Balancing Innovation and Regulation: A Comprehensive Analysis and Neural Network Approach to AI Copyright Challenges

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Abstract

This article explores emerging issues surrounding artificial intelligence (AI) and copyright through a two-pronged approach. First, it provides an extensive literature review analyzing government and industry strategies for addressing AI copyright concerns and evaluates their rationality. Second, it details experiments conducted using neural networks to examine relevant information and investigate image copyright challenges, assessing mainstream large language models' efficacy in handling copyright matters.

The literature review explores AI copyright perspectives of the United Kingdom, China, the European Union, and the United States. It finds that countries emphasize balanced regulation and innovation (UK), ethical content creation (China), regulating high-risk applications (EU), or principles like non-discrimination and privacy (US). However, comprehensive governance frameworks are needed to navigate AI's ethical, social, and legal intricacies.

The experimental portion trains a convolutional neural network on a dataset of 41 infringing and non-infringing image sets to identify copyright infringement. While achieving over 80% accuracy, enhancements through expanded training data, segmentation, and multi-domain detection could improve generalization. The paper concludes with an analysis advocating copyright adaptation for AI creations, measured protections for standalone AI works, and constructive policies from interdisciplinary dialogue.

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Keywords: artificial intelligence, machine learning, copyright law, intellectual property, AI ethics, neural networks, convolutional neural networks, training data, copyright infringement, image recognition

1 Introduction

1.1 Background

In the face of the new wave of AI and generative content, many people have begun to realize the copyright problems caused by the superb ability of AI to imitate language and images. If this problem is not dealt with in time, it will infringe on the rights of many authors and artists, and if the generated content is banned across the board, it will cause great resistance to the development of many industries. Obviously, the problem of copyright ownership in AI is not a copyright problem in the traditional sense, and it needs to be solved urgently.

1.2 Definition of Copyright

A copyright refers to the legal rights bestowed upon creators for their literary and artistic works. This encompasses the legal ownership of reproduction rights for computer programs, literary works, musical works, photos, games, movies, and other manifestations of creative expression [2].

Copyright is typically linked to the author, unless it is assigned to a different individual or entity [1]. It is important to underscore that copyright protection does not extend to the ideas per se, but rather their particular expression.

Consequently, copyright does not protect algorithms, mathematical methods, techniques, or machine designs.

2 Research on Relevant Studies

As AI's applications continue to expand, lawmakers and regulators are working to understand the technology's potential impact and to try to regulate it. Different countries have adopted different approaches to AI governance, and each approach reflects different legal systems, cultures, and traditions.

2.1 Different Governments' Attitudes Towards AI Copyright

In the rapidly evolving landscape of artificial intelligence (AI), governments across the globe have recognized the need for comprehensive governance policies to guide the development, deployment, and use of AI technologies. This section delves into a comprehensive analysis of case studies from leading countries, namely the United Kingdom (UK), China, the European Union (EU), and the United States. These case studies provide important insights into the regulatory

frameworks and initiatives implemented by each country to ensure responsible AI development and mitigate potential risks.

2.1.1 The UK Government

The UK government's Department of Science, Innovation, and Technology (DSIT) issued a seminal White Paper on Artificial Intelligence on March 29, 2023. This strategic document outlines the UK's ambition to become a "superpower in artificial intelligence" by fostering a harmonious ecosystem of AI regulation and innovation. It emphasizes the importance of addressing AI risks while promoting the growth and competitiveness of the AI industry.[3]

2.1.2 The Chinese Government

In a similar vein, the Cyberspace Administration of China took a proactive approach by releasing the Administrative Measures for Generative AI Services (Draft for Comment) on April 11, 2023. This measure aims to ensure that the content generated by generative AI systems adheres to societal order, social ethics, intellectual property rights, and non-discrimination principles. By regulating generative AI services, China aims to strike a balance between technological advancements and upholding social values [4].

2.1.3 The EU Government

On June 14, 2023, the European Parliament passed a crucial milestone in shaping AI governance across the EU by voting for a draft negotiating mandate for the Artificial Intelligence Bill. This legislation marks a significant step towards regulating AI technologies within the EU by imposing bans or restrictions on high-risk AI applications. The bill's draft encompasses a comprehensive framework that aims to ensure the ethical and responsible development and deployment of AI systems across various sectors [5].

