

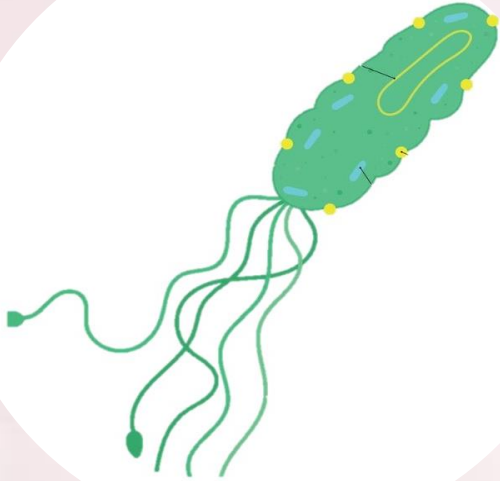
The background is a light pink gradient with a bokeh effect of white circles. Scattered around the text are several medical-themed icons: two red capsules (one top-left, one top-right), a blue virus-like sphere with spikes (top-center), a cluster of red spheres (top-right), a cluster of blue spheres (bottom-left), a red capsule (bottom-center), a blue capsule (bottom-right), a red virus-like sphere with spikes (bottom-right), and a red capsule (bottom-right).

Machine-Learning-Guided Diagnosis for Helicobacter Pylori

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Helicobacter Pylori

- Bacteria colonizes stomach
- 40% global incidence
- Often asymptomatic
- 10-20% develop ulcerus
- 0.5-2% develop stomach cancer



Diagnosis of H.pylori



Use case:

symptoms of stomach infection
or high genetic risk of stomach cancer



Methods:

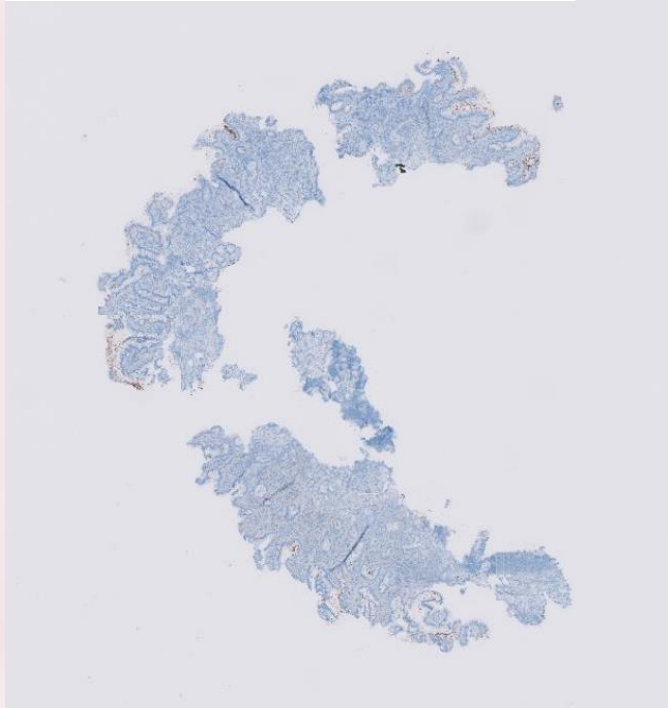
Stomach biopsy or antibody detection in blood



Treatment:

Patients receive antibiotics

Biopsy analysis is time consuming

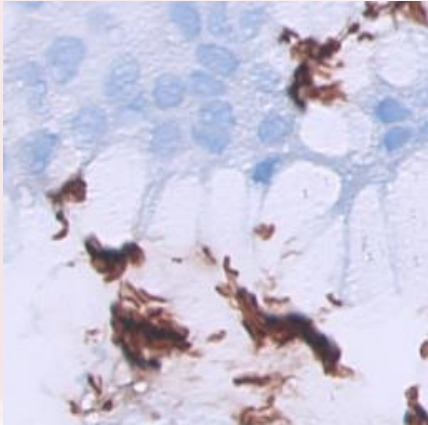


- samples of gastric mucosa
- very large images (120000 x 16000 pixels)

