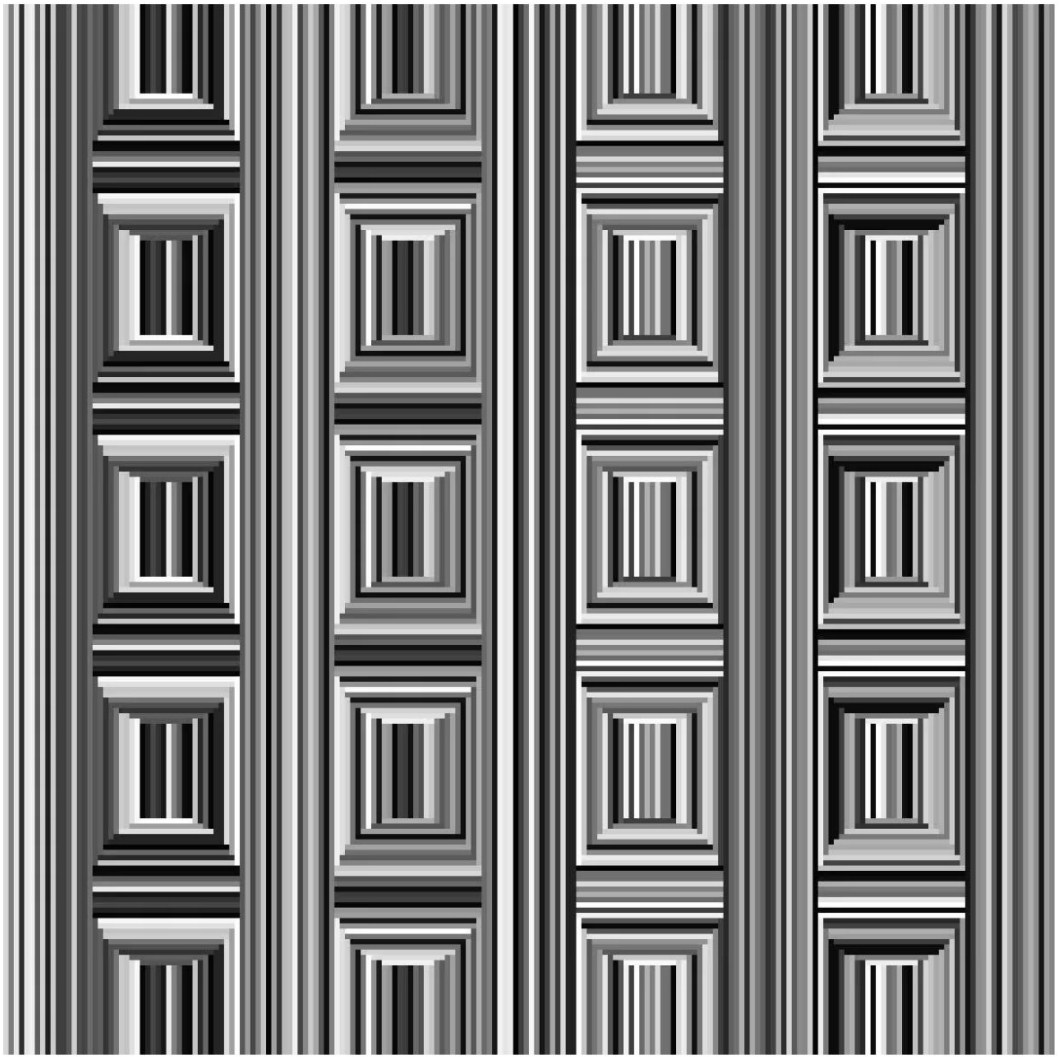
Introduction

