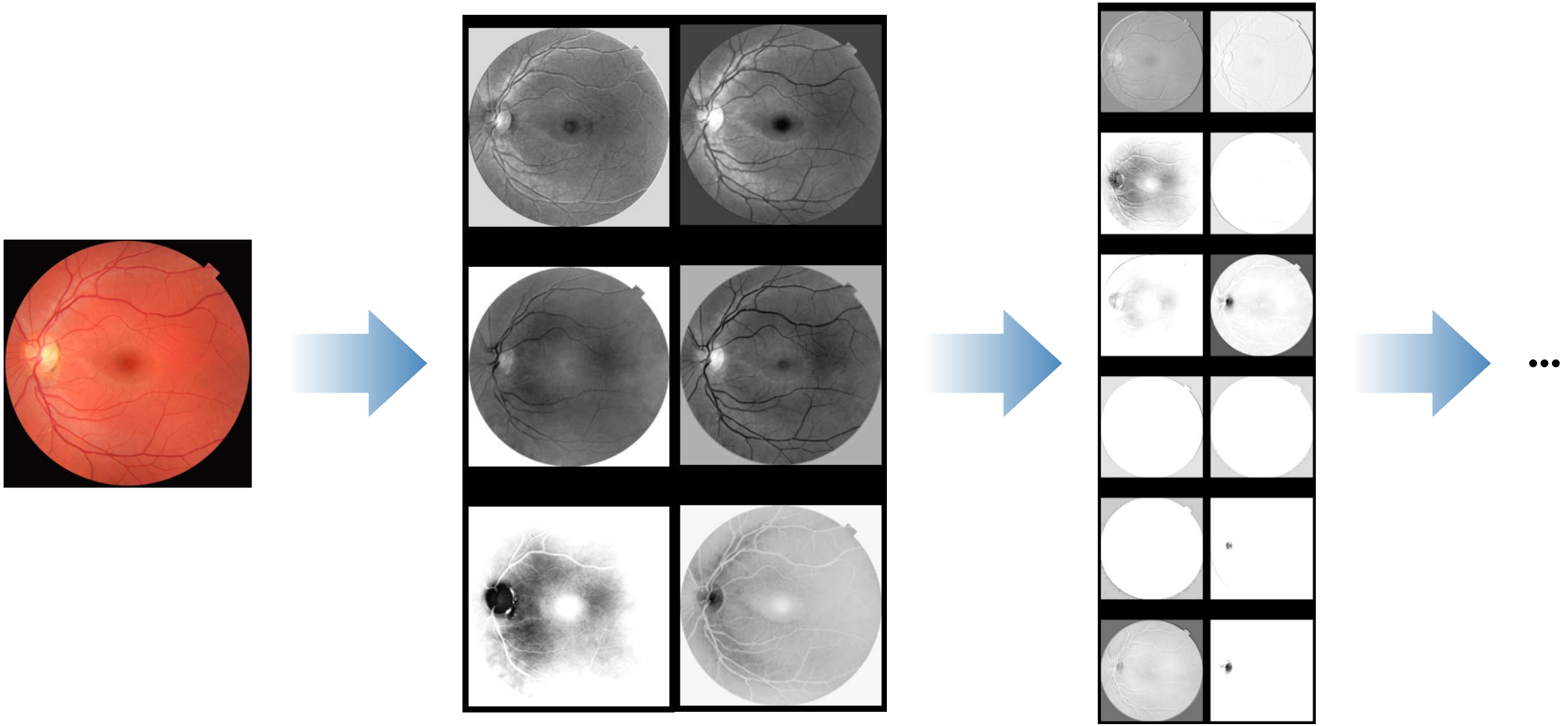
검증 및 알고리즘의 문서화

합성곱 신경망(Convolutional Neural Network)

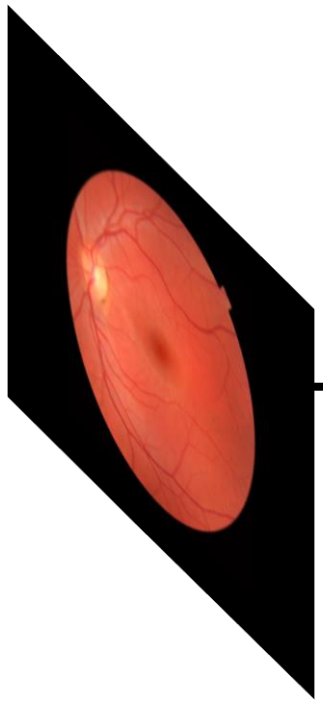




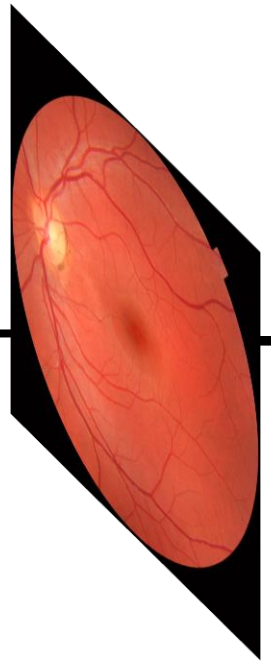
합성곱 신경망(Convolutional Neural Network)



