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Traffic Sign Recognition Using Convolution Neural Networks

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ABSTRACT: Traffic signs have been designed to be easily readable for humans. For computer systems however, classifying traffic signs is still a challenging pattern recognition problem. Both image processing and machine learning algorithms are continuously refined to improve the recognition performance. A geo-coded traffic sign data set is constructed and used for training and testing the data for the recognition of the traffic signs. Instead of using handcrafted features such as HOG or SIFT which gives an accuracy around 75%, Convolutional Networks (ConvNets) use biologically-inspired multi-stage architectures that automatically learn hierarchies of invariant features. By applying ConvNets to the task, traffic sign classification becomes much easier and gives a better accuracy of about 85% - 95%.Using this recognition system, an application for the driver safety purpose is built. The application will keep the driver updated about the traffic signs which will lead in fewer to no mistakes while driving.

KEYWORDS: Traffic sign; Classification; Image detection, Convolutional Networks.

I. INTRODUCTION

Traffic signs or road signs are signs erected at the side of or above roads to give instructions or provide information to road users. The earliest signs were simple wooden or stone milestones. Later, signs with directional arms were introduced, for example, the fingerposts in the United Kingdom and their wooden counterparts in Saxony.

With traffic volumes increasing since the 1930s, many countries have adopted pictorial signs or otherwise simplified and standardized their signs to overcome language barriers, and enhance traffic safety. Such pictorial signs use symbols (often silhouettes) in place of words and are usually based on international protocols. Such signs were first developed in Europe, and have been adopted by most countries to varying degrees.

Road safety signs are primarily of three types:

1. **Mandatory Signs** - Mandatory signs are road signs which are used to set the obligations of all traffic which use a specific area of road. Unlike prohibitory or restrictive signs, mandatory signs tell traffic what it must do, rather than must not do. Most mandatory road signs are circular, may use white symbols on a blue background with white border or black symbols on a white background with a red border, although the latter is also associated with prohibitory signs.

Fig.1. Mandatory Signs

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2. **Cautionary Signs**- A warning sign is a type of traffic sign that indicates a hazard ahead on the road that may not be readily apparent to a driver. While designs vary, they usually take the shape of an equilateral triangle with a white background and thick red border.

Fig .2. Cautionary Signs

3. **Information Signs**- An information sign is a very legibly printed and very noticeable placard that informs people of the purpose of an object, or gives them instruction on the use of something. An example is a traffic sign such as a fuel pump.

Fig .3. Information Signs

The goals and objective of the project is to develop a method for traffic signs detection for vehicles that reduces the number of accidents while driving. This method will be developed as an automated software-hardware solution that will be supplied with the vehicle. To build a high performance traffic sign recognition system for Indian roads. Build dataset of Indian Traffic Road Signs. Build a classification system to recognize the road signs.

II. RELATED WORK

In [1]To design a good recognizer, many parameters should be taken into consideration. The recognizer should present a good discriminative power and low computational cost .It should be robust to the geometrical status of sign, such as the vertical or horizontal orientation, the size, and the position of the sign in the image. It should be robust to noise. The recognition should be carried out quickly if it is designed for real time applicationsIn [2]There are two main approaches in this field:Color-based approach allows reducing false positives results in the recognition process. These are based on segmentation by threshold in color space for image processing. andGreyscale methods concentrate on the geometry of the model to recognize it, color is used as a complementary technique to eliminate false positive results of classification. In [3]The images are pre-processed with several image processing techniques, such as, threshold techniques, Gaussian filter, Canny edge detection, Contour and Fit Ellipse. Then, the Neural Networks stages are performed to recognize the traffic for sign pattern. Objective is to reduce the search space and indicate only potential regions for increasing the efficiency and speed of the system. The traffic sign images are investigated to detect potential pixel regions which could be recognized.In [4]What makes CNNs such a good fit for working with image data?Their capacity can be controlled by varying their depth and breadth, and they also make strong and mostly correct assumptions about the nature of images (namely, stationary of statistics and locality of pixel dependencies). Thus, compared to standard feed forward neural networks with similarly-sized layers, CNNs have much fewer connections and parameters and so they are easier to train, while their theoretically-best performance is likely to be only slightly

