NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

CC0007 Science and Technology for Humanity

Artificial Intelligence II (Business Aspect)

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AI Applications

- Recommendation systems
- Predictive maintenance

Image Recognition

- Advances in AI have tremendously boosted accuracy of image recognition.
- A 2015 *deep convolutional neural network (CNN) architecture* won first place in the ImageNet Large Scale Visual Recognition Challenge (ILSVRC) with an error rate of **3.57%**.
- In contrast, *humans* have an error rate of **5.1%**, on the same task.

Image Recognition: Humans vs. AI

- In the past, machines struggled to recognise images, as the input given to them are arrays of numbers from 0 to 255, representing the intensities of pixels.
- In contrast, our human brains can identify features of perceived images, like edges, shapes, shades, shadows, which allow us to easily identify them.
- The CNN deep neural network architecture has this basic idea of *feature identification*.

Convolutional Neural Network

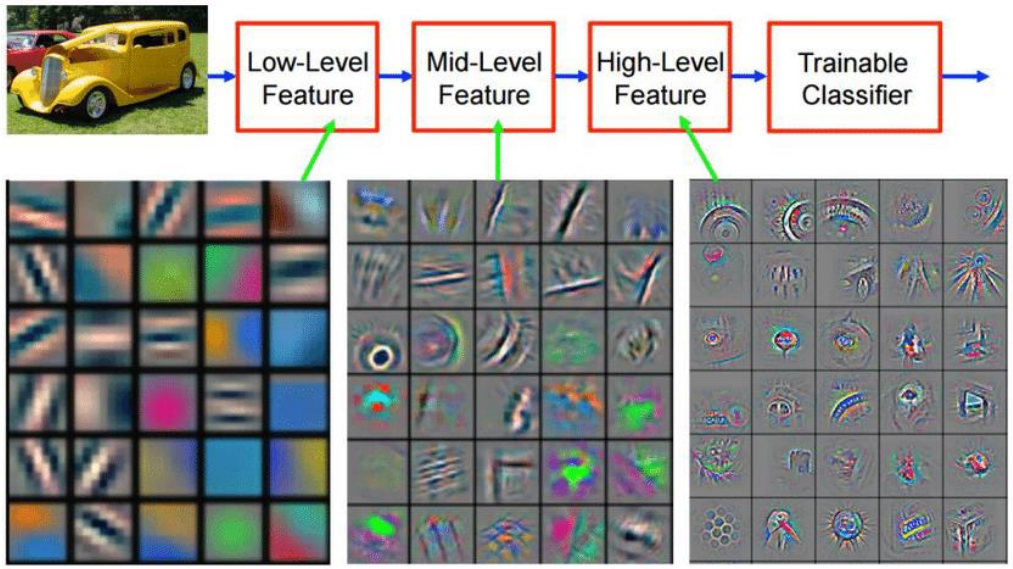


Image Recognition

- Input comprise pixels (array of numbers denoting the intensity of *red*, *green* and *blue*).
- These input are processed to identify images using a deep learning architecture that is based on *convolutional neural networks* (CNN).

- Objects identification
- Handwritten texts
- Facial recognition
- Photo enhancements
- Autonomous vehicles
- Robotics
- Drone technology

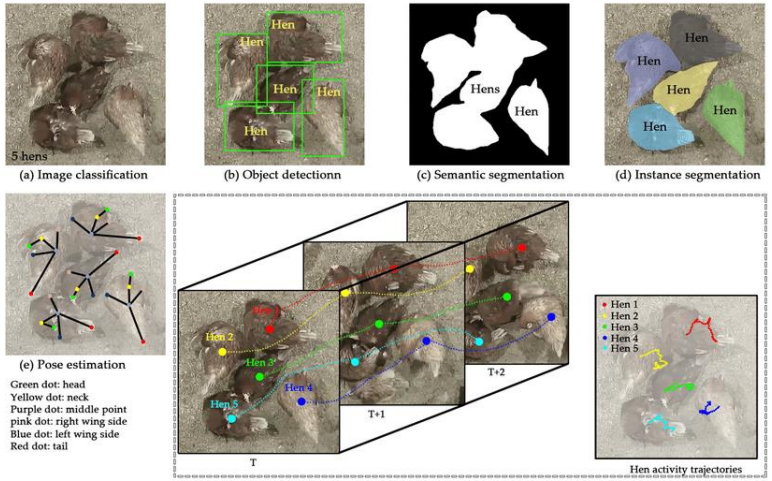
Iris and Facial Biometrics for Immigration Clearance at all Checkpoints in Singapore