인공지능 알고리즘



Input



전처리

Section 1

Section 2

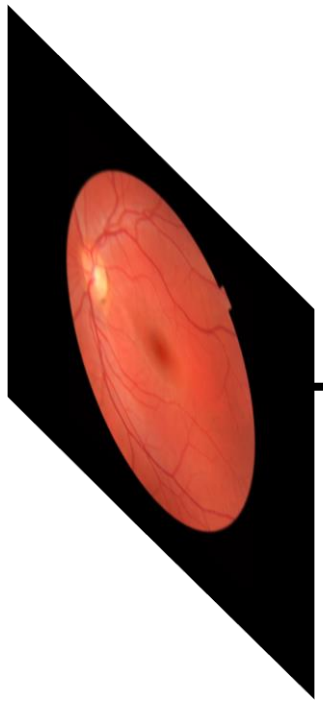
Section 3

Section 4

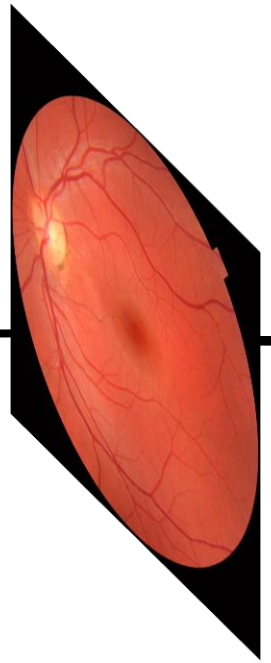
취합

최종 진단

인공지능 알고리즘



Input



전처리

Section 1

Section 2

Section 3

Section 4

취합

최종 진단

약 80,000장의 안저사진을 통한 Training

인공지능 알고리즘

Section 1

황반변성, 상피막, 황반원공 등
20개의 질병 중 어느 질병인지 판독

Section 2

녹내장이 의심되는 영역과
심각한 정도를 판독

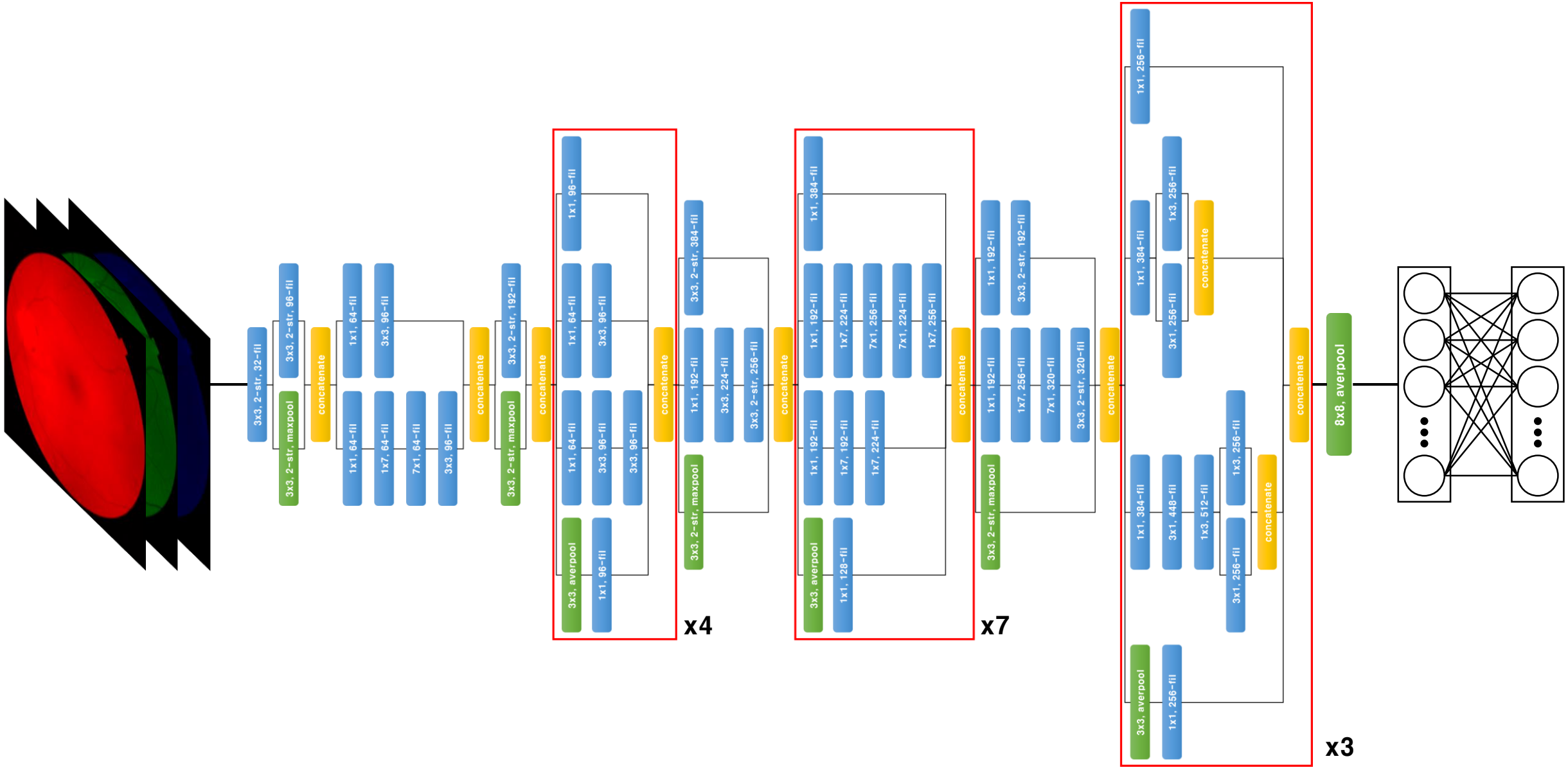
Section 3

56가지의 경증 질환의 존재 여부 판독

Section 4

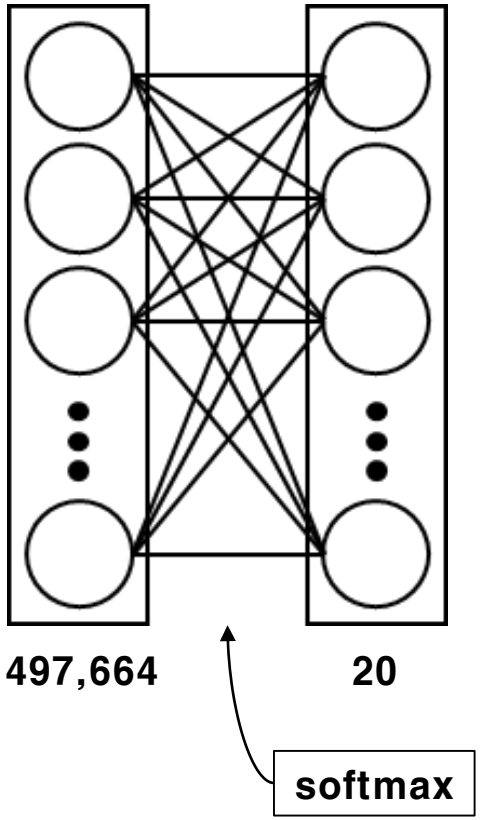
미세혈관병증이나 경성삼출물 같은
미세병변의 위치를 판독

Section 1, 3 – 495 layers

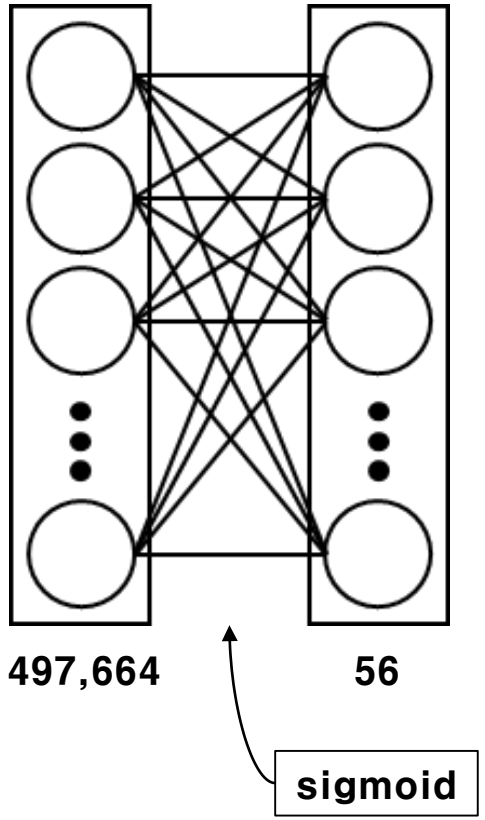


Section 1, 3

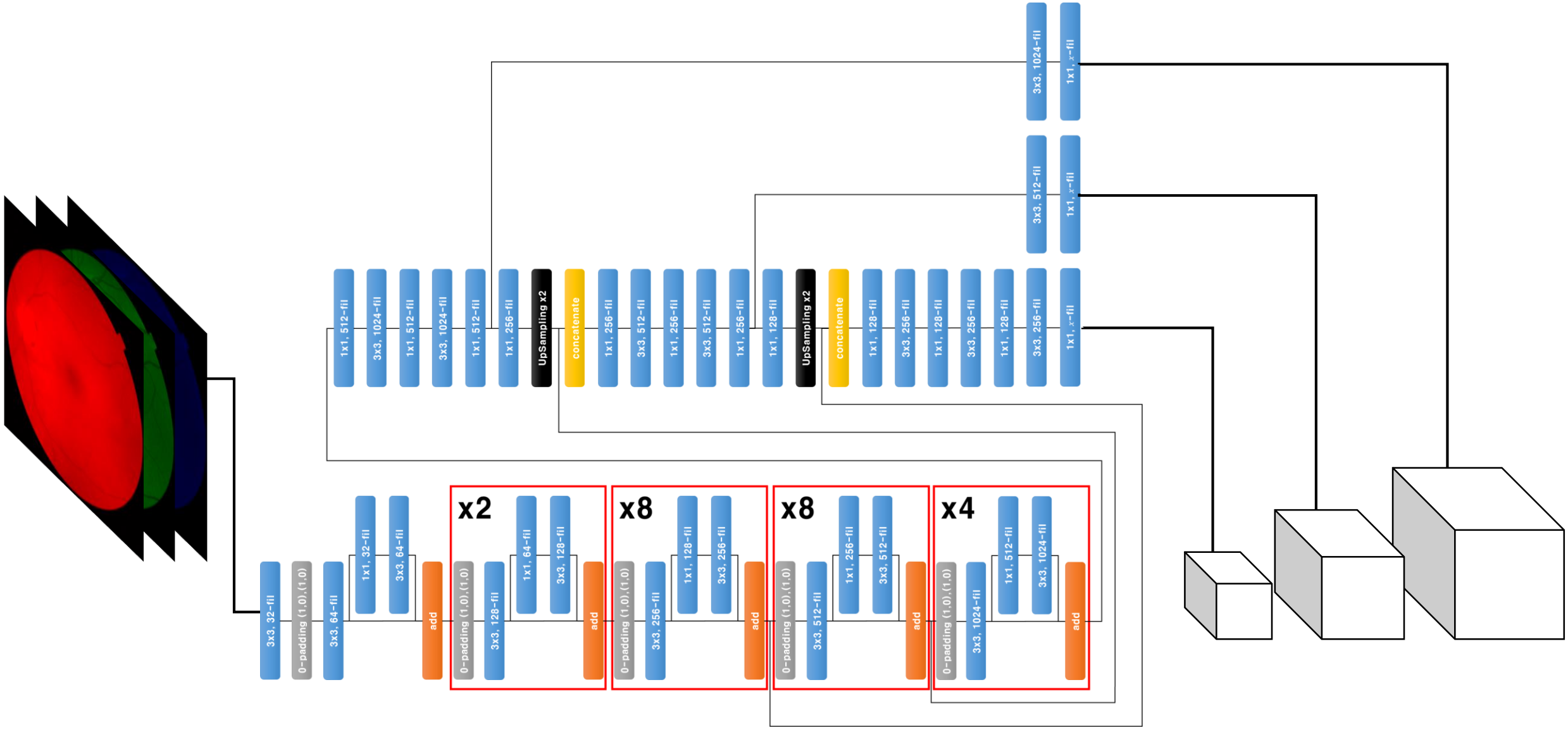
Section 1



Section 3

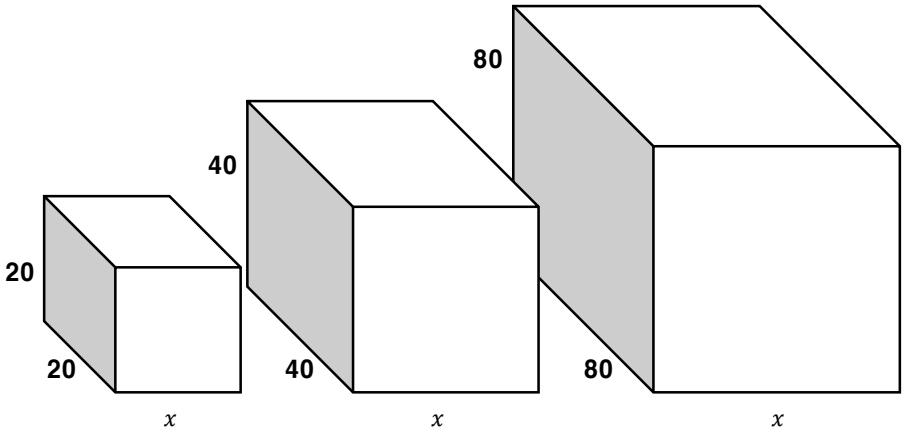


Section 2, 4 – 253 layers



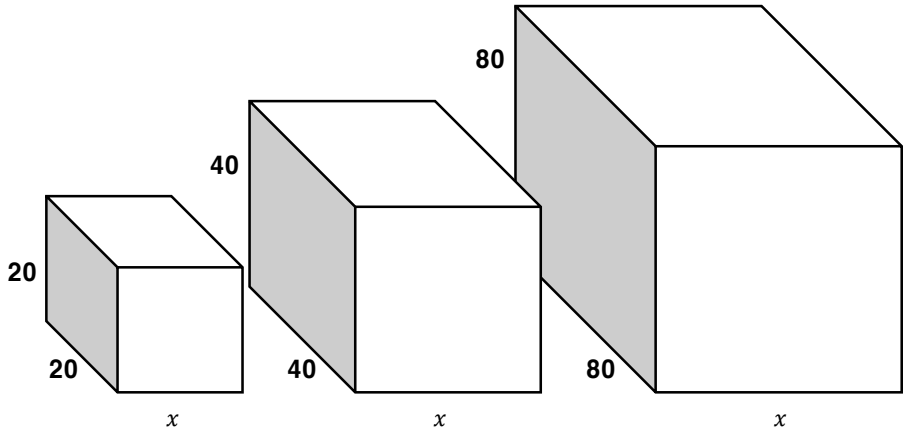
Section 2, 4

Section 2



$x =$ **anchors** $\times$ **(classes** $+$ **5)**

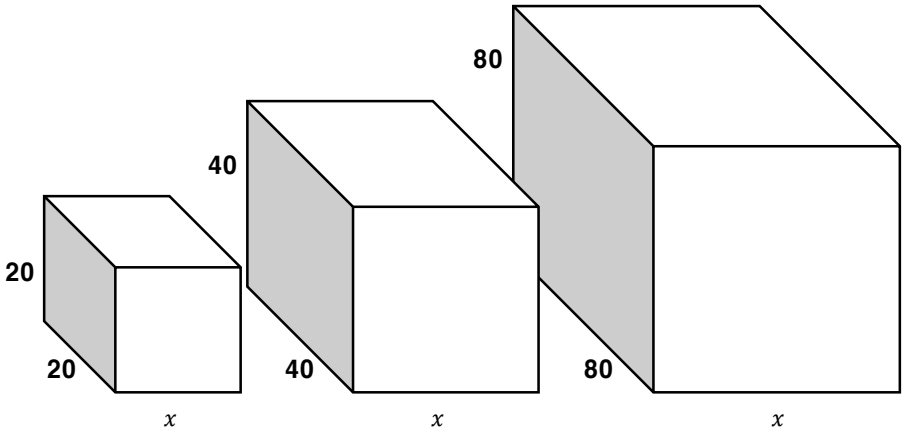
Section 4



$x =$ **classes** $+$ **2**

Section 2, 4

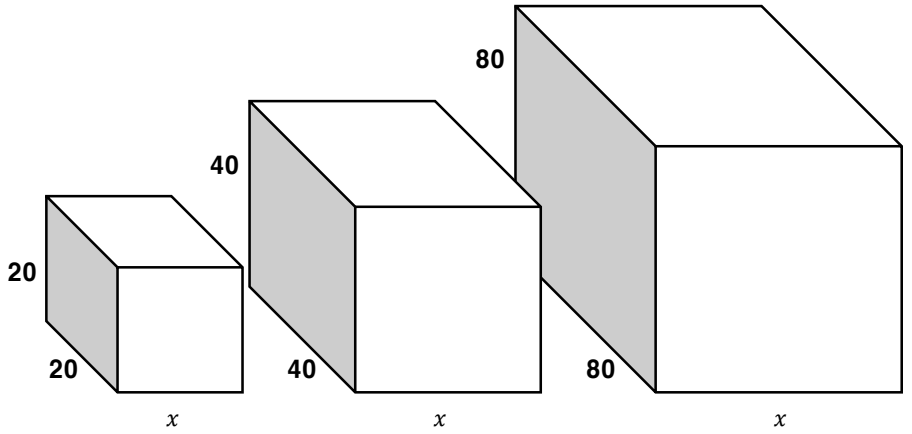
Section 2



$x = \text{anchors} \times (\text{classes} + 5)$

YOLO(You Only Look Once)