2.1.4 The US Government

Notably, the United States under the administration of President Biden has made substantial strides in advancing AI governance policies. In October 2022, the White House's Office of Science and Technology Policy (OSTP) released the "AI Bill of Rights Blueprint: Making Automated Systems Work for the American People" [6]. This foundational document outlines five principles that guide the design, use, and deployment of AI systems to protect the American populace. These principles encompass technological security, effectiveness, prevention of algorithmic discrimination, data privacy protection, and human involvement in decision-making processes.

Furthermore, President Biden signed an Executive Order on Further Promoting Racial Equality and Supporting Underserved Communities through the Federal Government in February 2023 [7]. This order specifically directs federal

agencies to eliminate biases in the design and implementation of new technologies, including AI, with a focus on preventing algorithmic discrimination and safeguarding the public.

Building on these initiatives, the Biden administration took further steps to elucidate its approach to AI governance. The OSTP released a revamped National Human Intelligence R&D Strategic Plan in late May 2023 [8]. This plan aims to coordinate and prioritize federal research and development efforts concerning AI technologies. Additionally, the OSTP published a Request for Information to solicit public input on mitigating AI risks, safeguarding individual rights, ensuring safety, and utilizing AI for societal improvements. This call for comments reflects the government's commitment to incorporating diverse perspectives and expertise into the formation of robust AI governance policies.

2.2 Summary to Governments' Reactions

In summary, these case studies highlight the diverse approaches taken by leading countries to shape AI governance policies. While the UK emphasizes a balanced approach between regulation and innovation, China strives to ensure ethical content creation through specific administrative measures. The EU aims to regulate high-risk AI applications, and the United States focuses on principles such as non-discrimination, privacy protection, and human involvement. These initiatives underscore the global recognition of the need for comprehensive AI governance frameworks to navigate the ethical, social, and legal challenges posed by AI technologies.

2.3 Copyright Issues on AI-Generated Contents

In the course of our research, we came across some insightful articles and case studies about AI-generated images. While there are relatively few articles on this topic, they shed some light on the current status of copyright laws regarding AI-generated images.

It has come to our attention that a considerable quantity of AI-generated images currently lack copyright protection, as can be observed in Kris Kashtanova's Zarya of the Dawn illustrations. These visuals were produced using the Midjourney image generator and initially obtained copyright in September 2022. However, the Copyright Office of the United States rescinded the copyright protection in February 2023. As a result, it can be deduced that the existing copyright laws inadequately safeguard AI-generated images. It is crucial to address this issue promptly and revise the current copyright laws to provide adequate protection for AI-generated images. The absence of copyright protection not only undermines the rights of creators but also poses challenges in terms of ownership and attribution. This loophole leaves AI-generated works vulnerable to unauthorized use, reproduction, and commercial exploitation.

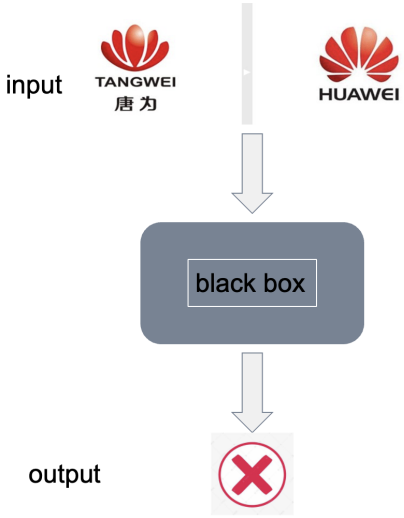

Figure 1: How the Model Works

3 Building A Machine-Learning Copyright Identifier

3.1 Data

3.1.1 Data Source

Most of our dataset was obtained from Google, but the process we went through to obtain the data was not a simple one. To be more specific, we had to go through a series of complex steps to get our hands on the images we needed. Initially, we conducted a thorough review of news and columns about image copyright infringement. This was a crucial step that allowed us to identify potential sources of infringing images. Once we had a list of these sources, we went to relevant legal websites to determine whether these images were indeed infringing or not. This was a meticulous process that required us to exercise caution and rely on our legal expertise to ensure that we were not infringing on anyone's copyright.

