

Intro to Computer Vision



Yoni Chechik
Computer Vision course

contents

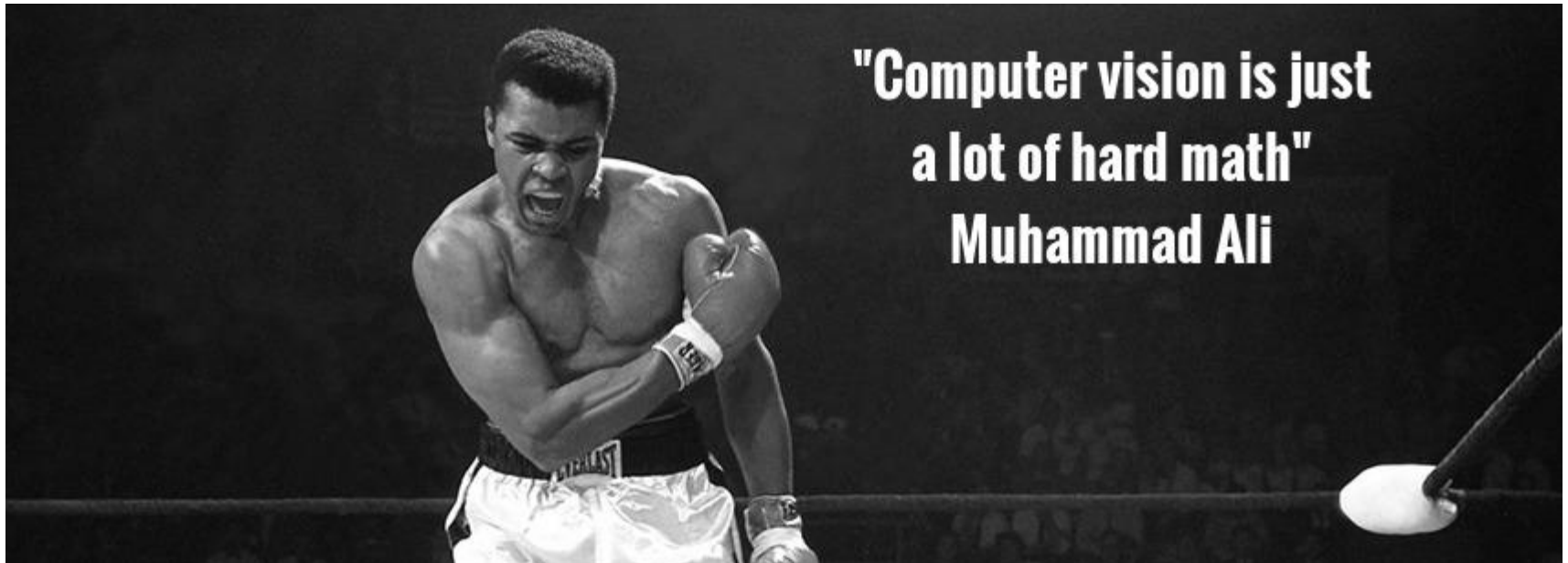
- **Course details**
- What is computer vision (CV)?
- Course outline
- Intro to Python

References

- Lectures Based on the book: **Computer Vision: Algorithms and Applications**, 2010, Richard Szeliski (<http://szeliski.org/Book/>)

Prerequisites

- No prior knowledge in signal/image processing is assumed.
- Heavy use in algebra and calculus- mathematical maturity **is assumed.**

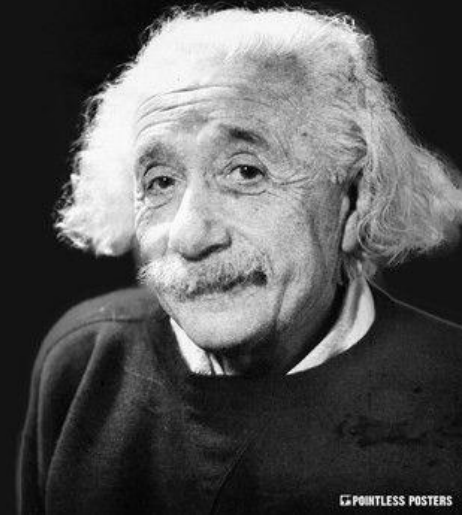


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Don't believe
everything you read
on the internet just
because there's a
picture with a quote
next to it.

