Comprehensive Autonomous Driving System Leveraging **Cityscapes Dataset** using **Deep Learning**

Project Statement:

The goal of this project is to develop a comprehensive autonomous driving system that can perform semantic segmentation, object detection, lane detection, and traffic sign recognition. Using the Cityscapes dataset, we will train deep learning models to understand and interpret urban street scenes.

Outcomes:

By the end of this project, students will:

- Understand and implement data preprocessing techniques for various computer vision tasks.
- Develop and train deep learning models for semantic segmentation, object detection, lane detection, and traffic sign recognition.
- Evaluate and improve the performance of these models using various metrics.
- Prepare detailed documentation and presentation of their findings and results.

Dataset: https://www.cityscapes-dataset.com/downloads/

Modules to be implemented

1. Dataset Acquisition and Exploration
   - Download and explore the Cityscapes dataset.
2. Data Preprocessing
   - Preprocess images and annotations for different tasks.
3. Semantic Segmentation Model
   - Develop and train a model for semantic segmentation.
4. Object Detection Model
   - Develop and train a model for object detection.
5. Lane Detection Model
   - Develop and train a model for lane detection.
6. Traffic Sign Recognition Model
   - Develop and train a model for traffic sign recognition.
7. Model Evaluation and Fine-tuning
   - Evaluate all models and fine-tune them for better performance.
8. Documentation and Presentation Preparation
   - Prepare documentation and presentation to showcase the project.

Week-wise module implementation and high-level requirements with output screenshots

Milestone 1:

Week 1: Project Initialization and Dataset Acquisition

- Define project goals and outcomes.
- Download the Cityscapes dataset from the official website.
- Explore the dataset structure, classes, and sample images and annotations.
- Verify the integrity of the dataset.

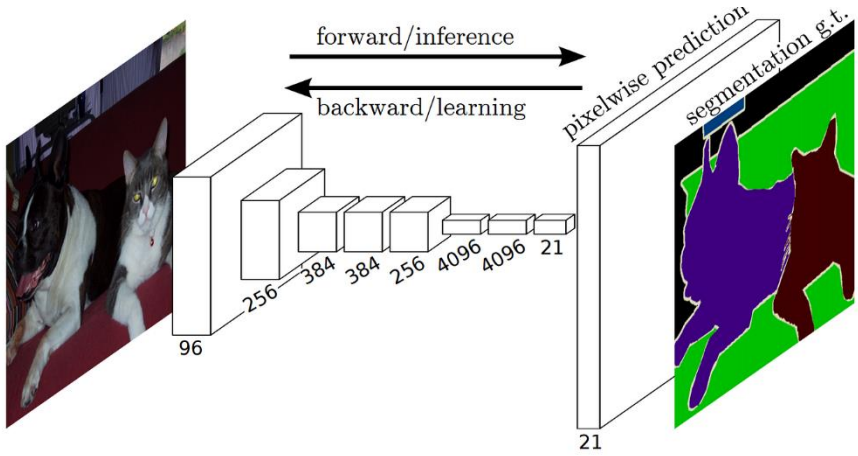
Week 2: Data Preprocessing

- Implement data loading functions to read images and annotations.
- Preprocess the images (e.g., resizing, normalization).
- Preprocess the annotations for each task (e.g., semantic segmentation, object detection, lane detection, traffic sign recognition).
- Split the dataset into training, validation, and test sets.

Milestone 2:

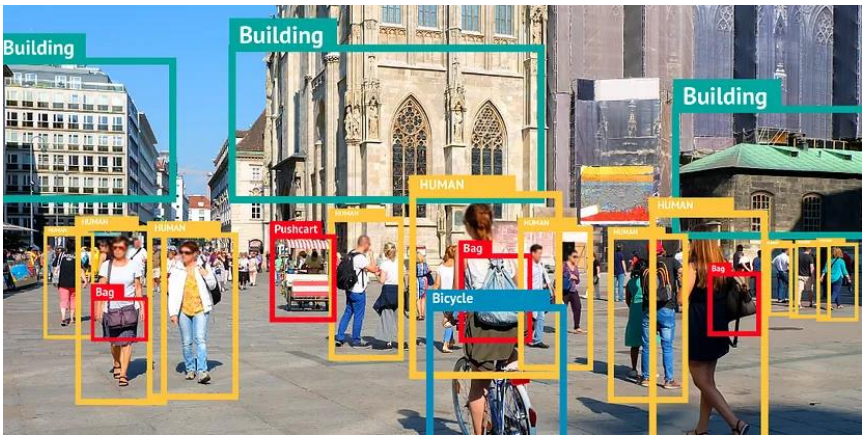
Week 3: Semantic Segmentation Model Development and Training

- Develop a semantic segmentation model using U-Net or a similar architecture.
- Train the model using the preprocessed dataset.
- Save the initial model weights.



Week 4: Object Detection Model Development and Training

- Develop an object detection model using YOLO or SSD.
- Train the model using the preprocessed dataset.
- Save the initial model weights.



Milestone 3:

Week 5: Lane Detection Model Development and Training

- Develop a lane detection model using a custom CNN or an existing architecture.
- Train the model using the preprocessed dataset.
- Save the initial model weights.

Week 6: Traffic Sign Recognition Model Development and Training

- Develop a traffic sign recognition model using a CNN.
- Train the model using the preprocessed dataset.
- Save the initial model weights.

Milestone 4:

Week 7: Model Evaluation and Fine-tuning

- Evaluate all models using the validation and test datasets.
- Calculate appropriate metrics (e.g., IoU for segmentation, mAP for object detection).
- Identify areas where each model is underperforming.
- Experiment with different hyperparameters and data augmentation techniques to improve performance.
- Fine-tune all models based on evaluation results.

Week 8: Model Evaluation and Fine-tuning

- Compile project documentation, including methodology, results, and conclusions.
- Prepare a presentation summarizing the project.
- Create a demo to showcase the performance of all models on sample images.
- Conduct a final review and rehearsal of the presentation and demo.

Evaluation Criteria:

1. **Completion of Milestones:** Assess the extent to which each milestone was achieved within the designated timeline. This includes successful dataset acquisition, preprocessing, model development, training, and evaluation.
2. **Quality and Performance of the Models:** Evaluate the effectiveness of the models, the accuracy of the segmentation and detection results, and the improvement achieved through hyperparameter tuning and fine-tuning. This includes quantitative metrics like IoU, pixel accuracy, and mAP, as well as qualitative visualizations.
3. **Clarity and Depth of Documentation and Presentation: Review** the final documentation for completeness, clarity, and technical depth. Assess the presentation and demo for their ability to clearly convey the project's objectives, methodology, results, and conclusions. This includes the quality of the visual aids, the coherence of the narrative, and the responsiveness to questions during the demo.