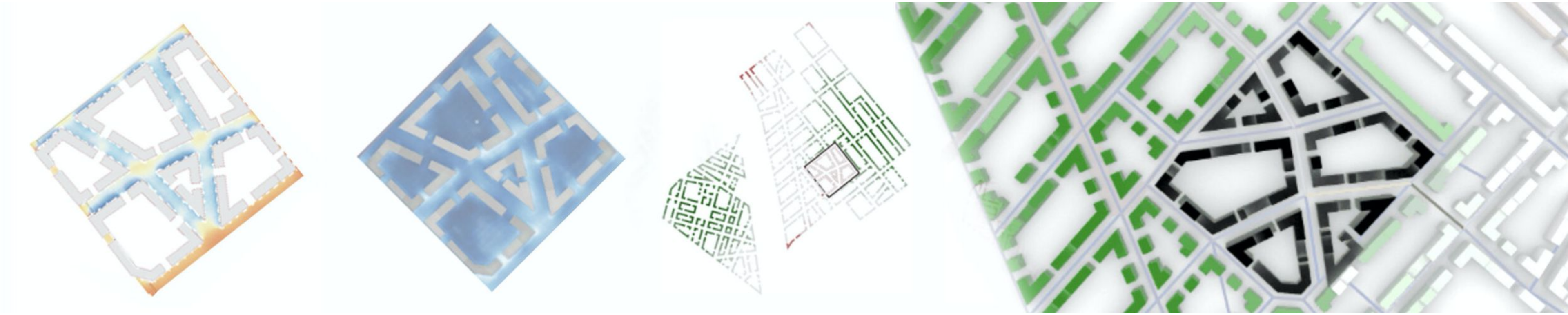
Artificial Intelligence for resilient urban planning



CITY INTELLIGENCE LAB

Day 2 (Mon 29th)

Name	Room	Time (GMT)	Description
Talk: Intro	Webinar	10:00 - 10:05	Recap + today's schedule
Talk: Intro to Computer Vision	Webinar	10:05 - 10:20	How do computers make sense out of images using convolutional neural networks?
Demo: Semantic Segmentation	Webinar	10:20 - 10:35	Introduction to semantic segmentation in Colab and how to use it on your own images
Demo: Style Transfer	Webinar	10:35 - 10:50	Introduction to style transfer in Colab and how to use it on your own images
Demo: pix2pix in GH	Webinar	10;50 - 11:20	Introduction of the pix2pix model and demo on how to integrate it into GH workflow
Demo: DQL in GH	Webinar	11:20 - 11:50	Introduction of the DQL model and demo on how to integrate it into GH workflow
Talk: Summary	Webinar	11:50 - 12:00	Overview and summary of models
Break	break	12:00 - 12:15	-
Exercise: Project Work	Meeting	12:15 - 13:30	In breakout rooms with advisory supervision
Presentation: Refined Pitches	Webinar	13:30 - 14:00	Update presentation from groups

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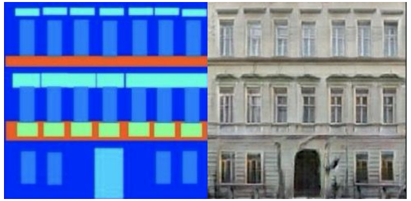
Convolutional Neural Networks and how computers see images

Convolutional Neural Networks and how computers see images

Generative Adversarial Networks (GAN)

Pix2pix

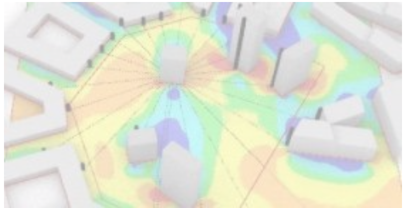
Generates new images based on an input image



Reinforcement learning (RL)

Deep-Q-learning

Trains a decision making and strategy developing agent



Convolutional Neural Networks (CNN)

Mask R-CNN model

Finds and labels objects in images

Generative Adversarial Networks (GAN)

Style Transfer

Changes the look of images based on a reference image

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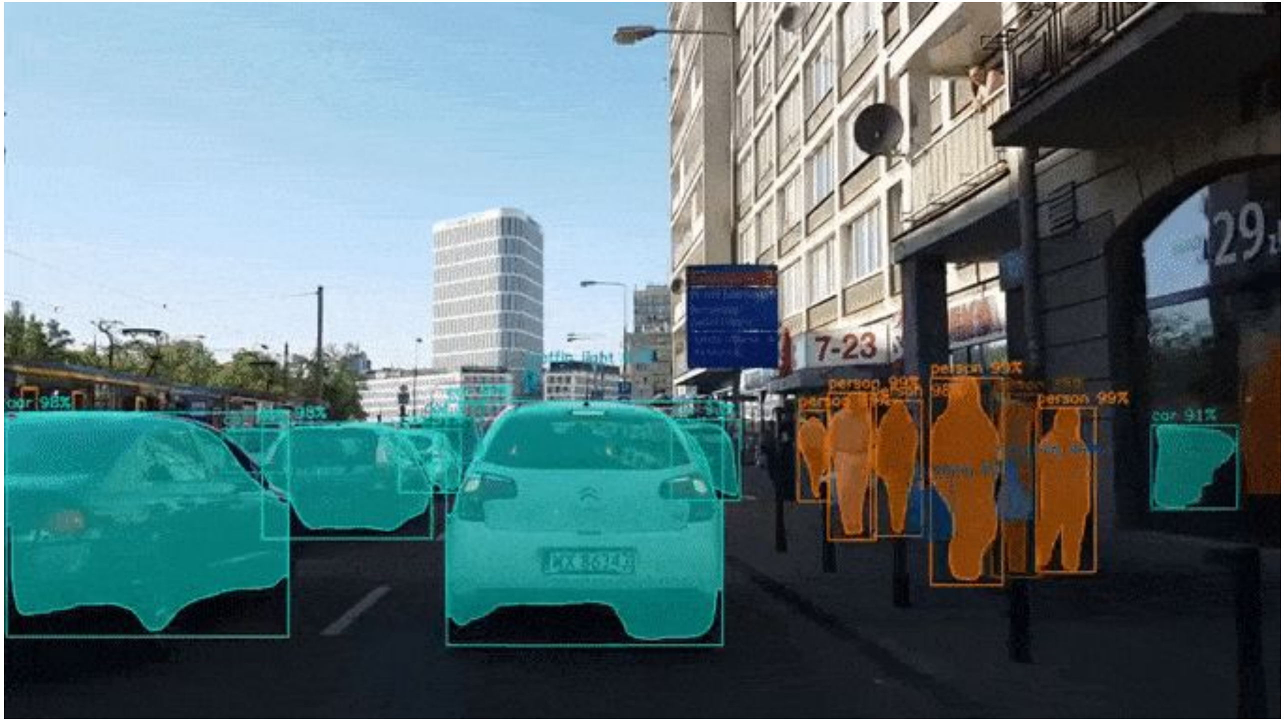
Convolutional Neural Networks and how computers see images