ALBERT EINSTEIN

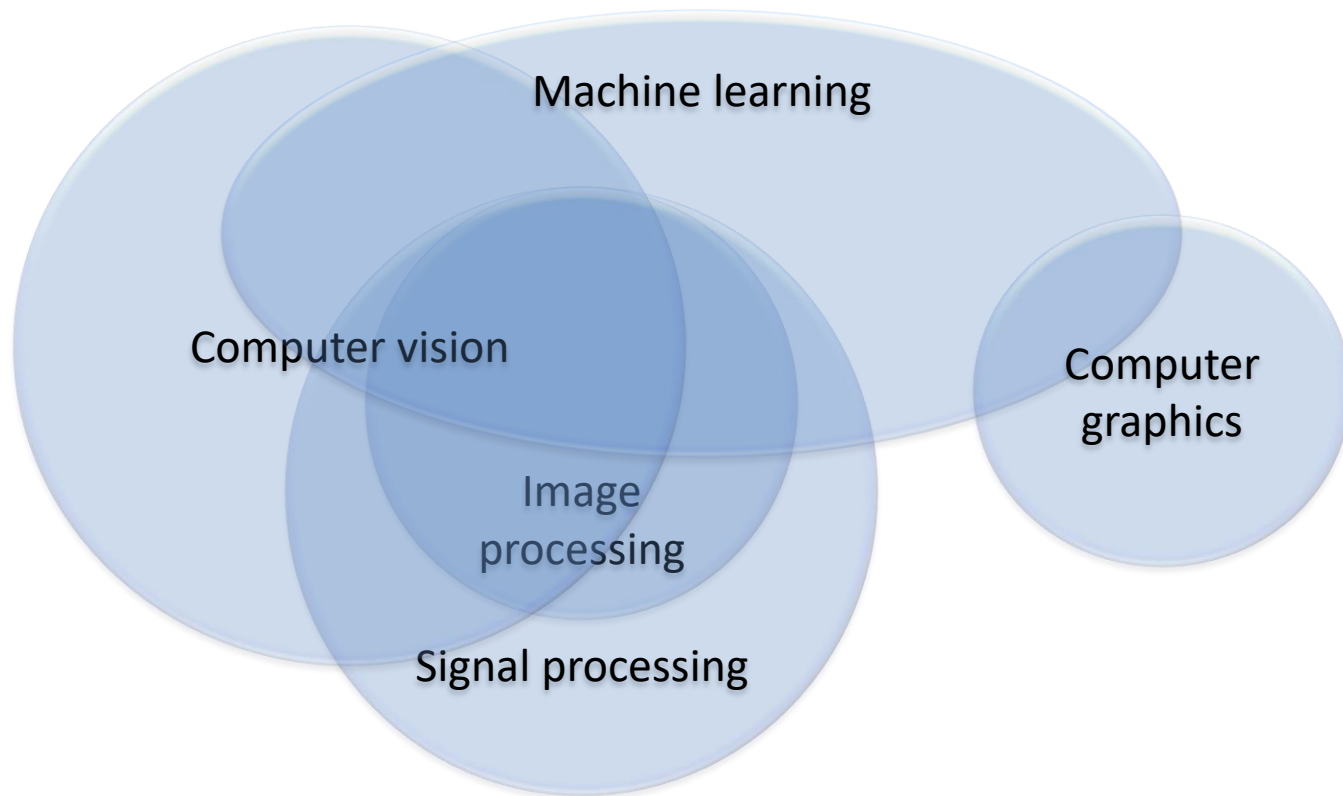


What is CV?