Biopsy analysis is time consuming

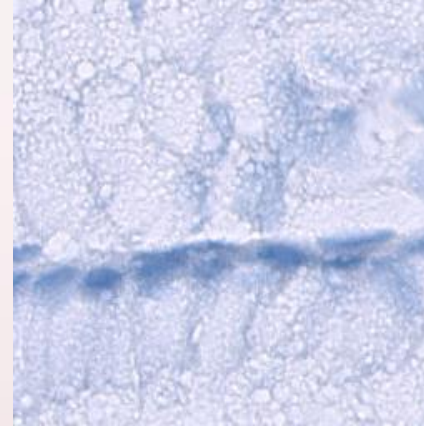
Infected tissue

Immunostained H.Pylori are visible as dark brown spots

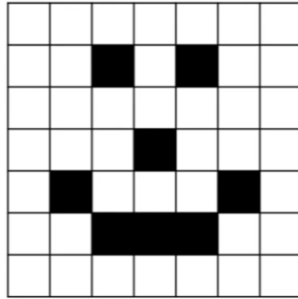


Healthy tissue

Tissue is free of H.Pylori



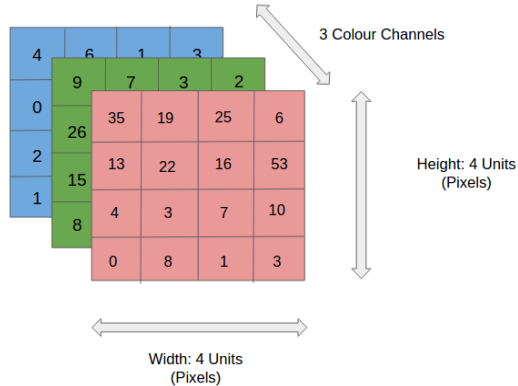
Pictures are just grids of numbers



0	0	0	0	0	0	0
0	1	0	0	0	1	0
0	0	0	0	0	0	0
0	0	0	1	0	0	0
0	1	0	0	0	1	0
0	0	1	1	1	0	0
0	0	0	0	0	0	0



Pictures is grid of pixels. Each pixel contains number, eg for grayscale



Often >1 grid per picture to encode colour

Convolutional operations

original



convolved



Original image



Yellow pixels suppressed



Method:

Apply specialized filters (kernels) to each pixel

Function:

Extract features like edges, textures & shapes.

Mathematics of kernels

Source layer

5	2	6	8	2	0	1	2
4	3	4	5	1	9	6	3
3	9	2	4	7	7	6	9
1	3	4	6	8	2	2	1
8	4	6	2	3	1	8	8
5	8	9	0	1	0	2	3
9	2	6	6	3	6	2	1
9	8	8	2	6	3	4	5

Convolutional
kernel

-1	0	1
2	1	2
1	-2	0

Destination layer

	5						

$$\begin{aligned} &(-1 \times 5) + (0 \times 2) + (1 \times 6) + \\ &(2 \times 4) + (1 \times 3) + (2 \times 4) + \\ &(1 \times 3) + (-2 \times 9) + (0 \times 2) = 5 \end{aligned}$$

