Deep Dream Lab Report

GoogLeNet-based Image Hallucination Experiments

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1. Introduction

Deep Dream is a computer vision technique that uses a pretrained convolutional neural network (CNN) to enhance and modify patterns within an image. By maximizing activations of selected layers in the network, the model generates dream-like, surreal hallucinations, often creating patterns resembling eyes, animals, or abstract shapes.

In this lab, we use GoogLeNet (Inception v1), a CNN with inception modules, which is particularly well-suited for Deep Dream due to its hierarchical representation of image features. The lab experiments explore the effect of different parameters, layers, and optimization settings on the generated images.

Key techniques explored:

- Multi-scale (octaves) processing to enhance patterns at different resolutions
- Jitter to prevent artifacts
- Layer selection and weighting to control hallucination style
- Total Variation (TV) loss to reduce high-frequency noise

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2. Baseline Setup

The baseline pipeline consists of:

- `data_loader.py` – loads images from a folder and converts them to tensors.
- `model.py` – loads pretrained GoogLeNet, implements Deep Dream with multiscale and jitter, and calculates loss.
- `utils.py` – contains helper functions such as deprocess, total_variation_loss, and jitter functions.
- `main.py` – orchestrates the workflow: loads images, applies Deep Dream, saves output images, and plots loss curves.

Initial parameters (baseline for Version 1):

- Iterations: 50
- Learning rate (LR): 0.01
- Number of octaves: 5
- Octave scale: 1.4
- Layers & weights: `{'inception4a': 1.0}`
- Jitter: 32

Pipeline:
Load image → preprocess → send to GPU → Apply Deep Dream multiscale with jitter → Store loss history and generated image → Save dreamed image and plot loss

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3. Experiments & Parameter Modifications

Version 1 – Strong hallucination

Parameters:
Iterations: 50 | LR: 0.01 | Octaves: 5 | Octave scale: 1.4 | Layers: `{'inception4a': 1.0}` | Jitter: 32

Observations:
Extremely strong hallucinations. Hypnotic circular patterns, eyes, and vivid colors dominate. Original images almost completely lost.

[Image Placeholder: Original Image – Version 1]
[Image Placeholder: Dreamed Image – Version 1 (Strong hallucination)]
[Image Placeholder: Loss Curve – Version 1]

Version 2 – Moderate hallucination

Parameters:
Iterations: 25 | LR: 0.01 | Octaves: 3 | Octave scale: 1.2 | Layers: `{'inception4a': 0.5}` | Jitter: 32

Observations:
Original image shapes visible. Hypnotic circles and eyes still present, but less intense. Patterns are more structured and slightly calmer.

[Image Placeholder: Original Image – Version 2]
[Image Placeholder: Dreamed Image – Version 2 (Moderate hallucination)]
[Image Placeholder: Loss Curve – Version 2]

Version 3 – Structured hallucinations

Parameters:
Iterations: 30 | LR: 0.008 | Octaves: 3 | Octave scale: 1.2 | Layers: `{'inception4a': 0.3, 'inception4e': 0.7}` | Jitter: 16

Observations:
Original image shapes clearly visible. Eyes less frequent, triangular and structured patterns appear. Overall balance improved, hallucinations visually appealing.

[Image Placeholder: Original Image – Version 3]

[Image Placeholder: Dreamed Image – Version 3 (Structured hallucinations)]
[Image Placeholder: Loss Curve – Version 3]

Version 4 – Subtle enhancement (Final Version)

Parameters:
Iterations: 20 | LR: 0.008 | Octaves: 3 | Octave scale: 1.0
Layers & weights: `{'inception3a': 0.1, 'inception4a': 0.2, 'inception4d': 0.3, 'inception4e': 0.4}` | Jitter: 16

Observations:
Original image largely preserved in color and shape. Hallucinations subtle, less hypnotic, eyes appear sparsely. Patterns blend softly with original image. Loss curve shows slow, stable fluctuation.

[Image Placeholder: Original Image – Version 4]
[Image Placeholder: Dreamed Image – Version 4 (Subtle enhancement – Final)]
[Image Placeholder: Loss Curve – Version 4]

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4. Comparisons & Analysis

Version	Iterations	LR	Octaves	Octave Scale	Layers & Weights	Jitter	Key Observations
1	50	0.01	5	1.4	{'inception4a': 1.0}	32	Strong hallucinations, hypnotic circles, eyes, original image almost invisible
2	25	0.01	3	1.2	{'inception4a': 0.5}	32	Original shapes visible, patterns & eyes still present, hypnotic circles reduced
3	30	0.008	3	1.2	{'inception4a':0.3, 'inception4e':0.7}	16	Original shapes visible, eyes less frequent, triangular patterns, better overall balance
4	20	0.008	3	1.0	{'inception3a':0.1, 'inception4a':0.2, 'inception4d':0.3, 'inception4e':0.4}	16	Original image mostly preserved, subtle hallucinations, soft blending, stable loss

Key findings:

- Higher iterations and stronger layer weights → more intense hallucinations
- Later layers introduce object-like features; early layers give textures
- More octaves + larger scale → exaggerated effects
- Reducing jitter stabilizes patterns
- TV loss ensures smoothness

The progression from Version 1 → Version 4 demonstrates precise control over the Deep Dream effect.

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5. Conclusion

Deep Dream can transform images from subtle texture enhancement to surreal, highly hallucinatory visuals depending on parameter choices. Careful tuning enables control over intensity, preservation of the original image, and artistic style.

The final Version 4 achieves an appealing balance: the original photograph remains recognizable while being enhanced with subtle, artistic neural patterns.

This lab provided practical insight into pretrained CNNs, feature visualization, and the interpretability of deep neural networks through creative exploration.