https://github.com/matterport/Mask_RCNN

Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES

```
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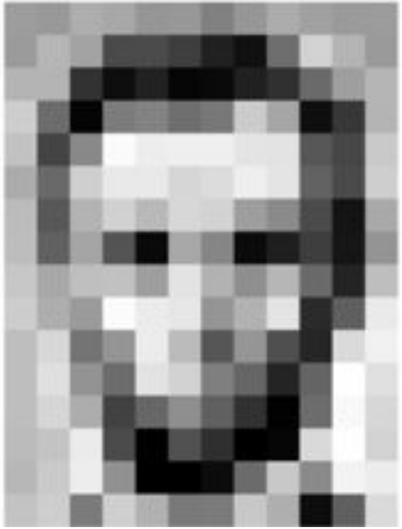
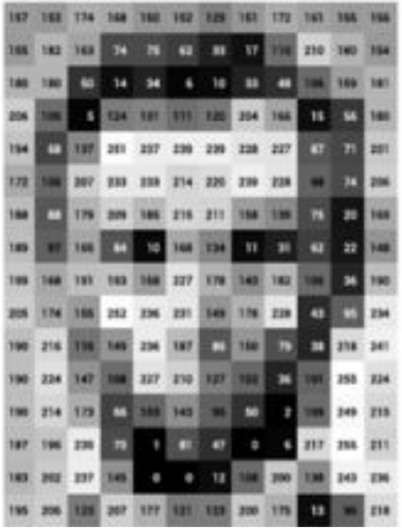
Convolutional Neural Networks and how computers see images

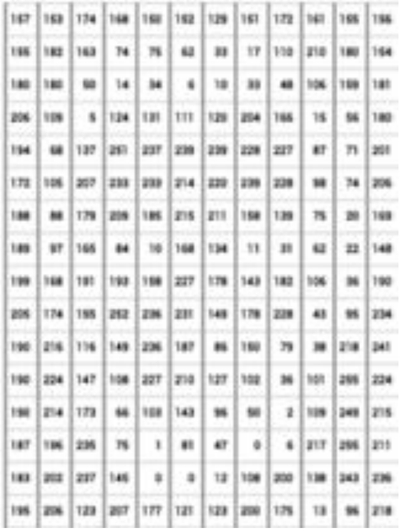
HOW COMPUTERS SEE IMAGES



Pixels and colors



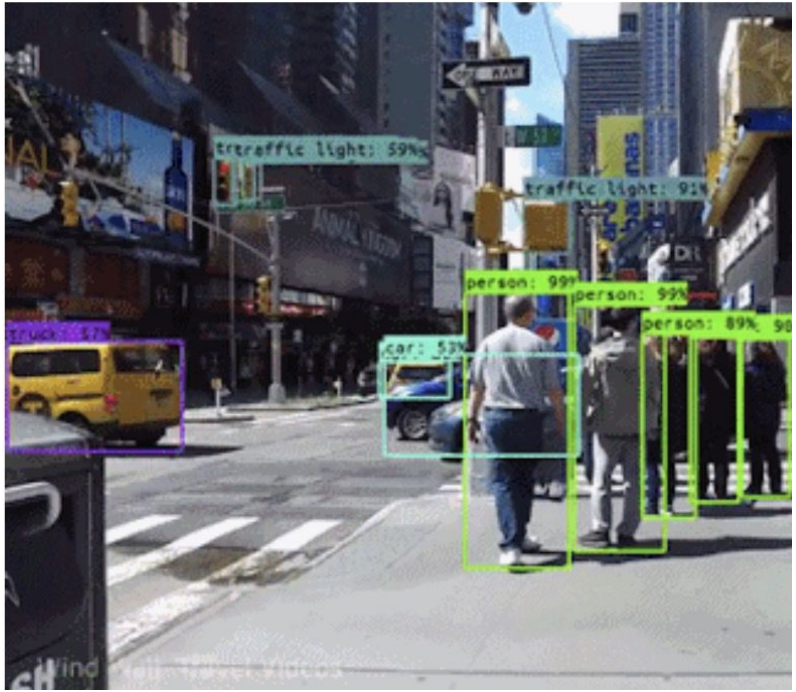
An array of numbers

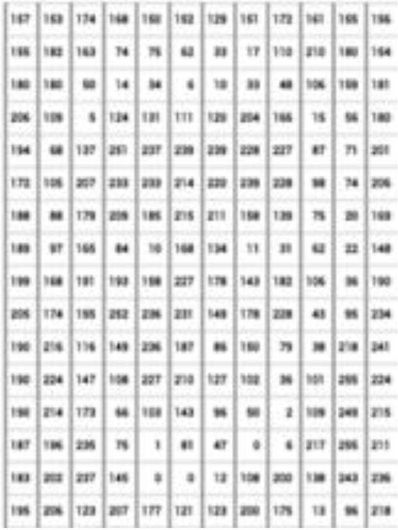


A string of numbers

Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES

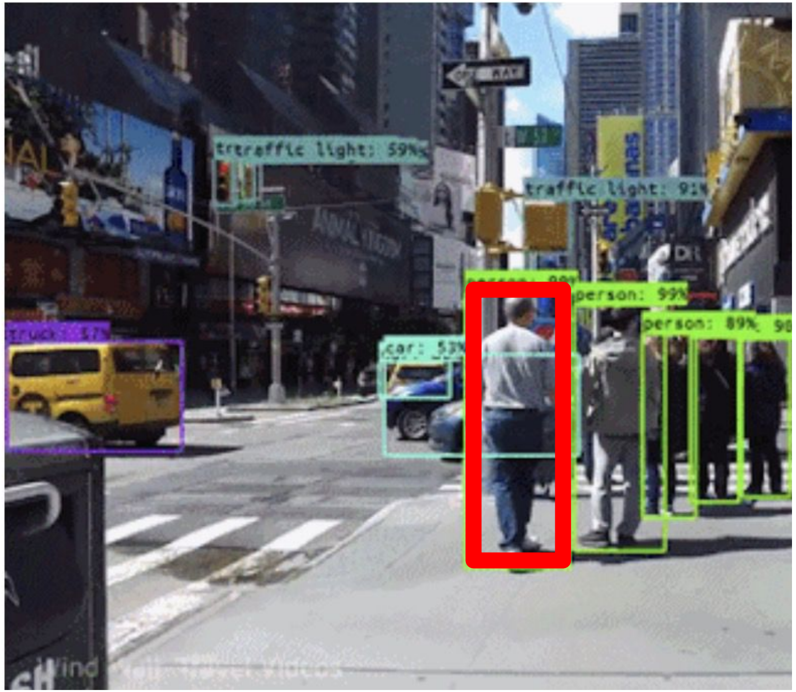


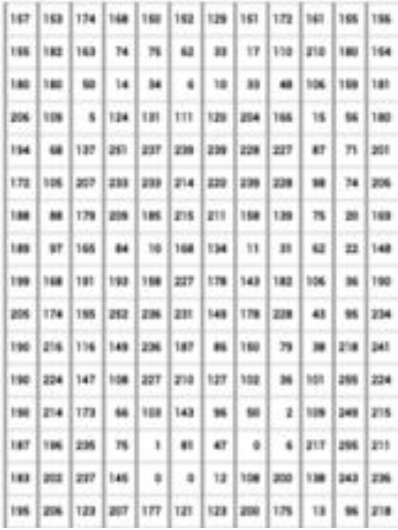


A string of numbers

Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES

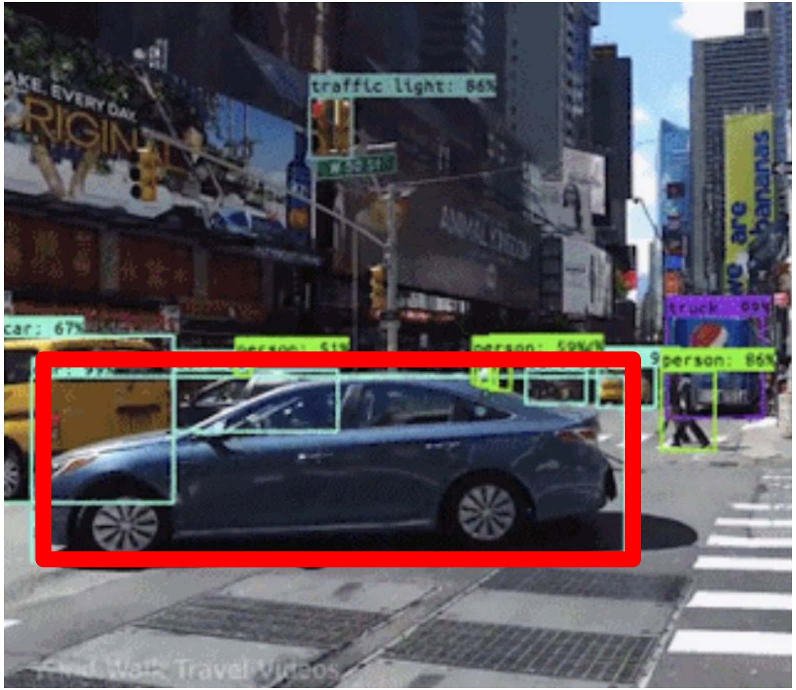


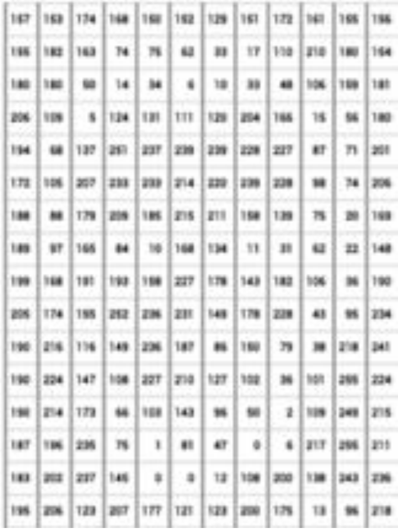


A string of numbers

Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES

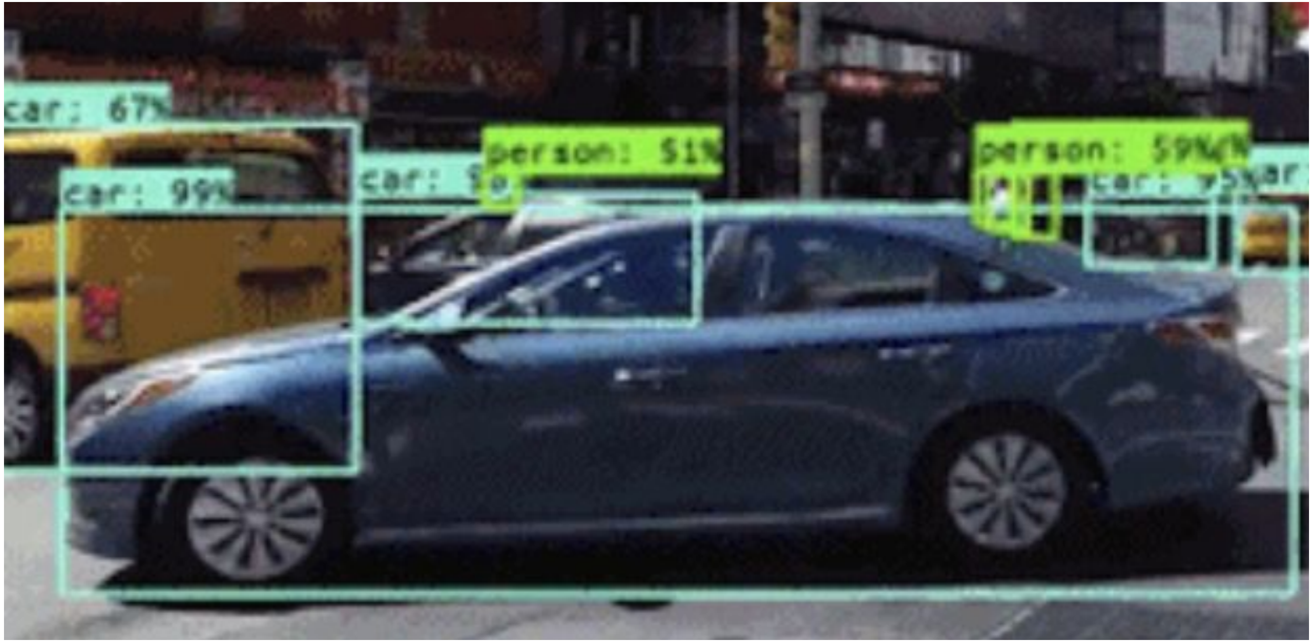




A string of numbers

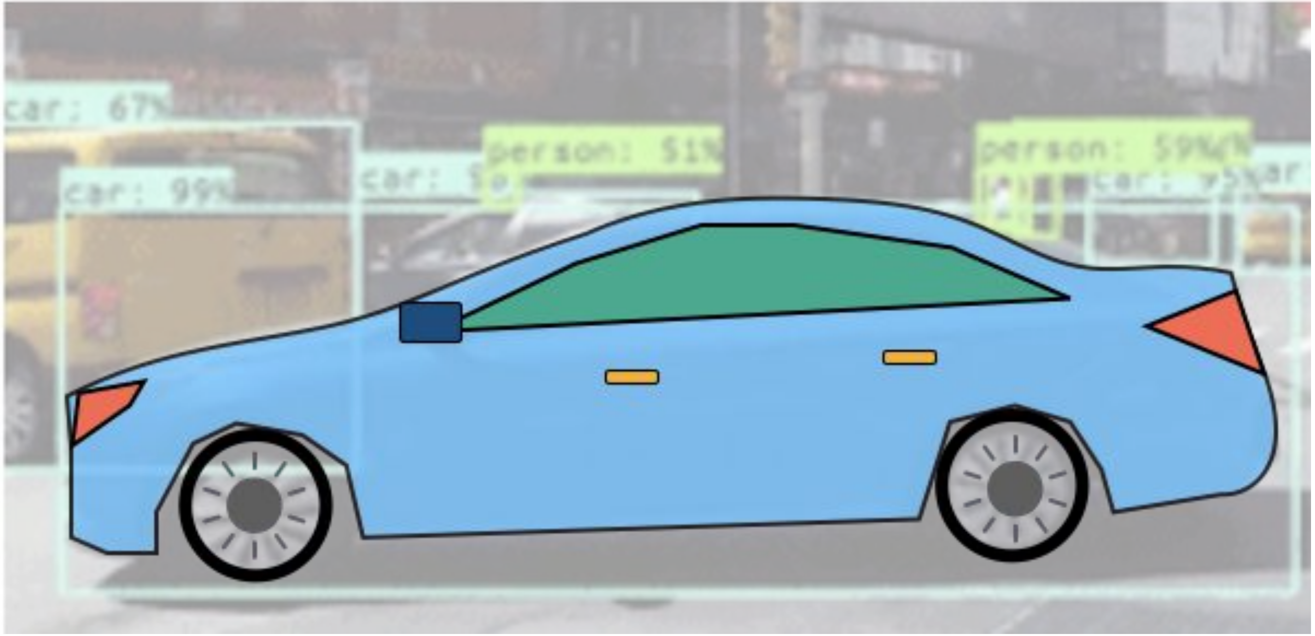
Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



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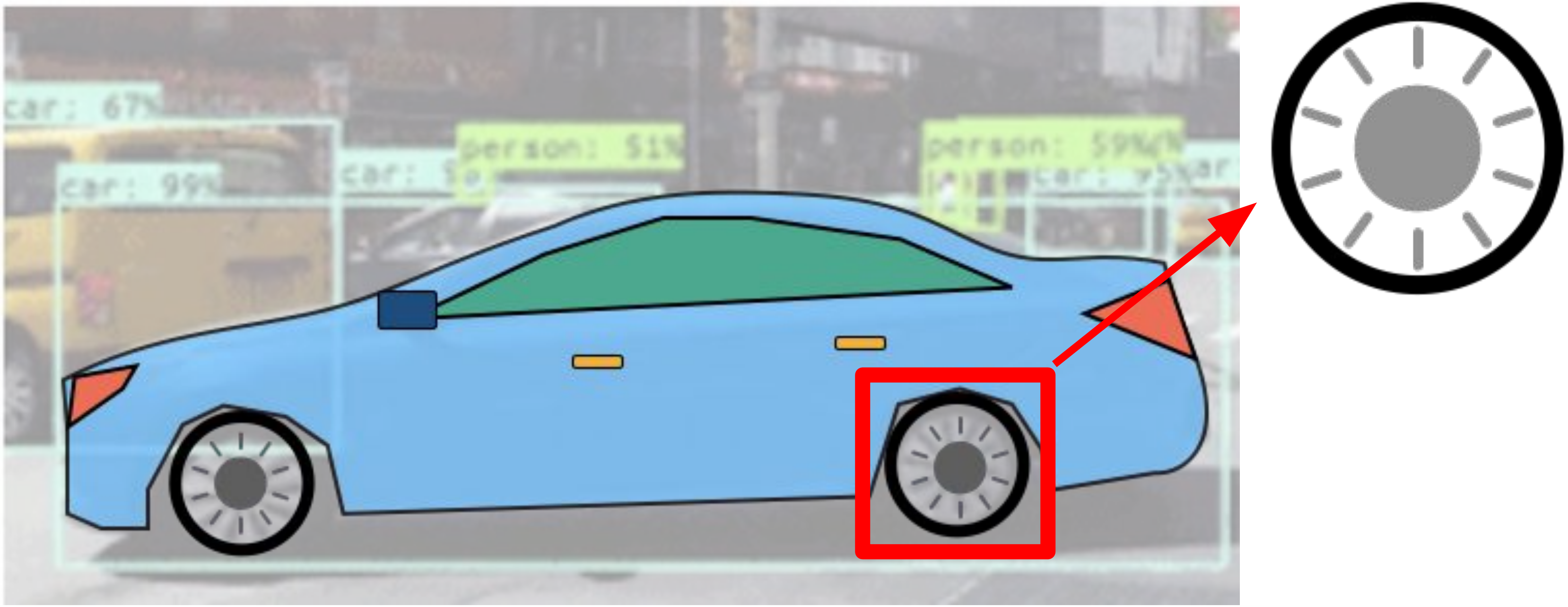
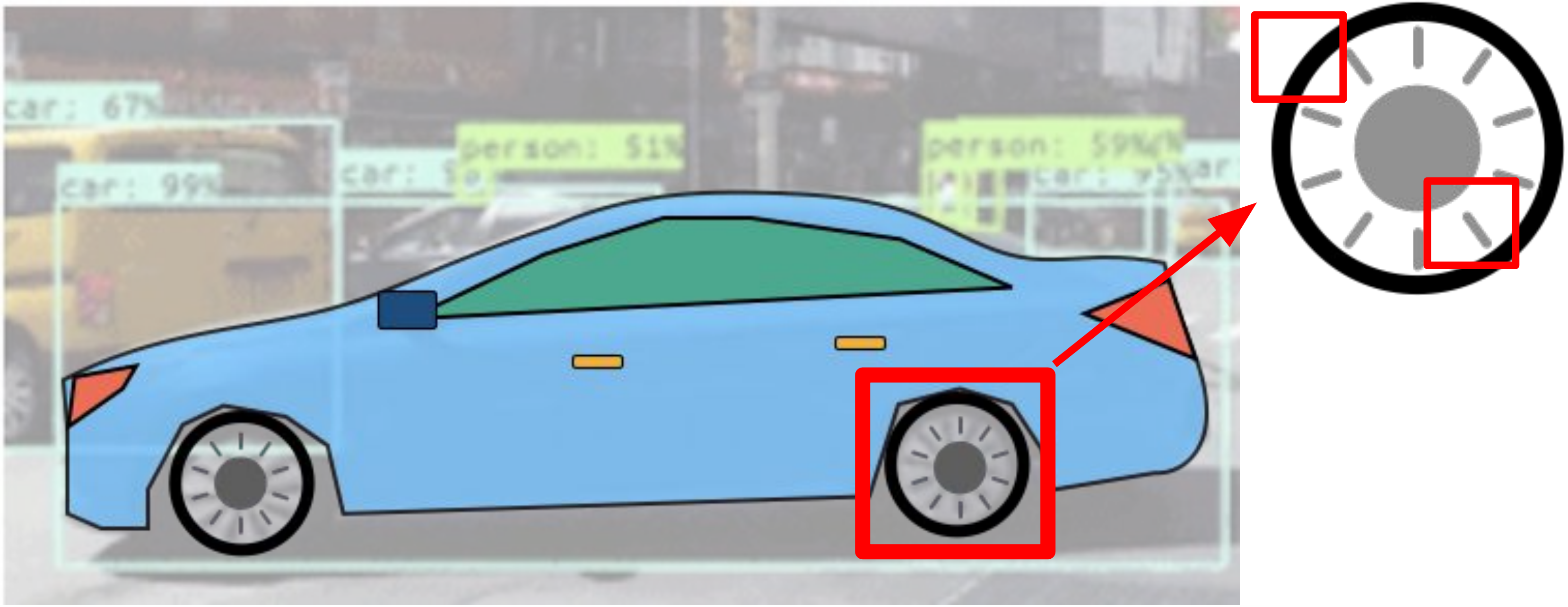
Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



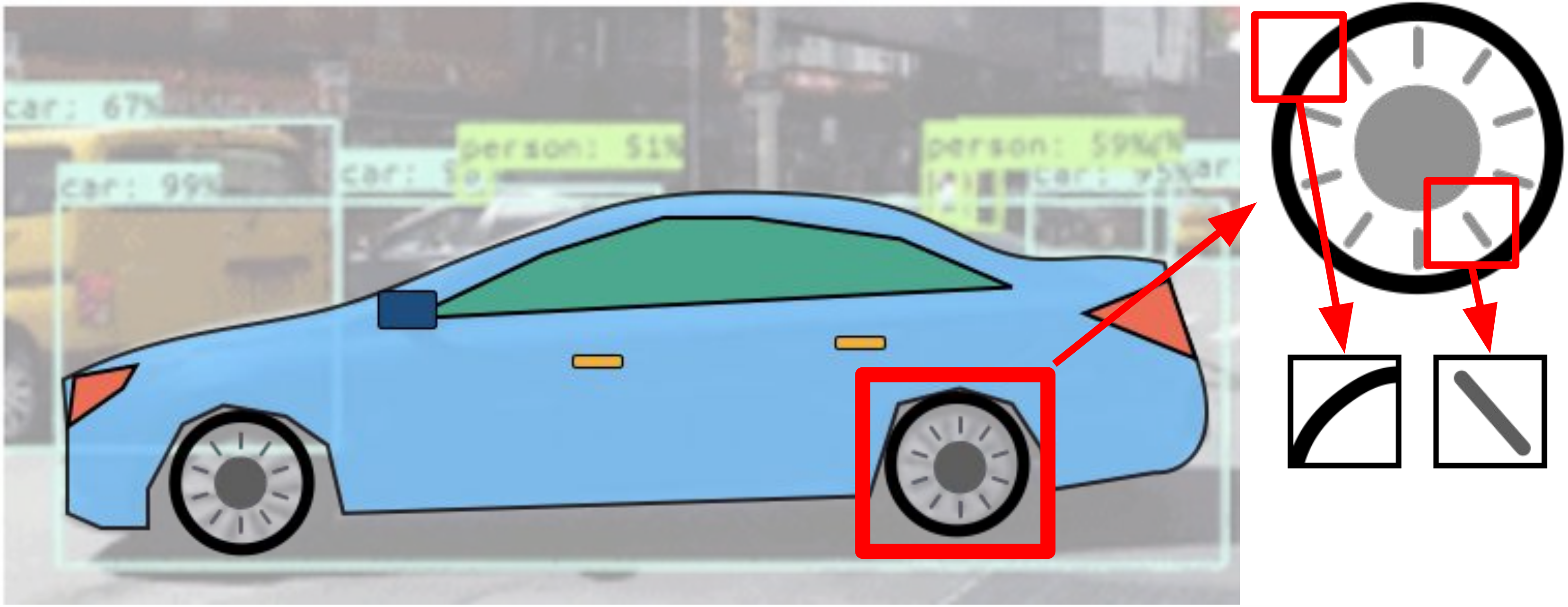
Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



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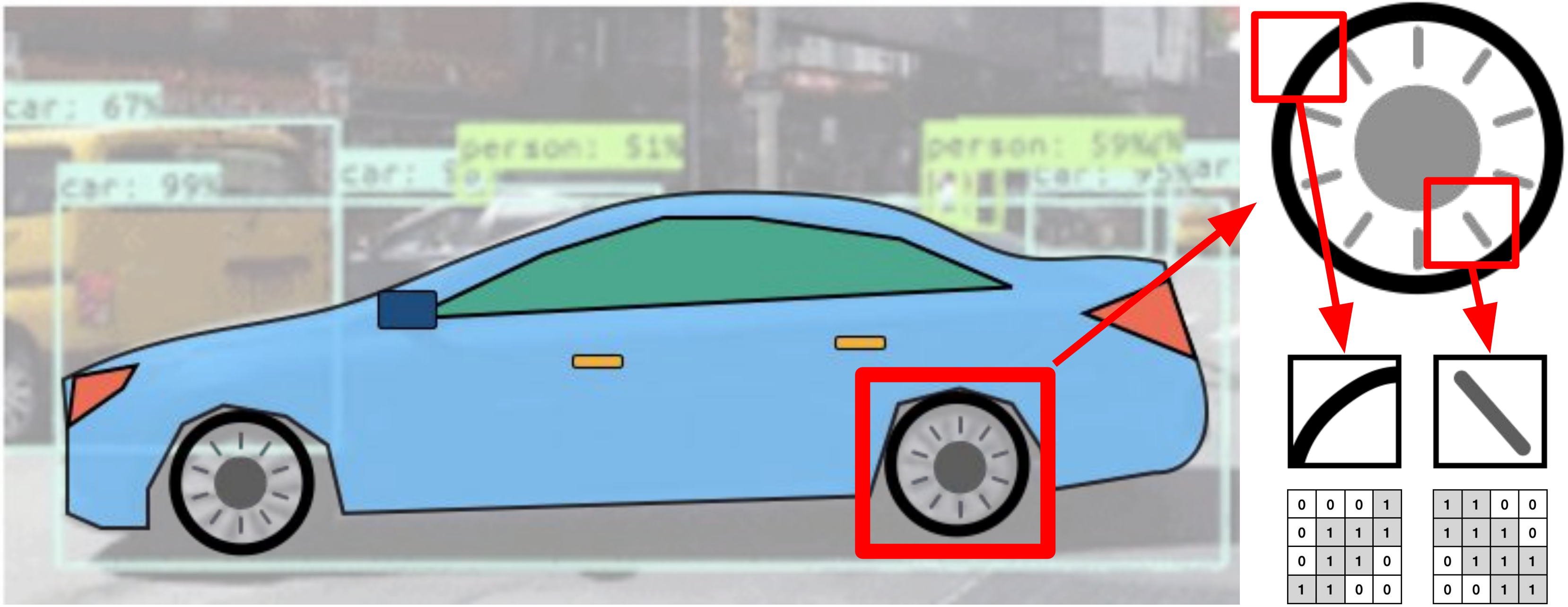
Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES

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

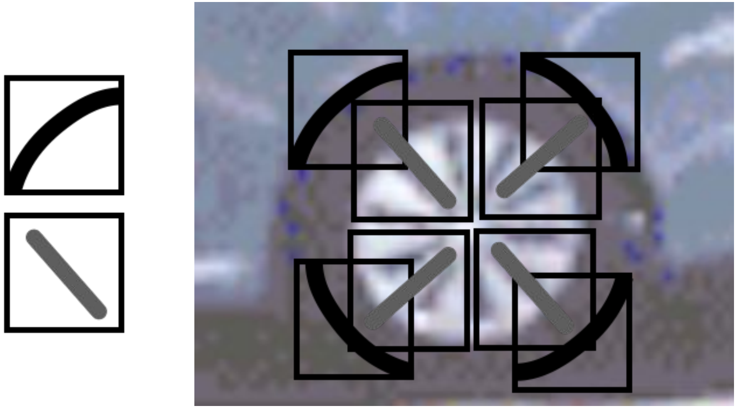
1	1	0	0
1	1	1	0
0	1	1	1
0	0	1	1

Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES

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

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

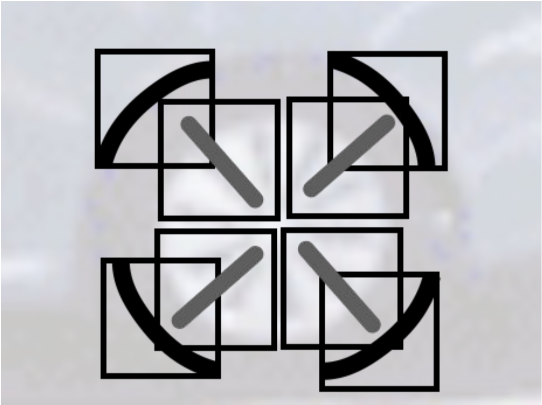


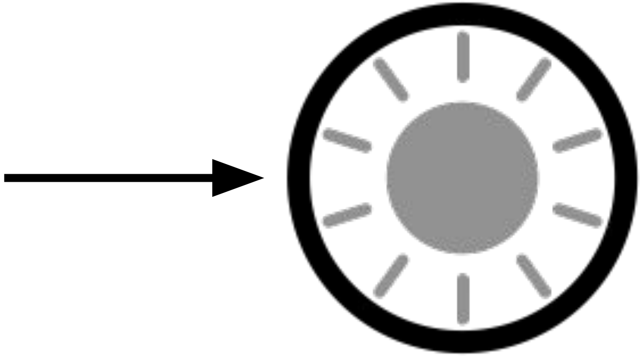
Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES

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

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

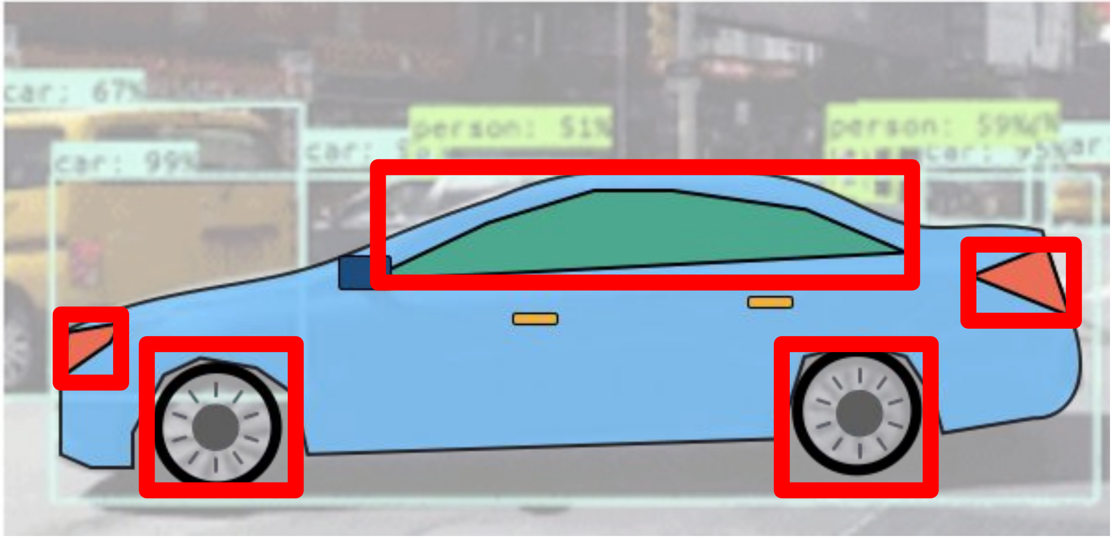




This is probably
a wheel

Convolutional Neural Networks and how computers see images

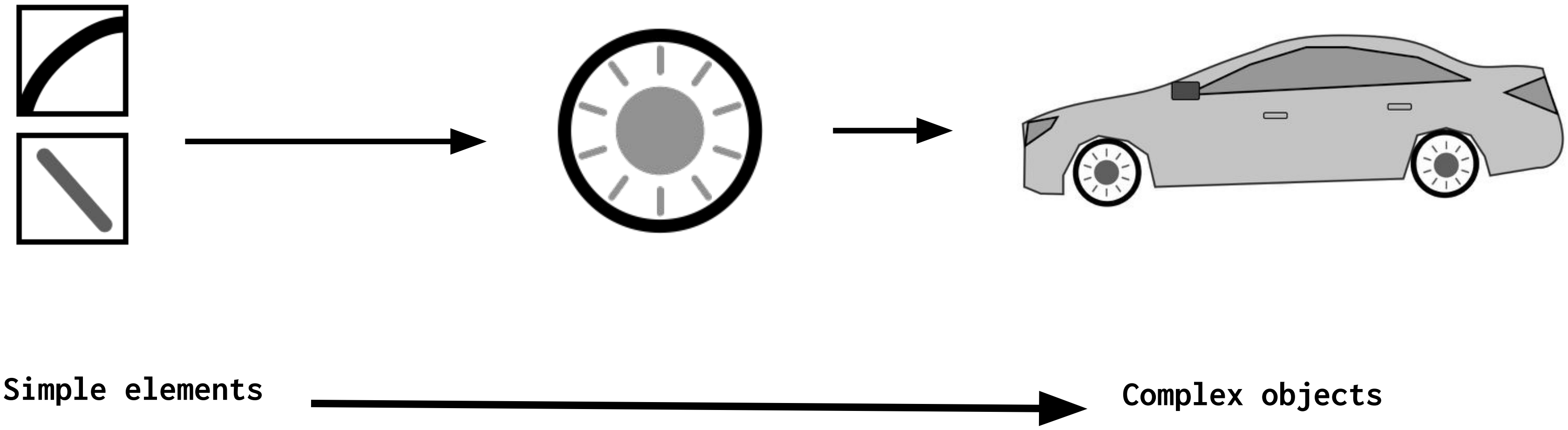
HOW COMPUTERS SEE IMAGES



Two wheels, door handles, carrosserie, windows, lights → This is probably a Car

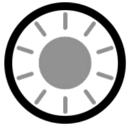
Convolutional Neural Networks and how computers see images

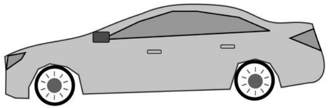
HOW COMPUTERS SEE IMAGES

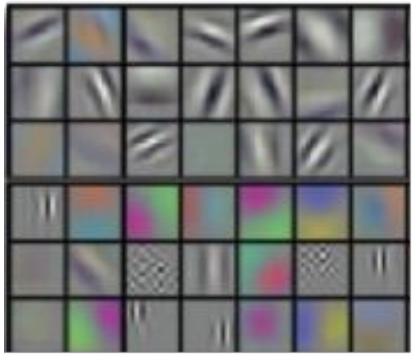


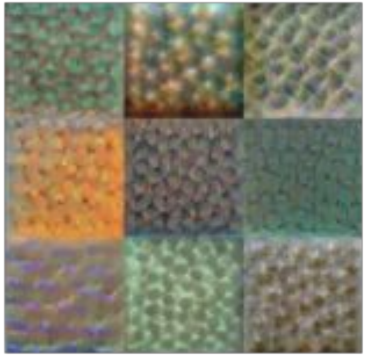
Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES

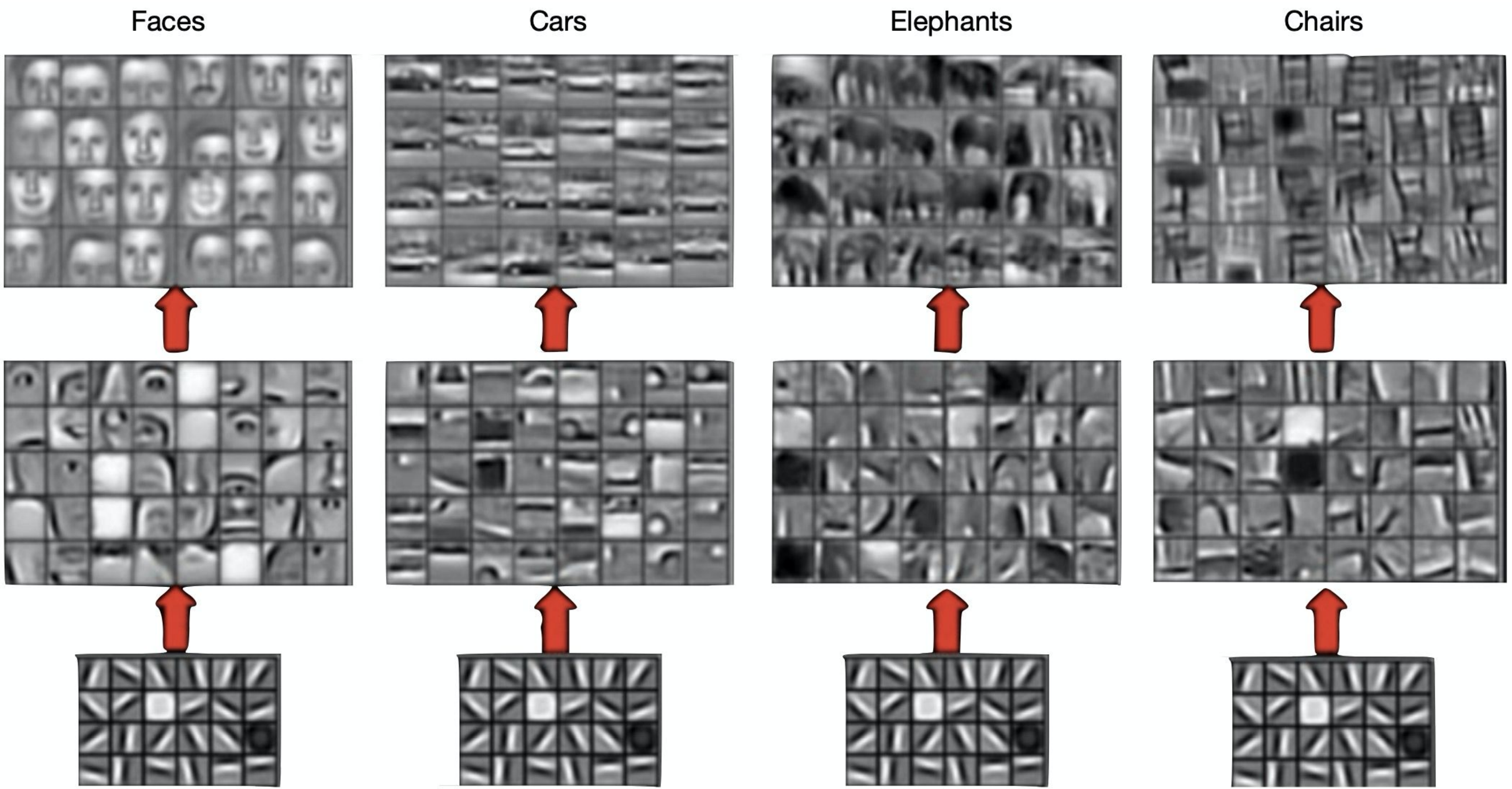






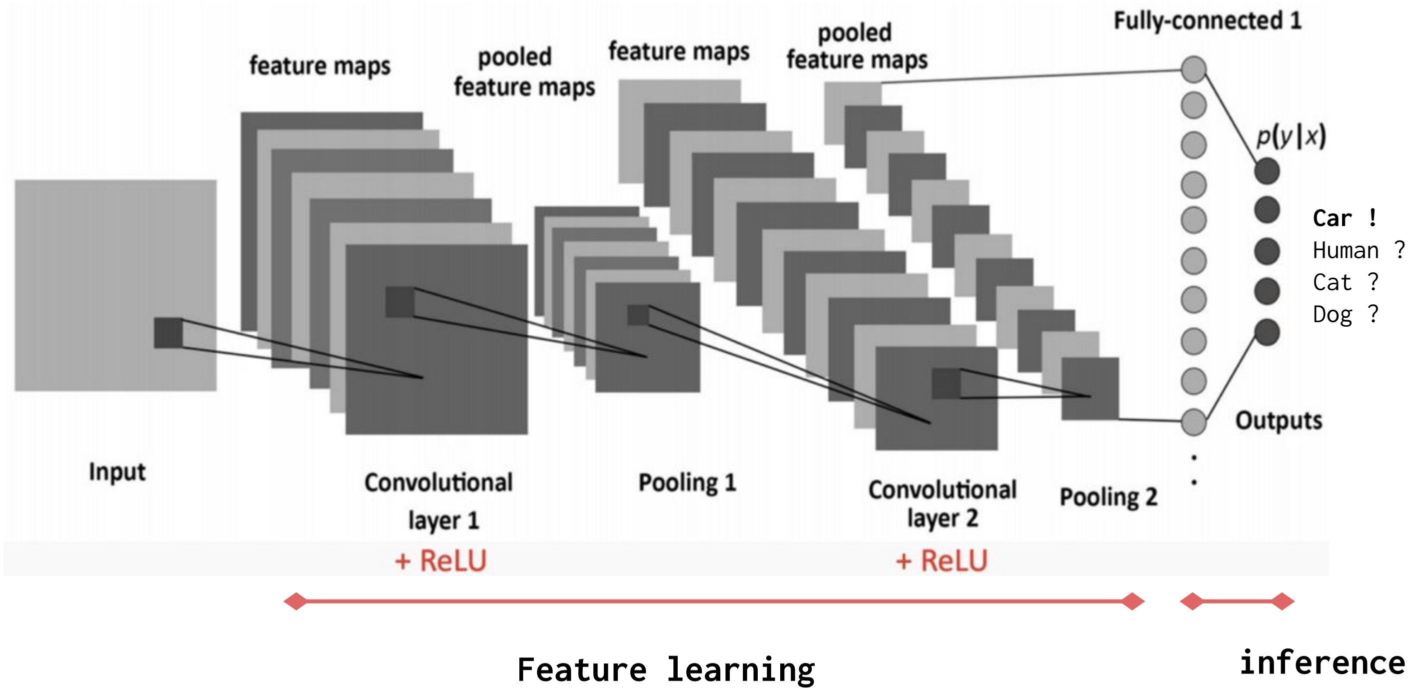


Simple elements → Complex objects


Faces
Cars
Elephants
Chairs

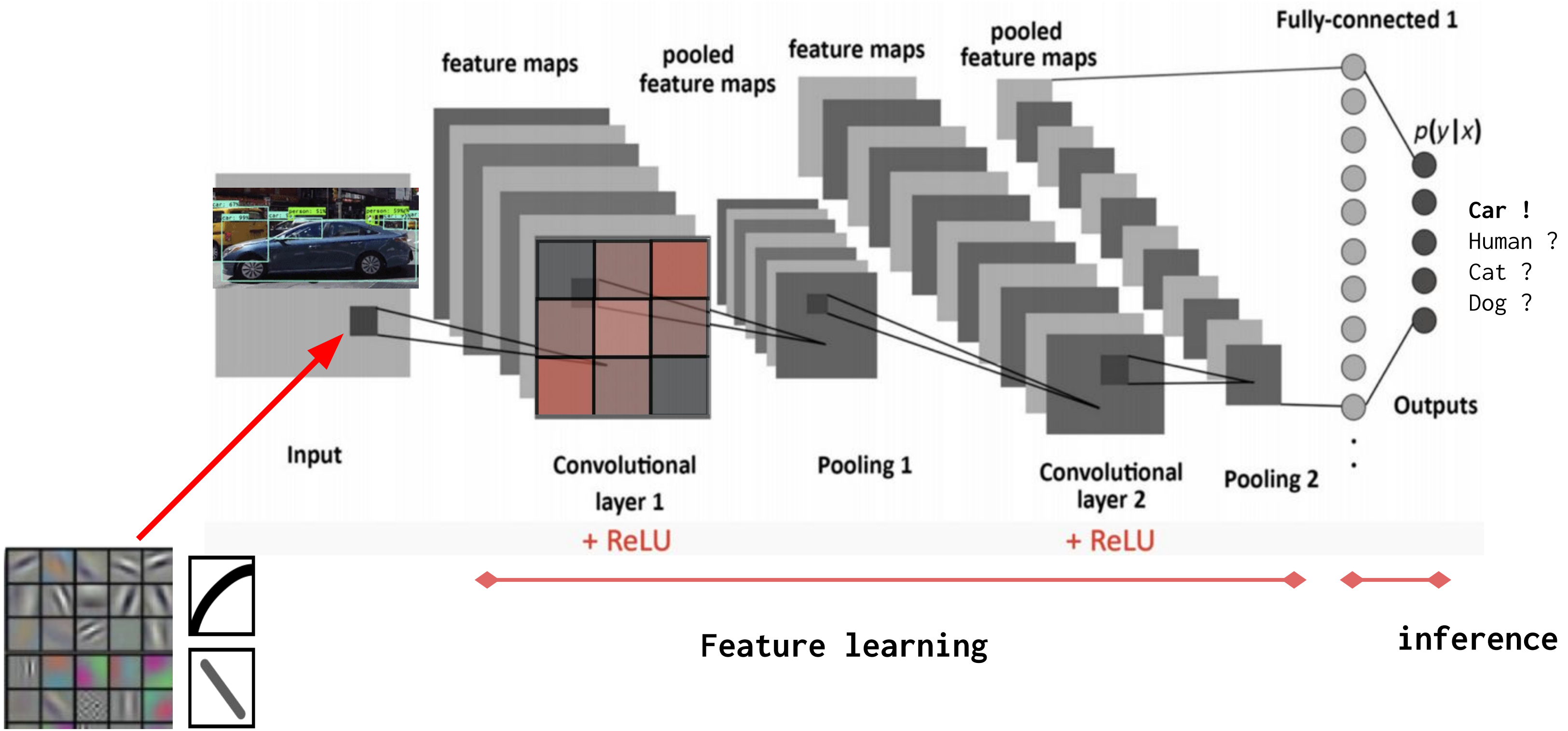
Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



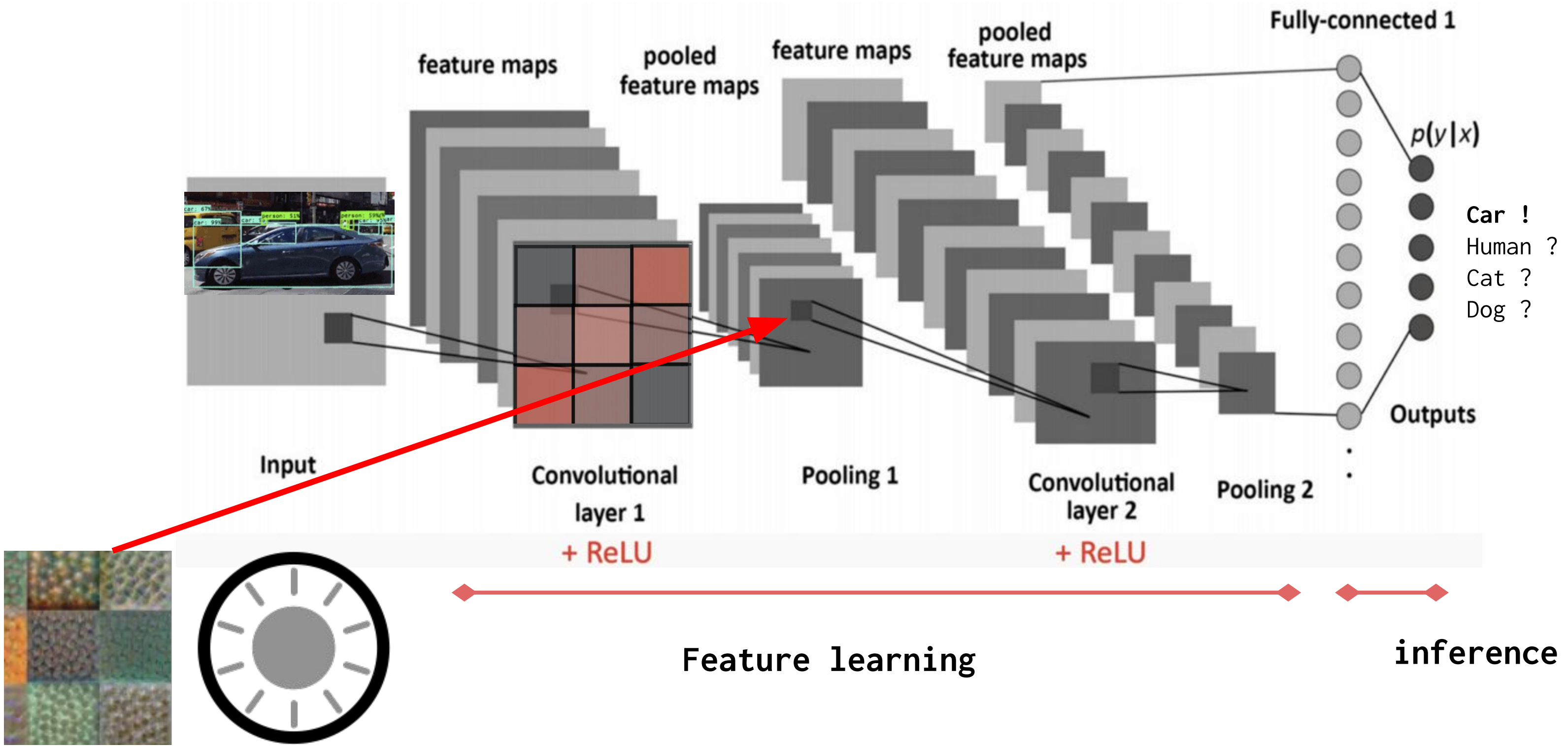
Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



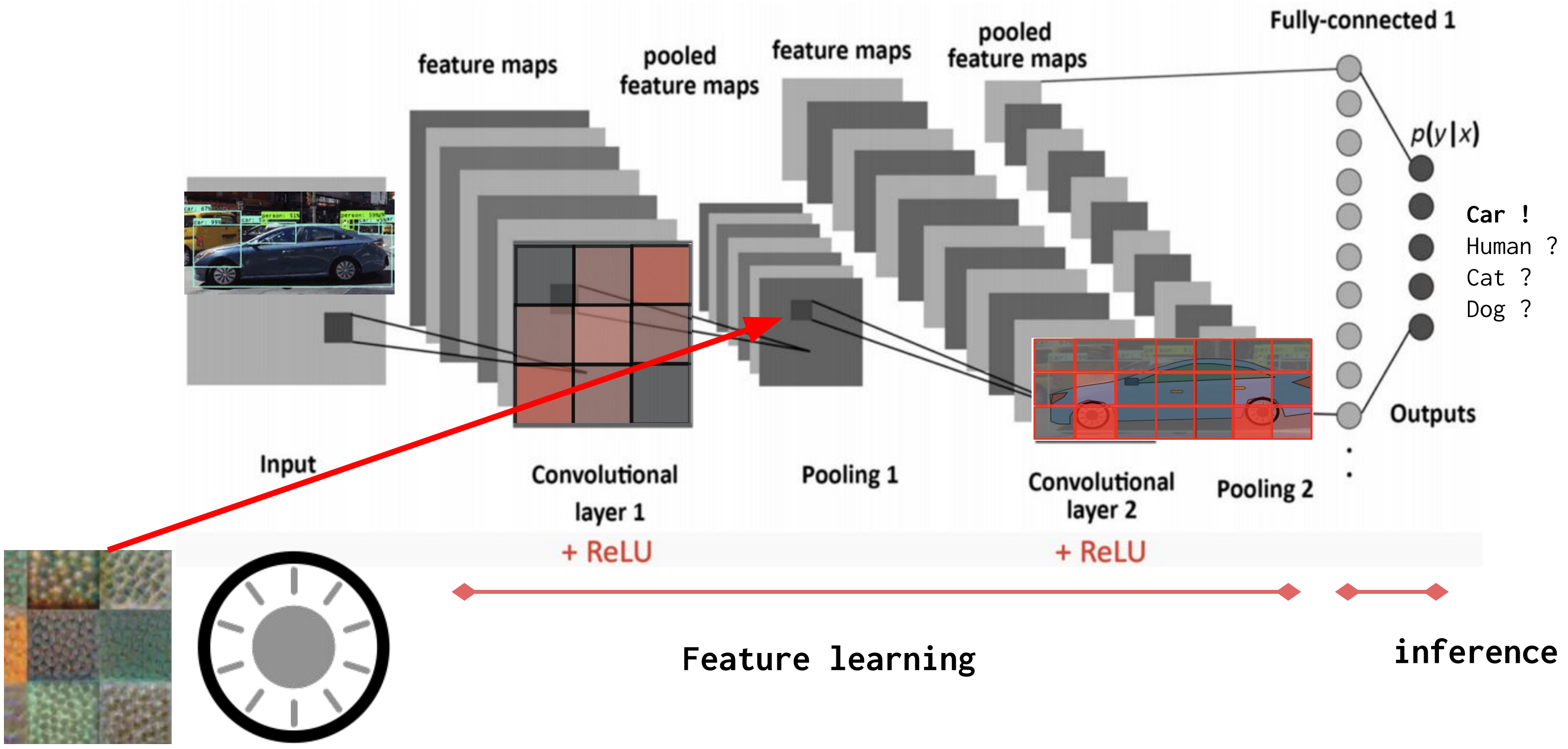
Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



Convolutional Neural Networks and how computer see images

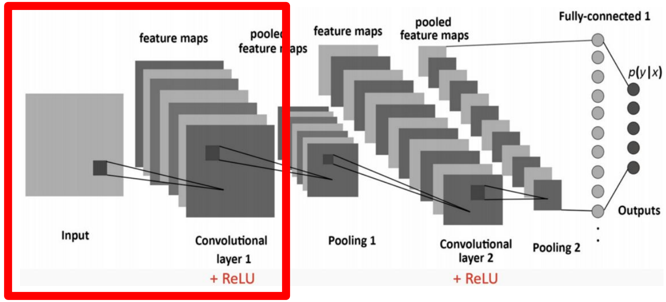
CONVOLUTION

-1	1	1	-1
1	-1	-1	1
1	1	1	1
1	-1	-1	1

Image

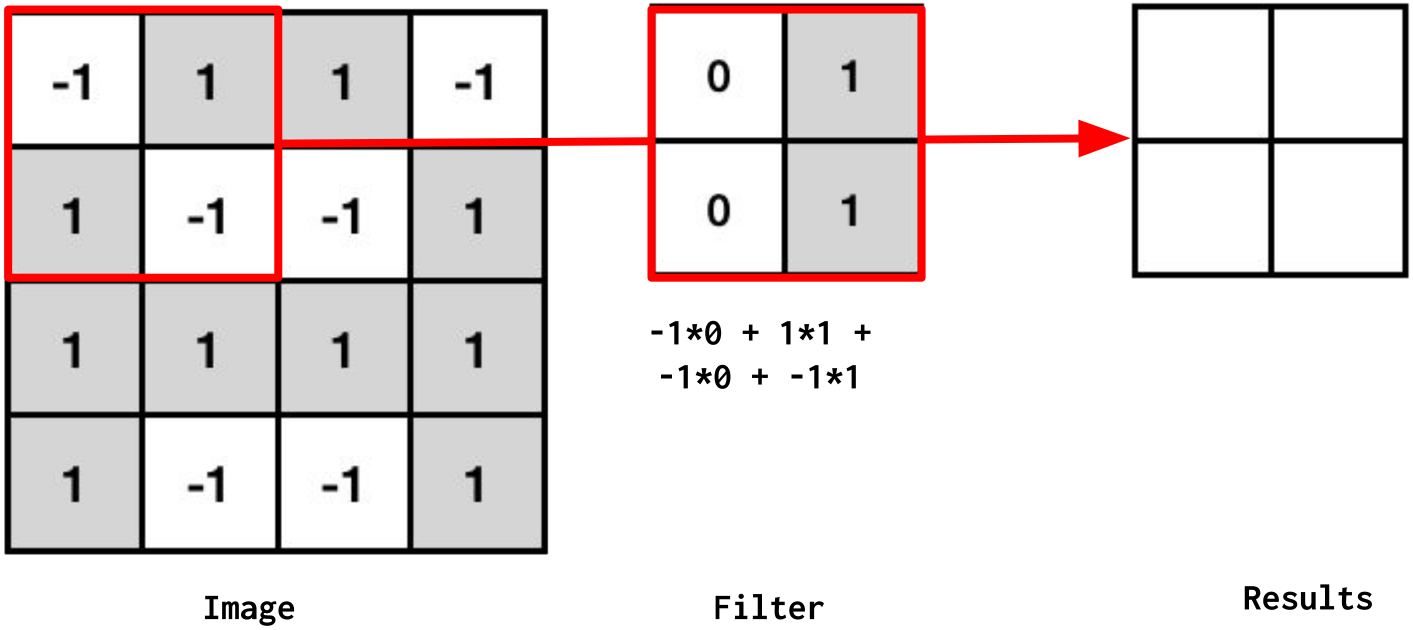
0	1
0	1

Filter



Convolutional Neural Networks and how computer see images

CONVOLUTION



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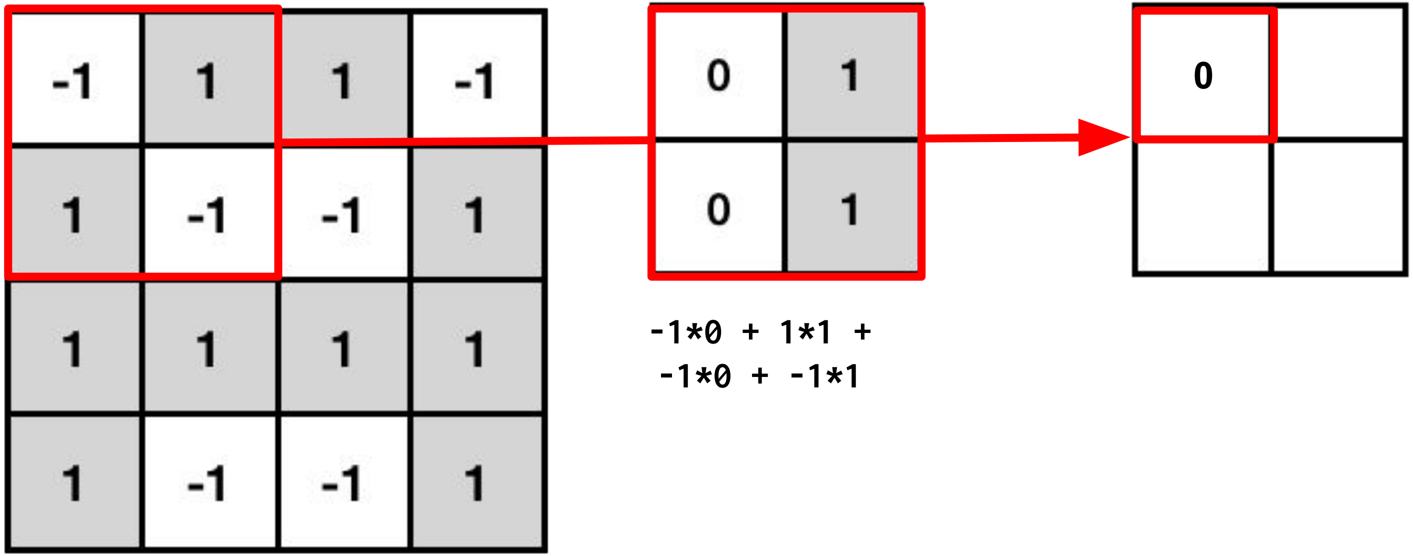
Convolutional Neural Networks and how computer see images

CONVOLUTION



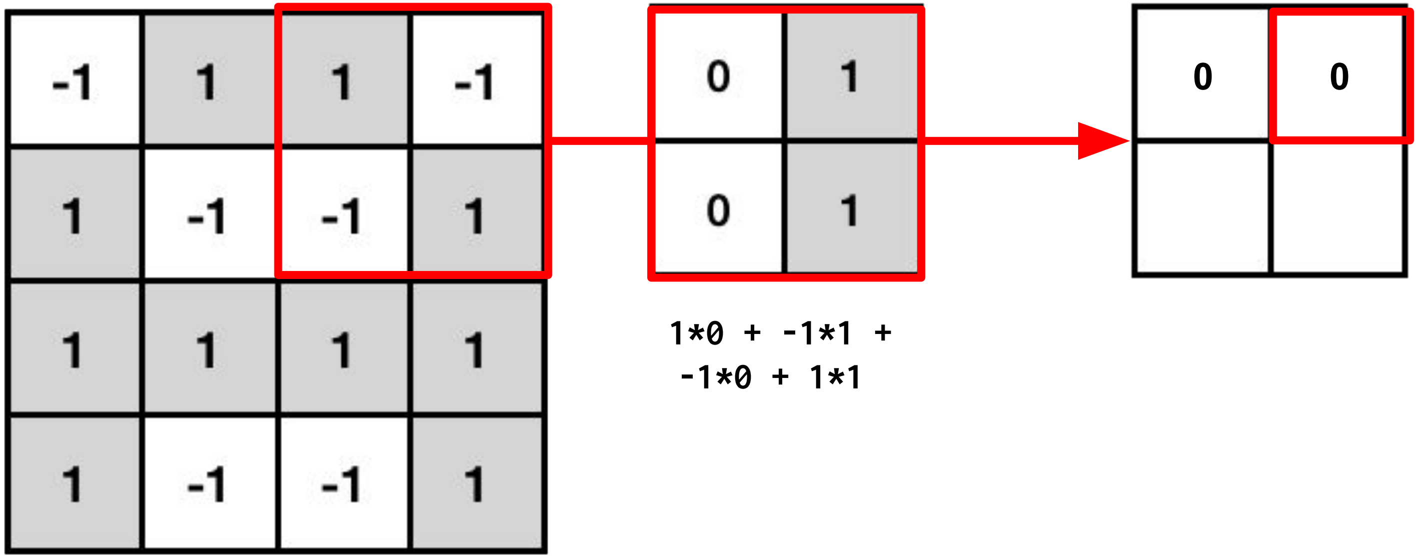
Image

Filter

Results

Convolutional Neural Networks and how computer see images

CONVOLUTION



1*0 + -1*1 +
-1*0 + 1*1

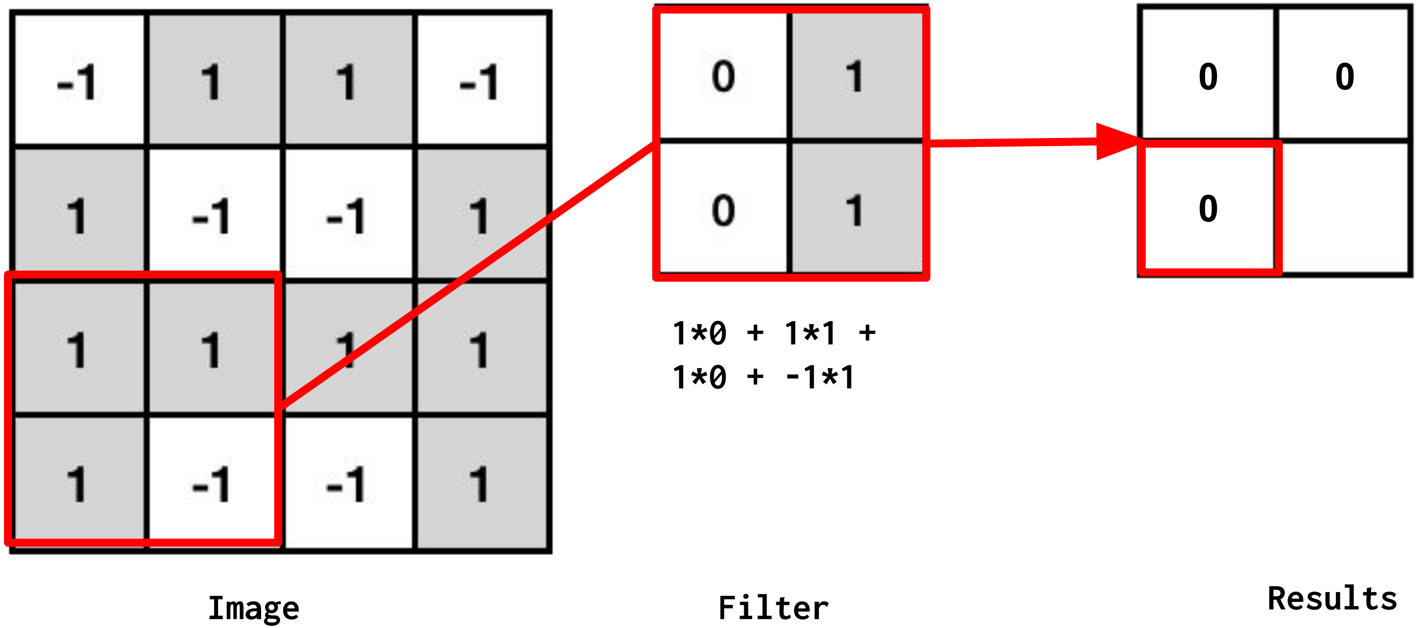
Image

Filter

Results

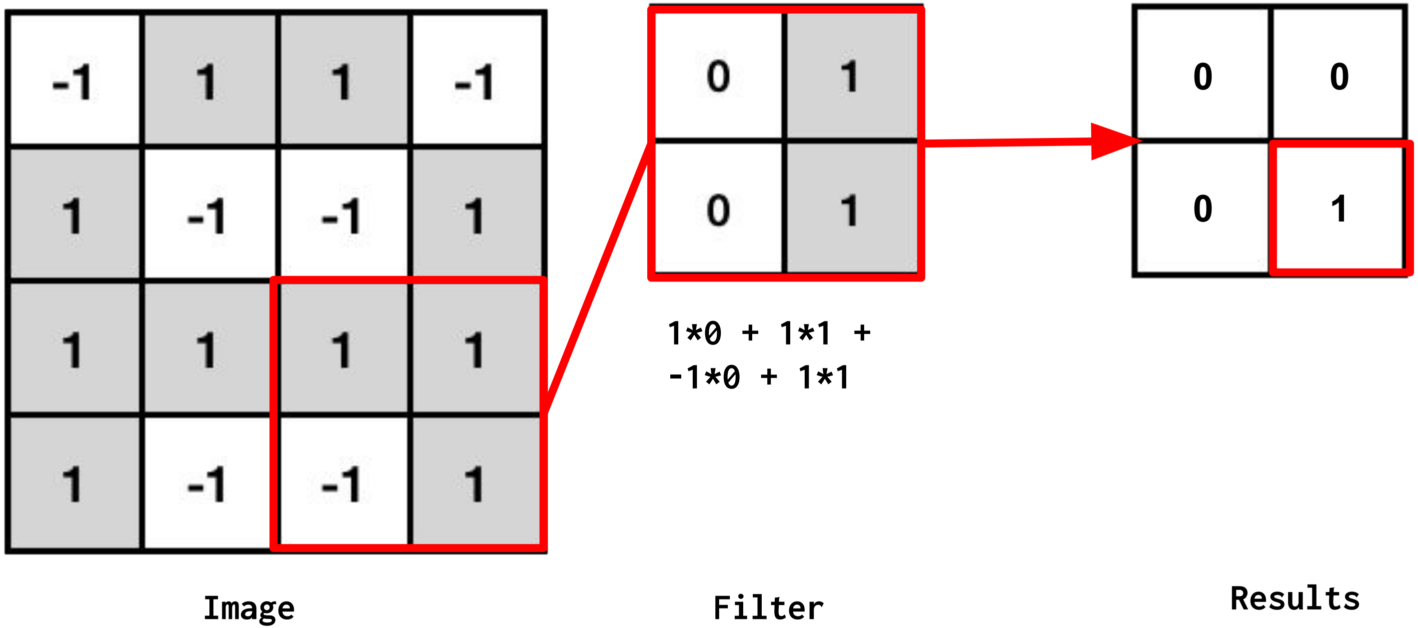
Convolutional Neural Networks and how computer see images

CONVOLUTION



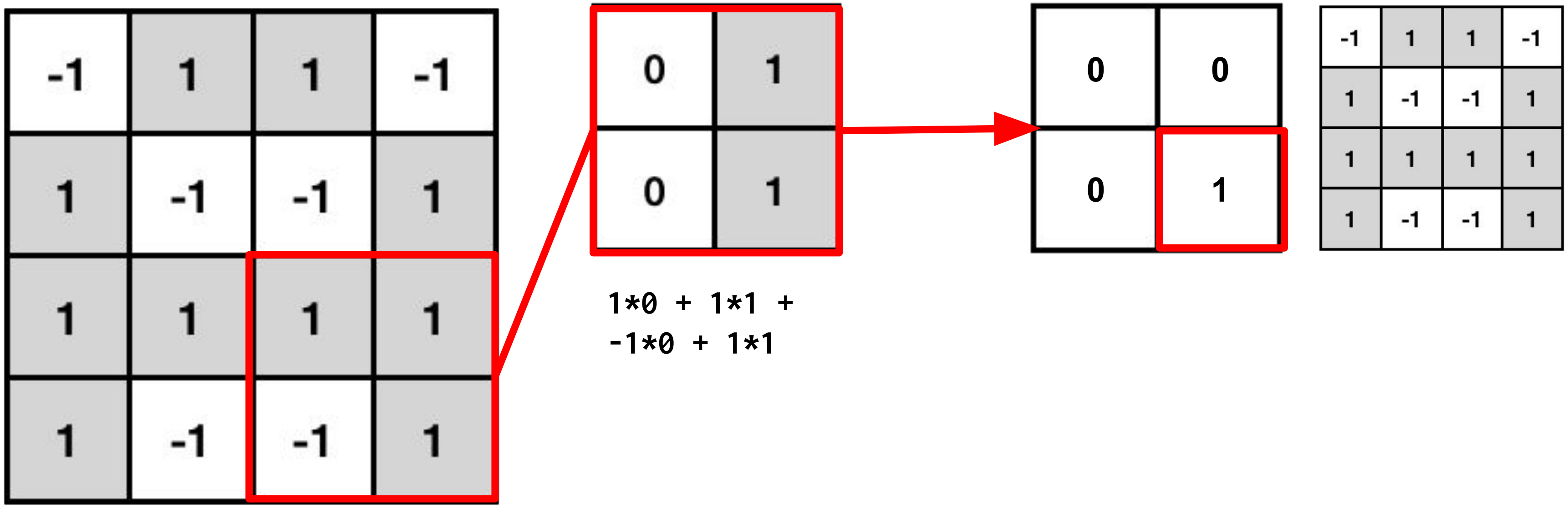
Convolutional Neural Networks and how computer see images

CONVOLUTION



Convolutional Neural Networks and how computer see images

CONVOLUTION



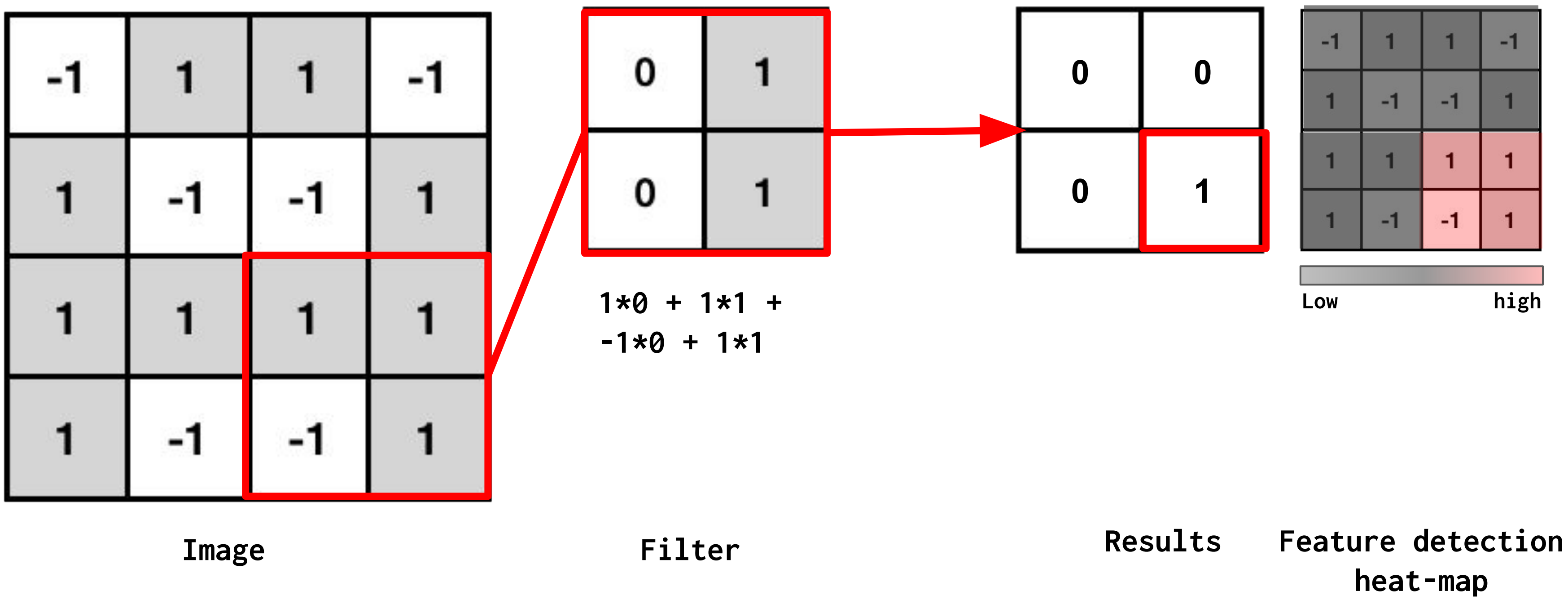
Image

Filter

Results

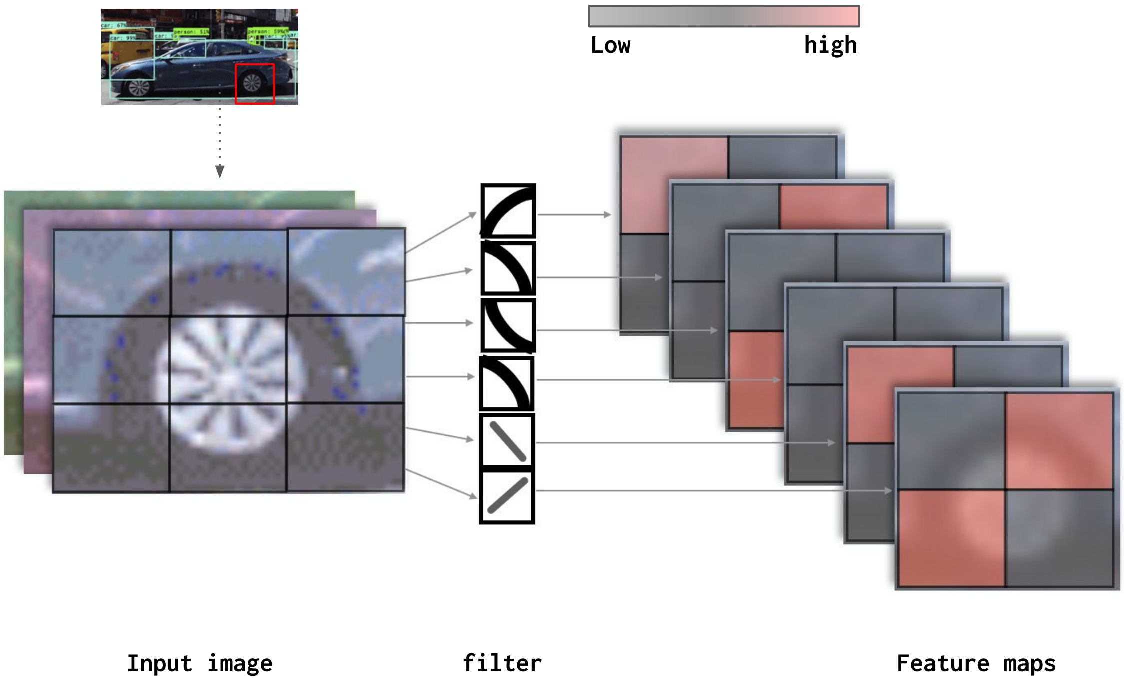
Convolutional Neural Networks and how computer see images

CONVOLUTION



Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



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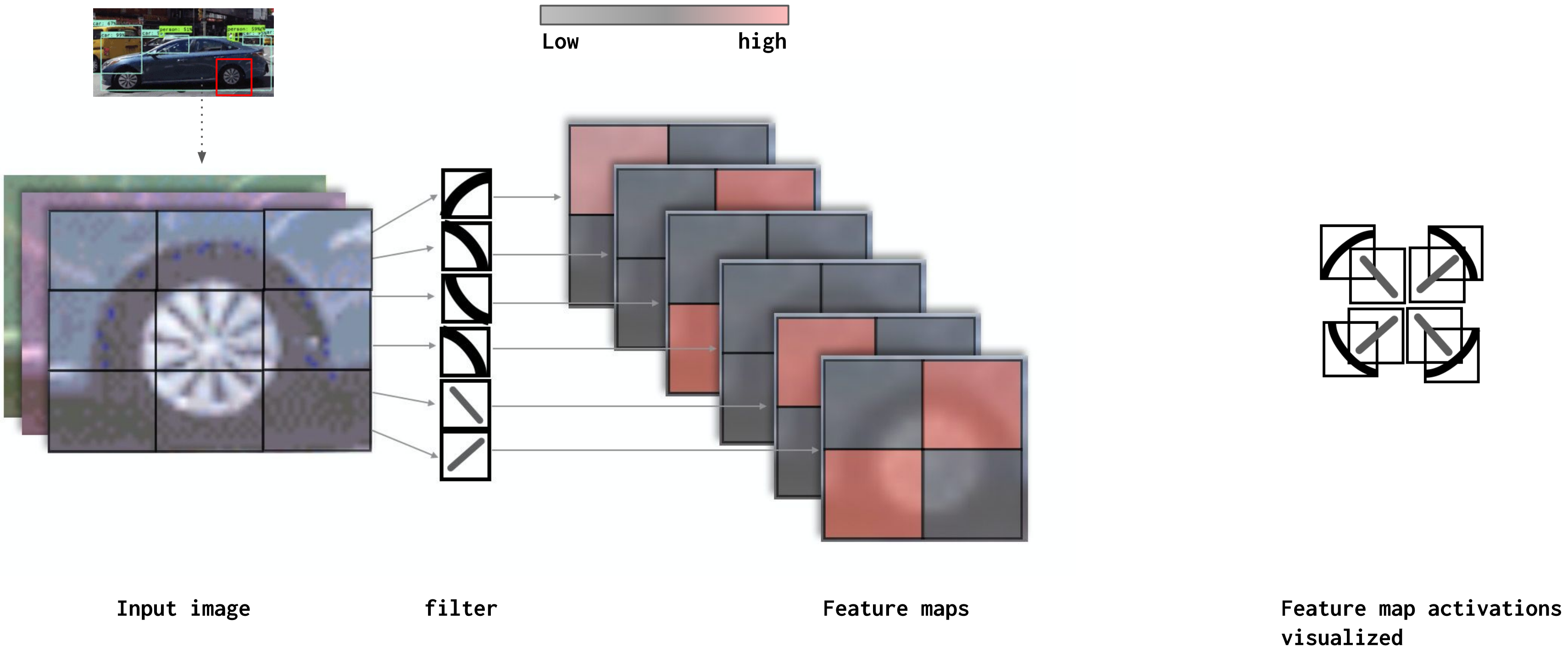