However, this process was not without its challenges. We had to iteratively go through our dataset, searching for similar images and ensuring that they were indeed infringing. This proved to be a time-consuming and difficult task, as there are many images on the internet that are similar but not necessarily infringing. This meant that we had to be extremely cautious when selecting images for our dataset, and that we had to rely on our legal knowledge to ensure that we were not infringing on anyone's copyright.

Moreover, there were other complications we had to consider, such as images

with copyright issues that may be in the midst of lawsuits or images that have been determined to be infringing after they were initially deemed not to be infringing. These challenges further complicated our search for relevant databases, and ultimately led to a smaller dataset than we initially anticipated.

3.1.2 Data Processing

After obtaining the dataset, we had to preprocess it in several ways. First, we categorized the infringing and non-infringing images. Second, we performed two-by-two similarity processing on these infringing and non-infringing images and put the similar images in one piece for comparison and categorization. Finally, we could put these different classes of images into the model for training. This allowed us to create a robust dataset that would help us train our model to detect infringing images more effectively.

3.2 Model Establishment

3.2.1 CNN model

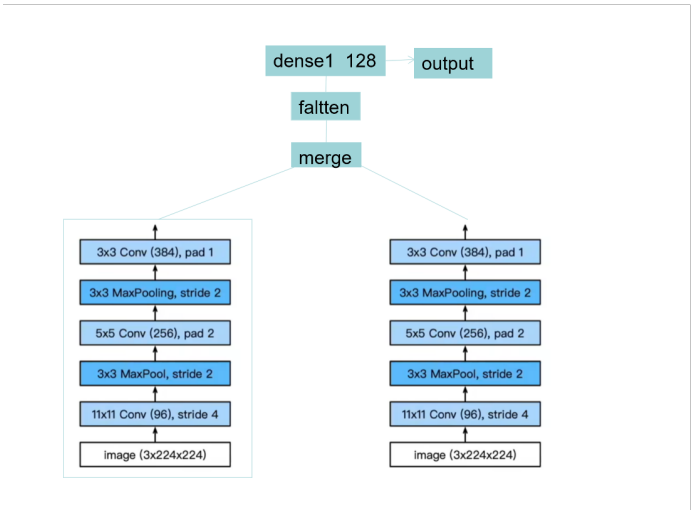

Figure 2: Model Schematic Diagram

This convolutional neural network (CNN) model takes two pictures as input, through convolution and pooling operation, then information merger, and access to the fully connected neural network, to get the output classification results.

3.2.2 The place of innovation

The role of a 1x1 convolutional kernel The role of a 1x1 convolutional kernel attempts to extract the fusion of multi-channel features based on the

same pixel position expression. It can achieve the goal of feature dimensionality enhancement and dimensionality reduction. And added non-linear networking improves fitting ability by improving performance.

Dropout After adding training data, we added dropouts to the network, and 50% of dropouts could effectively suppress overfitting.

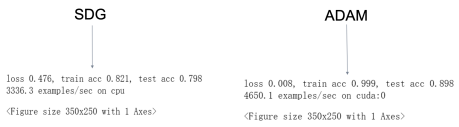

Figure 3: SDG and ADAM Comparison

Selection of and SGD and ADAM optimization algorithms The test set acc of 0.79 for SDG is lower than 0.89 for ADAM, indicating that ADAM is more suitable for this model. ADAM is a more advanced optimization algorithm that combines the advantages of the momentum method and adaptive learning rate. It not only considers the first-order moment estimation of the current gradient, but also considers the second-order moment estimation. ADAM utilizes these estimators to adjust the adaptive learning rate of each parameter, allowing for faster convergence and better performance.

3.3 Accuracy

From the graph, it is evident that the model error has been consistently decreasing, indicating the improvement in the performance of our model.

Concurrently, the accuracy of the dataset used for training and testing purposes has demonstrated an upward trend. Remarkably, the achieved accuracy has already surpassed 80%, indicating a satisfactory level of success for our model.

4 Model Evaluation

4.1 Advantages

Artificial intelligence is undoubtedly a hot spot in today's society: the emergence of artificial intelligence has set off a huge wave in society, and the emergence of new machines has brought many possibilities, but also brought new urgent problems. The issue of infringement is at the intersection of law and machine learning, and we hope that this paper can provide useful suggestions for how to address it.