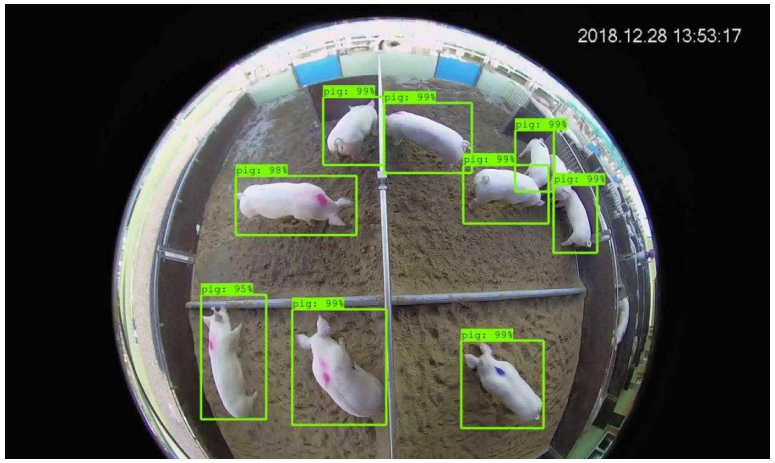
- Fingerprint verification as been implemented in Singapore since 2006.
- With improved image recognition, *iris scanning* started to roll out in 2017. This alleviated fingerprint issues due to ageing, scarring or dryness.
- Iris scanning uses 250 feature points for matching, compared to around 100 for fingerprints.
- Human iris patterns are more distinctive, with *greater degree of variations*, making it more *robust for identifications*.
- Iris matching has an accuracy of 90%–99%. In live iris scanning, eyeball movements are detected, eliminating possible fooling of scanning using a picture of the eye. This also makes it impossible to scan a dead person's iris—after death, the pupil expands and the iris area is too narrow for scanning.
- Impact: Significantly speeds up immigration clearing processes and reduces manual labour.

Aipoly Vision

- A “visionary” app that assists **visually impaired, colour-blind or blind individuals**.
- Capable of identifying texts, food, plants, animals, etc., including **facial** identification of known identities.
- After object identification, the app then displays or reads out the object’s identity.

Agriculture





- Livestock farming, fish farming, fruits and vegetable yields have benefitted greatly from the use of computer vision.
- These live trackers allow for management of livestock to ensure animal welfare, monitor animal behaviour, tackle diseases, as well as promote better facility design.
- In fish farms, computer vision tracking provides automated mechanisms for feeding and fish count.
- For fruits and vegetable yield estimates via image recognition, this allows pre-harvest planning by farmers.
- Overall, computer vision permits better agricultural yield predictions which minimises wastage.

Defect Detection

- In a production line, image recognition technology has proliferated in *quality control* and *defect detection*.
- Large-scale manufacturing plants require massive checks on their products. Without the use of AI to do this, a large equivalent human workforce would be required.
- An example of this is a raft of defect detection applications by *Foldsolutions,* that inspect cookies, bakery products, meat, seafood, dairy products, and agro products.

AI Applications

- Image recognition

Generate Realistic Photos of *Non-Existent* Humans

Not only images …
but also generating
non-existent videos
with audios!

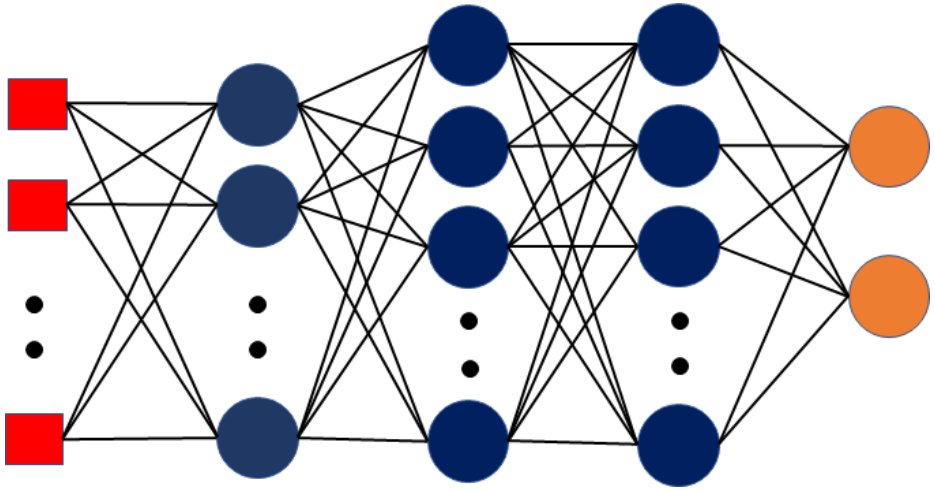
AI Applications

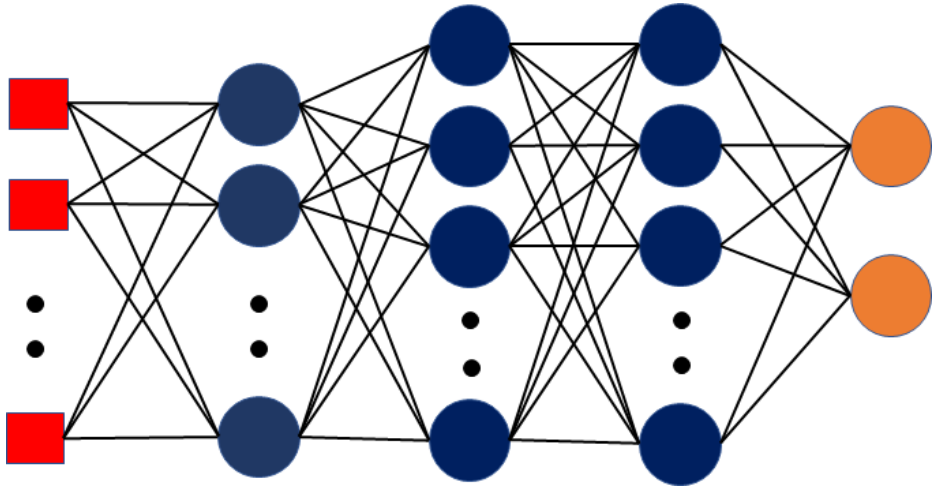
- Image recognition
- Deep fakes

Generative Adversarial Network (GAN)

