Computer vision

laboratories

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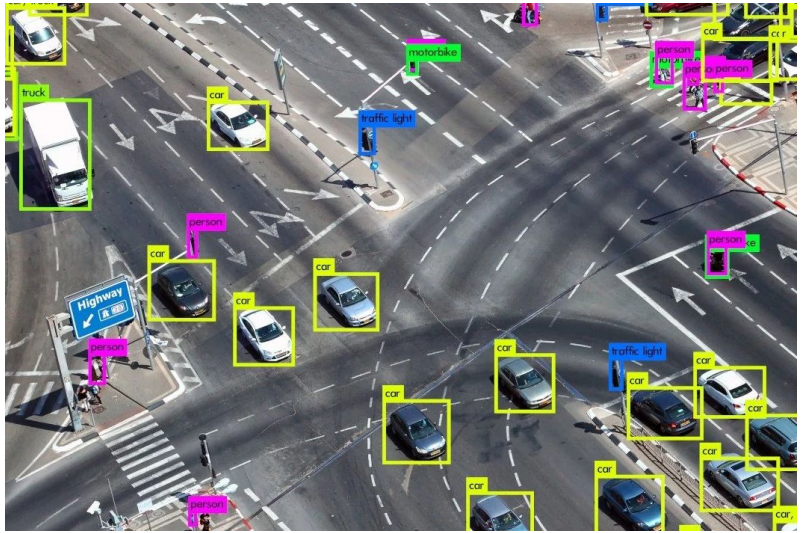
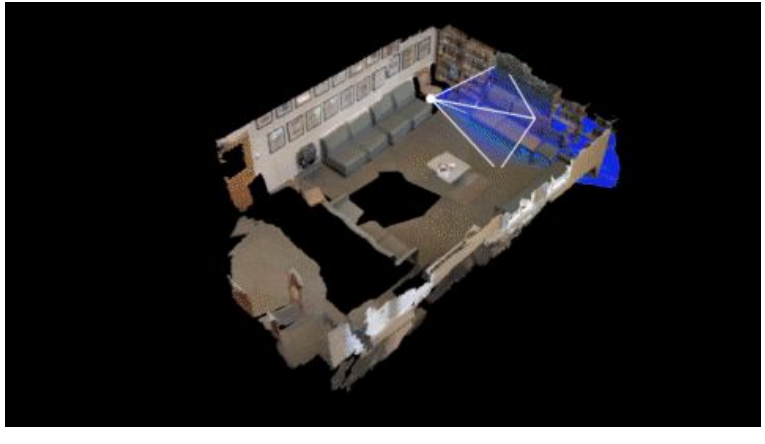
Computer vision - tasks