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worse.This is a highly influential paper that kicked off a whole stream of work using deep convolutional neural networks for image processing. Two factors changed that made this possible: The availability of large enough datasets specifically, the introduction of ImageNet with millions of images, whereas the previous largest datasets had 'only' tens of thousands and The development of powerful enough GPUs to efficiently train large networks.In [5] For localization the classifier layers are replaced by a regression networks trained to predict bounding boxes at each spatial location and scale. The regression predictions are then combined, along with the classification results at each location. Training with multiple scales ensures predictions match correctly across scales, and exponentially increases the confidence of the merged predictions. Bounding boxes are combined based on the distance between their centres and the intersection of their areas, and the final prediction is made by taking the merged bounding boxes with maximum class scores.In [6] The use of ReLU activation "Deep convolutional neural networks with ReLUs train several times faster than their equivalents with tanh units Faster learning has a great influence on the performance of large models trained on large datasets"Using multiple GPUs (two!), and splitting the kernels between them with cross-GPU communication only in certain layers. The scheme reduces the top-1 and top-5 error rates by 1.7% and 1.2% respectively compared to a net with half as many kernels in each layer and trained on just one GPU.Using overlapping pooling. Let pooling layers be of size z x z, and spaced s pixels apart. Traditionally pooling was used with s = z, so that there was no overlap between pools. Krizhevsky et al. used s = 2 and z = 3 to give overlapping pooling This reduced the top-1 and top-5 error rates by 0.4% and 0.3% respectively.

Traffic sign recognition has direct real-world applications such as driver assistance and safety, urban scene understanding, automated driving, or even sign monitoring for maintenance. It is a relatively constrained problem in the sense that signs are unique, rigid and intended to be clearly visible for drivers, and have little variability in appearance. Still, the dataset provided presents several difficult challenges due to real-world variability’s such as viewpoint variations, lighting conditions (saturations, low-contrast), motion-blur, occlusions, sun glare, physical damage, colour fading, graffiti, stickers. Although signs are available in the training set, temporal information is not in the test set. The present project aims to build a robust recognizer without temporal evidence accumulation. Several existing approaches to road-sign recognition have used computationally-expensive sliding window approaches that solve the detection and classification problems simultaneously. But many recent systems in the literature separate these two steps. Detection is first handled with computationally-inexpensive, hand-crafted algorithms, such as colourthresholding. Classification is subsequently performed on detected candidates with more expensive, but more accurate, algorithms. Although the task at hand is solely classification, it is important to keep in mind the ultimate goal of detection while designing a classifier, in order to optimize for both accuracy and efficiency. Traffic Sign Recognition covers two problems: traffic sign detection (TSD) and traffic sign classification (TSC).The dataset is available only for Belgium and Germany. Mean accuracy built by A.de la Escalera, J.MaArmingol,M.Mata “Traffic sign recognition and analysis for intelligent vechicles”using neural network system is 79.42%.This work does not use latest advances in the field of neural networks like convolutions.

Classification has been approached with a number of popular classification methods such as Neural Networks. Here we use the convolution neural network, The ConvNet. One advantage of ConvNets is that they can be run at very high speed on low-cost, small form-factor parallel hardware based on FPGAs or GPUs. Embedded systems based on FPGAs can run large ConvNets in real time, opening the possibility of performing multiple vision tasks simultaneously with a common infrastructure.

III. PROPOSED SYSTEM

Creating a dataset for Indian roads. The solution uses to propose recent advances in deep learning including convolution layers in addition to the feed forward neural network. Evaluate the performance of the system by considering additional signal like nearby detected signs. Building an application to demonstrate how this system can be used to improve driver safety.

- **User captured image:**

  An image with traffic sign is captured by the user. The image must contain at least 1 traffic sign to be detected. The outcome of the image will also depend on the quality of the image. The better the resolution the better the accuracy.

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- **Traffic sign detection:**

The fed image is processed and searched for the traffic signs. The parameter checked are round, triangle, square, pentagonal, octagonal shapes with red, blue or yellow color surrounding it. A bounding box is put around the traffic sign.