Examples of kernels

Original

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$



Blur

$$\frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

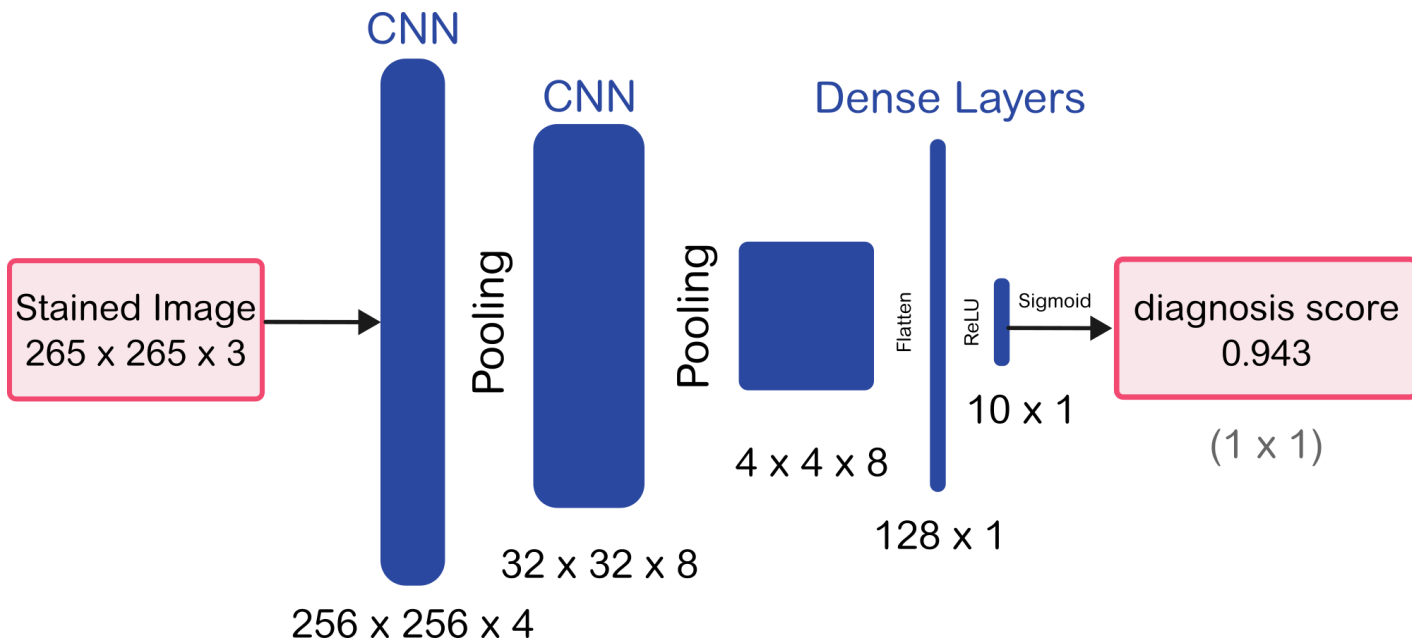


Edge Detection

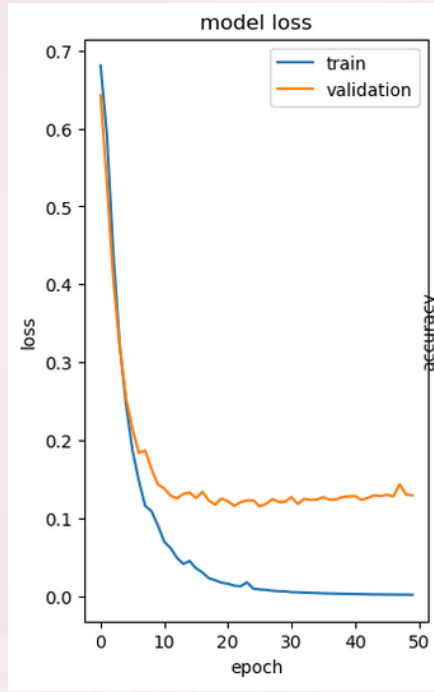
$$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$



Network Design



Training



<https://api.wandb.ai/links/rejio-universitat-aut-noma-de-barcelona/z8gdzvj4>

val_loss

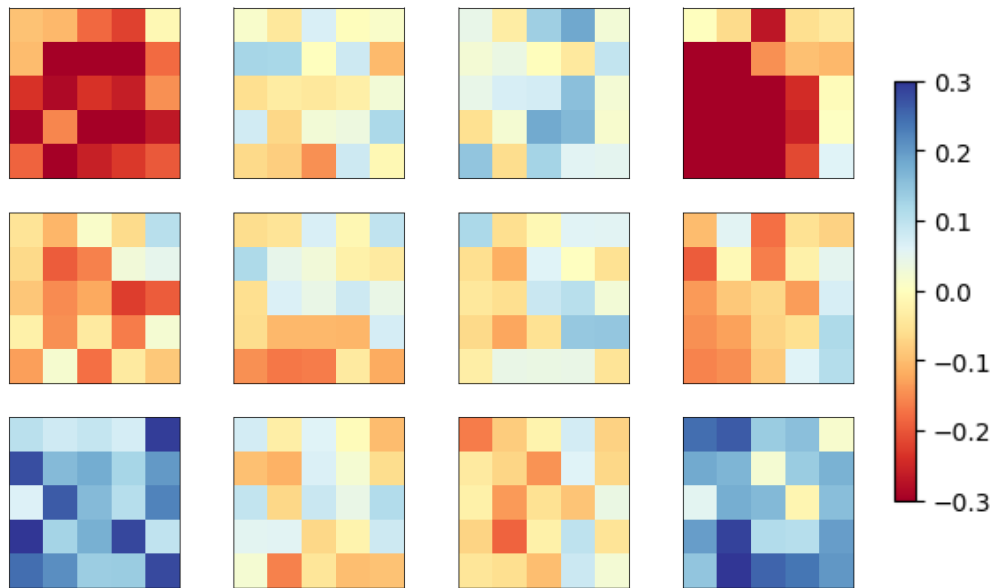
— 20241115_190532_103716_4 — 20241115_190532_103716_3 — 20241115_190532_103716_2 — 20241115_190532_103716_1 — 20241115_190532_103716_0