Structure of GAN

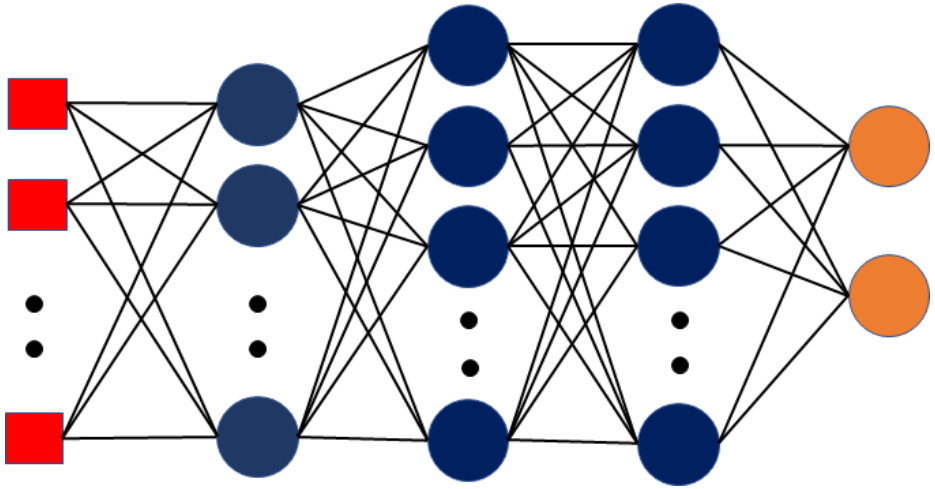
- GAN comprises two neural networks: *Generator* and *discriminator*





The Generator

- The *generator* aims to produce an output that is realistic. This generated output is evaluated by the *discriminator*.
- Generator strives to fool the discriminator by trying to produce realistic output.

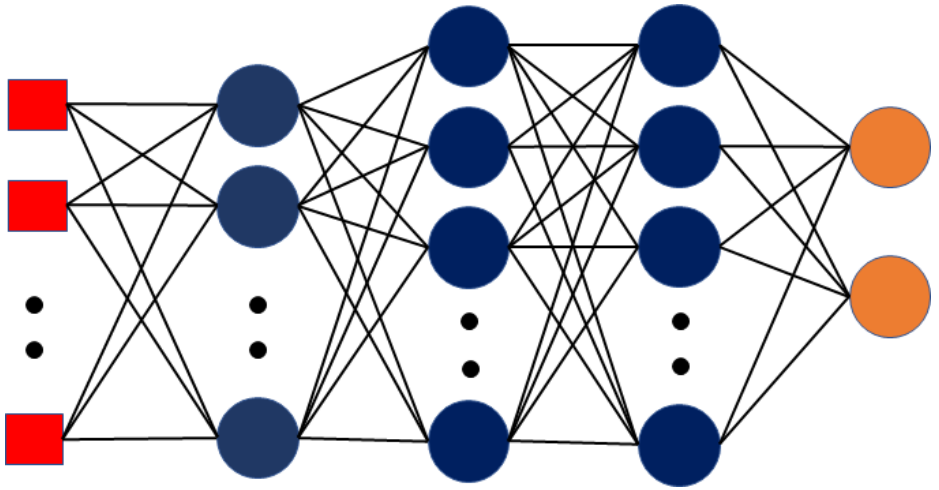


The generator

The Discriminator

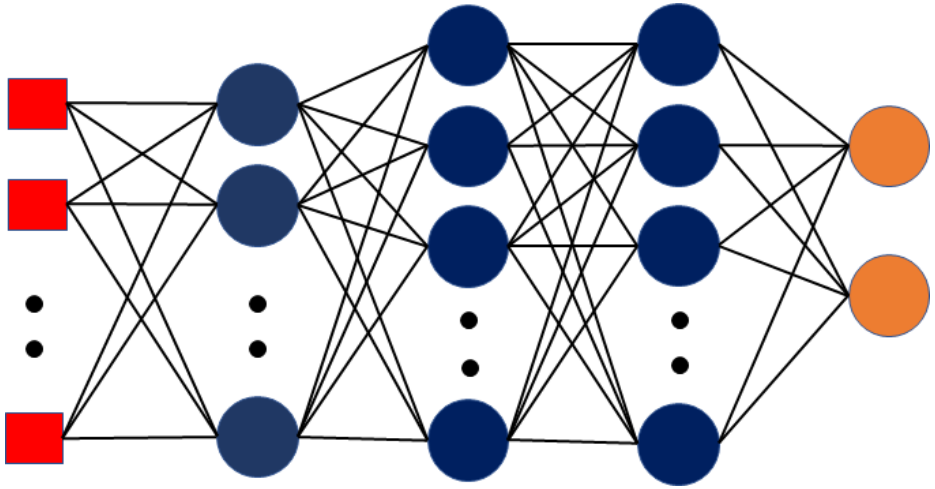
- The *discriminator*'s job is to discern whether a given sample is real or fake (generated by the generator).