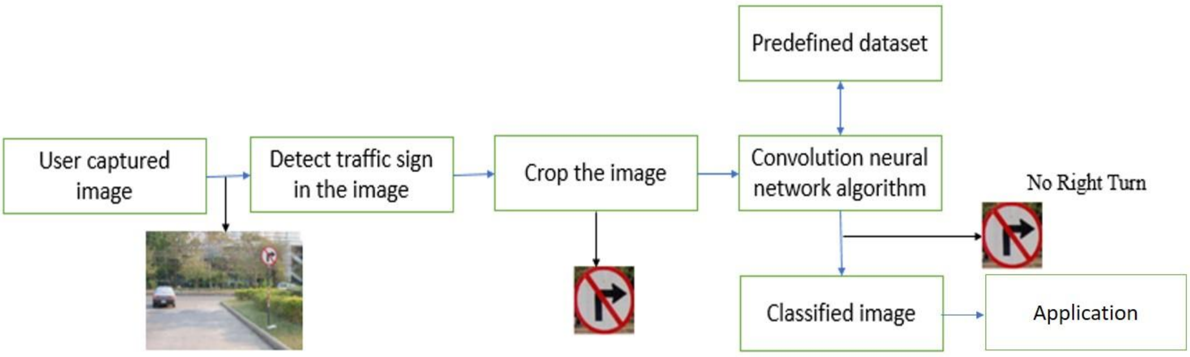

Fig .4. System Architecture Diagram

- **Crop image:**

Once the sign is detected then that image is cropped. The image within the bounding box is kept and the rest is discarded. That will help in the recognition process only to focus on the traffic sign.

- **Convolution neural network:**

A biologically-inspired, multilayer feed-forward architecture that can learn multiple stages of invariant features. Each stage is composed of a (convolutional) filter bank layer, a non-linear transform layer, and a spatial feature pooling layer. The spatial

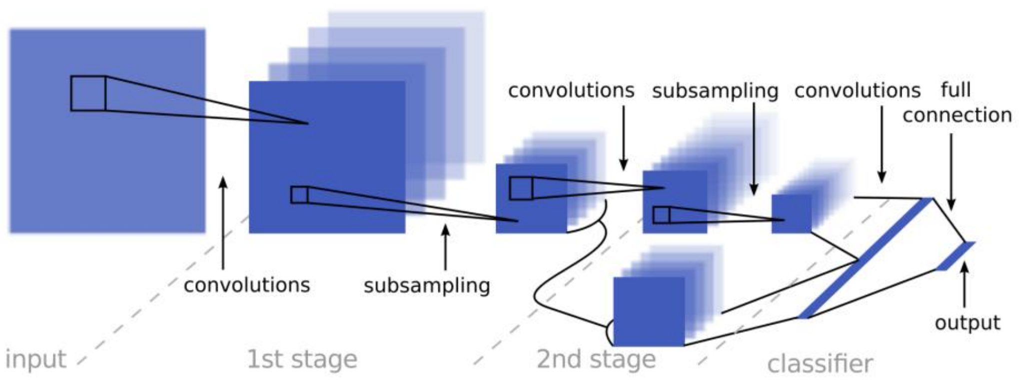

Fig . 5. Convolution Neural Network Architecture

pooling layers lower the spatial resolution of the representation, thereby making the representation robust to small shifts and geometric distortions, similarly to "complex cells" in standard models of the visual cortex. ConvNets are generally composed of one to three stages, capped by a classifier composed of one or two additional layers.

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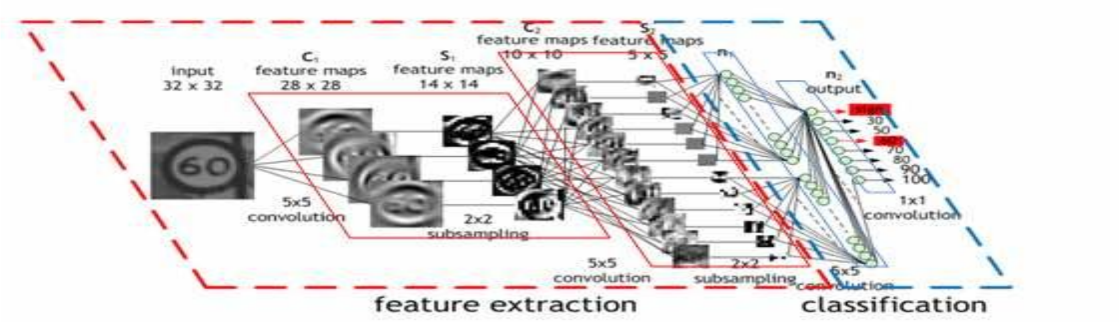