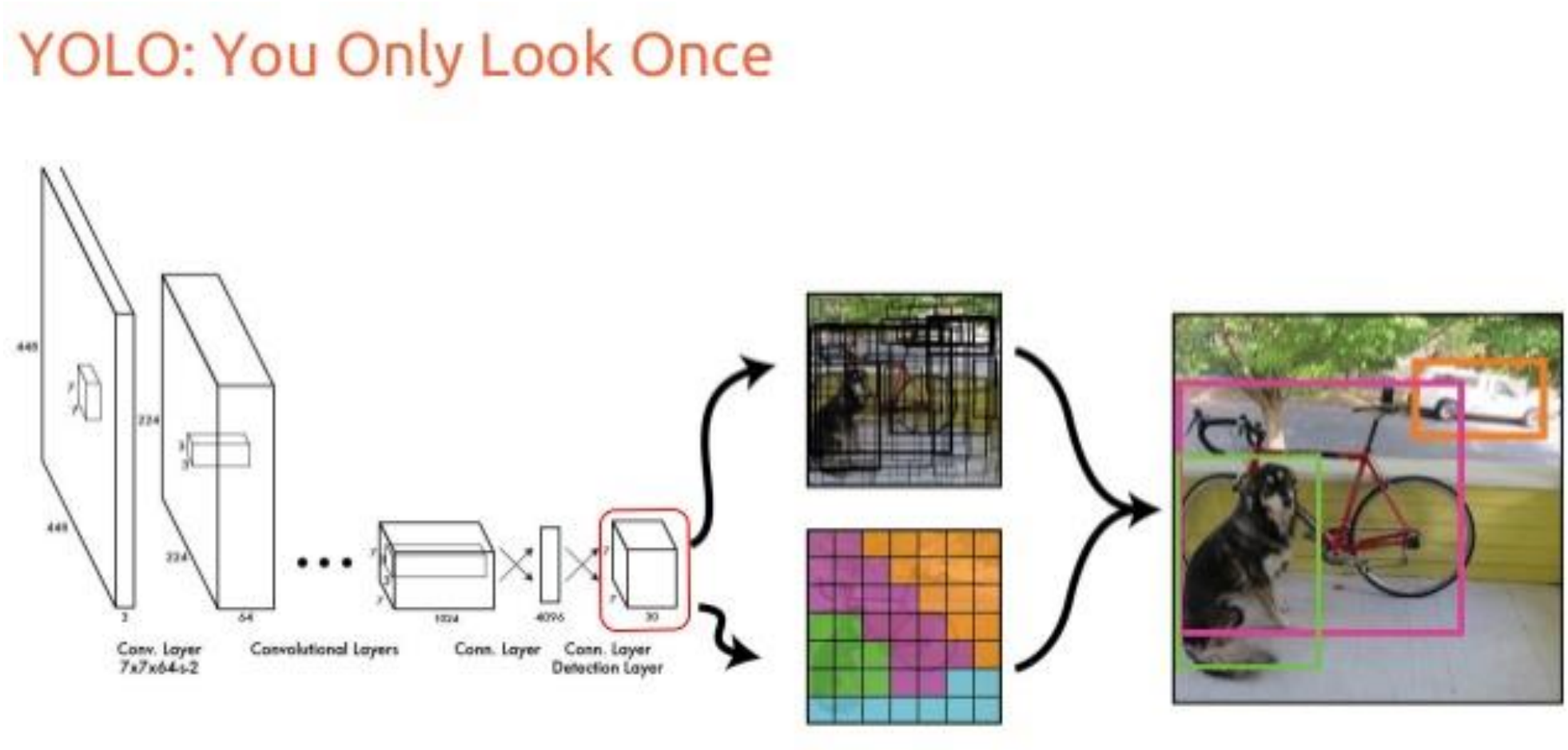
Section 4



$x = \text{classes} + 2$

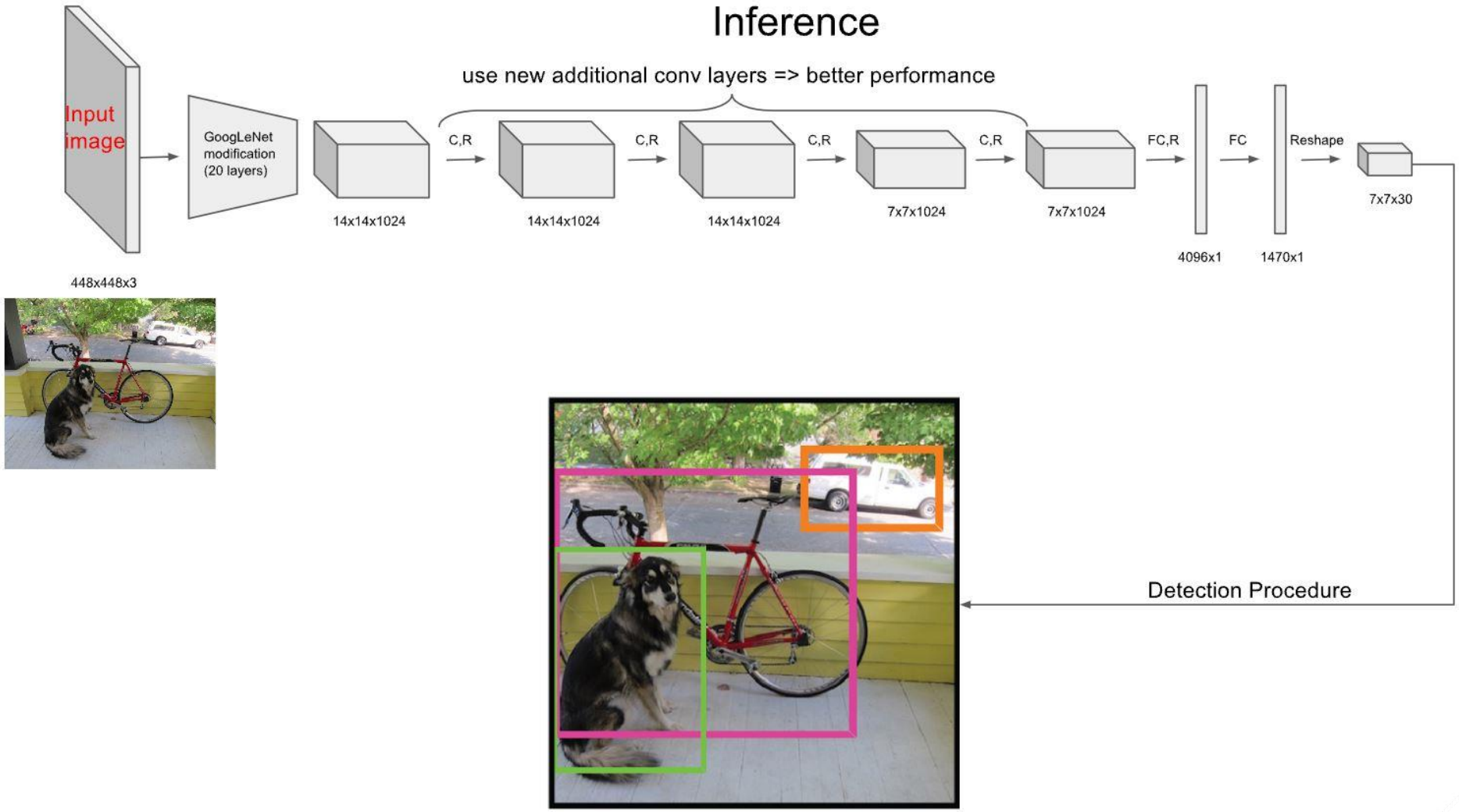
PointNet

YOLO 소개



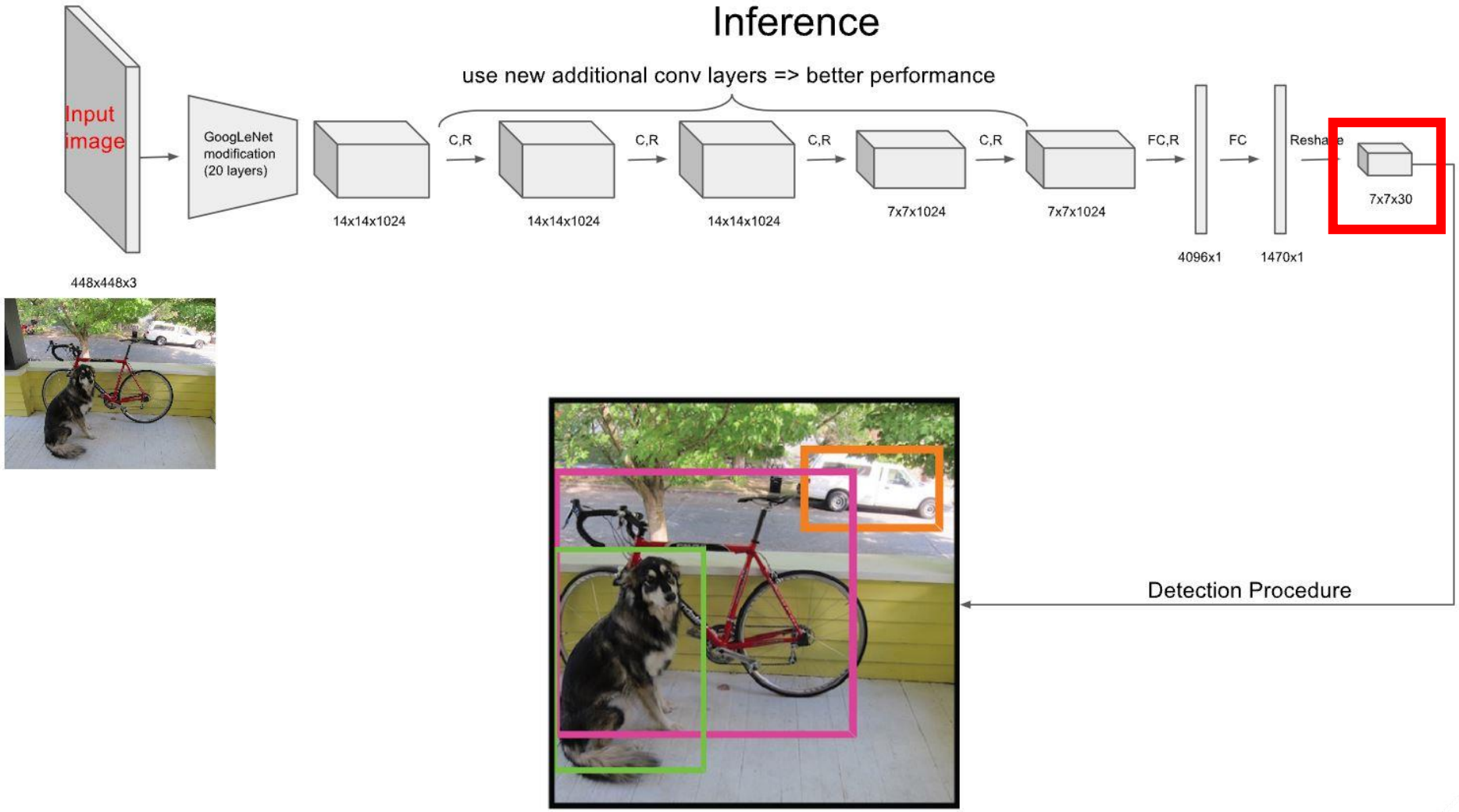
Reference : https://curt-park.github.io/2017-03-26/yolo/

YOLO 소개



deepsystems.io

YOLO 소개



deepsystems.io

YOLO의 Output

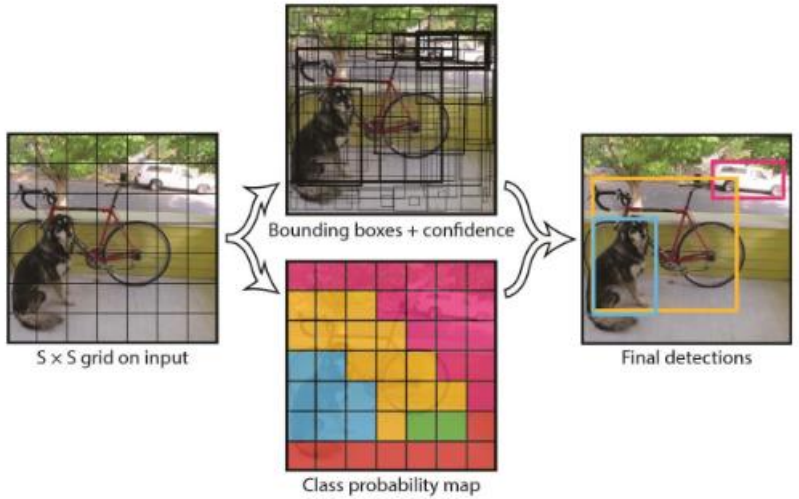


Figure 2: The Model. Our system models detection as a regression problem. It divides the image into an $S \times S$ grid and for each grid cell predicts B bounding boxes, confidence for those boxes, and C class probabilities. These predictions are encoded as an $S \times S \times (B * 5 + C)$ tensor.

1. Input image를 $S \times S$ **grid**로 나눈다.

2. 각 **grid cell**은 B개의 **bounding box**와 각 **bounding box**에 대한 **confidence score**를 갖는다. **(**만약 **cell**에 **object**가 존재하지 않는다면 **confidence score**는 **0**이 된다**.)**
Confidence Score: $\Pr(\text{Object}) \times IOU_{pred}^{truth}$

3. 각각의 **grid cell**은 C개의 **conditional class probability**를 갖는다.