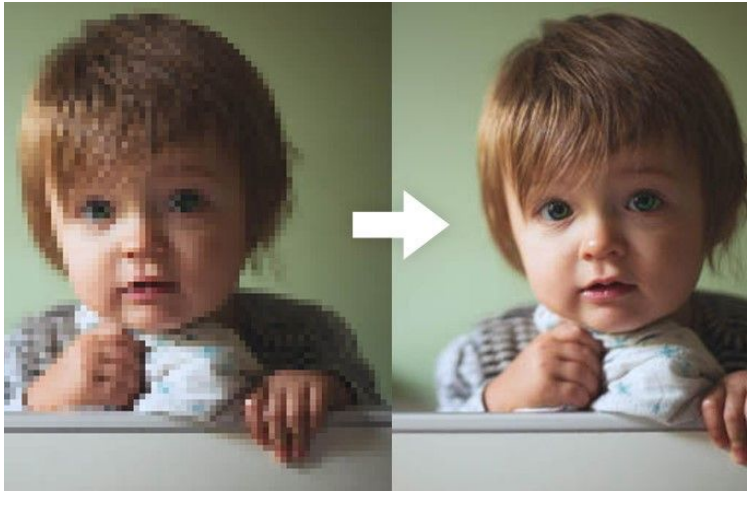


Object detection

Image segmentation

Original Photo Example Photo Result





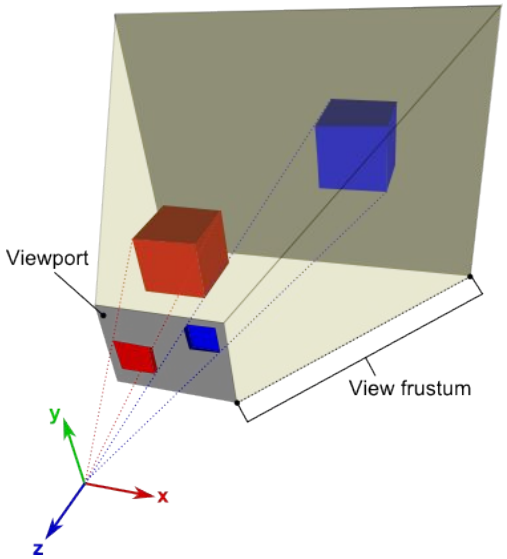
Agenda

1. Main parts:
    a. Image representation and processing,
    b. Object detection and semantic description,
    c. Neural network in computer vision
2. Environment and libraries
3. Cellular automaton

Image representation

Image = result of the projection of a 3D scene onto a 2D plane (image acquisition)

- How to represent a 2D plane?
- How to represent color?
  - Spatial domain: RGB, CMYK, Grayscale,
  - Frequency domain (image = 2D signal)
- How to transform between different image representations and what are the benefits?

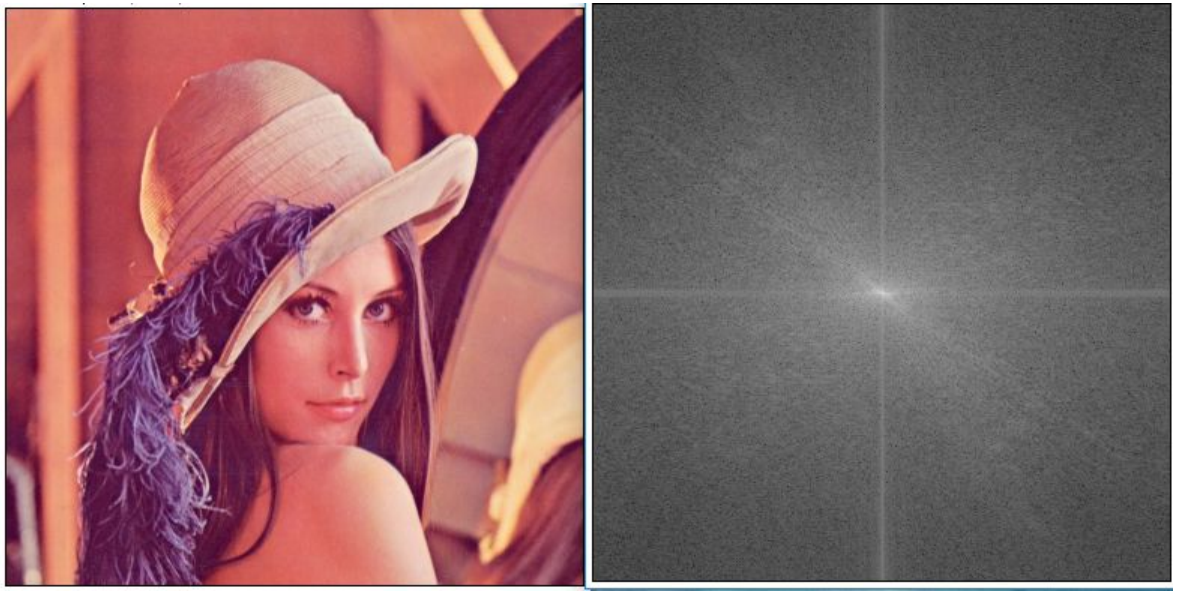


Scheme of projection of a scene into a 2D image

Image representation - spatial domain

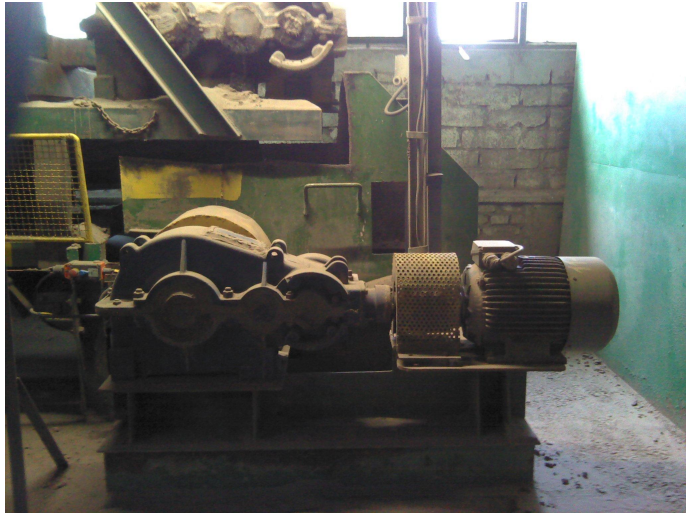
The picture shows the same scene, the way it is presented is different