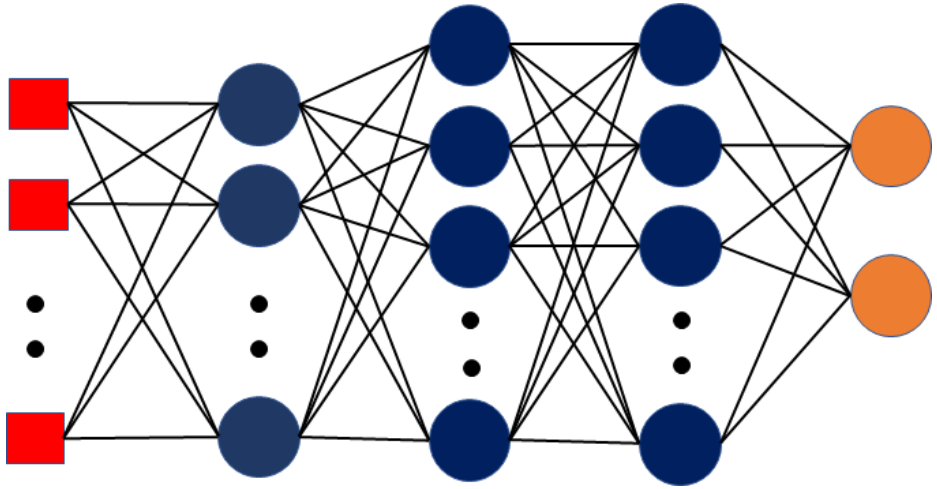
Discriminator



Generator Competes With Discriminator (Hence Adversarial)

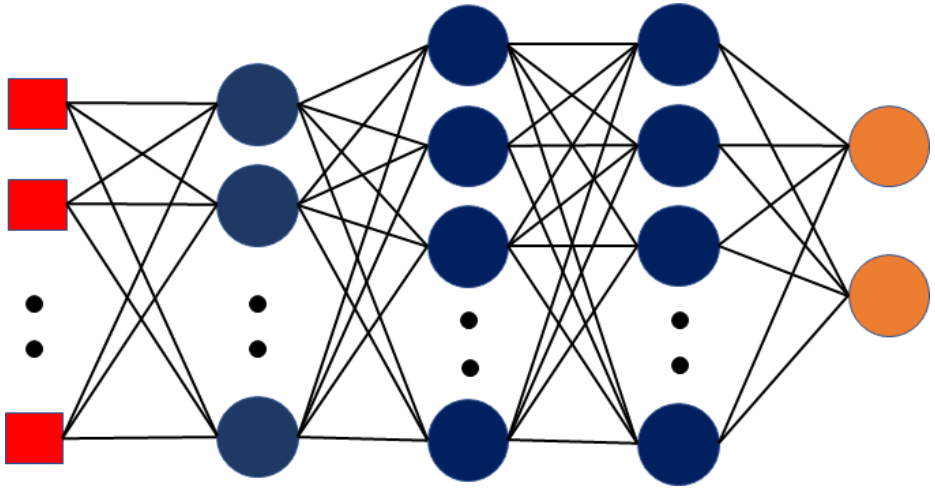
- These two networks compete to outsmart one another.
- *Generator* gets better at producing realistic output.
- *Discriminator* gets better at discerning between real and fake (generated) output.





The ***Trained*** Generator

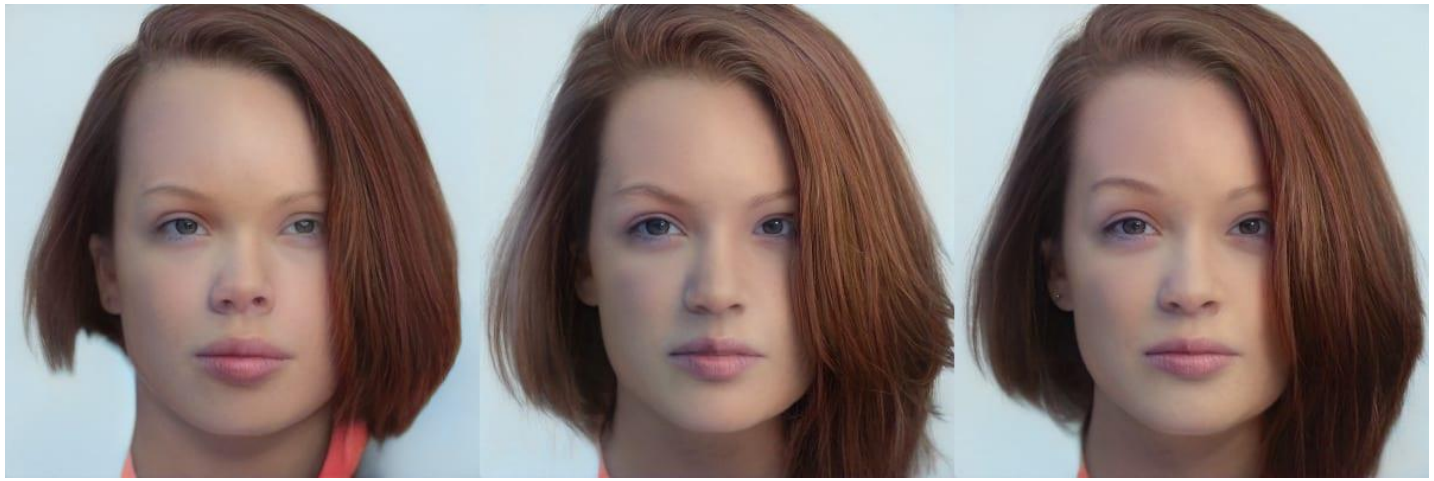
- Ultimately, we have a *trained generator deep neural network* that is capable of generating highly realistic output.



The generator

Image Customisation

GAN allows for subtle customisation of images based on certain desired features.



