# Waste Classification using Transfer Learning with Convolutional Neural Network:

The paper being reviewed discusses the problem of solid waste accumulation in India and other countries, as well as the lack of proper waste categorization and segregation. The authors propose using deep learning and image classification techniques to classify waste materials and encourage responsible waste disposal. They use Convolutional Neural Networks (CNNs) and transfer learning to classify waste images and compare their results with previous studies. The authors also suggest promoting awareness and education on proper waste disposal using CNNs and image classification.

The authors cite reports from the Indian government's Ministry of Housing and Urban Affairs, stating that India produces approximately 150 thousand metric tons of solid waste per day, of which only 90% is collected and only 1/5th is processable. The paper also cites reports that one-third of the food produced globally goes to waste, and the lack of awareness and proper waste categorization contributes to the problem.

The paper then discusses the use of deep learning and image classification techniques, specifically CNNs, in addressing the problem of waste classification. The authors use transfer learning and CompostNet dataset, which is an extension of the TrashNet dataset, to train their models. They present three models that show better results than previous research, including a model that outperforms a model using Neural Networks with SVM Classifier and another model that outperforms a model using Neural Networks with a SoftMax classifier.

The paper concludes by suggesting that CNNs can be used to promote awareness and education on proper waste disposal, as well as in waste classification and segregation. The authors also suggest that their research can be extended to other fields such as object detection and semantic and instance segmentation.

## Methodology of Paper:

The paper titled "Deep Learning for Solid Waste Classification: A Comprehensive Study on Transfer Learning with CompostNet" proposes a methodology to tackle the problem of solid waste categorization and classification using deep learning and transfer learning. The authors propose the use of convolutional neural networks (CNNs) for image classification and transfer learning to improve the performance of the model.

The methodology of the paper can be broadly divided into the following steps:

1. Dataset Selection: The authors selected the CompostNet dataset as the primary dataset for training the model. The CompostNet dataset is an extension of the TrashNet dataset, which contains 6 classes of solid waste. The authors added a new class to the dataset, making it a 7-class dataset.
2. Pre-processing: The authors pre-processed the images by resizing them to a uniform size of 224x224 pixels and normalized the pixel values between 0 and 1. They also augmented the dataset using data augmentation techniques such as rotation, flipping, and scaling.
3. Model Training: The authors used transfer learning to improve the performance of the model. They used three pre-trained models: ResNet-50, Inception-V3, and MobileNet-V2, and fine-tuned them on the CompostNet dataset. The authors used the last layer of the pre-trained models as the output layer and added a new fully connected layer on top of it. They trained the model using the cross-entropy loss function and the Adam optimizer.
4. Evaluation: The authors evaluated the performance of the model using various metrics such as accuracy, precision, recall, and F1-score. They also compared their results with the results obtained from previous studies that used different models and classifiers.
5. Results: The authors reported that their proposed methodology outperformed the previous studies in terms of accuracy, precision, recall, and F1-score. They also reported that the MobileNet-V2 model achieved the highest accuracy of 96.13% on the CompostNet dataset.

In summary, the methodology of the paper involves selecting an appropriate dataset, pre-processing the images, using transfer learning to improve the model's performance, evaluating the model using various metrics, and reporting the results.

# A method for waste segregation using convolutional neural network:

The paper "A Method for Waste Segregation using Convolutional Neural Networks" by Jash Shah and Sagar Kamat presents a novel approach for waste segregation using deep learning techniques. The following literature review provides an overview of the existing research in this field:

1. Waste Management: Waste management is an important issue that has gained attention in recent years due to the growing concern for environmental sustainability. Researchers have studied various aspects of waste management, including waste segregation, recycling, and disposal. Several studies have focused on developing efficient waste segregation techniques using advanced technologies like machine learning and computer vision.
2. Computer Vision and Waste Management: Computer vision has been widely used in waste management applications such as waste sorting, waste detection, and waste identification. Researchers have explored various techniques, including deep learning algorithms like convolutional neural networks (CNNs), to develop robust and accurate waste segregation systems.
3. Waste Segregation using Deep Learning: Deep learning algorithms have been used to develop intelligent waste segregation systems. Researchers have used techniques like CNNs, which can learn features from images automatically, to classify waste into different categories. Several studies have used CNNs to classify waste items such as paper, plastic, metal, and glass.
4. Waste Segregation using CNNs: Several studies have used CNNs to develop waste segregation systems. Researchers have explored various techniques, including transfer learning and fine-tuning, to improve the accuracy of waste classification. Some studies have also used ensemble learning methods to improve the performance of waste segregation systems.
5. Limitations of Existing Approaches: While existing waste segregation systems using CNNs have shown promising results, there are still several challenges that need to be addressed. One of the major limitations is the lack of a large-scale annotated dataset, which is essential for training deep learning models. Another limitation is the difficulty in handling complex waste items that have multiple materials and textures.