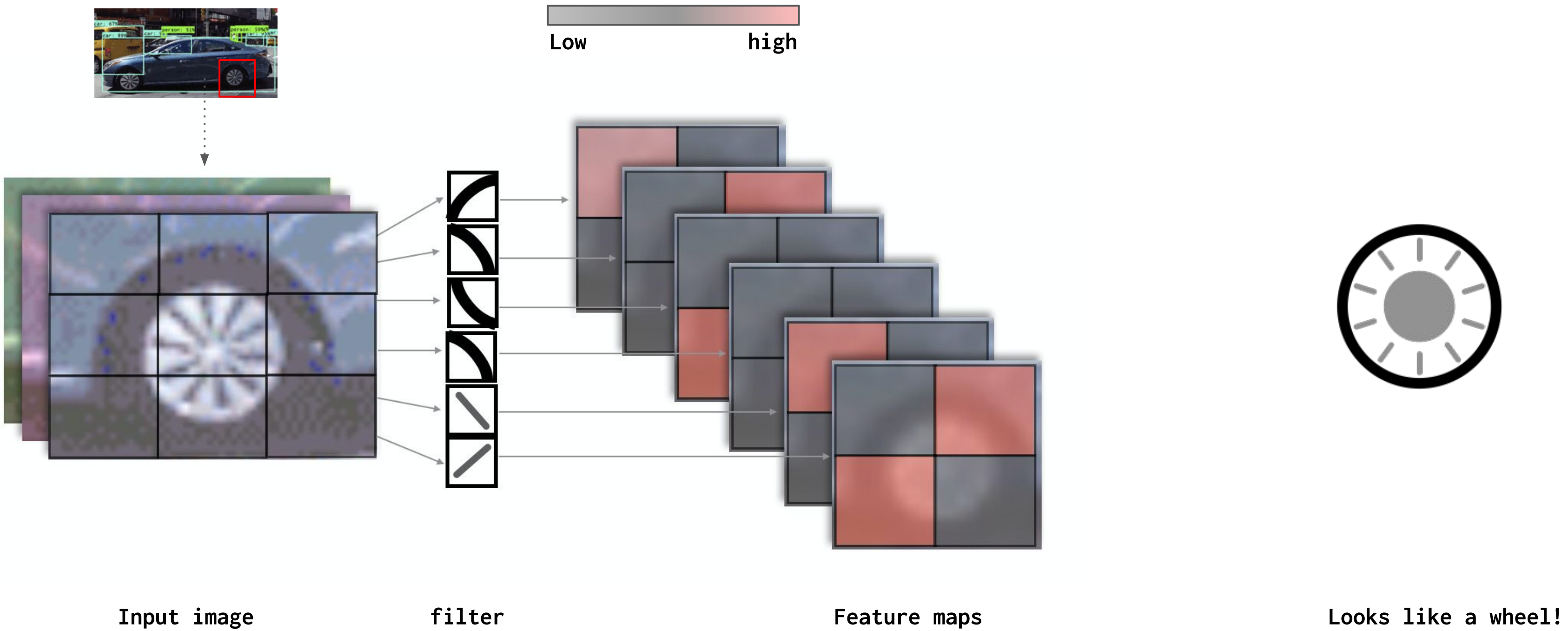
Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



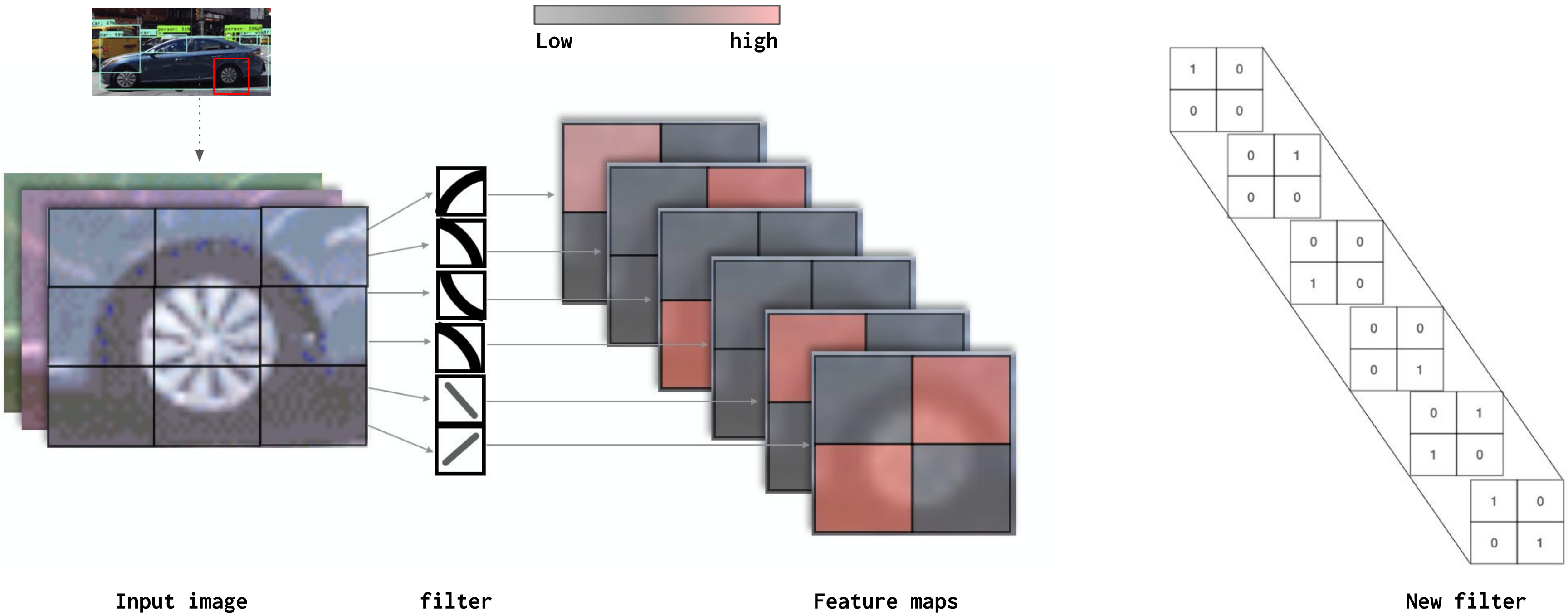
Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



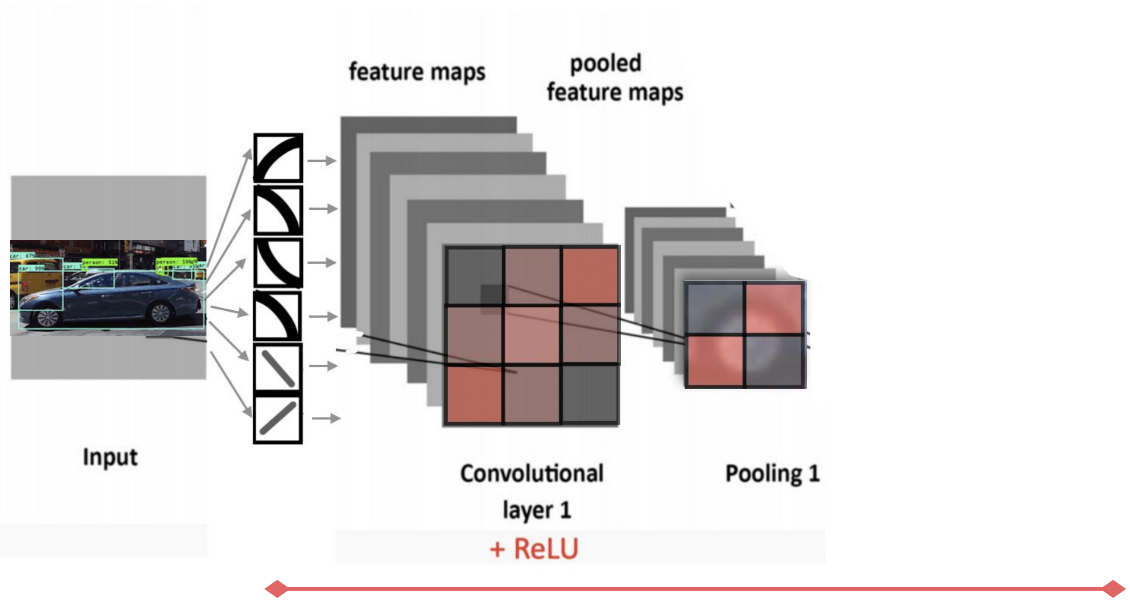
Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



Convolutional Neural Networks and how computers see images

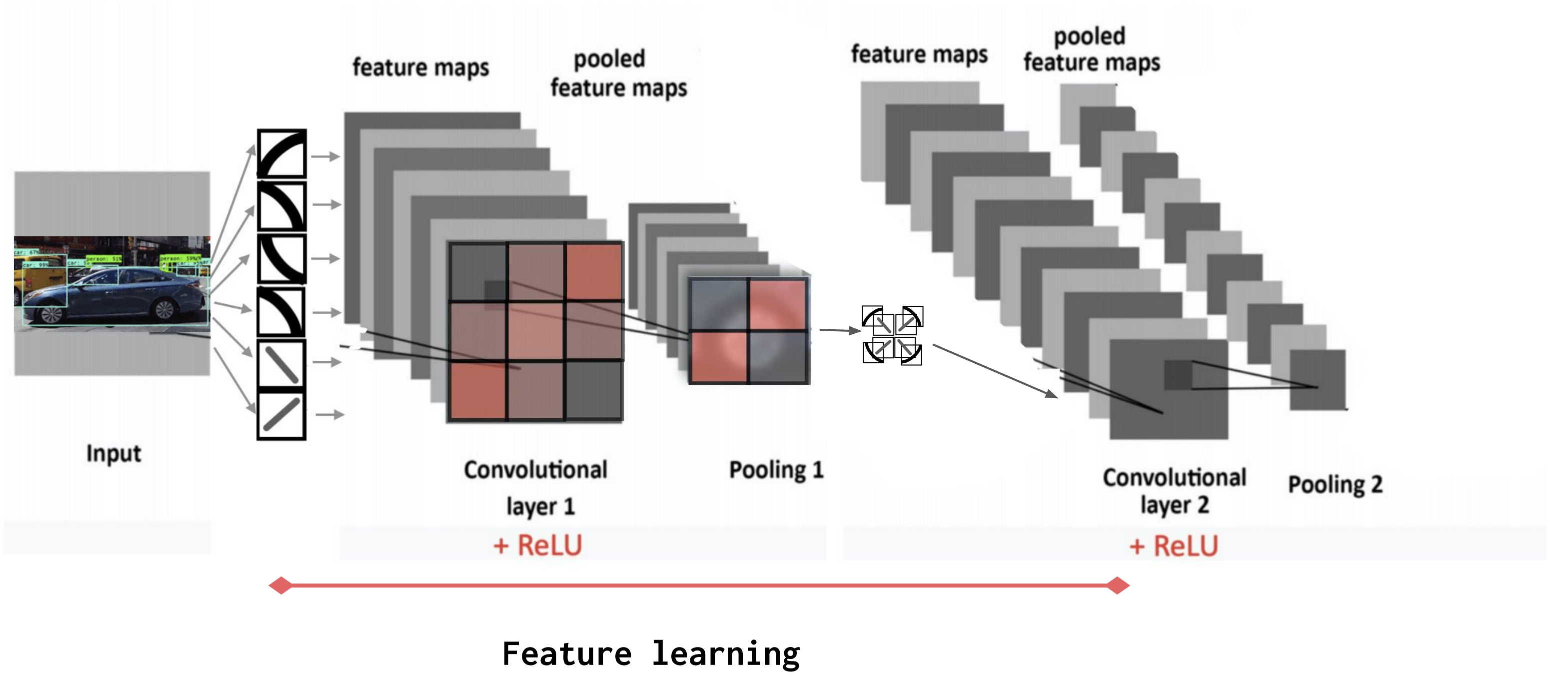
HOW COMPUTERS SEE IMAGES



Feature learning

Convolutional Neural Networks and how computers see images

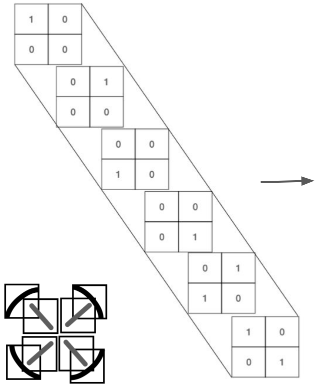
HOW COMPUTERS SEE IMAGES

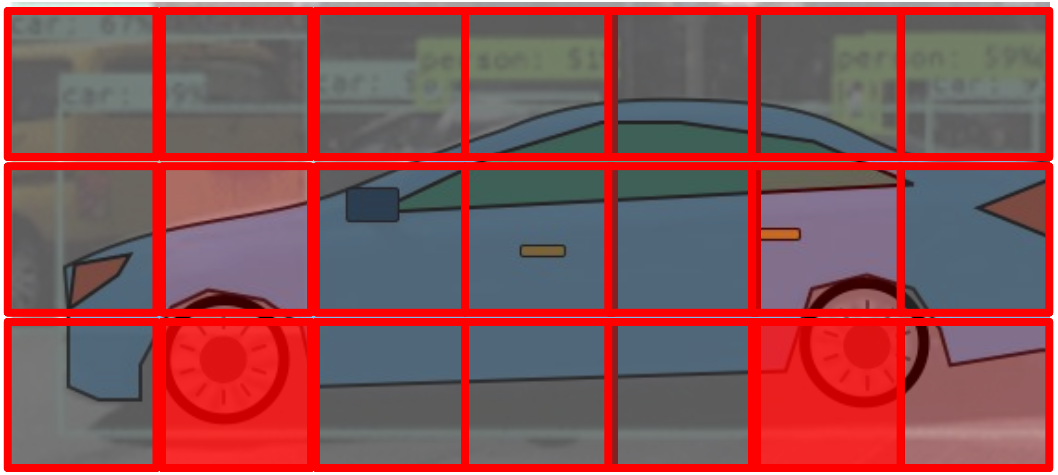


CIL CITY INTELLIGENCE LAB

Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES

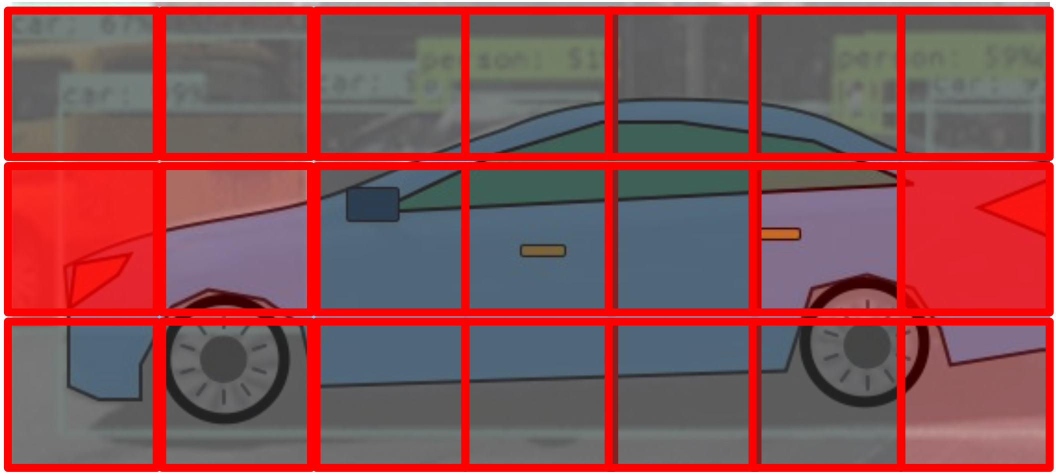




Feature map: Wheels

Convolutional Neural Networks and how computers see images

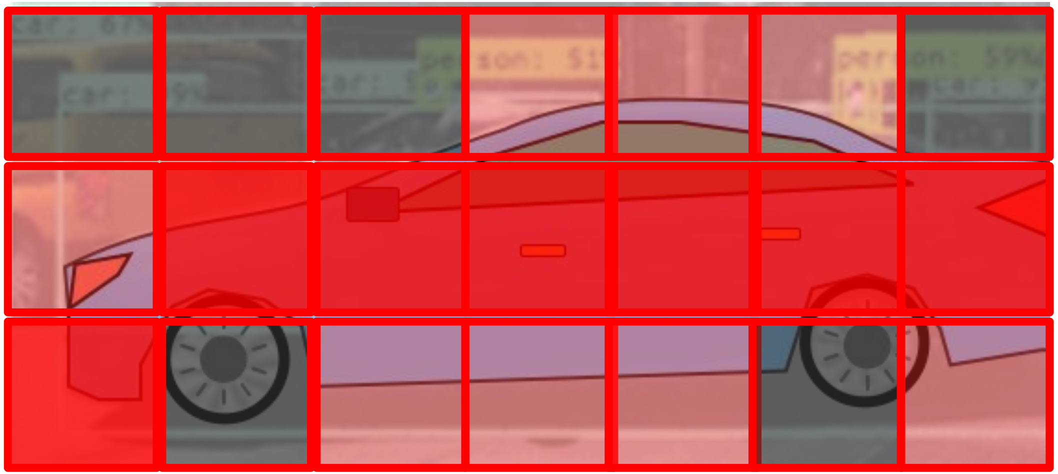
HOW COMPUTERS SEE IMAGES



Feature map: lights

Convolutional Neural Networks and how computers see images

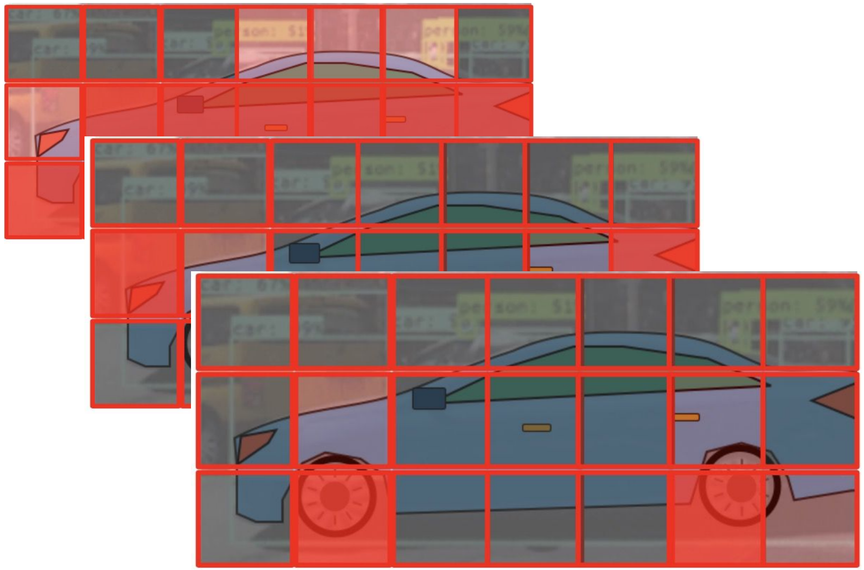
HOW COMPUTERS SEE IMAGES



Feature map: body

Convolutional Neural Networks and how computers see images

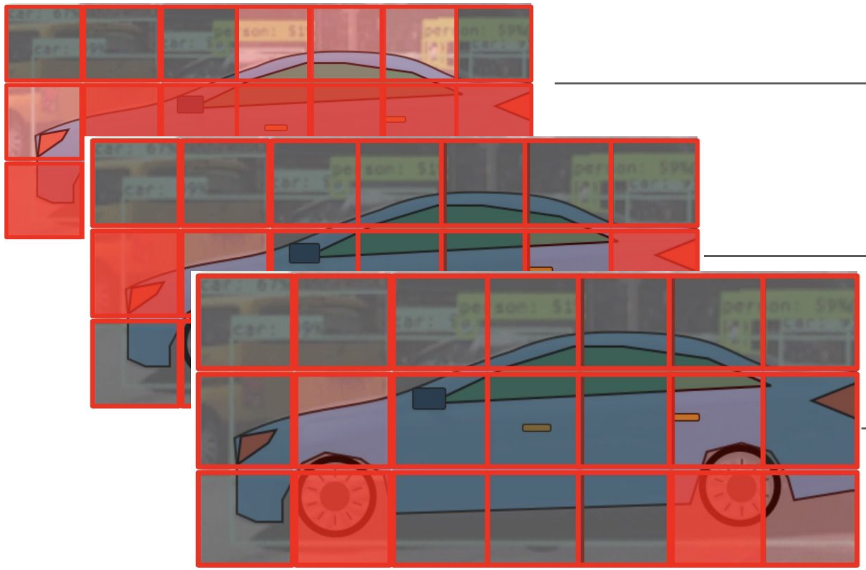
HOW COMPUTERS SEE IMAGES



Feature maps

Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



Feature maps

0	0	0	0	0	0	0
0	0.1	0	0	0	0.2	0
0	1	0	0	0	1	0.1

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

0	0	0.2	0.3	0.2	0	0
0.3	1	1	1	1	1	1