Fig .6. CNN feature extractor for Traffic Sign Classification

A gradient-based supervised training procedure updates every single filter in every filter bank in every layer so as to minimizes a loss function.

- **Classified image:**

The image comes out of the classifier as a lablled traffic sign, the confidence score.

- **Predefined dataset:**

Traffic sign images are cropped and labelled which will be used for training the dataset.

- **Application:**

Using this traffic sign recognition system, an application is built to demonstrate improved driver safety. The application keeps the driver updated about the traffic signs and violations. This will reduce accidents due to human error.

IV. PSEUDO CODE

I) **Dataset collection**

Input:The recognition task requires a set of images with various traffic signs for classification.

Step 1:These images are obtained by taking pictures of traffic signs with geolocation using an android app developed for this purpose.

Step 2:The app monitors changes in geolocation and uses this information when a picture is taken. This information is written into a CSV file which is then downloaded to a common machine for aggregation and processing.

II)**Image detection/processing:**

Input:The captured and geocoded images are available in separate CSV files originating from separate instances of the app.

Step 1:A program merges all this data into a single dataset making it ready for processing.

Step 2:Before the images can be fed into a classifier, the following tasks must be carried out:

i)The traffic signs in the image must be identified and a bounding box has to be marked around the signs

ii)The sign has to be extracted, labelled, for use as training data in the classifier

The size of the bounded area must be uniform across the dataset

Step 3:A web tool loads each image from the dataset onto a web page and the bounding box is marked. This information is added back into the dataset.

Step 4:The type of sign is also labelled.

Step 5:A script then crops all the bounding boxes and resizes them into a 30px * 30px image ready for the classification

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V. SIMULATION RESULTS

The proposed Traffic sign recognition using Convolutional neural network and Screenshot for Driver Assistance Application are as shown in fig.7.