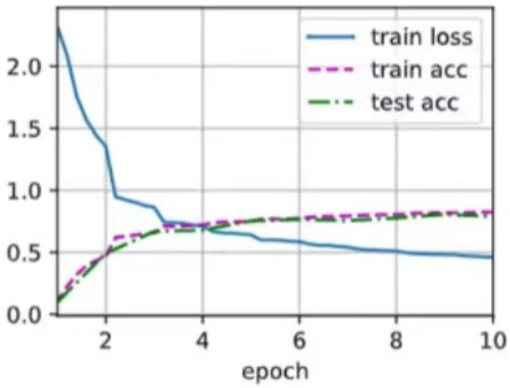

Figure 4: Model Accuracy

4.2 Disadvantages

This model is not already trained, its ideas can introduce new possibilities, and there is still room for improvement in the precise part. Improvement and optimization can yet be carried out on this simple basis.

To tackle the issue of poor generalization in our model, we have identified two key problems with the database. For example, our model mistakenly categorizes two different images of the same apple taken from different angles as identical. This problem stems from the lack of non-infringing image sets compared to infringing ones. Out of the 41 image sets we analyzed thoroughly, only 4 were officially recognized as similar yet non-infringing, while the rest were legally proven to be infringing in court. This substantial difference between non-infringing and infringing cases leads to significant inaccuracies.

Another concern relates to the insufficient pre-processing of our dataset. To improve the effectiveness of our machine learning training, we should meticulously segment our image material based on specific picture types such as brand, fashion, or landscape. By ensuring consistent segmentation within the training set, we can enhance the performance of our model.

4.3 Future Improvements

Looking forward, we anticipate two main future enhancements. First, if possible, we can enlarge our dataset and collect a wider range of cases. This would enhance the precision of our machine's output and improve its overall performance. Second, we can create a more extensive system for detecting infringe-

ment that surpasses image recognition. By employing the same principle to text and voice, we can establish methodologies for identifying infringement in different AI domains and further delineate the limits of infringement.

5 Analysis

5.1 AI-Generated Content

The unique nature of AI-generated images makes it imperative to adapt copyright regulations to encompass these creations. As AI technology continues to advance, it is vital to establish clear guidelines to protect the intellectual property rights of AI-generated content. Failure to do so may discourage innovation and hinder the growth of the AI industry.

To rectify this situation, policymakers must collaborate with experts in copyright law, artificial intelligence, and creative industries. They should work towards formulating comprehensive and inclusive copyright legislation that explicitly covers AI-generated works. This new framework should consider factors such as the intent of AI creators, algorithms used in the generation process, and the contribution of human input.

Moreover, international cooperation is crucial to address this issue effectively. The global nature of AI-generated images necessitates harmonized regulations to ensure consistent protection worldwide. Collaborative efforts can pave the way for establishing an international framework that safeguards the rights of creators and fosters creativity in the AI landscape.

In conclusion, the current deficiency in copyright protection for AI-generated images, as demonstrated by the aforementioned case of Kris Kashtanova's illustrations, calls for immediate action. By updating copyright laws and adapting them to the unique challenges posed by AI creations, we can foster an environment that encourages innovation, recognizes the contribution of AI systems, and ensures fair attribution and protection for creators. It is essential to address this matter comprehensively to support the continued advancement of AI technology and the creative industries as a whole.

5.2 Copyright Issues on Training Data

The use of copyrighted works as training data is indispensable for AI development, yet fraught with legal uncertainties. On the one hand, exposing AI algorithms to large datasets containing copyrighted materials appears imperative for effective learning. The diversity and volume of quality training data correlate directly with the sophistication of AI systems. However, the unlicensed incorporation of copyrighted works as training data risks constituting copyright infringement. There is a pressing need to strike a balance that enables sufficient access to training data for AI progress, while respecting copyright protections.

We propose the principle of "fair training" [9] as a potential solution, which would allow reasonable uses of copyrighted works for training purposes based

on factors like transformative usage, nature of the original work, and market substitution impact. This framework is analogous to the fair use doctrine in copyright law. However, clear boundaries must be set to prevent excessive appropriation of copyrighted works that could undermine creators' rights and incentives. Technical solutions like opt-out mechanisms for copyright holders could empower content creators to decide on AI training uses.