- **Computer vision** is an interdisciplinary scientific field that deals with how computers can be made to gain high-level understanding from digital images or videos. [Wikipedia]
- **Image processing** is an umbrella term for many functions that analyze images or convert one representation of an image into another.

What is CV?

Input \ Output	Data	Image
	Signal processing	Computer graphics
Data	Signal processing	Computer graphics
Image	Computer vision	Image processing



Why CV?

IT'S
F***ING
COOL

Why CV?

Top Public Company Acquirors

Company	Embedded Vision/Computer Vision M&A			
	 October – 2012 \$45.0M	 March – 2013 NA	 July – 2016 NA	 Undecidable! October – 2016 NA
	 November – 2013 \$360.0M	 January – 2016 NA	 January – 2016 NA	 REALFACE February – 2017 NA
	 May – 2005 \$115.0M	 July – 2008 \$3.0M	 August – 2016 \$2.4M	 November – 2016 \$4.7M
	 April – 2012 \$31.0M	 May – 2016 NA	 September – 2016 \$392.1M	 September – 2017 \$15,300.0M
	 January – 2014 NA	 September – 2014 NA	 August – 2017 NA	

PrimeSense == Kinect

- *Kinect for Xbox 360*: 3D scanner system using **Light Coding** approach for 3D reconstruction.
- KinectFusion [Newcombe et al., 2011] :
<https://www.youtube.com/watch?v=KOUSSIKUJ-A>



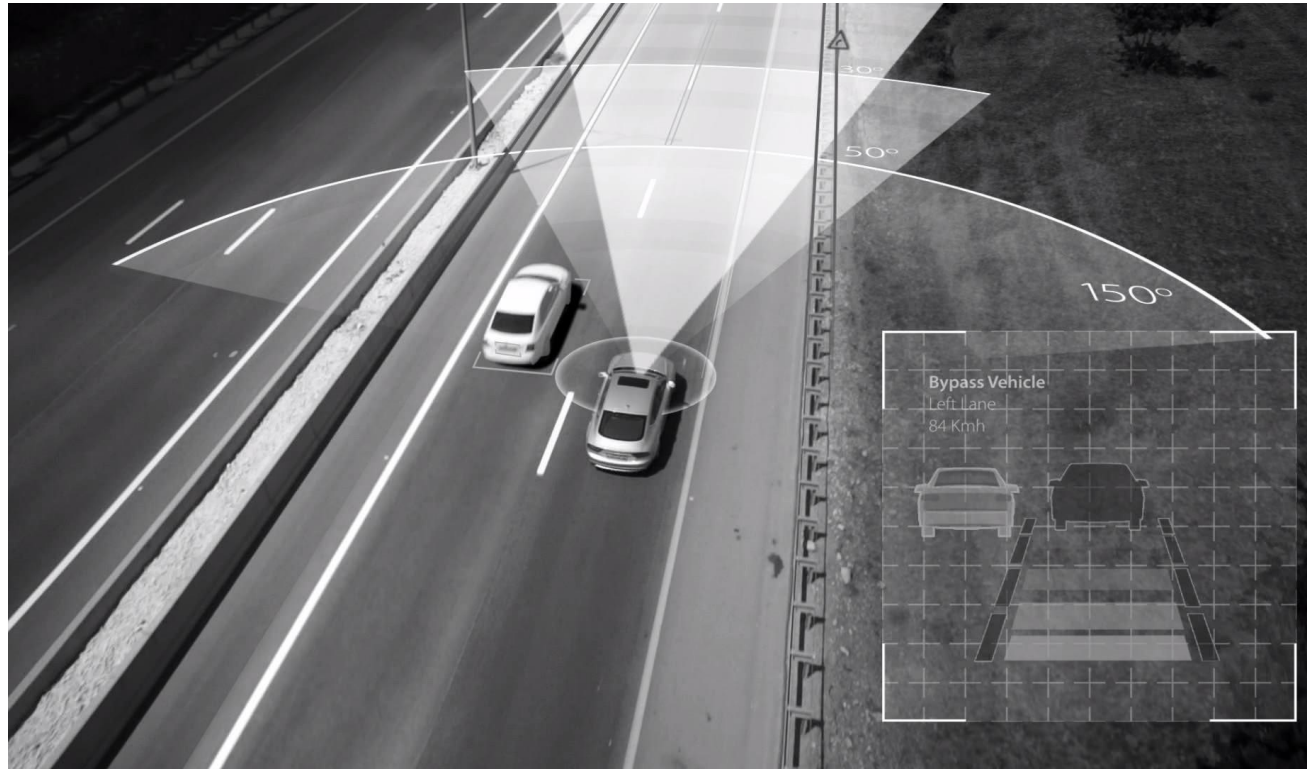
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Mobileye