Conditional Class Probability: $\Pr(Class_i|Object)$

4. 각각의 **bounding box**는 **x, y, w, h, confidence**로 구성된다.
(x,y): Bounding box의 중심점**, grid cell**의 범위에 대한 상대값
(w,h): 전체 이미지의 **width, height**에 대한 상대값

5. Test time에는 **conditional class probability**와 **bounding box**의 **confidence score**를 곱하여 **class-specific confidence score**를 얻는다.

$$ClassSpecificConfidenceScore_i = \Pr(Class_i|Object) \times \Pr(Object) \times IOU_{pred}^{truth}$$
$$= \Pr(Class_i) \times IOU_{pred}^{truth}$$

YOLO의 Output

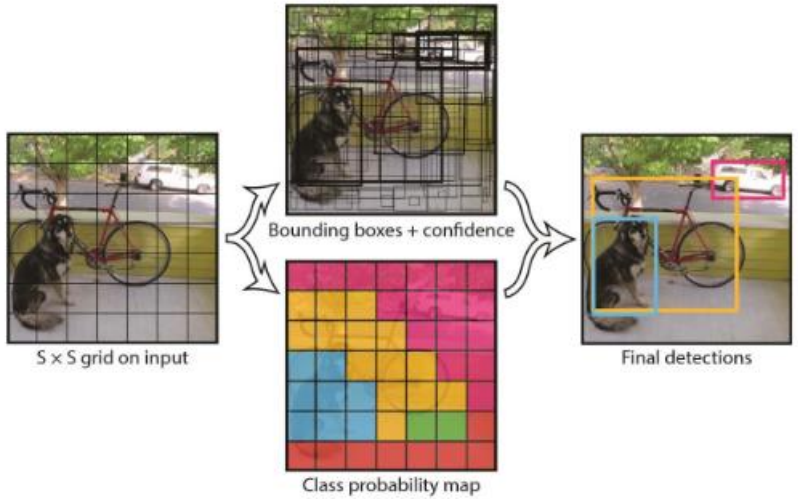
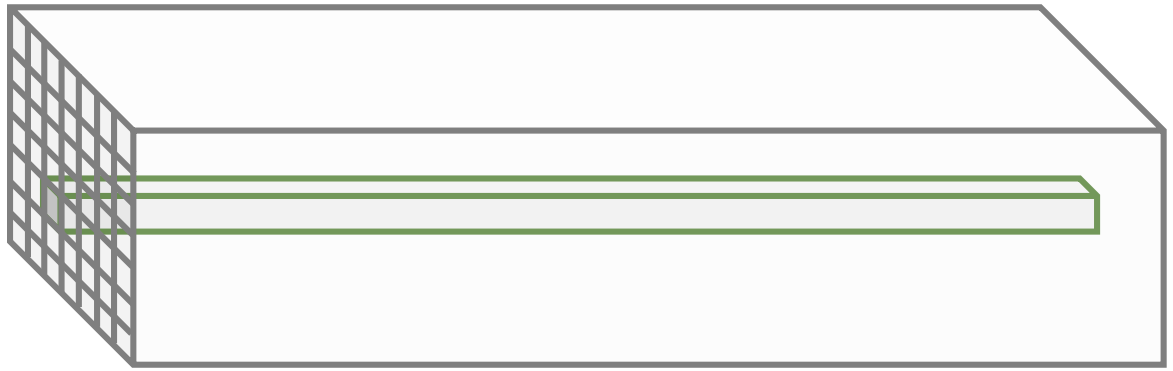


Figure 2: The Model. Our system models detection as a regression problem. It divides the image into an $S \times S$ grid and for each grid cell predicts B bounding boxes, confidence for those boxes, and C class probabilities. These predictions are encoded as an $S \times S \times (B * 5 + C)$ tensor.



grid의 정보

YOLO의 한계점

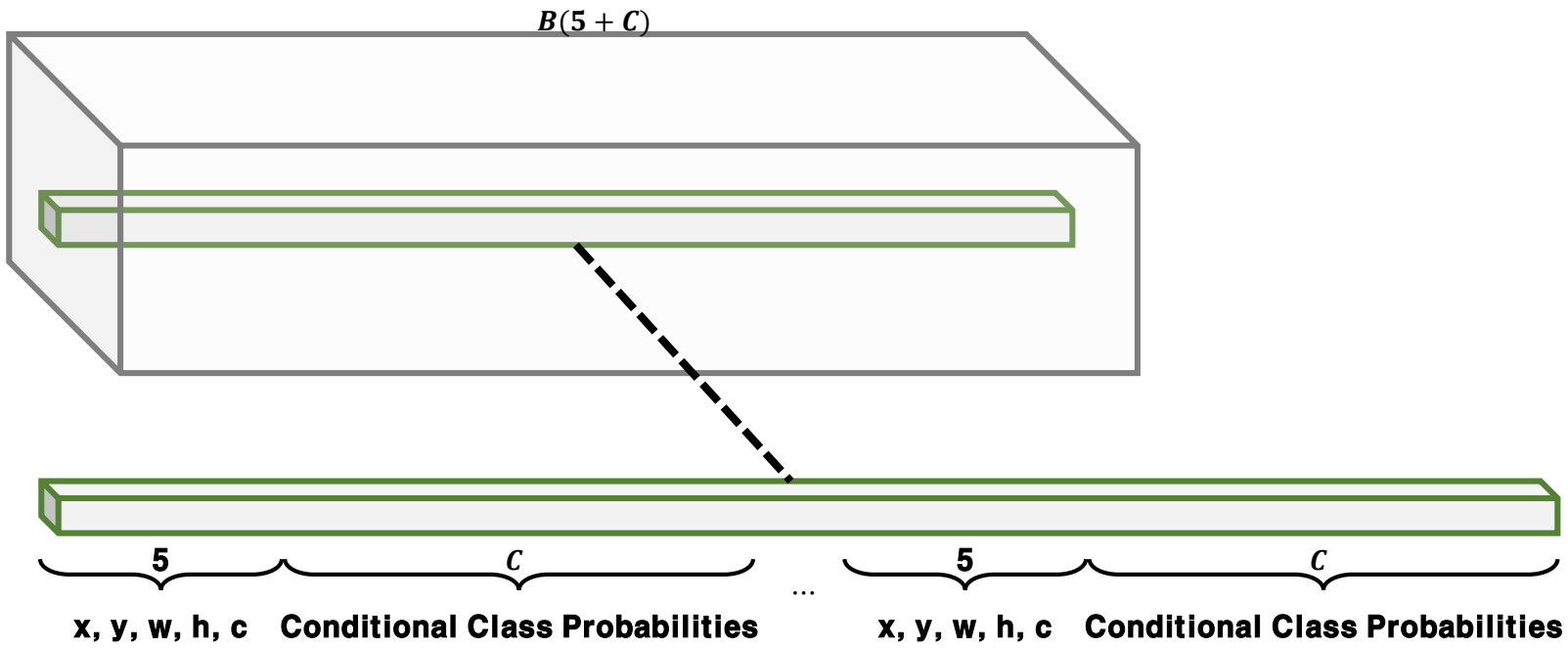
1.각각의 grid cell이 하나의 클래스만을 예측할 수 있으므로, 작은 object 여러개가 다닥다닥 붙으면 제대로 예측하지 못한다.