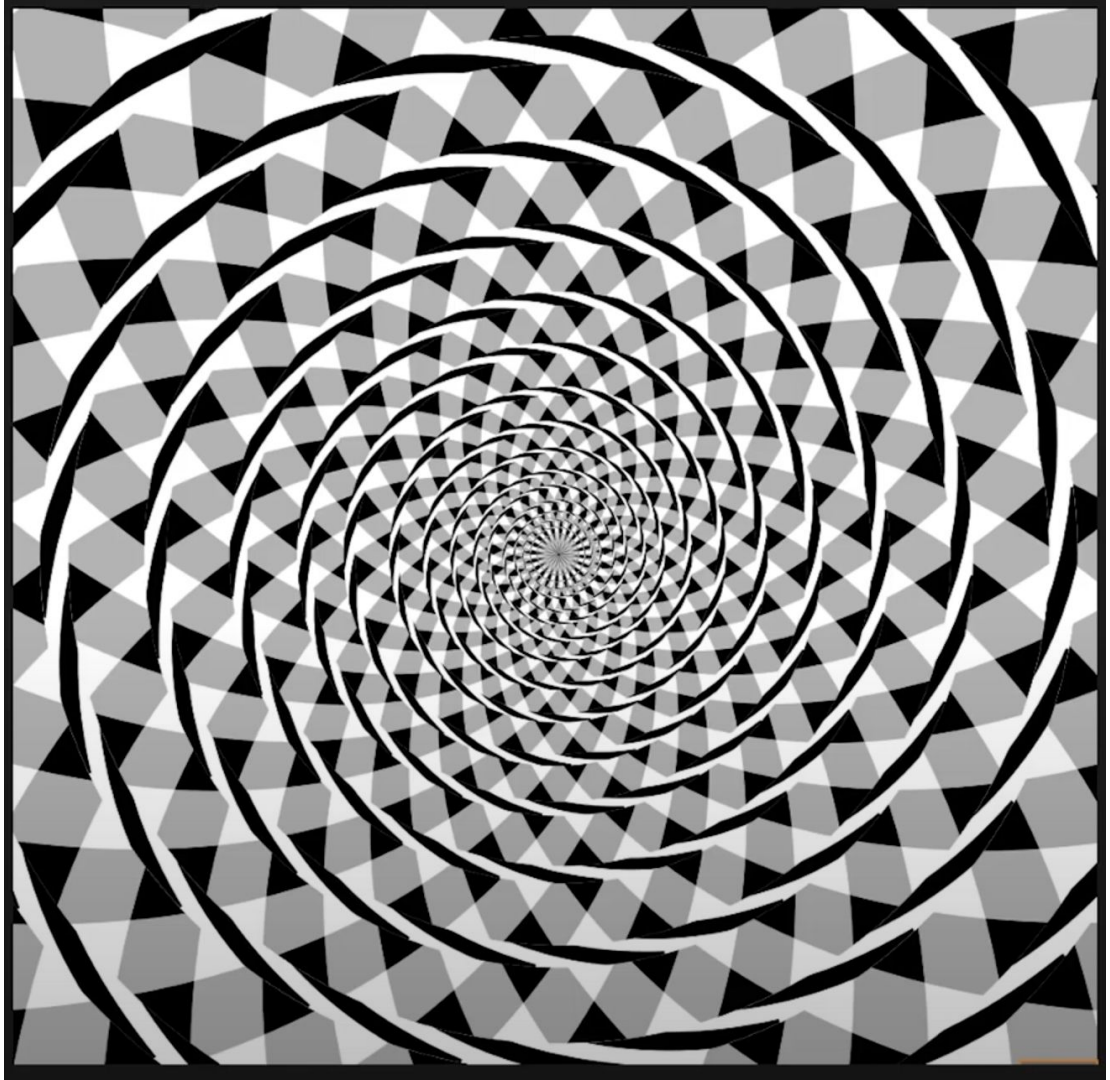
What is computer vision?