- **Mobileye** is an Israeli subsidiary of Intel corporation that develops vision-based advanced driver-assistance systems (ADAS) providing warnings for collision prevention and mitigation. [Wikipedia]
- <https://www.youtube.com/watch?v=JDUb6CurYJM>



Why CV?

StartupHub.ai

ISRAEL'S COMPUTER VISION STARTUPS

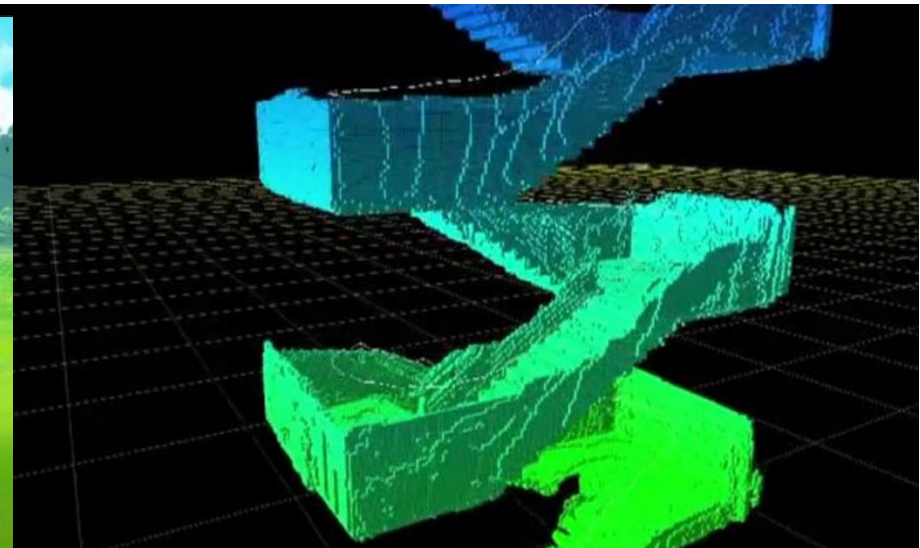


COMPUTER VISION TECHNOLOGY		HEALTHCARE	AUTOMOTIVE	AGRICULTURE	INDUSTRIAL	RETAIL	SECTORS
CHIPS	VIDEO INTELLIGENCE	MEDICAL IMAGING	AUTONOMOUS	CROP MANAGEMENT	ROBOTICS & UTILITIES	MONITORING & ANALYTICS	SMART CITY
Hailo INTEL INUVIS	AGENT2 EyeSafe QUANTUM RGB D Vision viisights GETALERT VIDEO Inform SENSORITY vidocites ZyroBot XR Vision any VISION. 1702ai	zebra MEDICAL VISION iz.ai aidoc BODY VISION DIA MobileODT maxQ sight Biomedical FDNA innogy HT DeePathology.ai ORCA DENTAL AI PerSimo RADLogics TECHSOMED IBEX XPRINT XRAY MAGENTIQ IMedis Deep Oncology nucleai SCOPIO MedHub-AI	arbe Imagray INNOVIZ TECHNOLOGIES Kodiak i4drive ADASKY oryx Vectoraic RIDEVISION RAM StreetLight.ai CRadar.AI BWV RFISSE IONTERRA VAYAVISION VOYAGE 81	TARANIS prospera See Tree SKYX fieldin AgroScout saillog arugga GemmaCert SeedX VIBBE HiGrade	Planet Watchers KITOV SYSTEMS DLR COGNITEAM MOVI SKYLINE ROBOTICS IPV ORCA AI pzartech BladeRanger	trax trigo eyezon WISE SHELF memomi MYSTOR-E SPORTS ANALYTICS & CONTENT playsight TRACK160 WSC Sports PhysiMax Pixellot SenSwim Zone7 L VISION Baseline.	SPATIAL LOGIC UTILIS VISUAL SEARCH syte clonde CONSUMER ROBOTICS & TECH nanit intuition robotics temi robotic RES scio FITNESS FITSCANNER MyselfFit
PROCESSING	OPTICAL & SENSOR	FACIAL RECOGNITION	IN-CAR MONITORING	HARVESTING	DRONES	ENTERPRISE	REAL ESTATE
Brodmann Edgify REDFALCON	vayyar KAYA INSTRUMENTS TRIEVE NEWSIGHT IMAGING unispectral	D-ID FACEPTION VIKI SENSE TECHNOLOGIES IS IT YOU verifyoo ONLINE Facetrom FAB BrighterAI IDENTITYTECH	MDGO eyesight neteera CLAIR LABS GUARDIAN JUNGGO SAVERONE CAARESYS	METOMOTION AUTOMATO meshek (76);	XTEND AerialGuard AIROBOTICS skywatch.ai EDGYBEES ClearVuze Sightec HIGH LANDER Sightec CIVDRONE vHive PERCEPTO	intervyo minereye appltools tuqqi INTELLIGO voca.ai ActiView TechSee	Leaperr Flatspace
