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A SURVEY OF CRIME PREDICTION USING MACHINE LEARNING AND RECURRENT NEURAL NETWORKS

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Abstract

Machine learning is used in different areas, like finance and business and even farming and government. One new way it is being used is to try to figure out where crimes might happen. Studies have shown that special computer programs can look at things like where a crime happened and when and use that to predict what kind of crime might happen next. Some new computer tools like TensorFlow and Keras have made it possible to use something called learning to predict crimes and this method is often better at predicting crimes than older methods of machine learning. Machine learning and deep learning are really good, at helping us understand crime patterns and predict activity.Recurrent Neural Networks are really good at figuring out time-series problems. This is because they can see how past and present crime events are connected to each other. This paper looks at a lot of studies that use intelligence to predict crime. It talks about what's good and what is bad about different algorithms. Recurrent Neural Networks with Long Short-Term Memory units are especially good because they can deal with problems like vanishing gradients. This helps them make predictions about crime. Recurrent Neural Networks are very useful, for this kind of thing.

Introduction:

The main goal of learning in crime research is to figure out when crimes might happen so that we can stop them before they do. Deep learning can help us find the places and times when crimes are more likely to happen. Then the police can do something about it before anything bad happens. This is an idea because it is better to stop something bad from happening in the first place. Deep learning is different from computer programs that are only good for one thing. Deep learning is a type of machine learning that helps computers understand what the data really means. Deep learning is really good, at looking at lots of data and finding patterns that can help us understand what is going on with crime.There are three ways that we learn: supervised learning, semi-supervised learning and unsupervised learning. When it comes to predicting crime we use learning models to find areas where crime is likely to happen and when it is likely to happen.

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These deep learning models look at a lot of information. Use special designs to find things that are not easy to see which makes them better, than other methods when things get complicated.

1. Machine Learning

Machine learning is when a system can figure out things from data on its own. It is a part of intelligence. Machine learning has three ways it can learn: supervised learning, unsupervised learning and reinforcement learning. Machine learning is really useful because it lets systems get better at doing things without someone having to tell them what to do.

Supervised learning is a way of teaching computers. It uses information that is already labeled to help the computer learn. The computer can use this to do things like make predictions about numbers that're not whole like how hot it will be tomorrow. It can also sort things into groups like what kind of animal a picture shows. Supervised learning does things like this by using labeled data to train models. These models can do tasks such, as regression, which is predicting values and classification which is assigning inputs to categories. Supervised learning uses labeled data for these tasks.

Unsupervised learning is about finding groups and patterns in information. It does this without using information that has already been labeled. Unsupervised learning looks for patterns and groups on its own. This means it can find things that people might not have seen before in the information. Unsupervised learning is really good, at finding patterns in sets of information.

Reinforcement learning is a way that algorithms can learn things. They do this by trying things out and seeing what happens in the environment. Then they get some kind of feedback. This feedback helps the reinforcement learning algorithms figure out what they should do next. Reinforcement learning is really, about learning from the environment and the feedback that the algorithms receive from it.

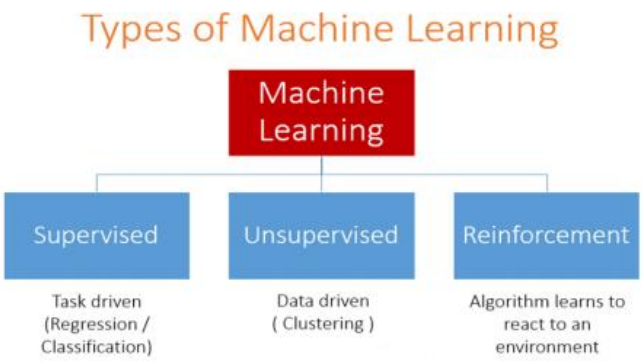

Fig 1.1 Types of Machine Learning

2. Deep Learning

Deep learning is a part of Artificial Intelligence that is inspired by the way human brains work. It is very good, at dealing with lots of data. Can solve problems that other Machine Learning methods cannot. Deep learning has become very popular because of this.

Artificial Neural Networks Consist of a Main Parts: input layers, hidden layers and output layers. Each connection between these layers has a weight. This weight is like a score that

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decides how important each piece of input is, to Artificial Neural Networks. The weights help Artificial Neural Networks figure out what to do with the input.

Convolutional Neural Networks are really good, at doing things with pictures. They are specialized for tasks that have to do with images.

Recurrent Neural Networks are made for data that comes one after the other like what happens over time. Recurrent Neural Networks are really good at handling this kind of information, like time series, where things happen in a sequence.