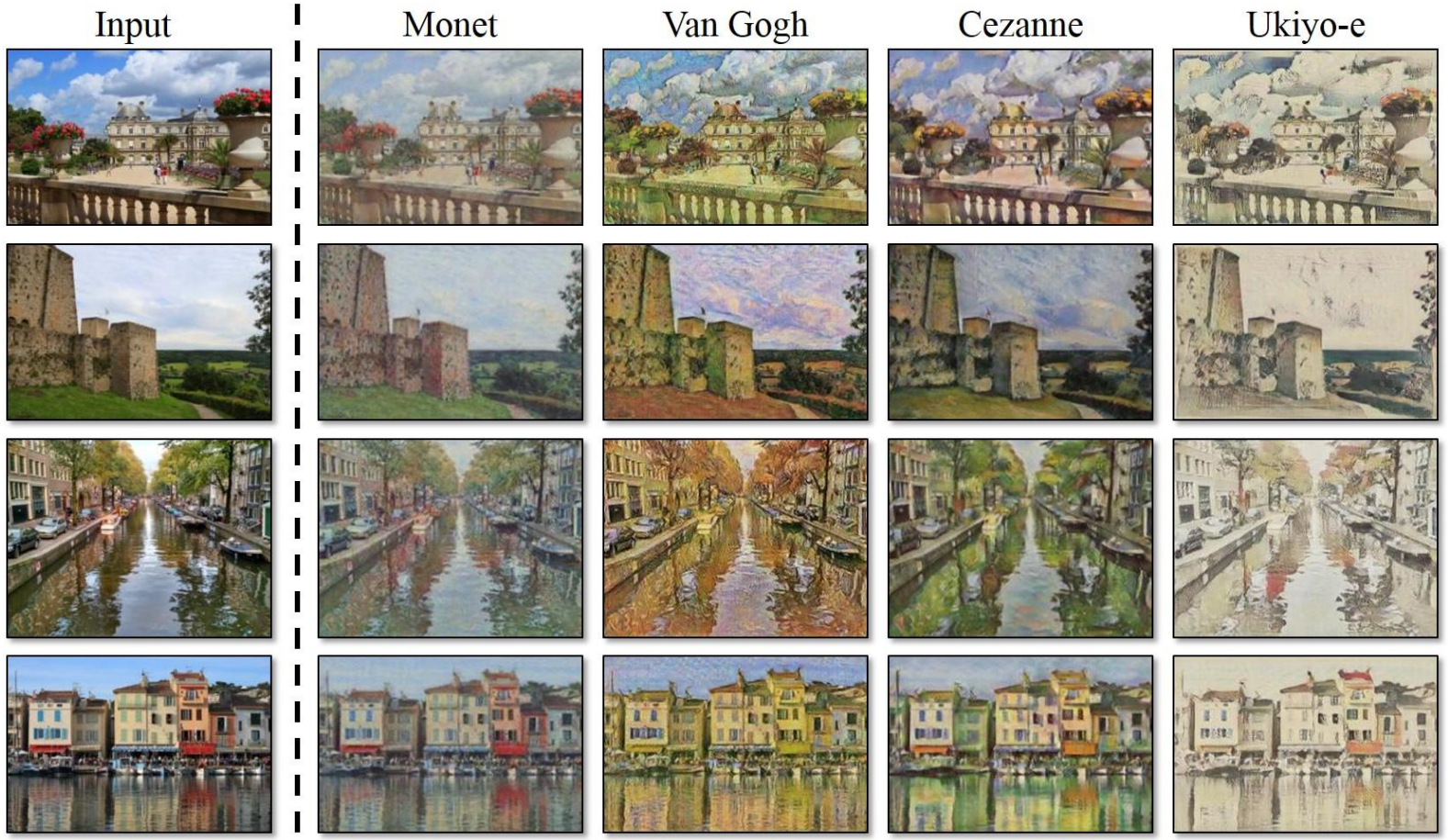
Rectify Corrupted or Damaged Photos

Ground truth

Missing data mask

Inpainted result

Domain Adaptation



Given an input image, adapt it into other desired domain.