2.bounding box의 형태가 training data를 통해서만 학습되므로, 새로운/독특한 형태의 bouding box의 경우 정확히 예측하지 못한다.

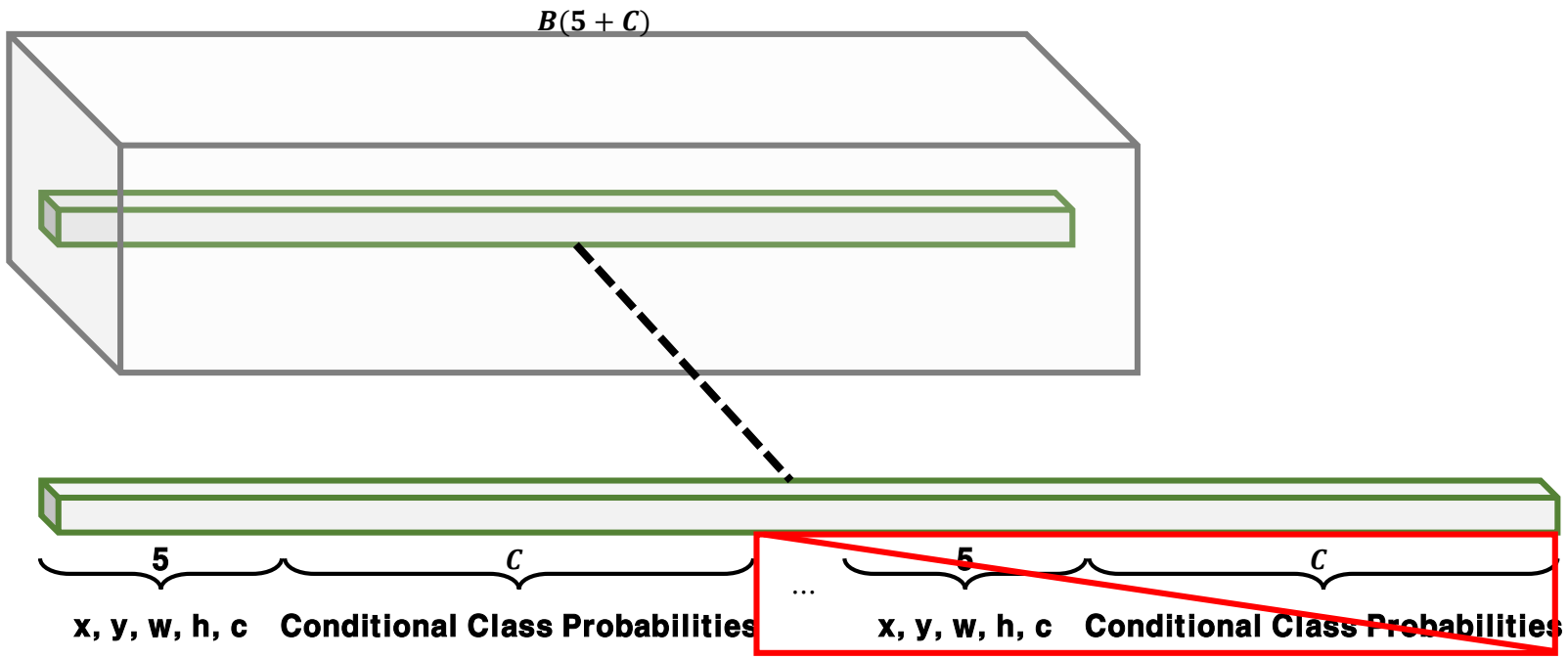
3.몇 단계의 layer를 거쳐서 나온 feature map을 대상으로 bouding box를 예측하므로 localization이 다소 부정확해지는 경우가 있다.

4.Bounding box를 기반으로 예측하기에 초소형 object를 예측하는 데에 부적합하다.

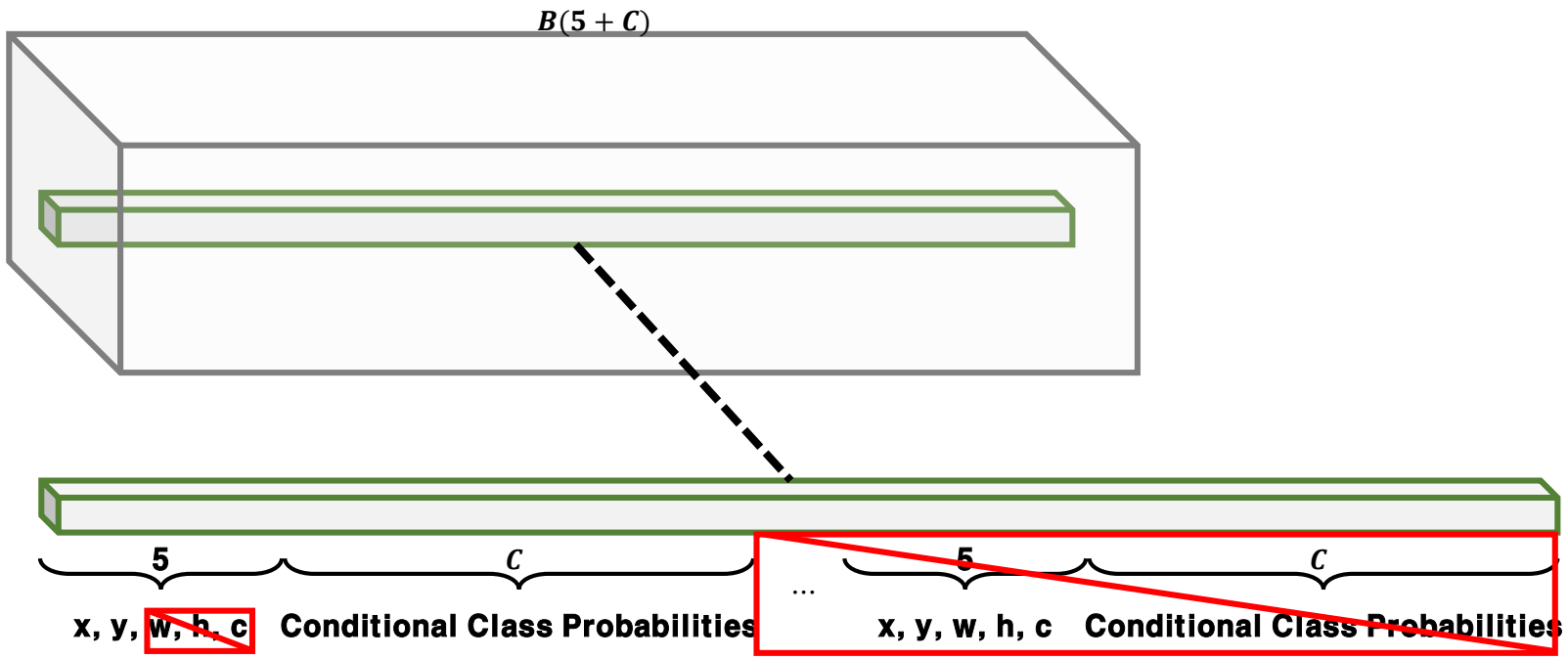
PointNet 소개


$B(5+C)$
5
C
5
C
...
x, y, w, h, c
Conditional Class Probabilities
x, y, w, h, c
Conditional Class Probabilities

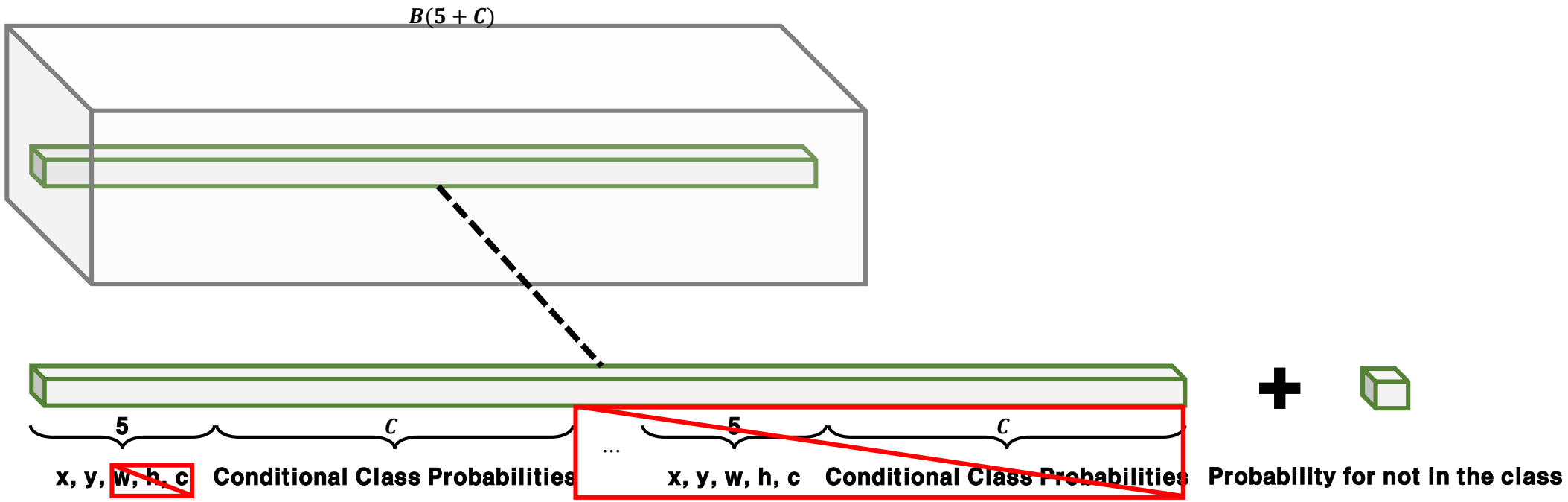
PointNet 소개


$B(5+C)$
5
C
5
C
...
x, y, w, h, c
Conditional Class Probabilities
x, y, w, h, c
Conditional Class Probabilities