0.3	0	0.4	0.4	0.3	0	0.1

New filter

Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES

image

0	0	0	0	0	0	0
0	0.1	0	0	0	0.2	0
0	1	0	0	0	1	0.1

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

0	0	0.2	0.3	0.2	0	0
0.3	1	1	1	1	1	1
0.3	0	0.4	0.4	0.3	0	0.1

Filter (cars)

Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES

Feature map

0	0	0	0	0	0	0
0	0.1	0	0	0	0.2	0
0	1	0	0	0	1	0.1

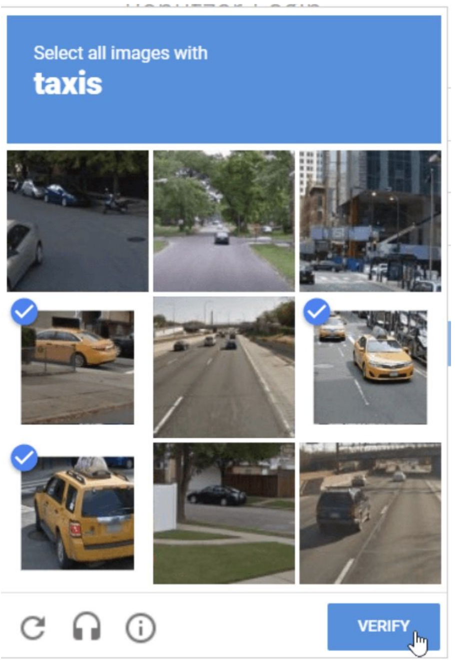
0	0	0	0	0	0	0
1	0	0	0	0	0	1
0	0	0	0	0	0	0

0	0	0.2	0.3	0.2	0	0
0.3	1	1	1	1	1	1
0.3	0	0.4	0.4	0.3	0	0.1

Filter (cars)

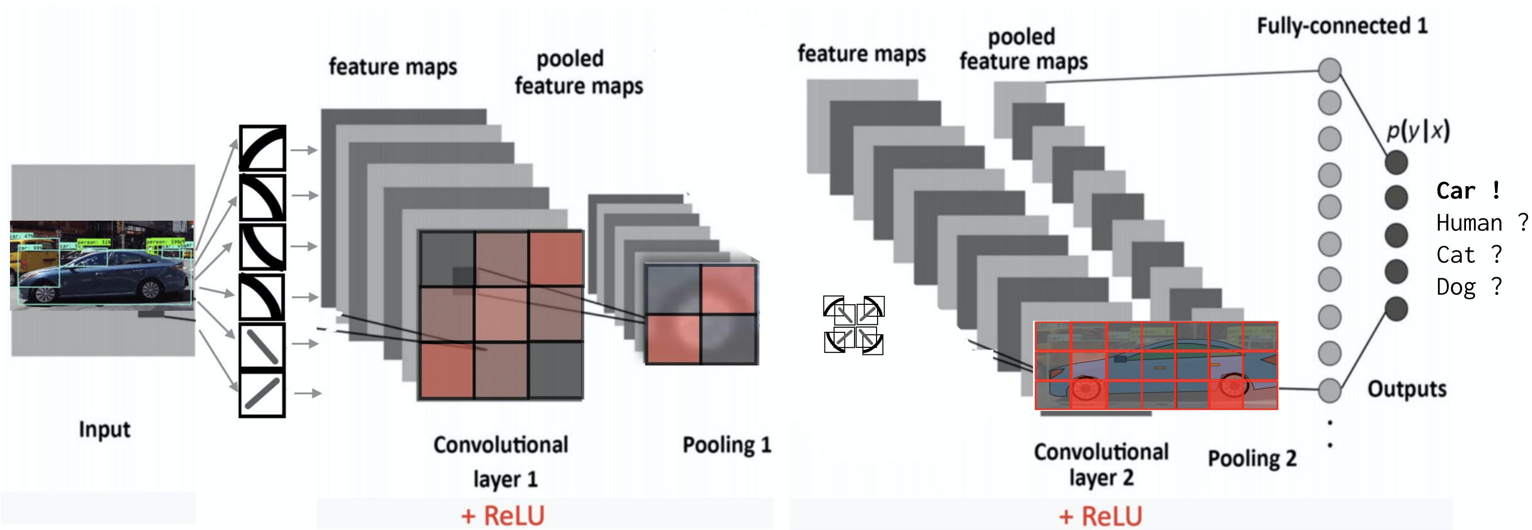
Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



Convolutional Neural Networks and how computers see images

HOW COMPUTERS SEE IMAGES



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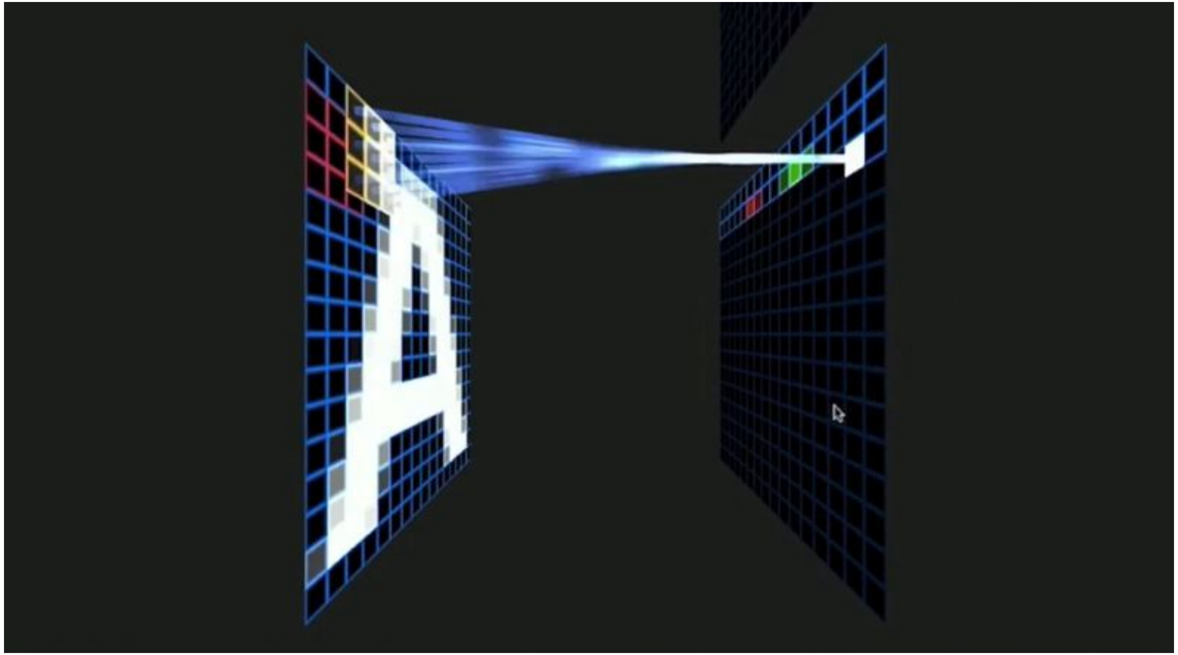
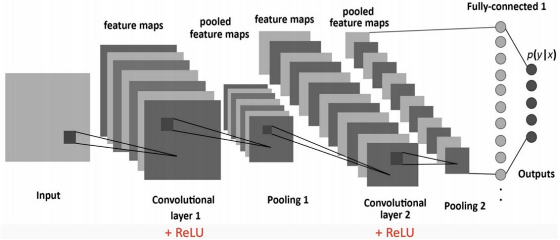
Convolutional Neural Networks and how computers see images

CLASSIFYING A CHARACTER





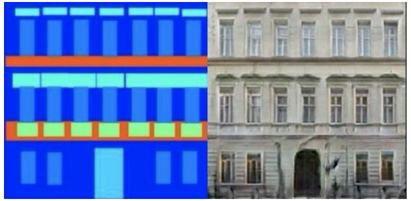
Deep Learning in the Built Environment

Generative models (GAN'S)

Generative Adversarial Networks (GAN)

Pix2pix

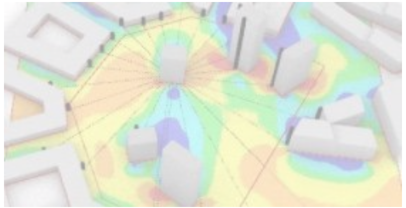
Generates new images based on an input image



Reinforcement learning (RL)

Deep-Q-learning

Trains a decision making and strategy developing agent



Convolutional Neural Networks (CNN)

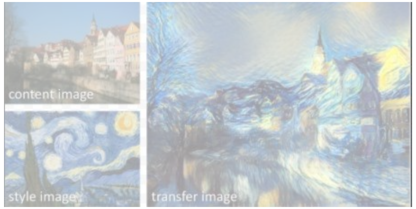
Mask R-CNN model

Finds and labels objects in images