THE STRAITS TIMES

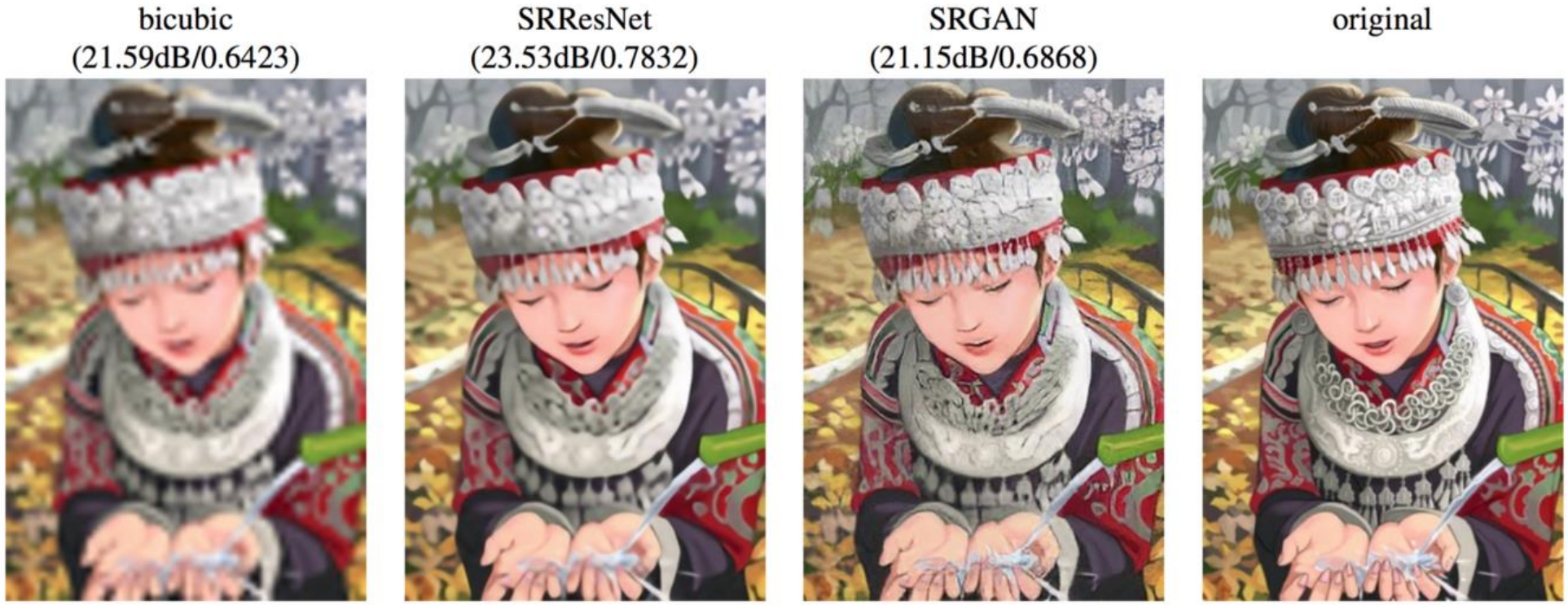
FOR SUBSCRIBERS

An AI-generated picture won an art prize. Artists aren't happy

New tools such as DALL-E 2, Midjourney and Stable Diffusion, which are able to create complex, abstract or photorealistic works simply by typing a few words into a text box, have created a stir.

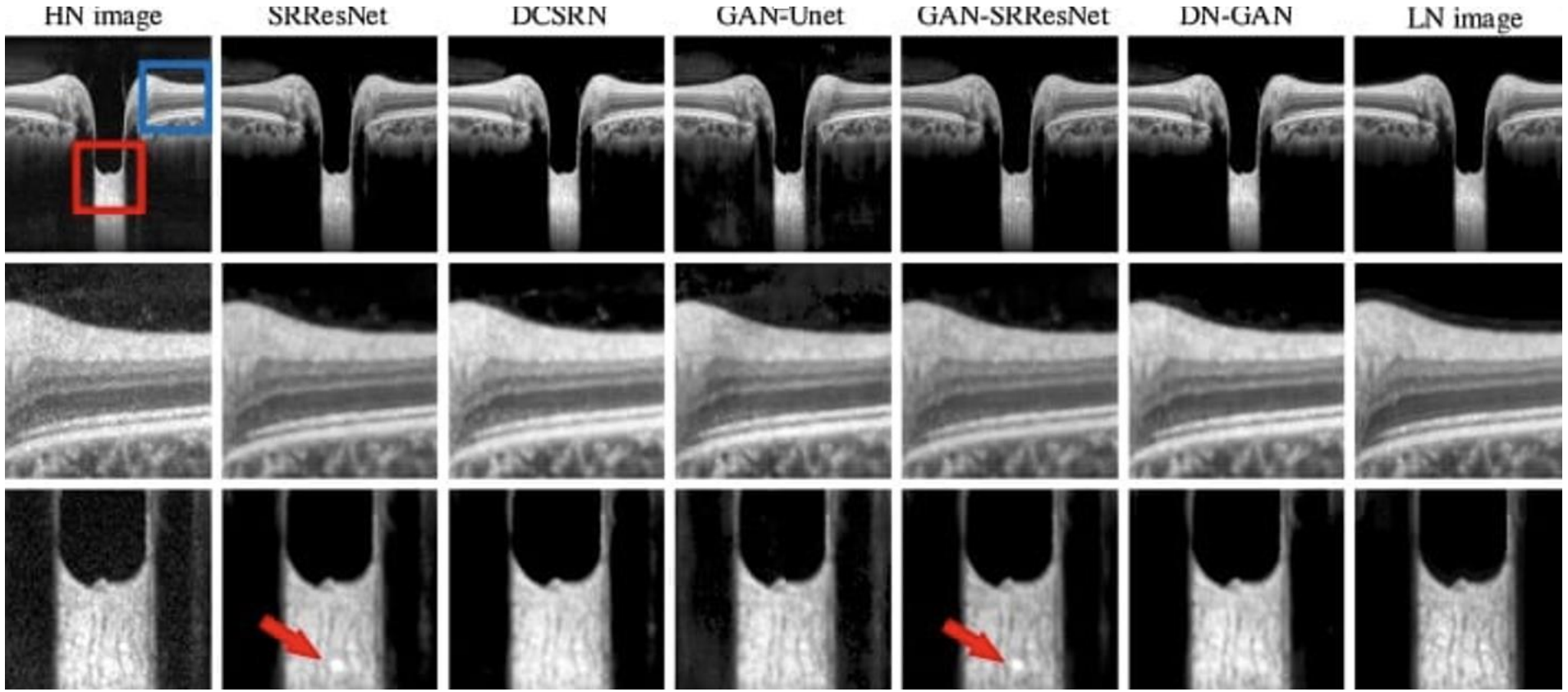
Kevin Roose

Image Super Resolution



Upscaling low-resolution images to high-resolution images without artefacts introduced by traditional methods.