Training



Trained Kernels

- Kernels of first convolutional layer



Training Results

- 2400 samples for training
- 600 samples for evaluation
- 120 patients for training
- 30 patients for evaluation

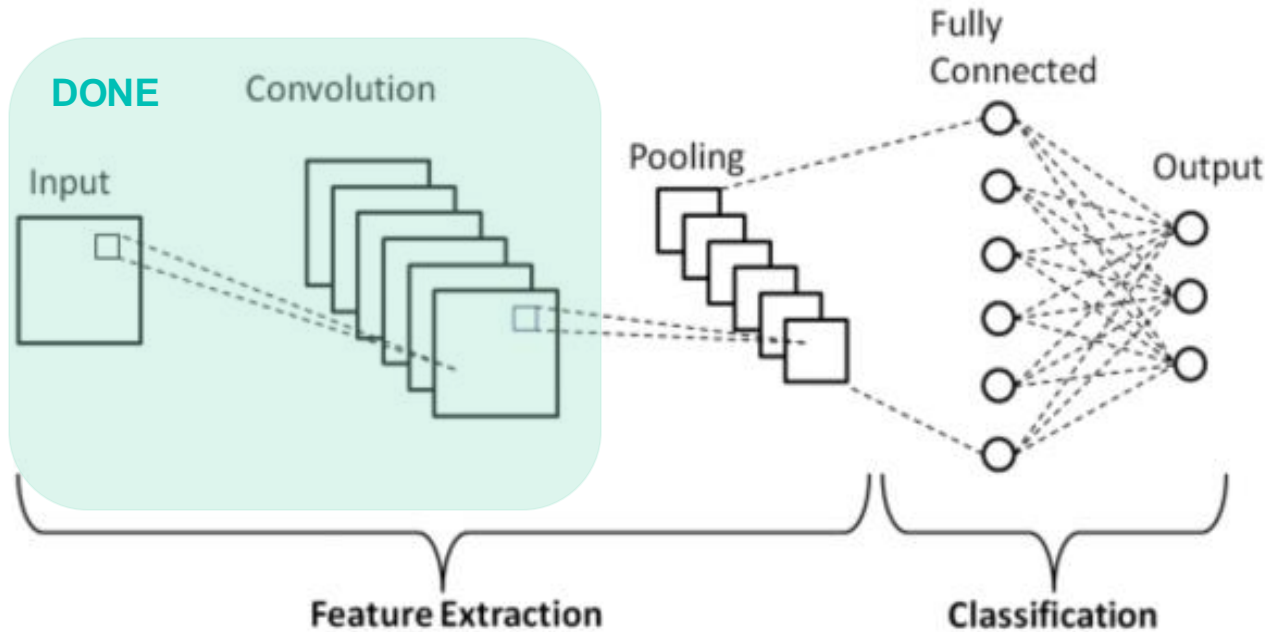
[eval]	neg diagnosis	pos diagnosis
healthy	53 % ± 12	3,5 % ± 3,5
sick	2,4 % ± 1,1	41 % ± 10

