An Understanding of Cityscapes Dataset as a Resource

A Case Study on Data Collection, Ownership, Regulatory Challenges, and Ethical Considerations

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The Cityscapes dataset, a comprehensive collection of urban street scenes, was fastidiously gathered through a collaborative effort involving Daimler AG R&D, the Max Planck Institute for Informatics, and TU Darmstadt Visual Inference Group. These three institutions responsible for creating and managing the Cityscapes dataset. These organizations collaborated to collect, curate, and distribute the urban street scene images that make up the Cityscapes dataset, combining expertise from automotive research, computer vision, and machine learning fields. The data collection process was both extensive and methodical, involving the recording of stereo video sequences from a moving vehicle across a variety of different cities in Germany, France, and Switzerland. This approach ensured a diverse representation of urban environments. The recordings spanned several months, capturing the varying seasons throughout the year, primarily during daylight hours and in favorable to moderate weather conditions. The camera setup for the Cityscapes dataset was quite advanced, featuring stereo cameras that worked in in conjunction with GPS and vehicle odometry for precise image localization. This precise setup allowed for the capture of lush, detailed urban scenes under various lighting conditions, ensuring a diverse and valuable dataset for computer vision research. To enhance the dataset's utility, the creators manually selected frames from these recordings, focusing on scenes that offered a rich variety of urban elements and complexities. This careful curation resulted in a final dataset comprising 5,000 images with fine annotations and 20,000 images, providing researchers with a robust foundation for urban scene analysis and understanding [Cordts et al., 2016][1].

The ownership of the Cityscapes dataset resides with the institutions that organized its creation: Daimler AG R&D, the Max Planck Institute for Informatics, and TU Darmstadt Visual Inference Group. These organizations collectively hold the rights to the dataset and oversee its distribution and management. In a commendable move to support academic and research endeavors, the dataset is made freely available to both academic and non-

academic entities for non-commercial purposes. This open access policy facilitates a wide range of applications, from academic research and teaching to scientific publications and personal experimentation. However, to maintain control over the dataset's use and ensure adherence to ethical guidelines, users are required to complete a registration process and agree to specific license terms before gaining access. This approach strikes a balance between accessibility and responsible use, allowing the dataset to serve as a valuable resource for the research community of scholars while maintaining oversight of its application.

The regulatory landscape surrounding the Cityscapes dataset presents several challenges that the dataset managers have actively addressed. Foremost among these is the need to control access and ensure compliance with usage terms. To this end, the managers have implemented a robust registration process, which serves as a gateway for users to access the data. This process not only helps in maintaining a record of who is using the dataset but also ensures that users explicitly agree to the terms of use. The dataset is released under a custom license that clearly prohibits commercial use without explicit permission, thereby addressing potential issues related to intellectual property rights and unauthorized commercialization. Furthermore, the dataset managers have taken significant steps to align with data protection regulations. Recognizing the sensitive nature of capturing images in public spaces, they have implemented anonymization techniques to protect individual privacy. This includes blurring license plates and faces of individuals captured in the images, demonstrating a commitment to balancing the dataset's utility with respect for personal privacy.

Ethical considerations form a crucial aspect of the Cityscapes dataset, particularly concerning privacy and consent. The dataset's nature, capturing images of public spaces including pedestrians and vehicles, inherently raises privacy concerns for individuals inadvertently included in these images. The dataset managers have proactively addressed this issue by implementing anonymization techniques, such as blurring faces and license plates. However, it's important to acknowledge that achieving complete anonymization in such a large-scale and detailed dataset presents significant challenges. While the measures taken greatly reduce privacy risks, users of the dataset should remain aware that some residual risks may persist. For example, advanced AI algorithms might potentially de-anonymize individuals based on clothing, gait, or context clues. There's also the possibility that certain landmarks or unique vehicle characteristics could indirectly identify specific people or businesses. These lingering concerns underscore the need for ongoing vigilance and ethical considerations in the use of such datasets. Another ethical consideration is the potential for bias in the dataset. While the Cityscapes dataset alone may not fully address all ethical concerns, it represents a significant step towards more responsible and

comprehensive urban data collection. This valuable resource contributes to the broader goal of creating ethical, diverse, and representative datasets for urban scene analysis and understanding. Given that the images primarily cover European cities, there's a risk that models trained on this dataset may not fully generalize to urban environments in other parts of the world. The dataset managers have partially mitigated this by including a variety of cities and capturing images across different seasons, but users should be cognizant of this limitation when applying their models to diverse geographical contexts. Additionally, the ethical use of the dataset extends to the responsibility of researchers and developers to consider the broader implications of their work, such as the potential for surveillance applications or unintended consequences in urban planning and policy decisions based on analyses derived from this dataset.

Some ethicality-related research has been with respect to the Cityscapes dataset. In the NVIDIA NGC Catalog, specifically in the work titled “Cityscapes SegFormer Model Card” [2], a paragraph has been written about the ethical considerations of using this dataset in their work. They clearly state the fact that since these images in the dataset were taken across 50 cities in a particular geographical location, it could lead to algorithmic bias. Additionally, in the work titled “The ethical dilemma when (not) setting up cost-based decision rules in semantic segmentation” [Chan et al.][3], they speak about applying a decision tree onto the Cityscapes and figuring out which method (Altruistic, Robotistic, or Egoistic) and figuring out which method is best suited to handle both ethical as well as mathematical considerations. They highlight that “different normative ethical schools of thought will provide different answers”. After giving various examples they highlight that they cannot choose one specific decision rule as right or not, in terms of ethicality. “It is not the aim of this paper to defend any specific approach or to provide an alternative answer to the above problem of choosing the “right” decision rule, but to make transparent the underlying ethical dimension of what may seem as mathematically innocuous “natural’ choices.” - Is what they clearly mention in the paper and this seems to be the best way to handle the debate as to which is the best. At the end they leave the floor open to debate, encouraging ethical considerations to be taken while choosing the right model.

As we can see, the Cityscapes dataset is an influential piece of data that is sparking many ethical conversations both on collection of data as well as usage of data. It has a few ethical shortcomings, but overall seems to be a great way to train and deploy robust machine learning models.

Work Cited:

1. M. Cordts, M. Omran, S. Ramos, T. Rehfeld, M. Enzweiler, R. Benenson, U. Franke, S. Roth, and B. Schiele, "The Cityscapes Dataset for Semantic Urban Scene Understanding," in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2016, pp. 3213-3223.
2. NVIDIA, "Pretrained SegFormer - Cityscapes," NVIDIA NGC Catalog, 2023. [Online]. Available: https://catalog.ngc.nvidia.com/orgs/nvidia/teams/tao/models/pretrained_segformer_cityscapes
3. R. Chan, M. Rottmann, R. Dardashti, F. Huger, P. Schlicht, and H. Gottschalk, "The Ethical Dilemma When (Not) Setting Up Cost-Based Decision Rules in Semantic Segmentation," in Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops (CVPRW), 2019, pp. 1-8.