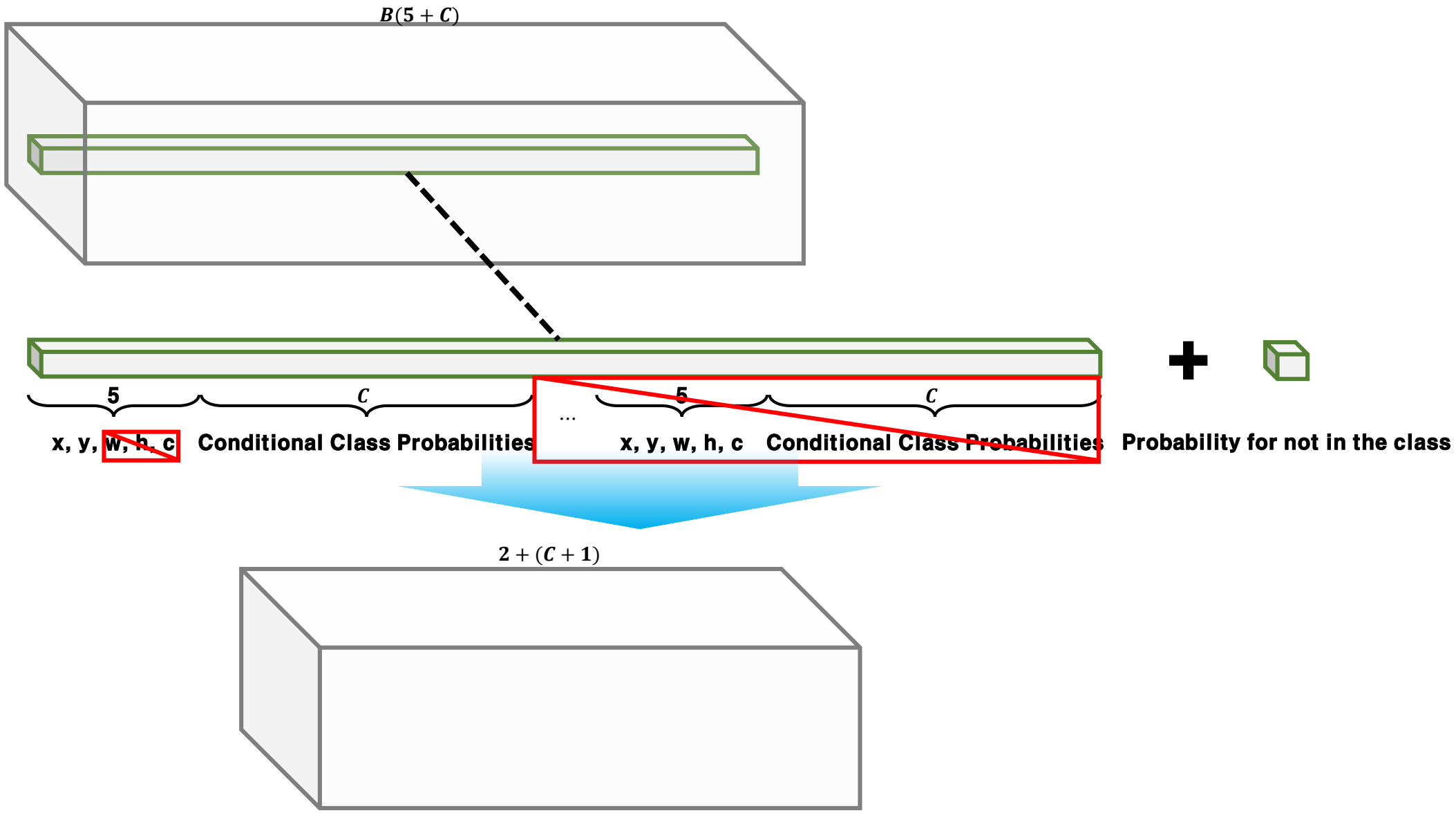
PointNet 소개


$B(5+C)$
5
C
5
C
...
x, y, w, h, c
Conditional Class Probabilities
x, y, w, h, c
Conditional Class Probabilities

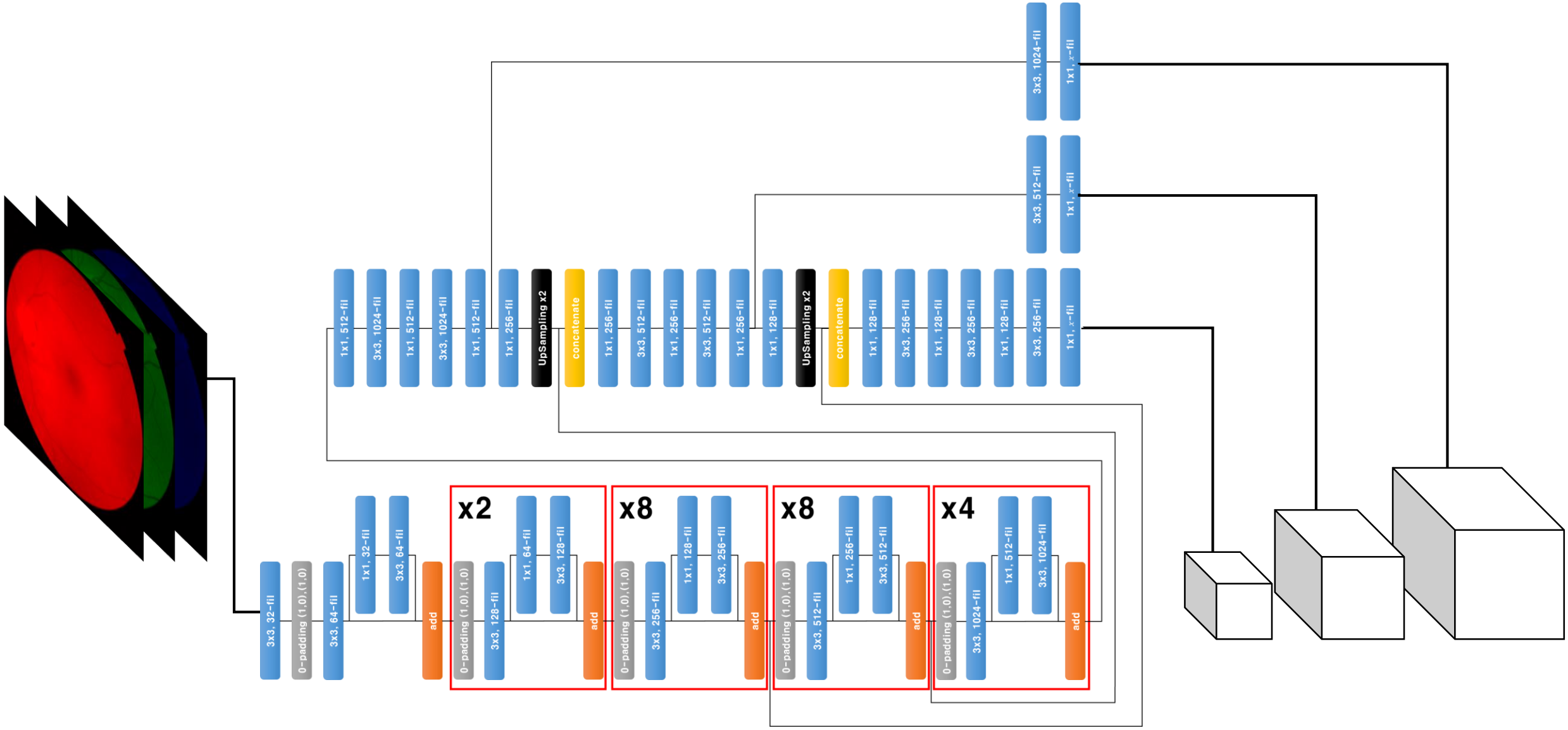
PointNet 소개


$B(5+C)$
5
C
5
C
...
x, y, w, h, c
Conditional Class Probabilities
x, y, w, h, c
Conditional Class Probabilities
Probability for not in the class

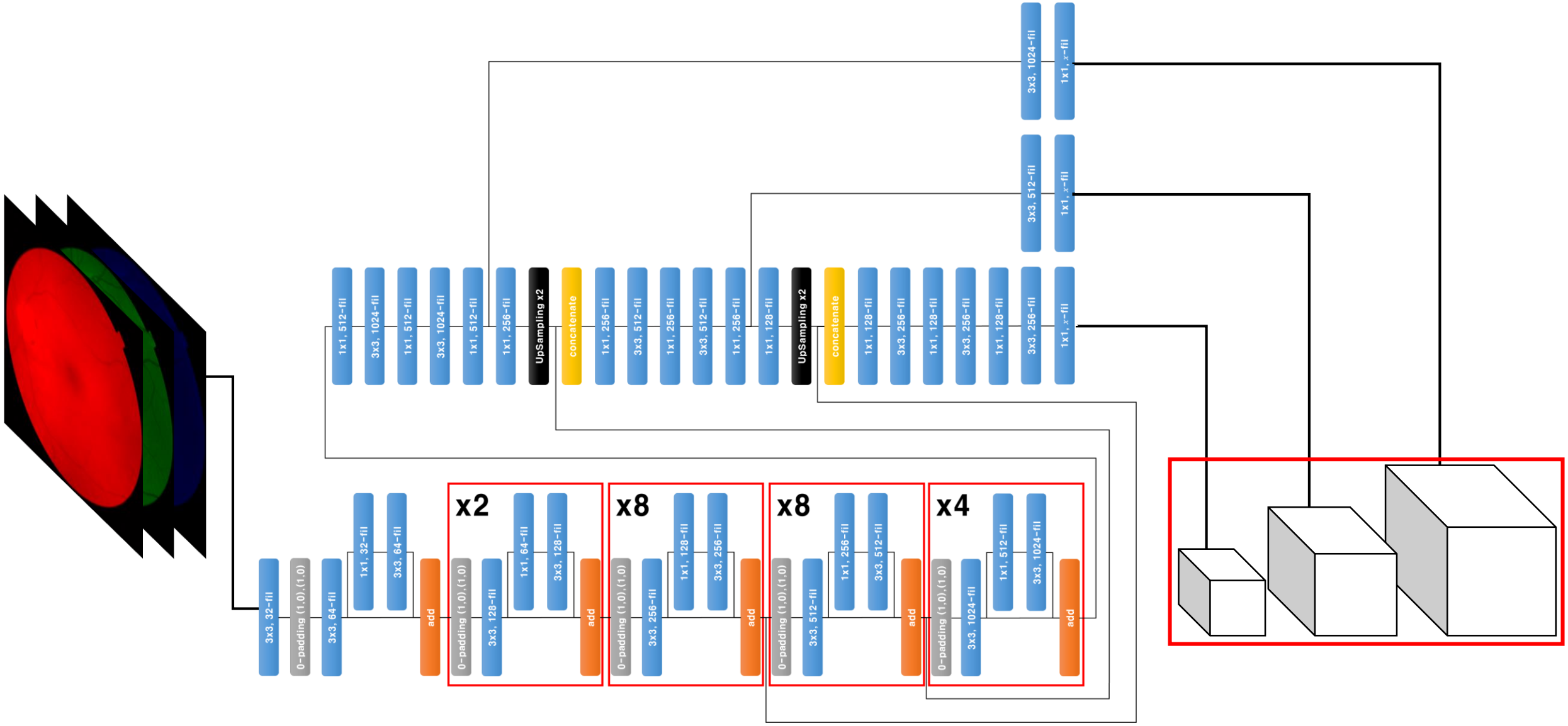
PointNet 소개


$B(5+C)$
5
C
5
C
...
x, y, w, h, c
Conditional Class Probabilities
x, y, w, h, c
Conditional Class Probabilities
Probability for not in the class
$2+(C+1)$