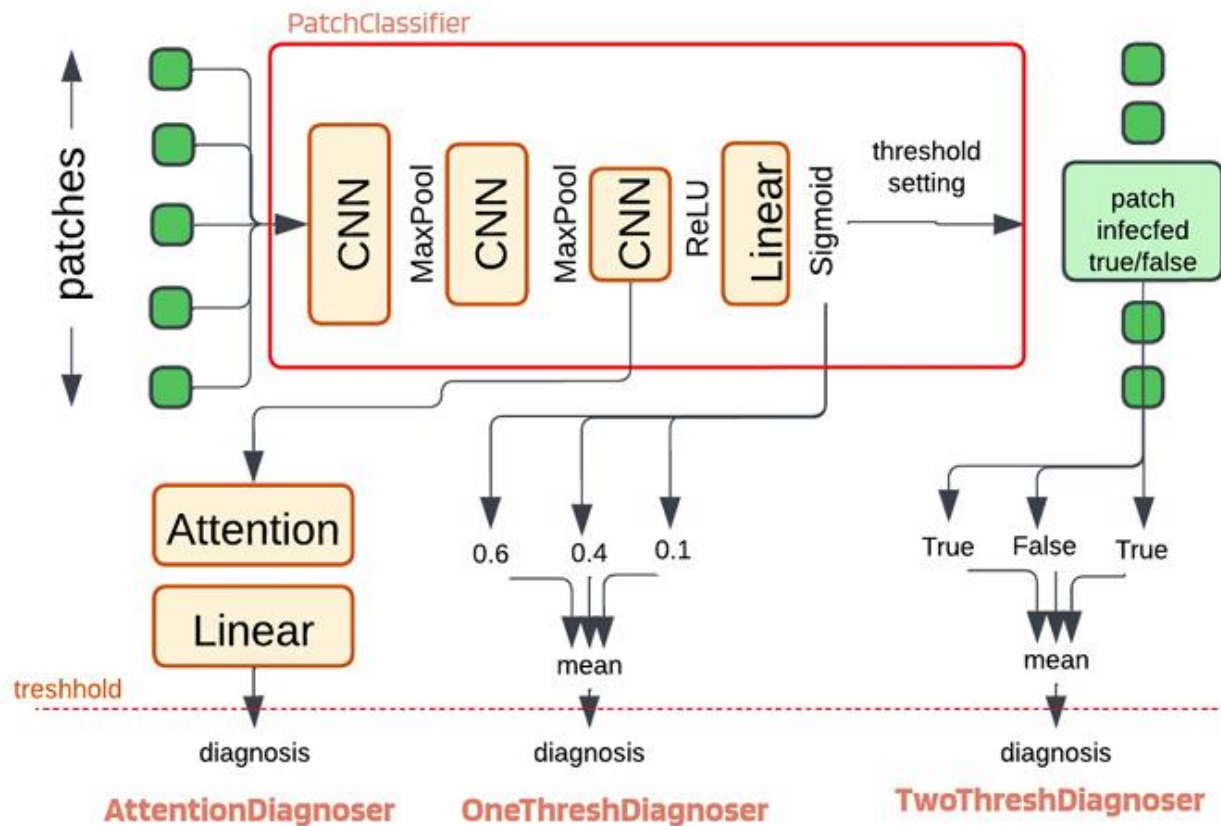
$$\frac{\text{correct diagnoses}}{\text{all diagnoses}} = 94 \% \pm 4$$

The background is a light pink color with a bokeh effect of white and pink circles. Scattered around the text are several medical-themed icons: two blue capsules at the top, a red and white capsule on the left, a red and white capsule at the bottom, a cluster of red spheres in the top right, a blue virus-like sphere with spikes on the right, and a red virus-like sphere with spikes in the bottom right.

**Thanks for your
Attention**

Next: dimension reduction via pooling





test-Cropped / HoldOut	Attention Diagnoser	OneThresh Diagnoser	TwoThresh Diagnoser	Distribution Diagnoser
Accuracy	90% \pm 5% / 84% \pm 2%	92% \pm 3% / 85% \pm 2%	92% \pm 2% / 85% \pm 1%	91 % \pm 3 % / 84 % \pm 2 %
Precision	89% \pm 8% / 95% \pm 3%	92% \pm 6% / 93% \pm 3%	93% \pm 7% / 94% \pm 3%	93 % \pm 8 % / 95 % \pm 5 %
Positive Recall	92% \pm 5% / 73% \pm 4%	92% \pm 4% / 76% \pm 3%	91% \pm 4% / 75% \pm 3%	88 % \pm 5 % / 73 % \pm 3 %
Negative Recall	87% \pm 11% / 96% \pm 3%	92% \pm 6% / 94% \pm 3%	94% \pm 7% / 95% \pm 3%	94 % \pm 7 % / 96 % \pm 4 %
F1	90% \pm 5% / 82% \pm 2%	92% \pm 3% / 83% \pm 2%	92% \pm 2% / 84% \pm 2%	90 % \pm 5 % 82 % \pm 2 %