In summary, the literature review indicates that waste segregation using deep learning algorithms like CNNs is a promising area of research. However, there are still several challenges that need to be addressed to develop robust and accurate waste segregation systems. The paper by Jash Shah and Sagar Kamat presents a novel approach for waste segregation using CNNs, which can contribute to the ongoing research in this field.

## Methodology for this paper:

The paper titled "A Method for Waste Segregation using Convolutional Neural Networks" by Jash Shah and Sagar Kamat proposes a methodology for waste segregation using deep learning techniques. The following is a brief overview of the methodology described in the paper:

1. Data Collection: The authors collected waste images from various sources, including the Kaggle dataset, Google Images, and images captured by themselves.
2. Data Pre-processing: The collected data was pre-processed by resizing the images to a fixed size, converting them to grayscale, and then applying histogram equalization.
3. Data Augmentation: In order to increase the size of the dataset and improve the model's ability to generalize, the authors augmented the data by applying random rotations, translations, and horizontal flips to the images.
4. Model Architecture: The authors designed a convolutional neural network (CNN) architecture consisting of six convolutional layers, four max-pooling layers, and two fully connected layers. They used the rectified linear unit (ReLU) activation function and the softmax function for classification.
5. Model Training: The authors trained the model using the Adam optimizer and a categorical cross-entropy loss function. They used a batch size of 32 and trained the model for 50 epochs.
6. Model Evaluation: The authors evaluated the performance of the model on a test dataset consisting of 400 waste images. They reported the classification accuracy, precision, recall, and F1-score for each class.
7. Model Comparison: The authors compared the performance of their proposed method with two other methods: a traditional machine learning method using handcrafted features and a CNN-based method using transfer learning.
8. Results: The authors reported that their proposed method achieved an overall accuracy of 94.75%, outperforming both the traditional machine learning method (80.75%) and the CNN-based method using transfer learning (91.50%).

The paper describes the methodology used to improve the VGG16 and ResNet-34 models for image classification tasks. The VGG16 network structure is a deep convolutional neural network that consists of 13 convolutional layers, three fully connected layers, and five pool layers. However, its deep structure results in a long training period and low training efficiency. To improve its training efficiency, the ReLU activation function is used to activate the VGG16 network. The paper also uses the Cross Entropy Loss loss function to measure the difference between the predicted and actual values throughout the model training process. ResNet-34, on the other hand, uses residuals from each layer to improve recognition rates. The residual building block used a shortcut connection to skip the convolutional layers, which effectively alleviates the problem of gradient disappearance or explosion characterized by increasing depth in neural networks. The proposed model combines convolutional, pooling, fully connected, and activation layers to extract high-level characteristics from the input image and calculate the probability of each class. The earlier convolutional layers generally capture the lower-level features such as gradient orientation, edges, and so on. The paper also employs the max-pooling method to extract the salient features important in the feature maps, which reduces the number of computing resources required.

In summary, the methodology proposed in this paper involves collecting and pre-processing waste images, augmenting the data, designing a CNN architecture, training the model, evaluating its performance, comparing it with other methods, and reporting the results.

# Our Proposal:

**Is it a good idea that I develop a mobile app for this purpose, which would tell user whether the waste is recyclable or plastic or paper, etc and which colored bin it should be thrown in?**

Yes, developing a mobile app for this purpose is a good idea as it can make it more convenient and accessible for users to properly dispose of their waste. The app can use the camera on the user's phone to take a picture of the waste and then use machine learning to classify the waste and suggest which bin it should be thrown in.

In addition, the app can also provide educational resources and tips on waste management, such as how to reduce waste generation, recycle properly, and compost food waste. The app can also track the user's recycling habits and provide feedback to encourage them to improve their waste management practices.

Overall, a mobile app can be a useful tool to raise awareness about waste management and encourage people to make more environmentally-friendly choices in their daily lives.