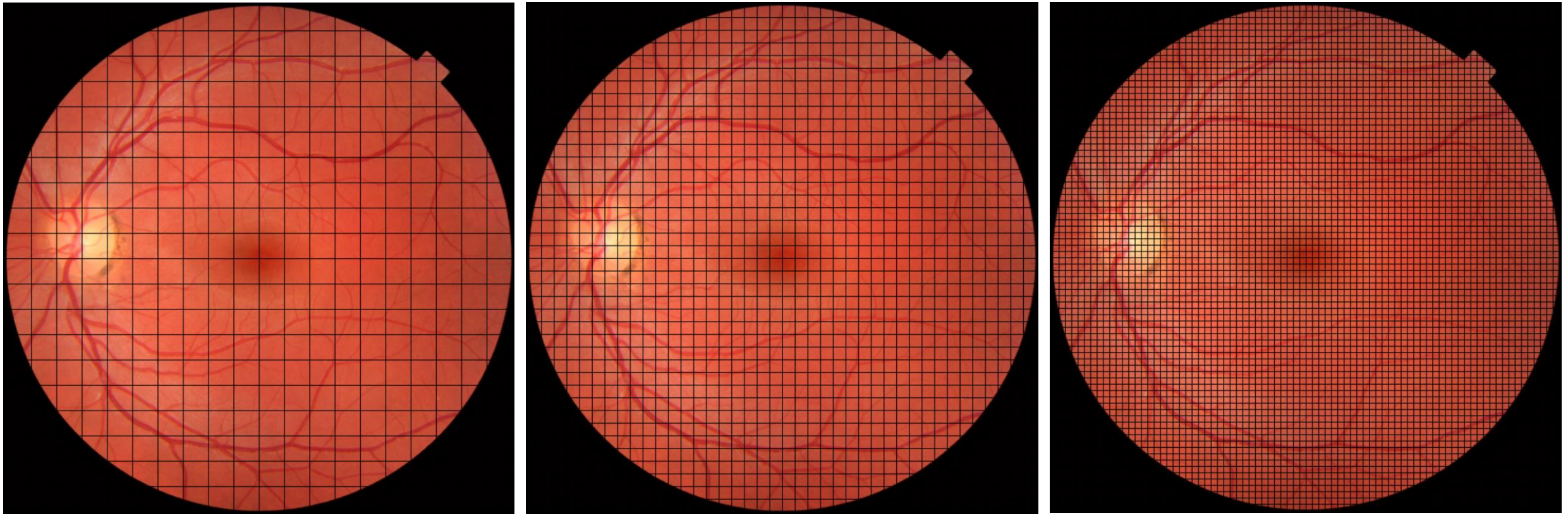
YOLO, PointNet



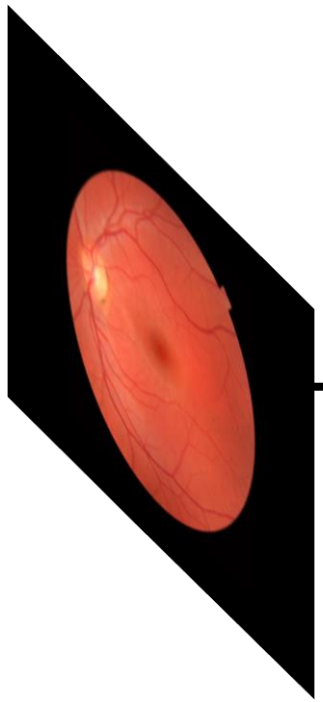
YOLO, PointNet



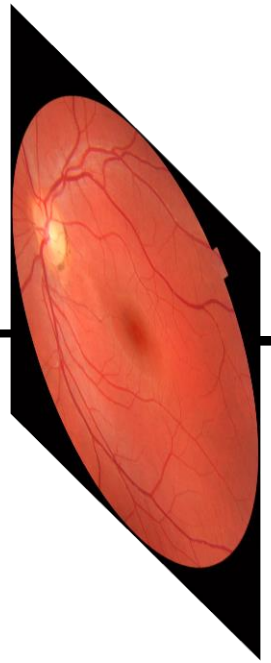
YOLO, PointNet



취합



Input



전처리

Section 1

Section 2

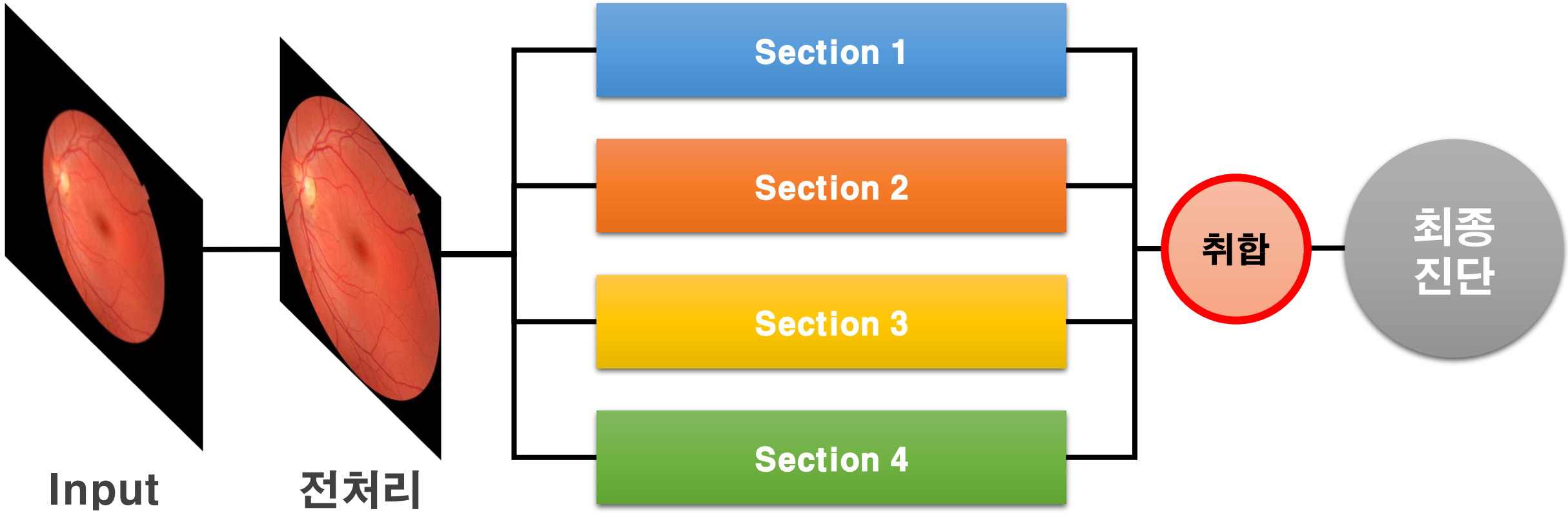
Section 3

Section 4

취합

최종
진단

취합



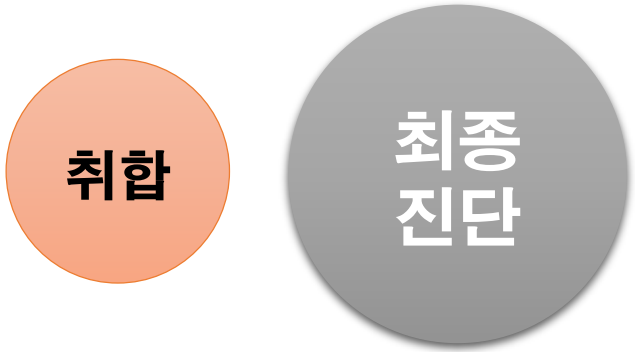
취합

Section 1

Section 2

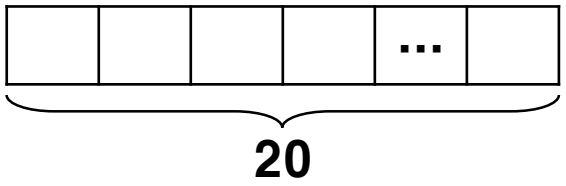
Section 3

Section 4



취합

Section 1



: 19+1가지의 주요질환 확률

Section 2

Section 3

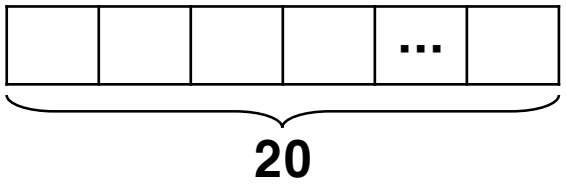
Section 4

취합

최종 진단

취합

Section 1



: 19+1가지의 주요질환 확률

Section 2

: 가장 확률이 높은 녹내장 심각도

취합

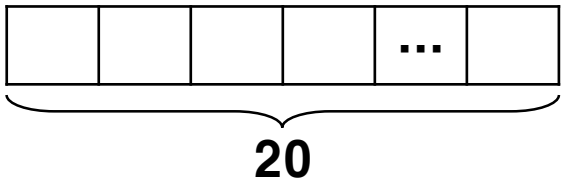
최종 진단

Section 3

Section 4

취합

Section 1

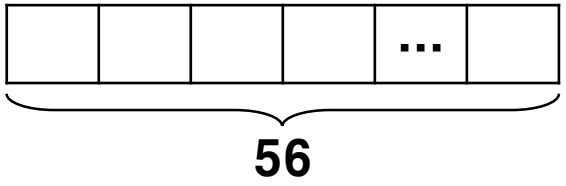


: 19+1가지의 주요질환 확률

Section 2

: 가장 확률이 높은 녹내장 심각도

Section 3



: 56가지의 경증질환 확률

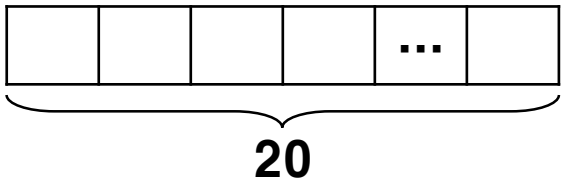
Section 4

취합

최종 진단

취합

Section 1



: 19+1가지의 주요질환 확률

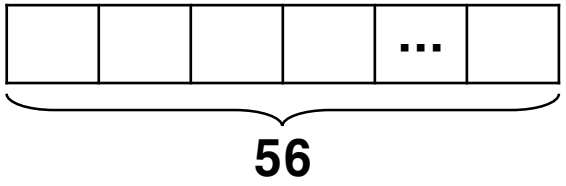
Section 2

: 가장 확률이 높은 녹내장 심각도

취합

최종 진단

Section 3



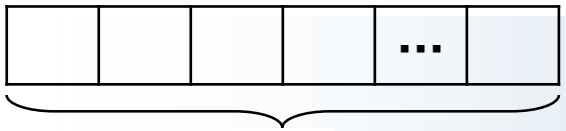
: 56가지의 경증질환 확률

Section 4

: 모든 소형병변 확률 합산

취합

Section 1