Image representation - frequency domain



Also the same scene, but in different domains

Image representation



Other representations can help with object detection / scene segmentation

Object detection

- Each pixel is a description of a piece of the scene,
- Can we tell what element of a scene is a pixel based only on itself and its neighborhood?
- How to describe each pixel?

Image transformations

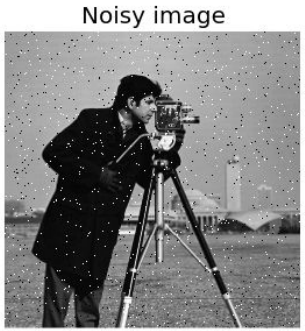
$$F: I_1 \rightarrow I_2$$

F - Transform function,

I_n - Image domain

F: RGB to Grayscale, Inverse, Clear, ...

Image transformations



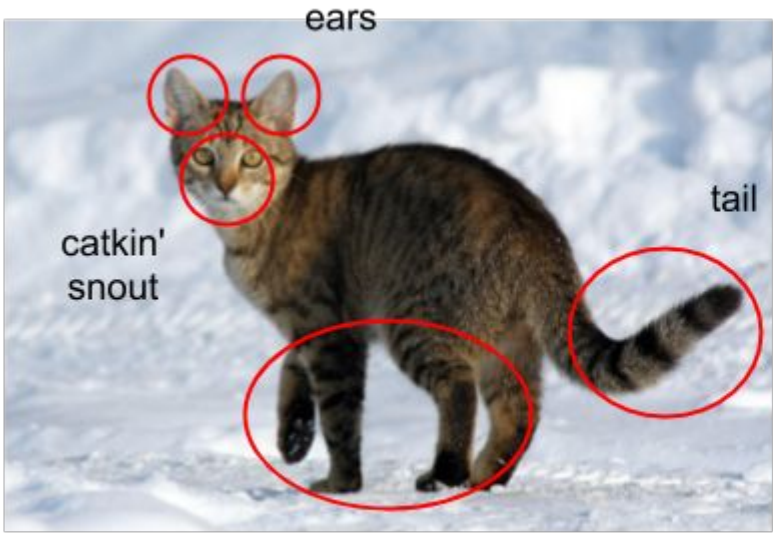
Object detection

Input image

Object detection

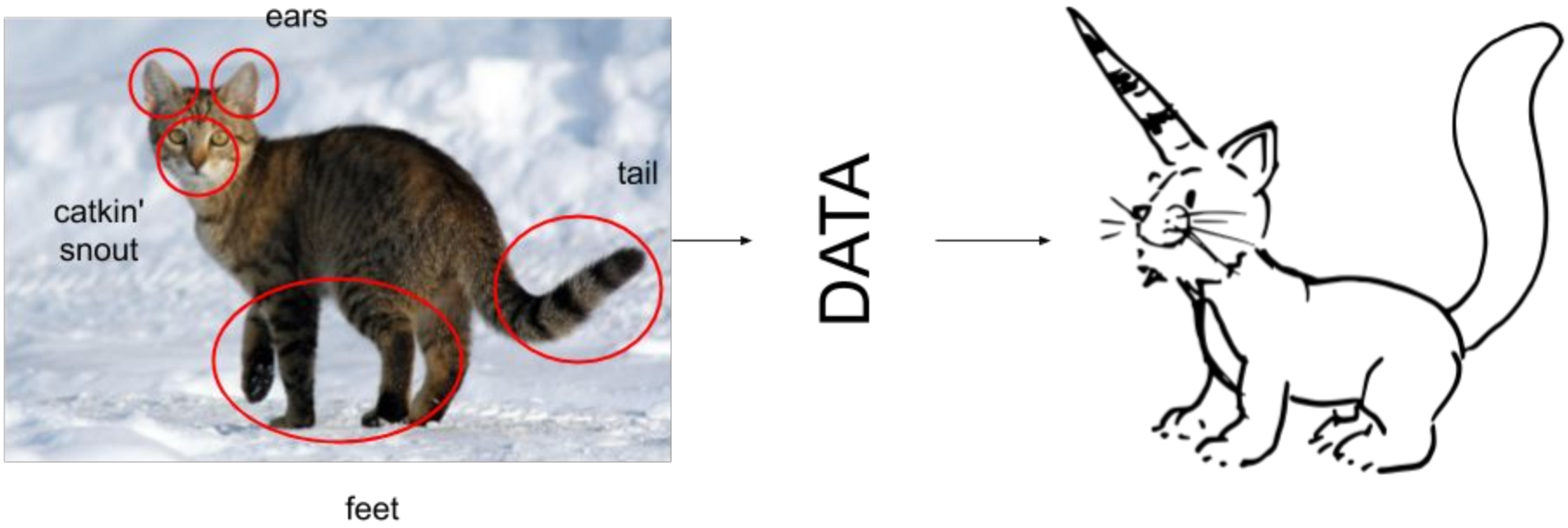
Interest points detection

Object detection