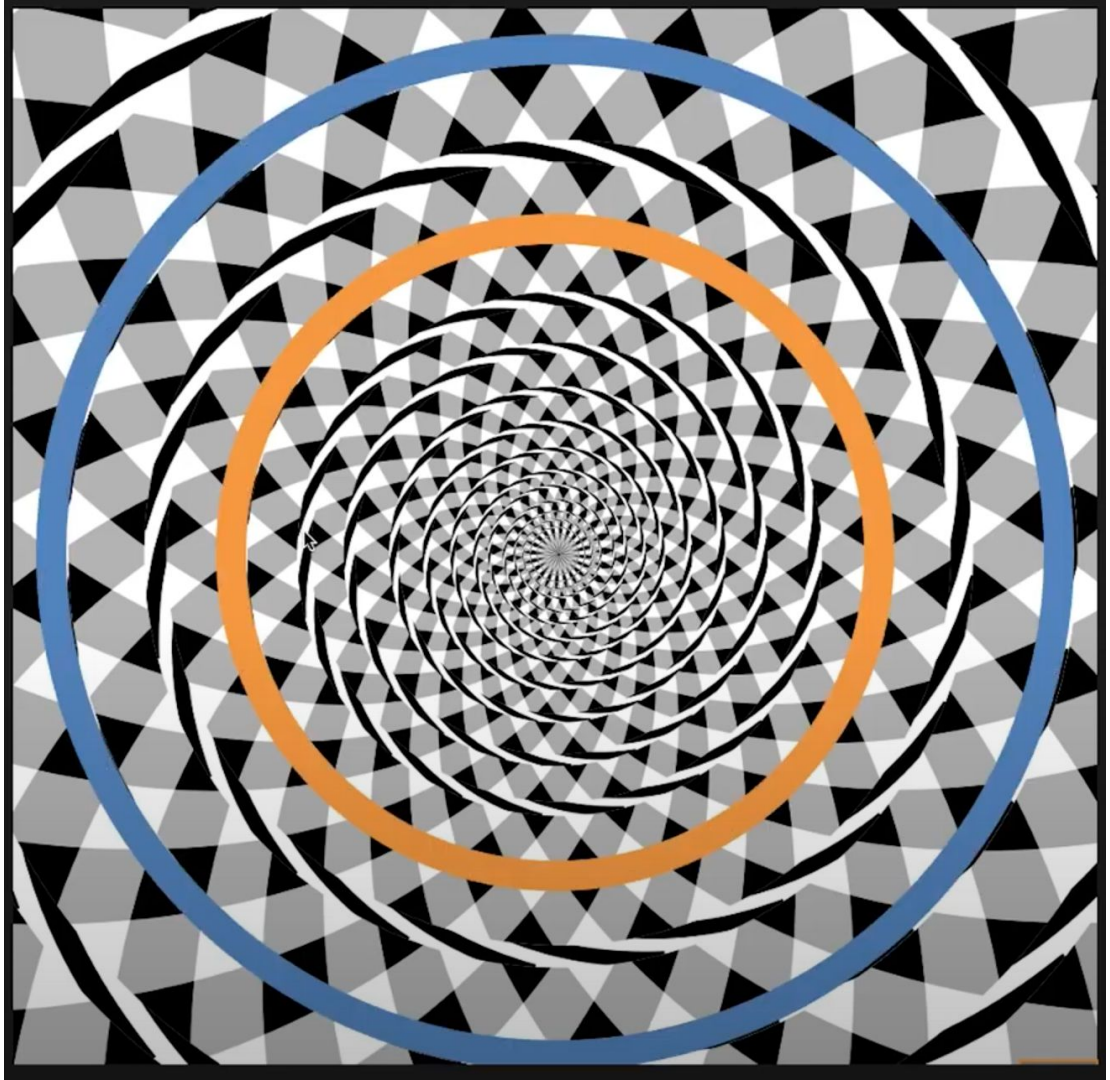
“Computer vision studies how to reproduce in a computer the ability to see.”

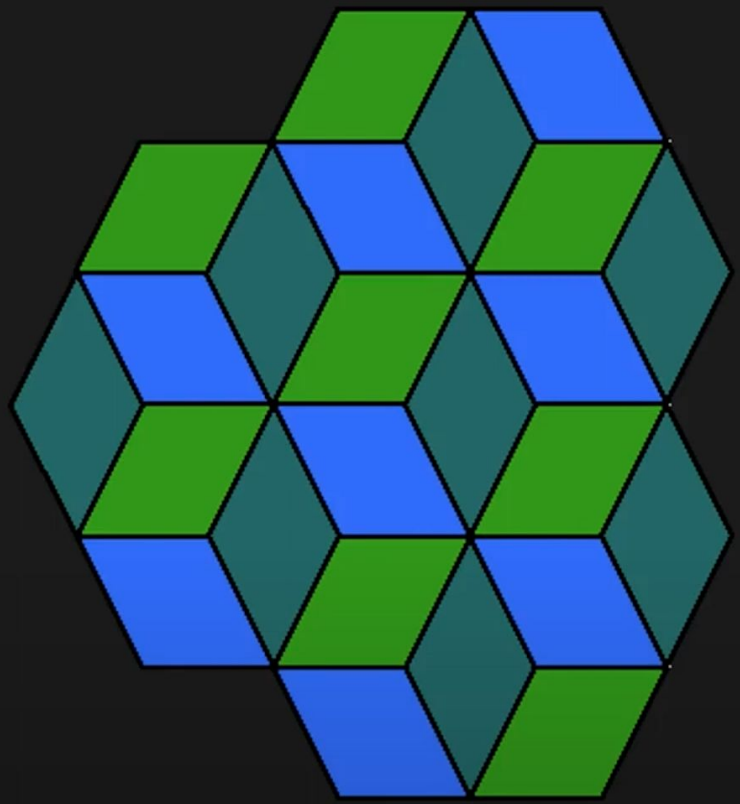
The light that reaches our eyes

1. “Human vision is capable of extracting information about the world around us using only the light that reflects off surfaces in the direction of our eyes.”
2. “It only give us information about the amount of light reaching our eye from each direction in space.”
3. “Our brains have to translate the information collected by millions of photoreceptors in our retinas into an interpretation of the world in front of us.”
4. “What we see is different than the light that reaches our eyes, as visual illusions prove to us.”