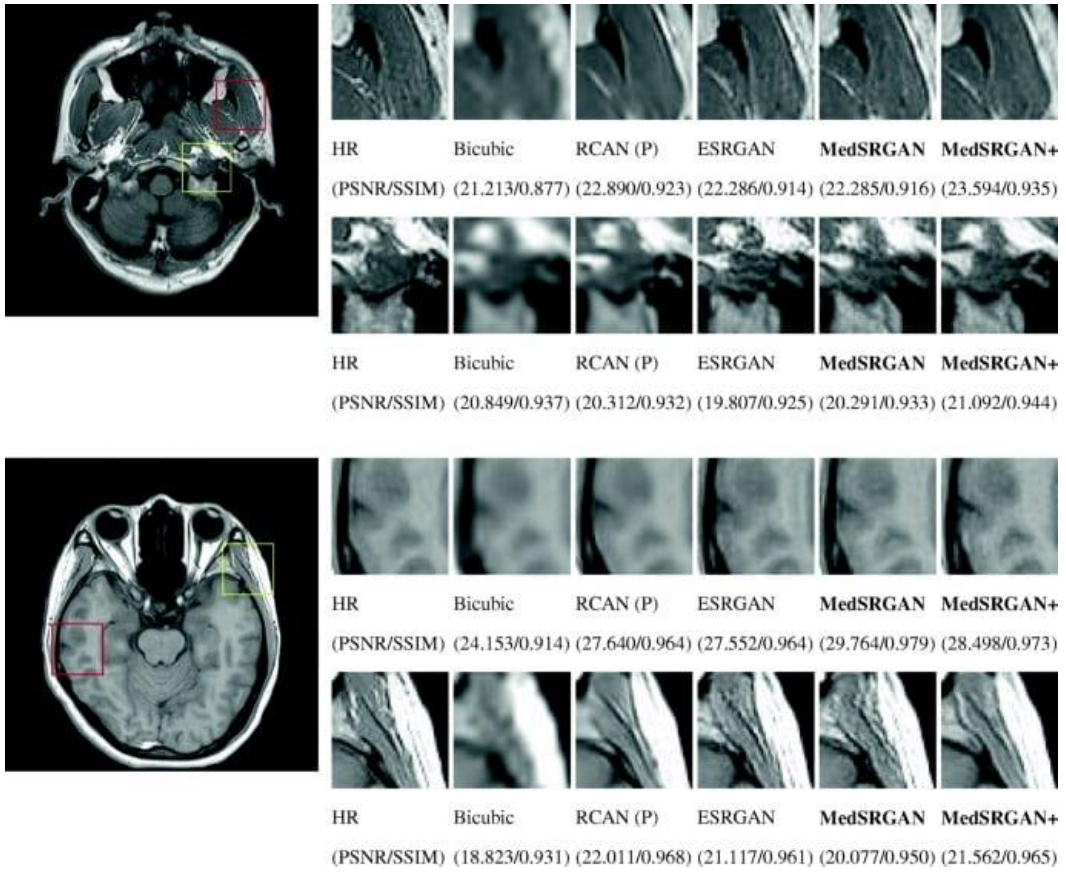
Denoising



GAN can remove statistical noise from data, like medical imaging.