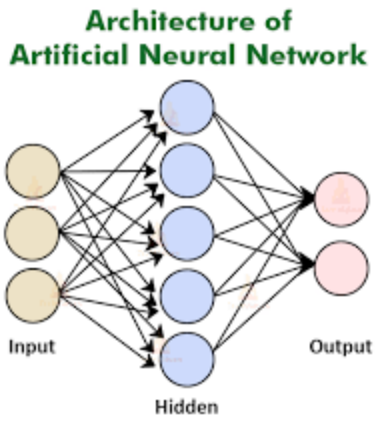

Fig 1.2: Architecture of Artificial Neural Network

Long Short-Term Memory (LSTM)

Standard Recurrent Neural Networks have a lot of trouble with term dependencies. This is because they can have vanishing or exploding gradients. Long Short Term Memory networks or LSTM networks are able to solve this problem. They do this by using memory cells and gates. The memory cells and gates in LSTM networks help them to remember things for a time. This makes LSTM networks really good, at handling term dependencies.

The forget gate gets rid of information that's not important to the neural network. This information is not needed so the forget gate removes it. The forget gate is used to decide what information to keep and what information to forget. The forget gate helps the neural network to focus on the information that's important, to the neural network.

The input gate is really important because it adds information. This is where the input gate comes in and it adds information to what we already know about the input gate. The input gate and its ability to add information is what makes it so useful.

The output gate lets useful information go forward. It is, like a gate that allows useful information to move to the step. This is what the output gate does with the information. The output gate is important because it passes information forward.

Associated Work

Many people have done research, on using intelligence to figure out when crimes will happen. They have looked at this idea a lot to see if it really works. Artificial intelligence is being used to try to predict crime.

Lin Ying-Lung and other people used Random Forest and Naïve Bayes and deep learning to figure out where crimes happen a lot in Taiwan. They found out that deep

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learning is really good at this. Deep learning was better than the methods they tried like Random Forest and Naïve Bayes at predicting crime hotspots, in Taiwan. They thought deep learning was the way to predict where crimes will happen in Taiwan, which is where they were studying crime hotspots. Shama Nishat and others used classification methods, on the San Francisco crime data.

They were able to get it about 81 percent of the time when they used certain sampling techniques on the San Francisco crime data. The San Francisco crime data was what they were working with. Ashwini et al. combined NLP preprocessing with SVM classifiers to analyze crime-related news articles.

Zhuang Yong et al. integrated RNN s with spatial-temporal networks to predict hotspots in Portland, Oregon.Amit Gupta et al. compared classifiers in Denver crime data, finding JRip most accurate.Nguyen Trung T. And the other people who worked with him added information about demographics and socioeconomic factors to the models they used to make predictions. They put this information into the models to try to make them better, at predicting things. The models are used to predict things and Nguyen Trung T. And the other people who worked with him wanted to make them more accurate by Francisco crime data was what they were working with.

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Research Deficits

There were some gaps that showed up in the survey. The survey had a gaps. These gaps were found in the survey. The survey was where the gaps emerged. We are using Machine Learning methods a lot, when Deep Learning methods could do a better job. We should think about using Deep Learning methods often because Deep Learning methods can be really good, at certain tasks.

Limited optimization of DL networks, with insufficient use of callbacks and hyper-parameter tuning. Not many people have really used RNN architectures to their potential even though they are very good for dealing with crime data that happens one after the other. The thing is RNN architectures are really suitable, for this kind of crime data.

Suggested Fixes

Future research should incorporate additional social and demographic factors (e.g., unemployment, literacy, and gender).Focus on RNN-based DL architectures, such as LSTM, for time-series crime prediction. I used things like

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EarlyStopping and LearningRateScheduler and ModelCheckpoint to make the training better. These things, like EarlyStopping and ModelCheckpoint and LearningRateScheduler really helped with the training.Apply hyperparameter tuning methods like Grid Search CV and Random Search CV for optimal performance.

This survey highlights the growing role of AI in crime prediction. Both machine learning and deep learning approaches have been applied, with RNN-based architectures showing particular promise for processing sequential data. Common tools include Python, R, TensorFlow, and Keras, whereas algorithms such as Random Forest, Naïve Bayes, and SVM remain widely used. Future studies should emphasize deep learning optimization and broader contextual factors to enhance predictive accuracy.

Conclusion

This survey highlights the growing role of AI in crime prediction. Both machine learning and deep learning approaches have been applied, with RNN-based architectures showing particular promise for processing sequential data. Common tools include Python, R, TensorFlow, and Keras, whereas algorithms such as Random Forest, Naïve Bayes, and SVM remain widely used. Future studies should emphasize deep learning optimization and broader contextual factors to enhance predictive accuracy.

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