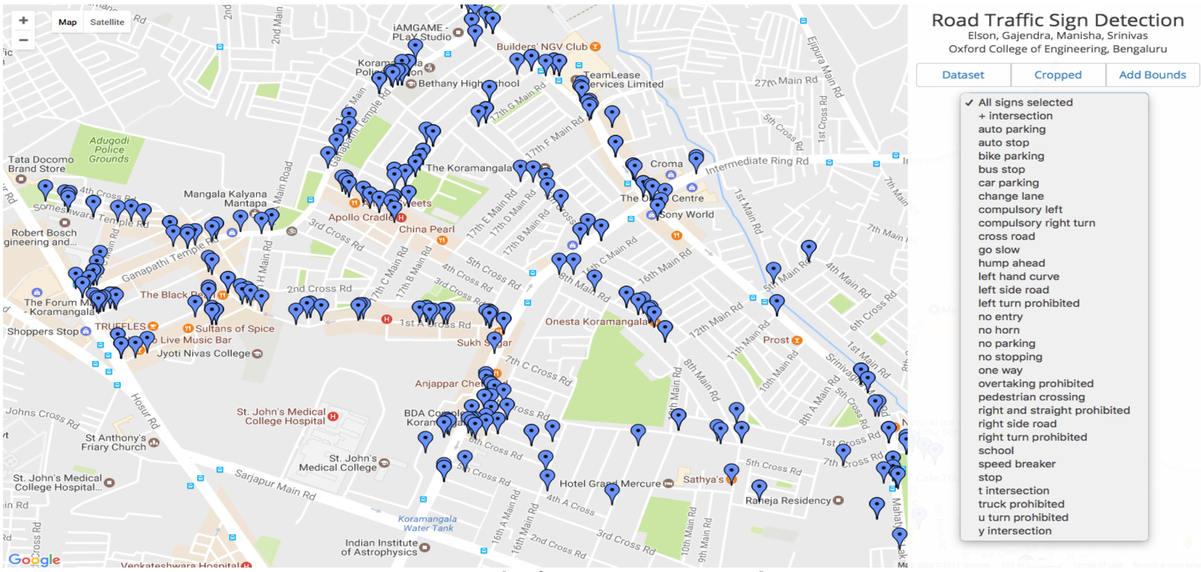

Fig.7.Screenshot for Driver Assistance Application

This web application will have a preloaded data set. Here we have collected traffic signs of 2 locations in Bangalore (HSR layout, Koramangala) and have loaded it in the map with its geo location. All the different signs are categorised into different groups (as shown on the right corner).
You can select a particular traffic sign. Here we have selected pedestrian crossing, only the pedestrian crossing tags in that area are shown and the rest are blurred.

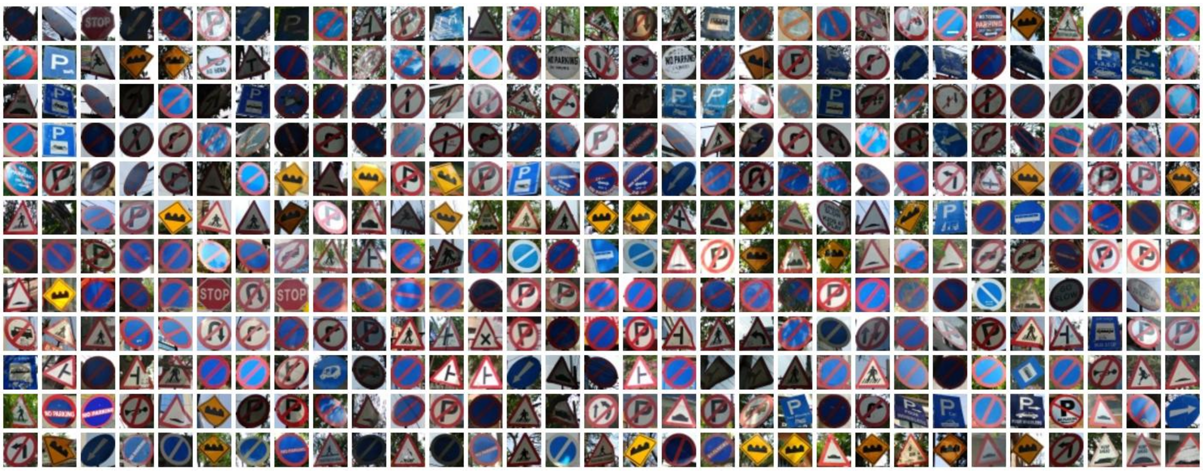
Fig.8.The dataset of the traffic sign

The dataset of the traffic sign is shown in fig.8.,which was collected and cropped for the recognition purpose. Each of the image is cropped and resized to 32*32 p. We collected over 500 pictures in these 2 locations.

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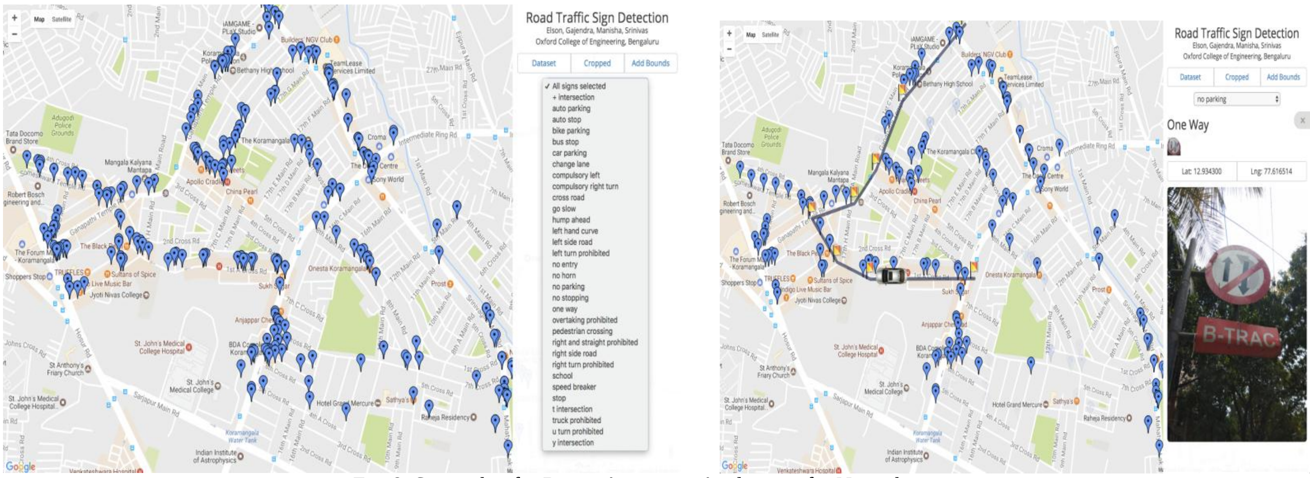

