Digital and Other Fields

- **Computer Graphics** describes the world visually
- Aims at perceived visual quality (not only realism, also art)

- **Computer vision** attempts to reconstruct the world (world → computer model)
- **Image processing** works with images

Examples:
- Computer Vision:
  - 3D geometry reconstruction from images
  - Texture capture
  - Scanning 3D world
  - Image understanding
CG and Other Fields

Examples:
- Image processing
  - Image compression
- Video codecs
- Image inpainting
- Computational cameras

Recent Advances

- Virtual Reality
- Augmented Reality
- Non-Photorealistic Rendering
- Artificial Intelligence

The Rendering Process
Virtual Reality

- The rendering process is doubled
- There are two cameras approx. distance of the human eyes apart
- They render two images
- The images are displayed to left and right eye
- The human brain perceives it as 3D
- The viewers is immersed into the virtual environment

Virtual Reality

- It needs precise head tracking
- Head movement is transferred to the dual-camera movement
- The environment is simulated all is synthetic

Virtual Reality

- How do we deliver the data to each eye?
- ...by using special displays
- Shutter Glasses
- Head Mounted Displays (HMD)
Shutter Glasses

- They turn on and off the display for each eye at high frequency
- A specialized display displays the left and the right images in fast sequence
- It needs to be synchronized

https://en.m.wikipedia.org/wiki/Active_shutter_3D_system

Shutter Glasses

  - USB-support
  - Stereoscopic gaming kit

Shutter Glasses

- The Cave
  - Four large active displays
  - Active shutter glasses
  - Can move the screen walls L, U, Flat

Shutter Glasses

- Challenges
  - Limited view (the screen)
  - Limited motion
  - Limited field of view
Head Mounted Displays

- Double display
- Worn on head
- Precise head tracking
- Good sound
- Some support eye-tracking

Head Mounted Displays

- Challenges
  - Motion sickness
  - Heavy (it is getting better, but...)
  - Needs huge computational power

VR

- VR Challenges in General
  - Lag
    - There is a delay between the movement and display
  - Limited field of view
    - We perceive in the corners of our eyes too
  - Full immersion is only visual
    - You cannot feel the weight of the objects.
  - And all the imprecisions
    - Colors, sound, tracking...

Augmented Reality
Augmented Reality

- AR displays additional data in real world
- Usually an image in the real world
- Provides some additional insight
- A popular ones are real-time translators

Augmented Reality

- Technology
  - Head mounted transparent displays e.g., Microsoft HoloLens
  - Cellphones
Augmented Reality

- Challenges
  - 3D positioning precision depends on sensors and cameras
  - Speed of rendering depends on the CPU/GPU
  - Data available depends on the internet connection

Non-photorealistic Rendering

- Usually we aim for photorealism
- Always we aim for fast displaying

- In some contexts **non-photorealism** is better

- Stylized rendering
- Artistic rendering

Non-photorealistic rendering

- Toon shading displays objects similar to cartoon animation (strong color changes, silhouettes)
**NPR**

- *Artistic rendering* attempts to simulate artistic style

- *Sketch-based rendering* simulates human sketches

- *Illustrative visualization of volumetric data*

- Needs smart processing of volumes and feature extraction

- Nowadays
  Strongly supported by deep learning

- Many of these approaches are image processing techniques
  Supported in image processing software e.g., Adobe Photoshop
Deep Learning

- DL belongs to machine learning (ML) and ML belongs to artificial intelligence (AI)
- Game changing technology
- DL
  - Works on large datasets (usually)
  - Requires huge computational power (usually)
  - Provides end-to-end solutions
- Traditional ML creates rules for decisions e.g., if it is round, it is a circle
- DL uses massive datasets to find answers
- Show it 10,000 cats and it will recognize cat
Deep Learning

1) Training
Requires a DL (with certain *architecture*)
Requires initial weights of neurons
Requires large dataset of labelled data

2) Inference
Deep Learning

1) Training

The DL is shown *batches* of pairs [label, data] DL assigns its weights by using back propagation algorithm For large datasets this can take days GPUs are commonly used for this task

2) Inference

The DL is shown *an unknown* data set It will assign it a label Inference is *very fast* (in orders of milliseconds)

Deep Learning

- Why it all works?
  - The DNN generalizes the data
  - Each layer holds higher level of *abstraction*

- Overfitting problem – it can “memorize” the input data and will not generalize at all (if you memorize the homework you will fail the exam)

Deep Learning

- Convolutional NN
  - Image classification
  - Image segmentation

- Recurrent neural networks
  - sequences in time
  - Translators
Deep Learning

- Generative Adversarial Networks
  - Can complete images

Real-Time Live Capture

© Philip Isola et al.

https://www.youtube.com/watch?v=5w685udM838&feature=youtu.be

Deep Learning - Reinforcement Learning

Multi-Agent
Hide and Seek

© Bedrich Benes

https://www.youtube.com/watch?v=kupfi.nxdJY

© www.openai.com

Food for thought...

StratoEnergetics LIVE STREAM
http://www.stratoenergetics.com
Buenos Aires Event
TV Truck 02

© Bedrich Benes

https://www.youtube.com/watch?v=TQ2kpecVYAt
https://autonomousweapons.org/

Use what you have learned
to make the world a better place