Six Cubes or Seven Cubes?

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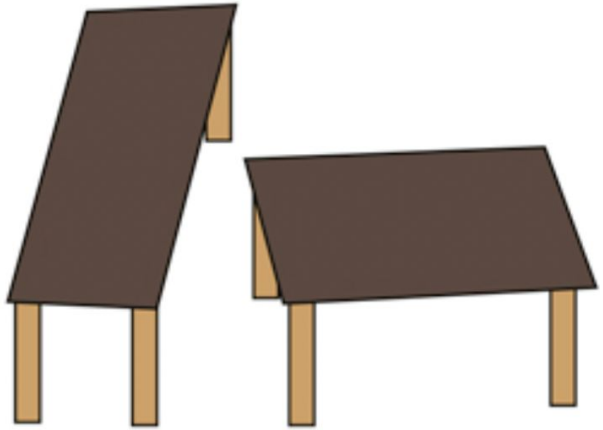
(a)



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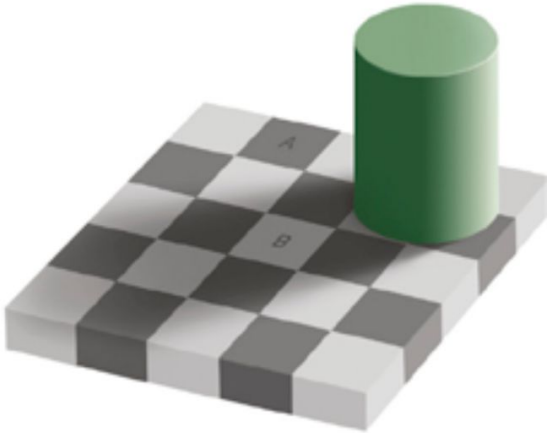

(c)

A
B

Model based vs learning based CV

1. Model-based computer vision relies on predefined rules, mathematical models, and geometric principles to interpret images and scenes.
2. Learning-based computer vision uses data-driven machine learning techniques, particularly deep learning, to learn patterns and features directly from data.

Model based computer vision

Handcrafted Features: Engineers manually design features like edges, corners, shapes, or textures.

Rule-Based Algorithms: Algorithms explicitly use mathematical models to detect, classify, or interpret objects.

Deterministic: The approach is usually rule-driven, making the output predictable for specific inputs.

Domain Knowledge: Requires extensive domain expertise to craft effective models tailored to specific tasks.

Model based computer vision

Advantages:

- Transparent and interpretable.
- Effective in controlled environments with limited variability.
- Requires less data compared to learning-based methods.

Limitations:

- Struggles with complex, noisy, or unstructured data.
- Limited scalability and generalization to new tasks.

Learning based computer vision

Automatic Feature Learning: Neural networks extract and learn relevant features from raw input data.

Training Required: Models are trained on large datasets to learn patterns.

Probabilistic: Outputs are based on learned probabilities, making the system adaptable to new inputs.

Learning based computer vision

Advantages:

- Highly scalable and generalizable with sufficient data.
- Can handle complex, noisy, and diverse datasets.
- Achieves state-of-the-art performance in many tasks.

Limitations:

- Requires large labeled datasets for training.
- Computationally expensive to train and deploy.
- Less interpretable (black-box nature).

Learning based vision

Code:

```
void quickSort(int input[], l, h) {
  if l < h {
    int pi = partition(input, l, h)
    …
  }
}
```

Compiler: GCC

Program: QuickSort

```
# training data
input1 = [5,2,1,3,4];      output1 = [1,2,3,4,5]
input2 = [1,8,4];          output2 = [1,4,8]
input3 = [6,5,4,3];        output3 = [3,4,5,6]
…
```

SGD

LearnedSort

References

1. Foundations of Computer Vision - Chapter 1
2. https://www.sydney.edu.au/news-opinion/news/2017/07/31/three-visual-illusions-that-reveal-the-hidden-workings-of-the-br.html