Fig .9. Screenshot for Driver Assistance Application for No parking

While conducting a simulation we need to give a start and a end location to a car, as the car moves in the given path the nearby traffic sign pops up. If there is any warning sign (hump ahead, school, pedestrian crossing etc,..) a pop up is shown on the right corner which gives a warning saying 'go slow' the pop up remains for 5 sec, every half a sec the color given to the pop up fades out and the end of the 5th sec it vanishes. when the car reaches the end location, if there is any no parking sign nearby it gives an alert saying 'No parking here' by which its understood for the driver not to park in that location. The Simulated graph for accuracy and Loss are shown in fig.10. and fig.11.

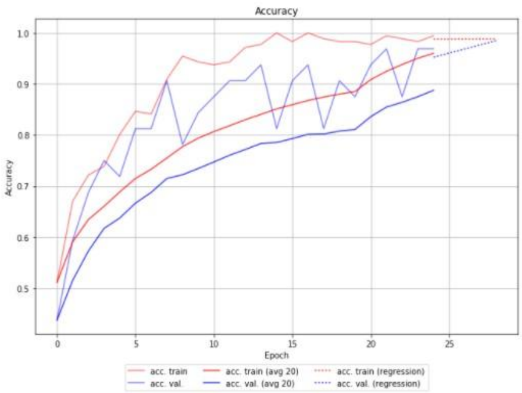

Fig .10. Accuracy for the Recognition

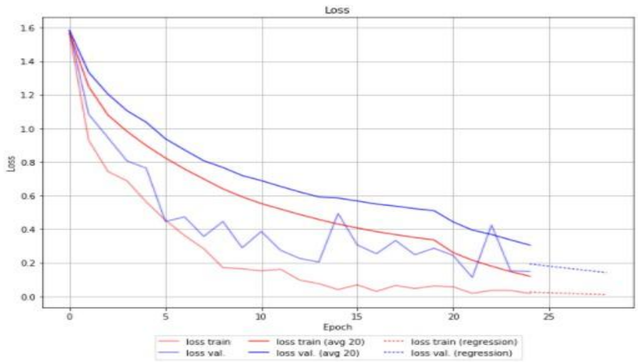

Fig .10. Loss/Error rate of the Recognition

VI. CONCLUSION AND FUTURE WORK

By applying ConvNets to the task, traffic sign classification becomes much easier and gives a better accuracy of about 85% - 95%.Using this recognition system, an application for the driver safety purpose is built. The application will keep the driver updated about the traffic signs for better driving assistance and safetyIn future the driver assistance system can be used on cars to work according to the traffic signs and the recognition system can be used on self driving cars to learn and understand the traffic signs

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BIOGRAPHY

S.Visalini has done her B.E in computer science from Adhiparasakthi Engineering college Affiliated to Anna University, M.E from RajaLakshmi Engineering College Affiliated to Anna University. She is currently working as the Assistant Professor in ISE Department of The Oxford College Of Engineering. She has presented a paper on Indoor location sensing using Bluetooth Technology in Journal of Engineering and IT Springer publications. She is guiding the M.Tech students in Network Engineering. She has around 9 years of teaching experience in leading educational Institutions in India. She has attended/conducted National and International level workshops, seminars and conferences.