DEVELOPMENT	DATA CREATION	AUGMENTED REALITY	TRAFFIC & MOBILITY	NEW MEDIA	CONSTRUCTION	MARKETING	FASHION
missinglink.ai allegro.ai Clay Sciences	INNEREYE DataGen technologies edgecase.ai	zsens Resonai AUGMIND hexa ADSHIR Reality human-eyes RESTAR SUPERB REALITY MANTIS VISION SPECTALIX	VALERANN NOTRAFFIC AGENT-TECH EyeWay	Lightricks Magisto Photomyne WIBBITZ tunity DEEPNEN	INT.SITE astralink OKIBO Datumate CLONE Buildots LIGHTYX CONSTRU	Taboola anyclip BrandTotal AdVeri.ai CHEQ TAILOR BRANDS minute. cedato COMIGO	SIZER fitfully ZEEKIT
PLATFORM	EYE TRACKING	IMPAIRMENT AID	DEVELOPMENT	INSPECTION	TELEOPERATION	WATER VISION	EDUCATION, RAIL & TRAVEL
Voyager Labs cortica	Blink	NOVASIGHT 6 over 6 RetiSpec	cognata The Wholly Egg	UVEYE NEOMATIX Visual Intelligence	Phantom Auto ottopia WHITE RAVEN VIA Parkam nexar.	LYNXIGHT DEEP VISION CORAL Rail VISION Anima SeeVoov	

More CV related topics

- Virtual/augmented reality
- navigation
- Gaming
- medicine
- And much more...

Segmentation Results



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Course outline

#	subject
1	Introduction to CV + Python: numpy, matplotlib.
2	Image processing recap: convolutions, LPF, HPF, morphology, connected components, gamma correction, histogram equalization.
3	Edge detection: gradient (roberts, prewitt, sobel), Laplacian, DoG (derivative of Gaussian), canny edge detector.
4	Shape detection: template matching, Hough transform.
5	Digital cameras: image formation, transformation, interpolation.
6	Camera calibration: extrinsic, intrinsic, radial distortion.
7	Stereo vision :dual camera rectification, triangulation.
8	3D cameras: LIDAR, KINECT, structured light, planoptic
9	Line fit: least squares, total least squares, RANSAC,
10	Feature extraction: SIFT, image stitching (scale space).
11	Neural networks: intro, CNN, MNIST, Alexnet.
12	Final project 1
13	Final project 2