Detection of individual features, e.g. ears, tail, etc.
Due to the semantics, the features can be combined to form a higher-order descriptor

Object detection

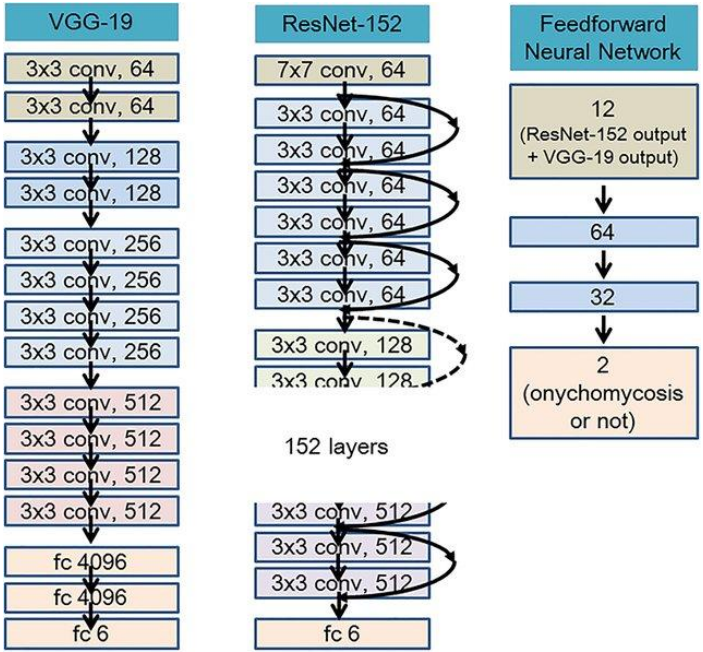


If the detected features exist in a certain configuration, they together form a new feature

Neural networks

- Why are neural networks so good for computer vision?
- What are the characteristics of neural networks used in computer vision??
- What do we need to train neural networks?

Neural networks



Environment and libraries

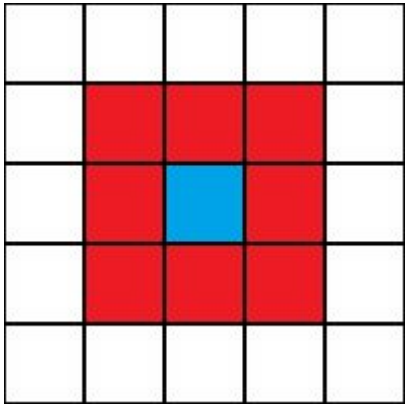
- Runtime environment:
  - Ubuntu 18.04 (Windows),
  - Google Colab,
- Programming environment:
  - Python 3,
  - Conda / Anaconda,
  - Jupyter Notebook,
- Libraries:
  - NumPy,
  - OpenCV,
  - Matplotlib,
  - TensorFlow 2.x