Generative Adversarial Networks (GAN)

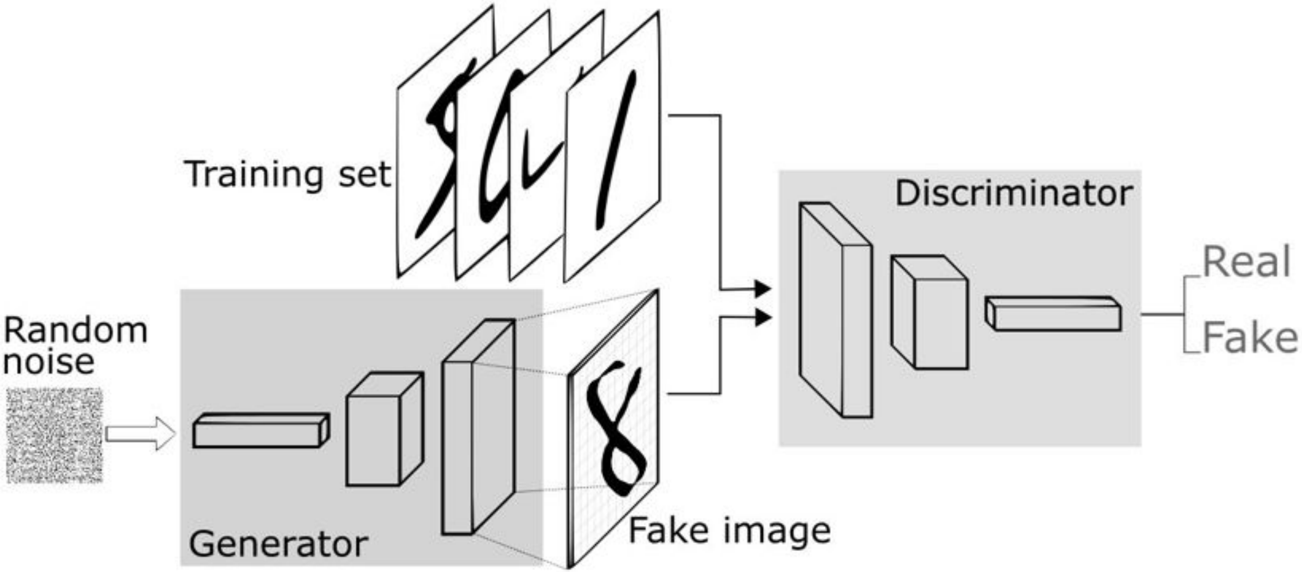
Style Transfer

Changes the look of images based on a reference image



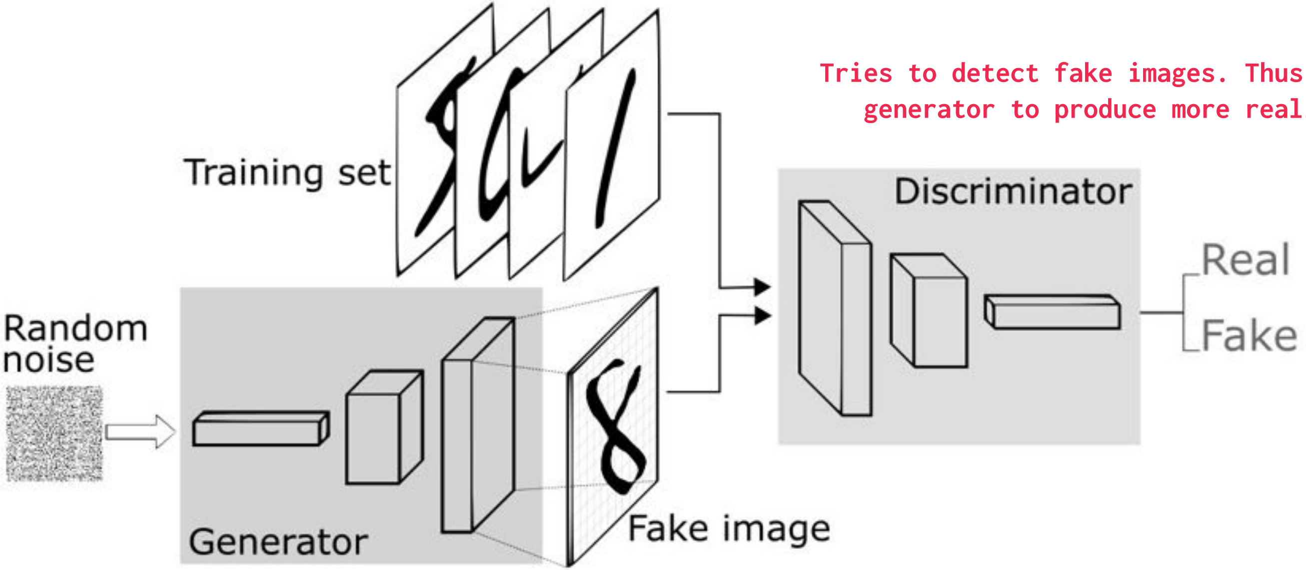
Deep Learning in the Built Environment

Generative models (GAN'S)



Deep Learning in the Built Environment
Generative models (GAN'S)

Tries to detect fake images. Thus, incentives the generator to produce more realistic results



Tries to fool the discriminator into believing its generated image is true

Deep Learning in the Built Environment

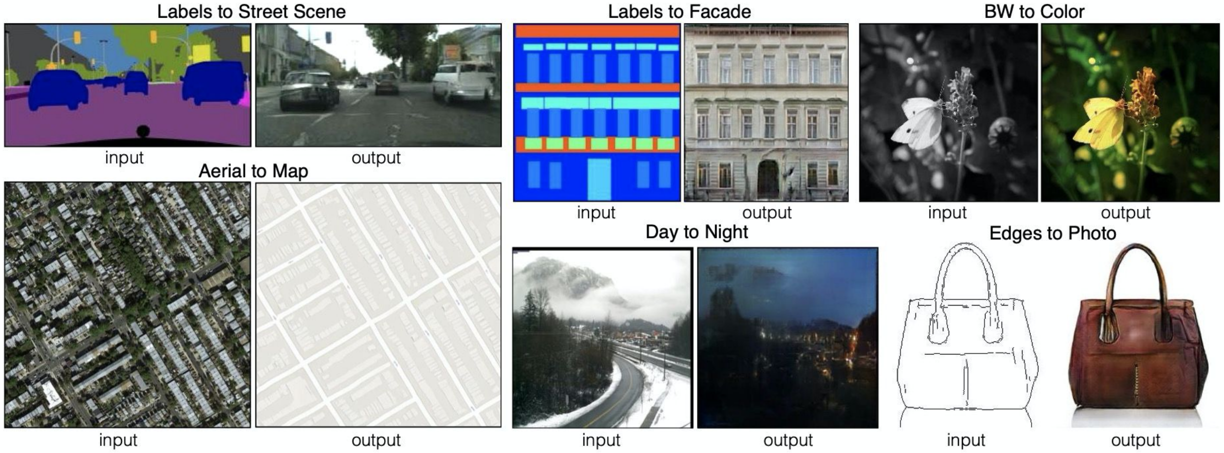
Image to image translation (pix2pix,, 2017)

Image-to-Image Translation with Conditional Adversarial Networks

Phillip Isola Jun-Yan Zhu Tinghui Zhou Alexei A. Efros

Berkeley AI Research (BAIR) Laboratory, UC Berkeley

{isola,junyanz,tinghuiz,efros}@eecs.berkeley.edu



https://arxiv.org/pdf/1611.07004.pdf

Deep Learning in the Built Environment

Image to image translation (pix2pix,, 2017)

Image-to-Image Translation with Conditional Adversarial Networks

Phillip Isola Jun-Yan Zhu Tinghui Zhou Alexei A. Efros

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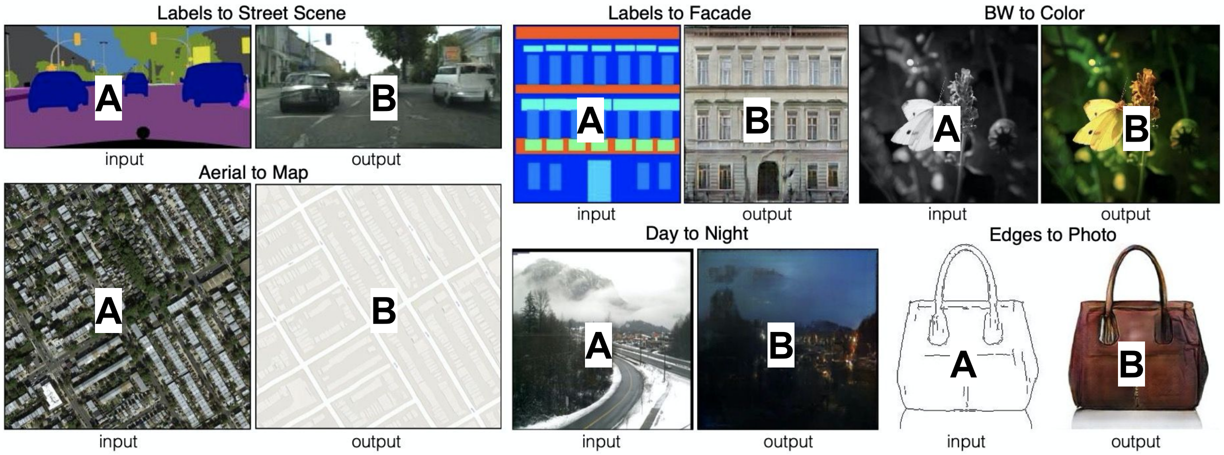
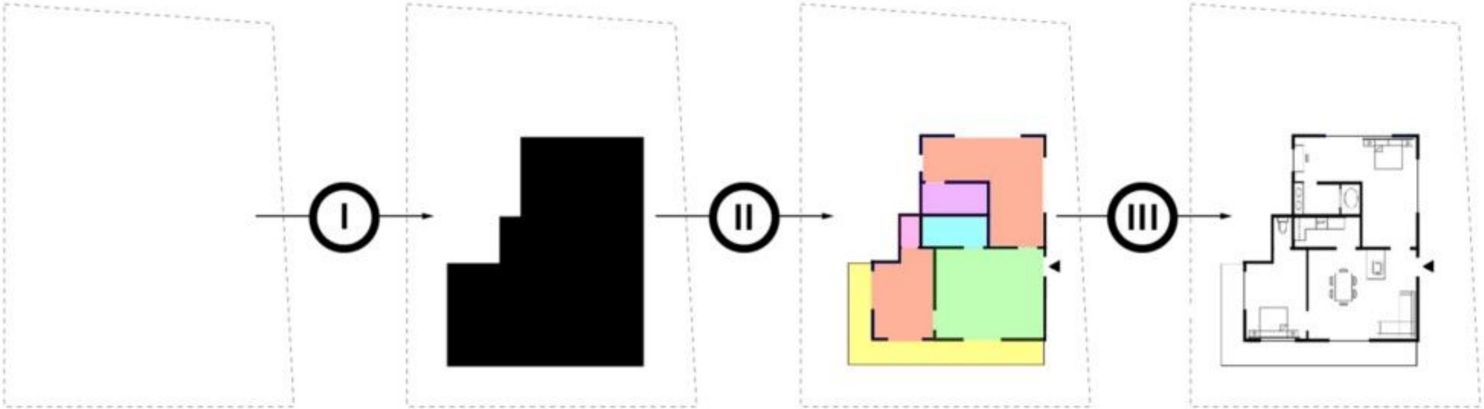


https://arxiv.org/pdf/1611.07004.pdf

Image to image translation
Generating maps

Image to image translation

Generating floor plans



Plot

Footprint

Rooms & Program

Furniture/ Details