Image processing

- Read more about Lenna – the standard test image:
<https://en.wikipedia.org/wiki/Lenna>

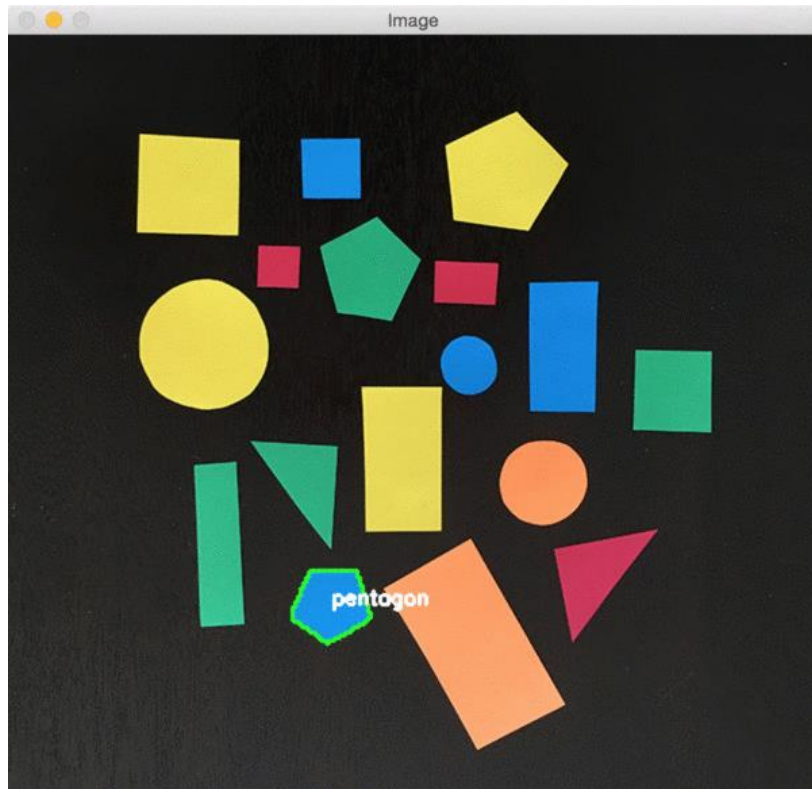


Edge Detection

- <https://www.youtube.com/watch?v=hQ-bpfdWQh8>
- <https://pinetools.com/image-edge-detection>



Shape detection



Digital cameras

- Image formation:
<https://www.youtube.com/watch?v=dY0K65eXhkA>
- Transformation and interpolation.



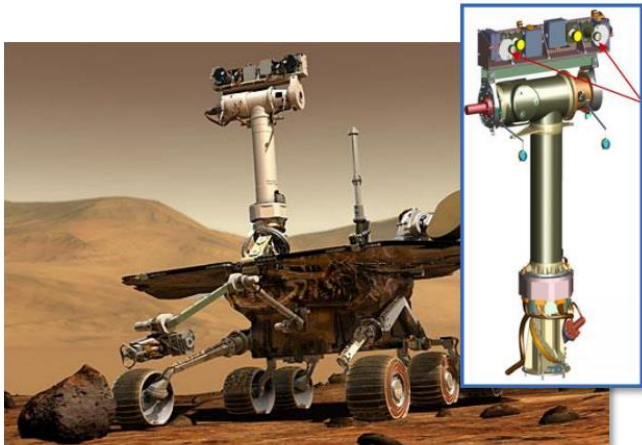
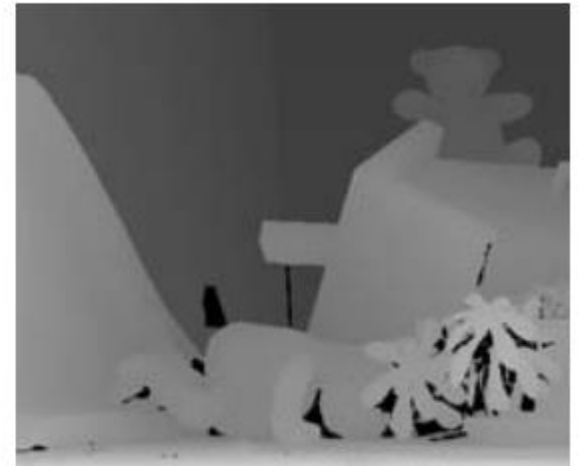
Image calibration