Installation

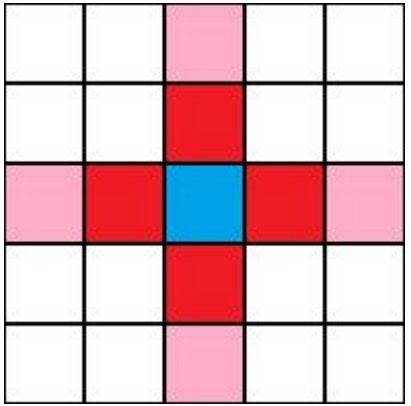
```
wget https://repo.anaconda.com/archive/Anaconda3-2020.11-Linux-x86_64.sh
bash ./Anaconda3-2020.11-Linux-x86_64.sh


conda create --name wk_lab python=3.8 # create environment
conda activate cv_lab                 # activate environment

pip install pillow numpy matplotlib   # possible classic installation

CPU:
pip install tensorflow

GPU:
conda install -c anaconda cudatoolkit=10.1       # conda installation
conda install -c anaconda cudnn=7.6.5=cuda10.1_0 # conda installation
pip install tensorflow-gpu                       # classic installation

conda install -c conda-forge opencv              # conda installation
conda install -c conda-forge jupyterlab          # conda installation
```

Cellular automaton

Cellular automaton - a system consisting of single cells adjacent to each other according to a predefined pattern.
Each cell is in one of a finite number of states.
The state of a cell changes synchronously according to the rules that tell how the new state of a cell depends on its current state and the state of its neighbors.



Moore neighborhood



von Neumann neighborhood

Cellular automaton - Conway's Game of Life

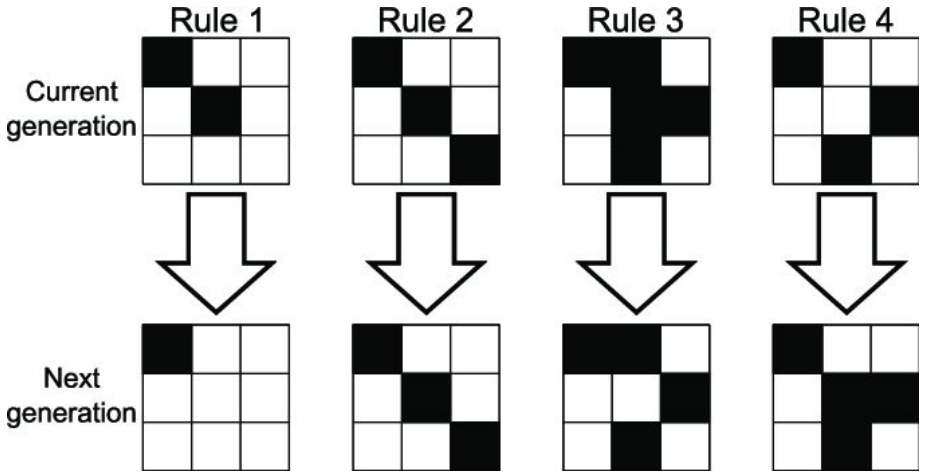
Rules for live cells:

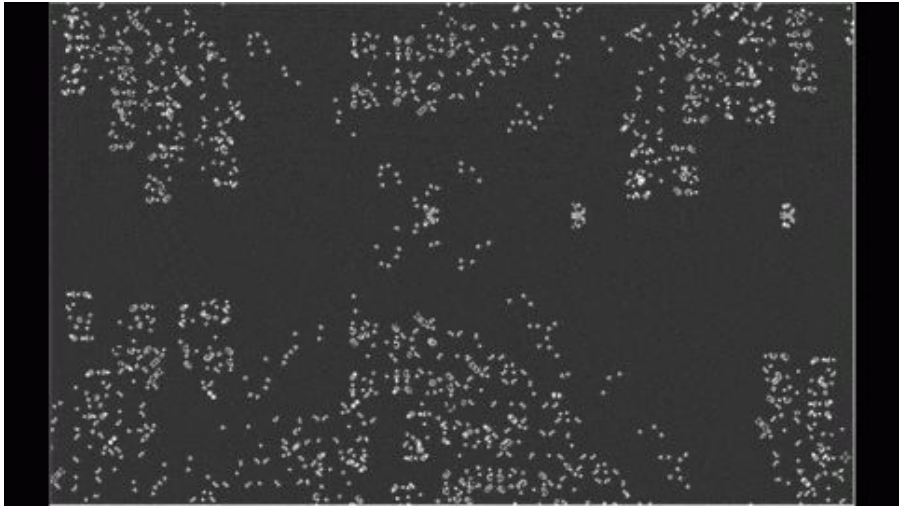
- Any live cell with fewer than two live neighbours dies, as if by underpopulation.
- Any live cell with two or three live neighbours lives on to the next generation.
- Any live cell with more than three live neighbours dies, as if by overpopulation.