https://devblogs.nvidia.com/archigan-generative-stack-apartment-building-design/

Image to image translation

Generating Urban Morphologies

Image to image translation
Generating Urban Morphologies

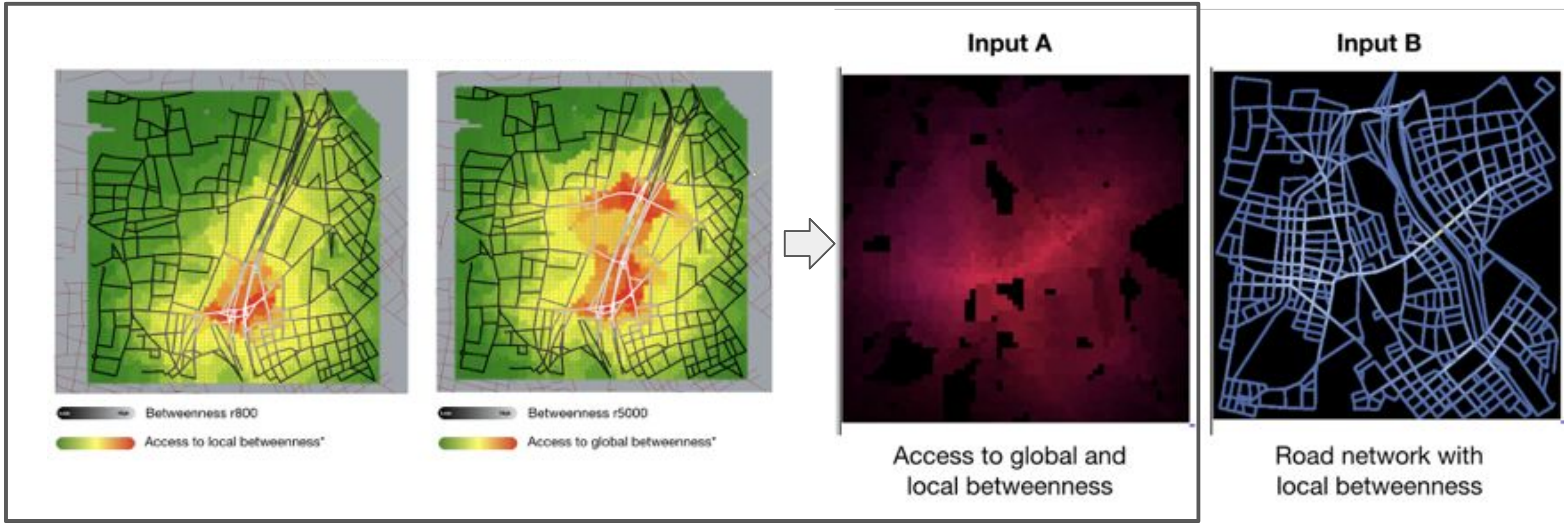


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Image to Image Translation with RHINO GRASSHOPPER

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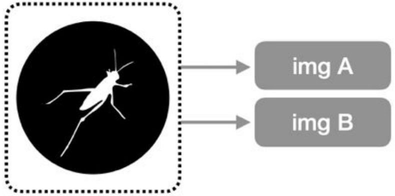
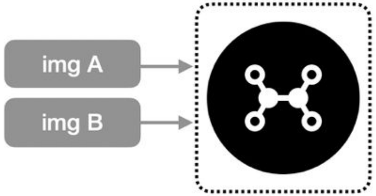
Image to image translation

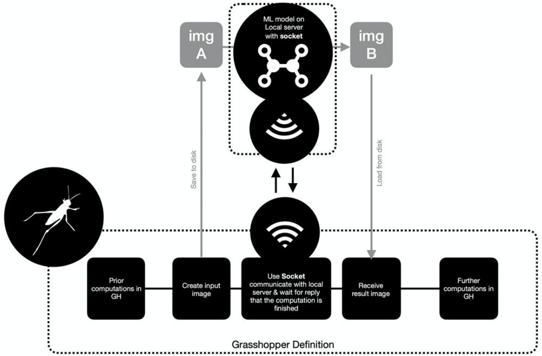
Local deployment with grasshopper



Create Training Data with Grasshopper



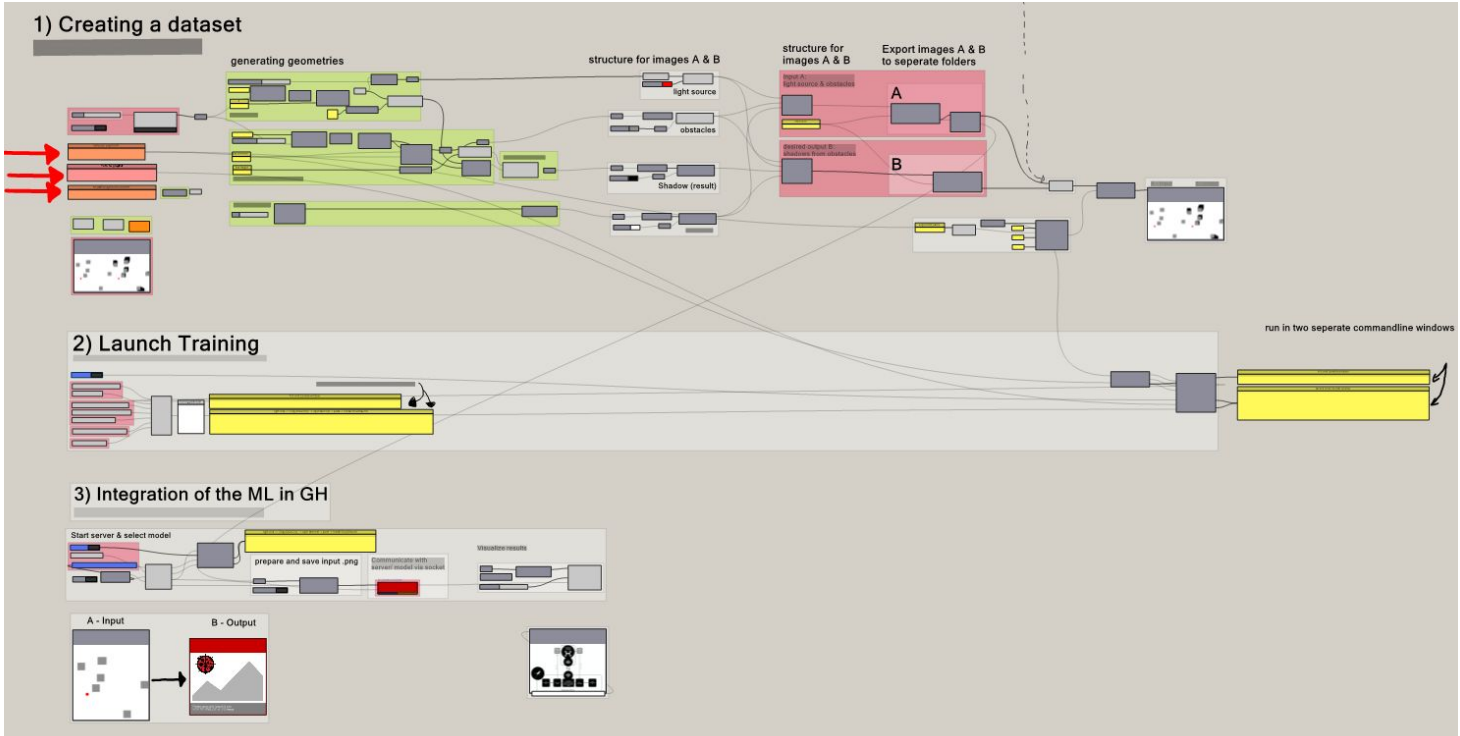
Train Model

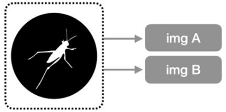


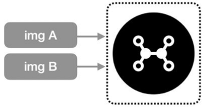
Integrate with Grasshopper

Image to image translation

Local deployment with grasshopper







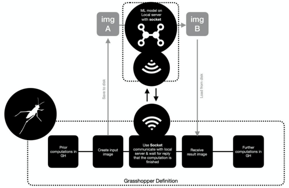


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Image to image translation

Example 1: non-physical shadow prediction (or shadow removal)

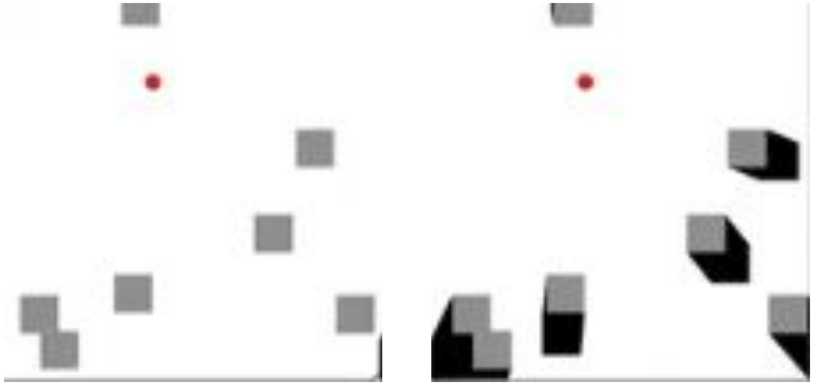


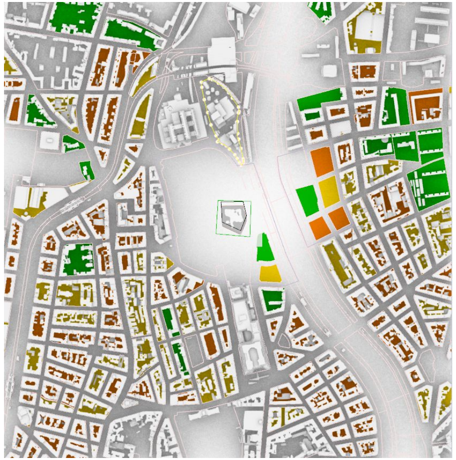
Image A Image B

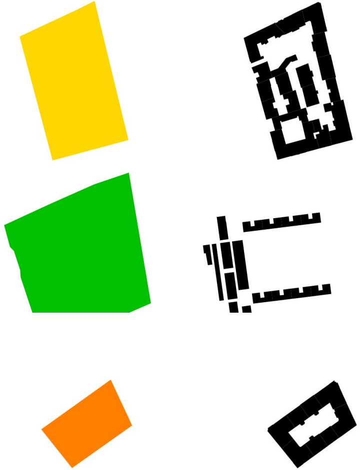
Image pairs for training
A → B

Goal: Predict the shadows of building based on a light source and obstacles

Image to image translation

Example 2: Plots2Blocks





Goal: Train pix2pix to generate building footprints based on a plot shape. It should be able to distinct between different typologies

Demo