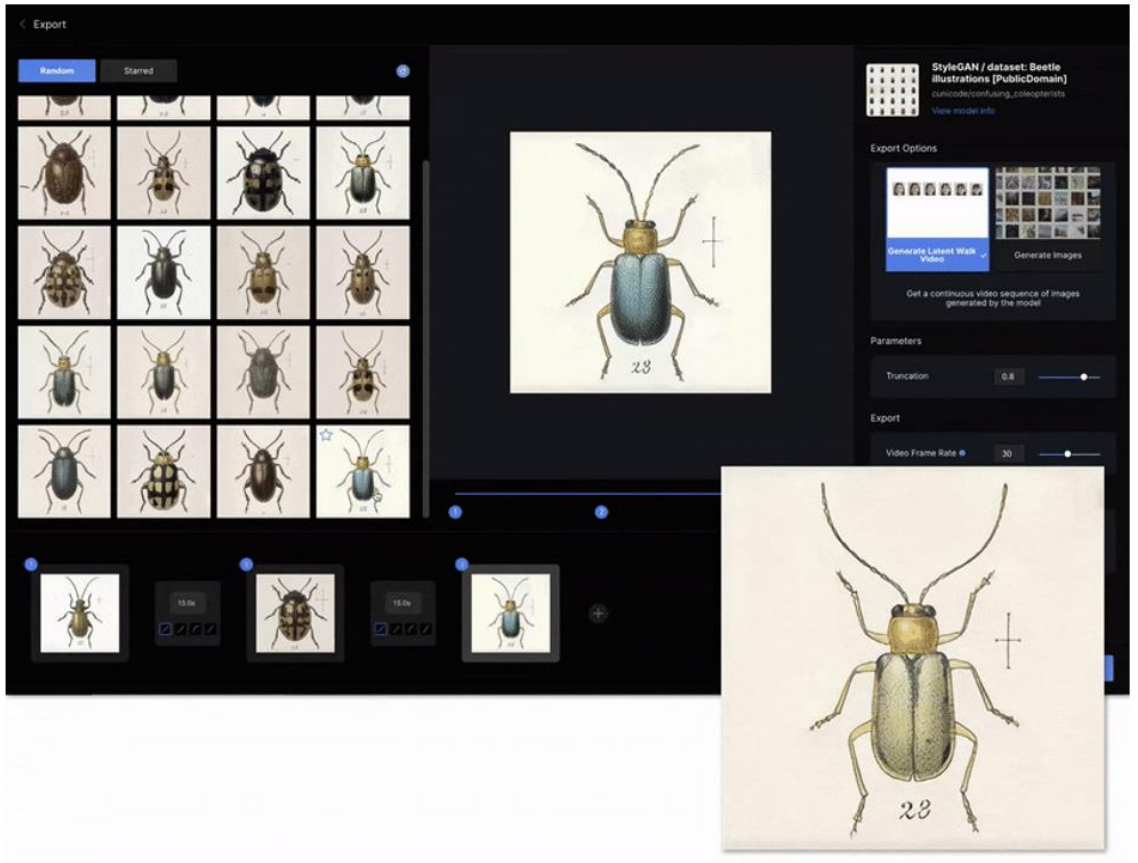
Use in Healthcare

- In healthcare, the ability to generate super-resolution images of medical imaging as well as denoising is highly useful.
- This is because, scans like X-ray and CT scan would expose patients to radiation.
- Being able to reduce radiation exposure but still obtaining critical information, without distorting the original scans would be valuable.



GAN as a Commercial Service

- Some companies are providing access to their infrastructure for data handling, model training with GAN “As-a-Service”.
- *Runway AI*: https://runwayml.com/



AI Applications

- Image recognition
- Deep fakes
- AI in healthcare

AI in Healthcare: Overview

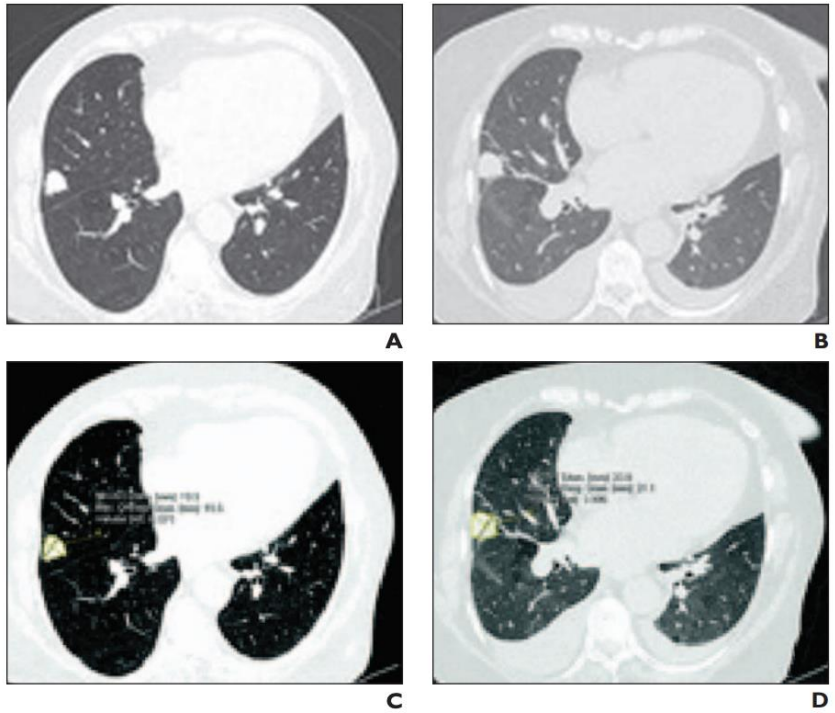
- AI technologies allow streamlining BOTH administrative and clinical healthcare processes.
- The scope of applications of AI healthcare is wide, including diagnostics, operational technologies, and wellness.

AI-Assisted Robotic Surgery

- In surgery, AI-assisted robotics can analyse data from pre-operation medical records, to physically guide the surgeon's instruments in an operation.
- Additionally, using data from actual surgeries, AI can help to formulate new surgical techniques.
- A study found that AI-assisted robotic technique allowed a 5-fold reduction in surgical complications.

Automated Imaging Diagnosis

- AI can undertake medical imaging diagnosis.
- NYU Langone Health researchers illustrated that automated analysis would find and match lung nodules from CT images around 62% to 97% faster than a regular panel of radiologists.
- It is estimated that such AI-generated efficiencies in image analysis may save $3 billion annually by freeing up radiologists to focus on reviews requiring greater judgment.



Dosage Error Reduction

- Drug dosage determination has traditionally been challenging.
- Dosing errors lead to 37% of preventable medical errors.
- A 2016 landmark paper presented a mathematical formula using AI to accurately dictate the optimal dosage of immunosuppressant drugs for organ patients.
- Such estimations using AI could produce $16 billion in annual savings.

Other AI Applications in Healthcare

- **Virtual nursing assistants**
  - Helps address shortage in medical labour.
- **Connected machines**
  - Provides connectivity amongst various medical equipment used in tandem.
- **Clinical trial participation**
  - Integrates plethora of such data, accelerate data- and outcome-based approaches.
- **Preliminary diagnosis**
  - Improves interpretability of data to enhance accuracy of medical diagnosis.
- **Cybersecurity**
  - Protects healthcare data.