Overall, a nuanced approach is imperative that aims to provide adequate training data access for AI developers to create societally beneficial applications, while safeguarding the rights of content creators through calibrated copyright limitations and exceptions. Reconciling these interests will require good faith efforts and willingness to compromise from both technology companies and creative professionals. With constructive dialogue and cooperation, workable solutions can likely be reached that further AI innovation within an ethical framework respectful of intellectual property rights. The "fair training" model offers a promising path forward in addressing the copyright issues surrounding AI training data.

5.3 Copyright of AI-Generated Content

The copyrightability of works produced by artificial intelligence systems remains a complex quandary with persuasive arguments on both sides. Proponents contend AI outputs exhibit creativity, originality, and social value comparable to human creations, thus warranting copyright incentives and protections. However, critics highlight the lack of human authorship and legal personhood as doctrinal barriers. Significant uncertainties also exist regarding authorship attribution, ownership rights, and infringement for AI-generated works.

While categorical inclusion or exclusion appears unwise currently, measured adaptations to copyright frameworks may enable limited protections for standalone AI works, as exemplified by the UK's regime for computer-generated works. This demonstrates the feasibility of extending copyright to AI outputs without undermining the centrality of human authors. However, such incremental changes require balancing the interests of AI developers, content creators, and the enrichment of the public domain. Overly expansive rights for AI works may encroach on human creativity and the commons.

Constructive policies will likely emerge from sustained interdisciplinary dialogue between technology, law, philosophy, and culture. Moderation and social conscientiousness should shape the evolution of intellectual property governance for AI copyright issues. Neither unbridled rights nor blanket exclusions serve the greater good. But prudent recalibration of copyright doctrines, guided by ethical principles and dialogue, may enable measured protections amid responsible AI innovation and flourishing human creativity.

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A Image Sources

A.1 Infringing Images

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B Code Appendix

B.1 Python Code

B.1.1 Data Preprocessing and Custom Dataset Definition

```
import torch
import torch.nn as nn
import torch.optim as optim
from torch.utils.data import Dataset, DataLoader
from PIL import Image
import os

# Image folder path
image_folder = r"C:\Users\dadeweifa\Desktop\picture"

# Traverse the image folder
data = []  # List to store image data
targets = []  # List to store target labels
for filename in os.listdir(image_folder):
    if filename.endswith(".jpg") or filename.endswith(".png"):
        # Construct image path
        image_path = os.path.join(image_folder, filename)

        # Load image using PIL
        image = Image.open(image_path)

        # Add image data to the list
        data.append(image)

        # Assuming the image filename contains label information,
        # parse and add it to the target labels list as needed
        label = parse_label_from_filename(filename)
        targets.append(label)

# Finally, convert data and targets to NumPy arrays or other appropriate data types
```

B.1.2 Custom Dataset Class Definition

```
class ImageDataset(Dataset):
    def __init__(self, data, targets):
        self.data = data
        self.targets = targets

    def __len__(self):
        return len(self.data)
```

```
    def __getitem__(self, index):
        image = self.data[index]
        target = self.targets[index]
        return image, target
    # Split into training and testing sets
    from sklearn.model_selection import train_test_split
    X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42
```

B.1.3 Neural Network Model Definition

```
# Define input layers
input_1 = Input(shape=(height, width, channels))
input_2 = Input(shape=(height, width, channels))

# Define convolutional and pooling layers
conv1_1 = Conv2D(32, kernel_size=(3, 3), activation='relu')(input_1)
conv1_2 = Conv2D(32, kernel_size=(3, 3), activation='relu')(input_2)
pool1_1 = MaxPooling2D(pool_size=(2, 2))(conv1_1)
pool1_2 = MaxPooling2D(pool_size=(2, 2))(conv1_2)

# Merge the outputs of the two pooling layers
merge = tf.keras.layers.concatenate([pool1_1, pool1_2])

# Flatten layer
flatten = Flatten()(merge)

# Fully connected layer
dense1 = Dense(128, activation='relu')(flatten)

# Output layer
output = Dense(1, activation='sigmoid')(dense1)
```

B.1.4 Training Function Definition

```
def train(model, train_loader, criterion, optimizer, num_epochs):
    model.train()
    for epoch in range(num_epochs):
        # Training loop code here
```