- Fisheye correction from go-pro for example



Stereo & 3d cameras

- https://www.youtube.com/watch?v=PySBQ8Q_R8k



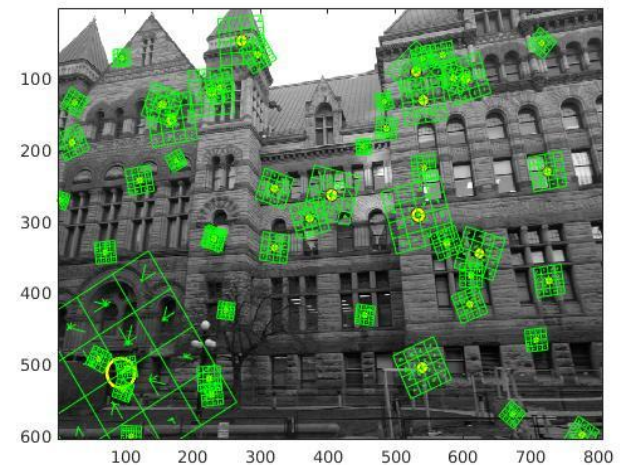
(a)



(b)

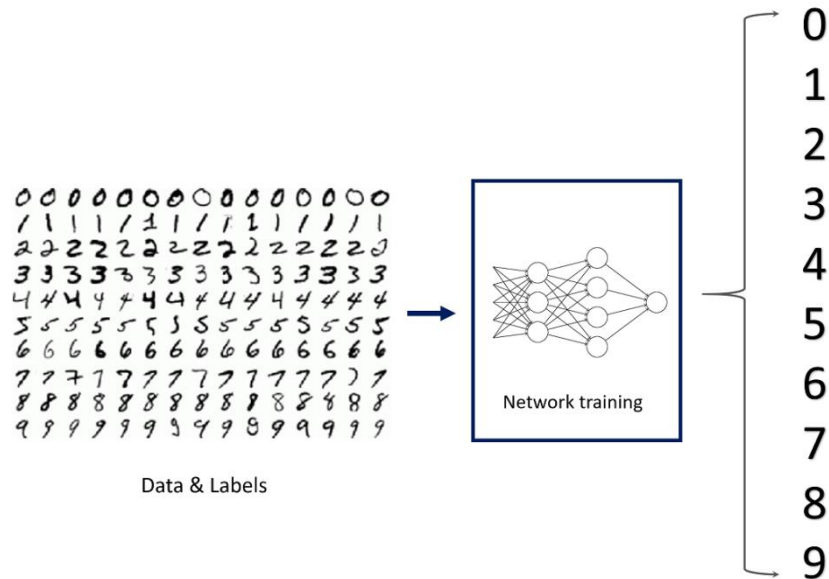
Fitting & Feature extraction

- Extract interesting points from image for later recognition, stitching, learning and more.
- <http://www.in2white.com/>



Neural networks

- <https://deepdreamgenerator.com/generator>
- <https://quickdraw.withgoogle.com>



Dream generator- style transfer



Dream generator- style transfer



And some more AI stuff

- Deep fake
 - <https://www.youtube.com/watch?v=cQ54GDm1eL0>
 - <https://www.youtube.com/watch?v=-QvIX3cY4lc>
- Nvidia GauGAN
 - <https://www.youtube.com/watch?v=p5U4NgVGAWg&t=40s>
 - <http://nvidia-research-mingyuliu.com/gaugan>

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