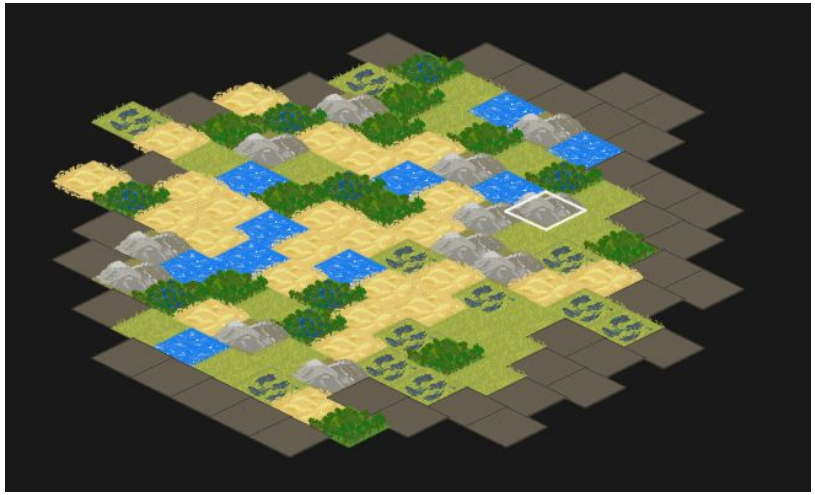
Rules for dead cells:

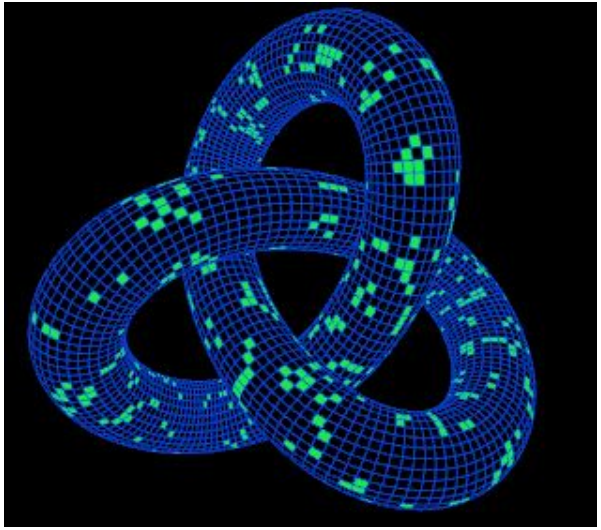
- Any dead cell with exactly three live neighbours becomes a live cell, as if by reproduction.
- All other dead cells stay dead.

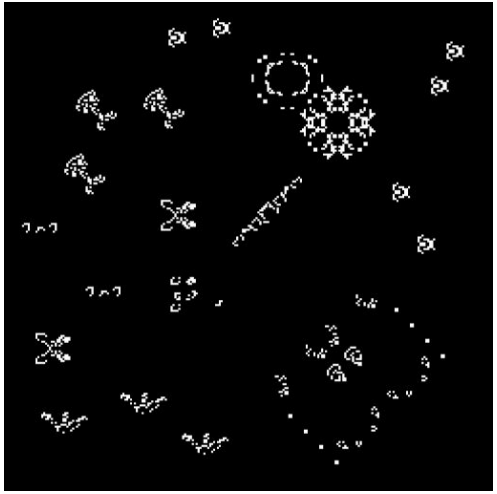
https://playgameoflife.com/

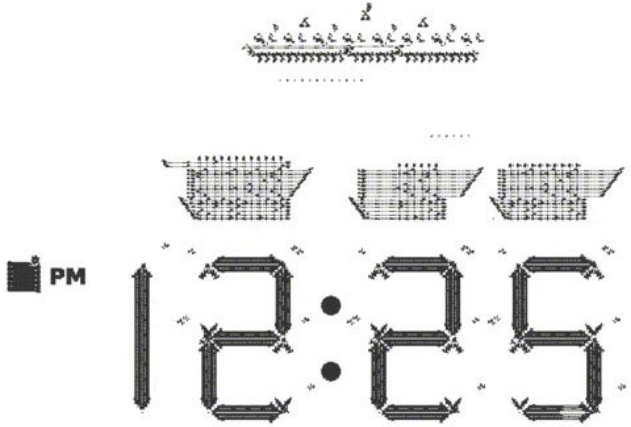








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