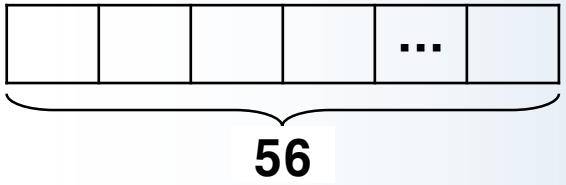


: 19+1가지의 주요질환 확률

Section 2

: 가장 확률이 높은 녹내장 심각도

Section 3



: 56가지의 경증질환 확률

Section 4

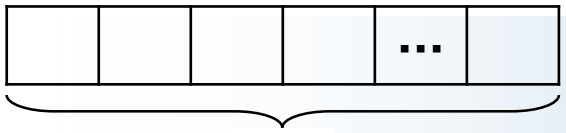
: 모든 소형병변 확률 합산

취합

최종 진단

취합

Section 1



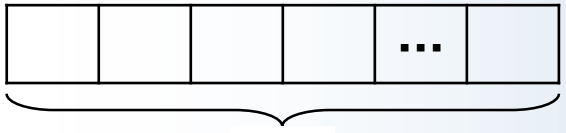
20

: 19+1가지의 주요질환 확률

Section 2

: 가장 확률이 높은 녹내장 심각도

Section 3



56

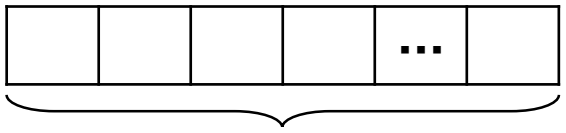
: 56가지의 경증질환 확률

Section 4

: 모든 소형병변 확률 합산

취합

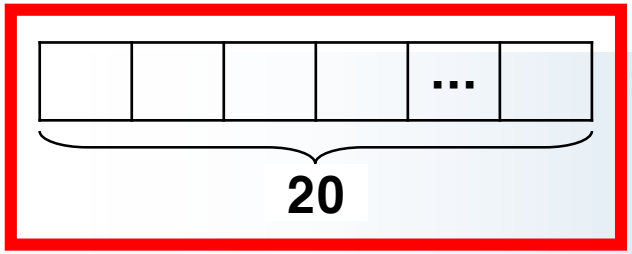
최종 진단



20

취합

Section 1

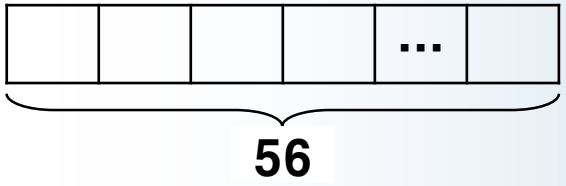


: 19+1가지의 주요질환 확률

Section 2

: 가장 확률이 높은 녹내장 심각도

Section 3



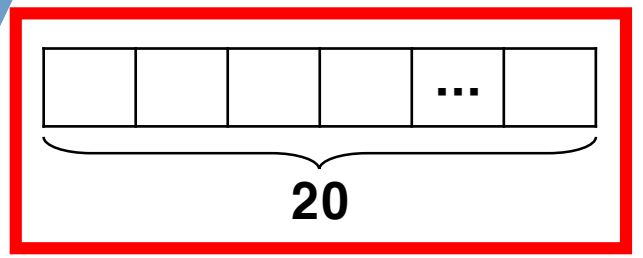
: 56가지의 경증질환 확률

Section 4

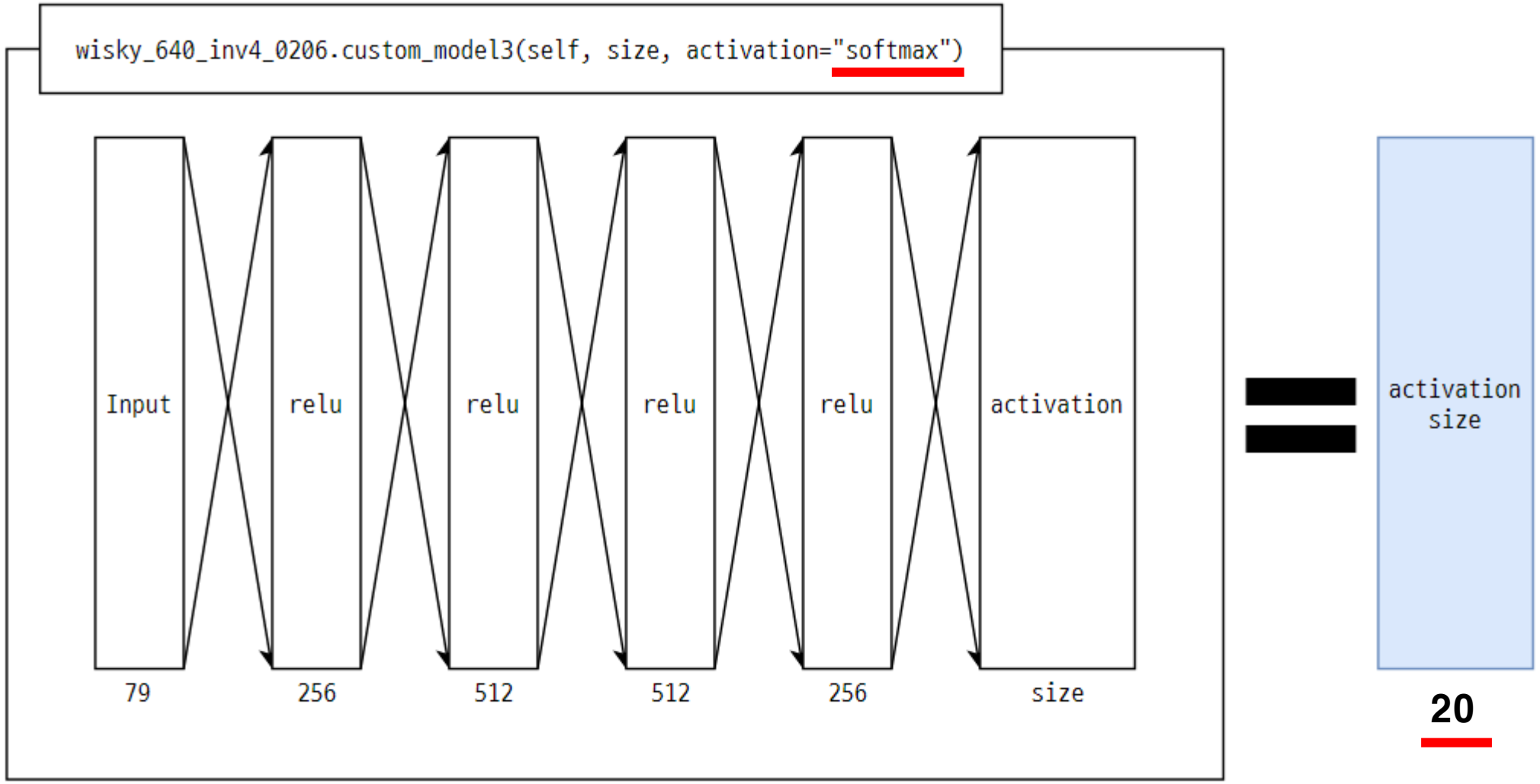
: 모든 소형병변 확률 합산

취합

최종 진단



취합


wisky_640_inv4_0206.custom_model3(self, size, activation="softmax")
Input
relu
relu
relu
relu
activation
79
256
512
512
256
size
activation size
20

정확도

Section 1

황반변성, 상피막, 황반원공 등
20개의 질병 중 어느 질병인지 판독

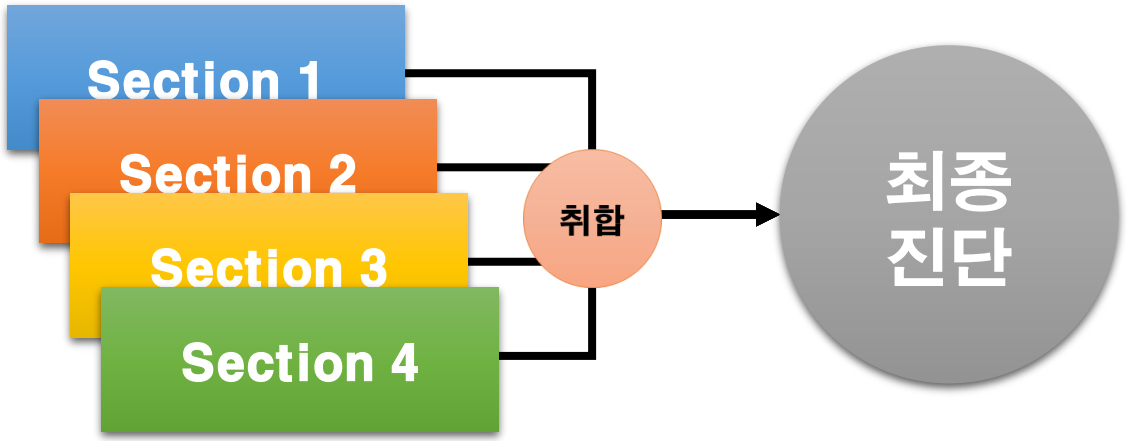
약 83%

정확도

Section 1

황반변성, 상피막, 황반원공 등
20개의 질병 중 어느 질병인지 판독

약 83%



약 85%

감사합니다

국가수리과학연구소
National Institute for Mathematical Sciences

부산의료수학센터