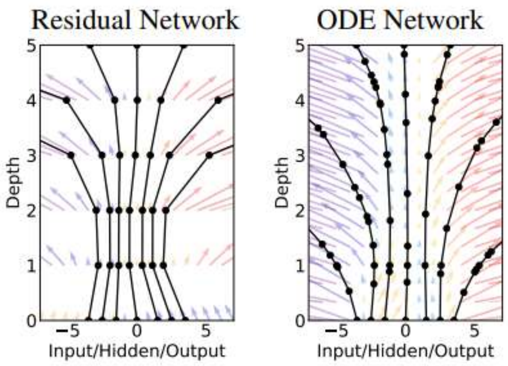
Simulating and Searching about the Neural ODE Paper

Karlsruher Institut für Technologie

Topic description

ODEs stand for Ordinary Differential Equations. These are mathematical equations that involve a function of one variable and its derivatives. In these equations, the derivatives represent rates of change, and the equation describes how a function changes as its independent variable changes. The Neural ODE paper (which won best paper at the NeurIPS conference) simulates ODEs using neural networks, providing a powerful new approach.



Chen, Ricky TQ, et al. "Neural ordinary differential equations." *Advances in neural information processing systems* 31 (2018).

Tasks

Understanding what are neural ODEs
Providing an overview of different use cases of neural ODEs
(Optional) Predicting time series using a neural ODE

Literature

Chen, Ricky TQ, et al. "Neural ordinary differential equations." *Advances in neural information processing systems* 31 (2018).

Supervisor

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Regularisierung von Entfaltungsproblemen

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Das Problem der (Bild-) Entfaltung stellt ein schlecht gestelltes inverse Problem dar. Entsprechend müssen bei der Lösung solcher Probleme passende Regularisierungsverfahren angewandt werden. Moderne, auf sog. „Deep Inverse Priors“ basierende Ansätze versprechen dabei bisher unerreichbare Rekonstruktionsqualitäten.

$$\mathbf{y} = \mathbf{A}\mathbf{x} + \eta,$$

$$\hat{\mathbf{x}} \in \arg\min_{\mathbf{x}} \frac{1}{2\sigma_n^2}\|\mathbf{y} - \mathbf{A}\mathbf{x}\|_2^2 - \log p_\theta(\mathbf{x}).$$

Aufgabe

- Literaturrecherche zum Thema.
- Aufbereitung der Ergebnisse in Form eines wissenschaftlichen Berichts und einer Präsentation.

Beispielliteratur

- https://deepinv.github.io/deepinv/
- https://en.wikipedia.org/wiki/Deep_image_prior
- https://ieeexplore.ieee.org/document/9788065

Betreuer

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System Identification

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Topic description

System identification is the art and science of building mathematical models of dynamic systems from observed input–output data. It can be seen as the interface between the real world of applications and the mathematical world of control theory and model abstractions. There are also some challenges in this area.

Tasks

- Investigate the topic of system identification and provide an overview of the literature in this field.
- Compare the state-of-the-art approaches in this area.

Literature

- Ljung, Lennart. "Perspectives on system identification." *Annual Reviews in Control* 34.1 (2010): 1-12.

Supervisor

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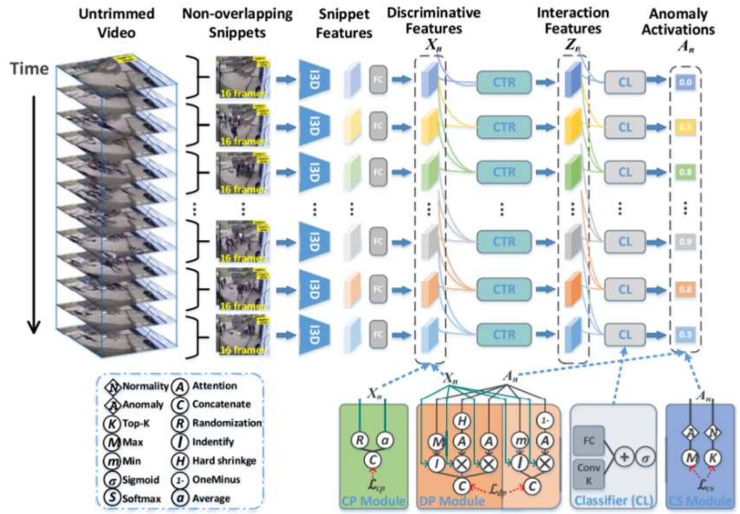
Spatial-temporal Causality in Image Analysis

Spatial-temporal causality in images is crucial for understanding the relationships between objects, events, and their contexts over both space and time. It helps us infer the causes and effects within a scene, enabling more accurate analysis and prediction. However, these pose several challenges.



Wu, Peng, and Jing Liu. "Learning causal temporal relation and feature discrimination for anomaly detection." *IEEE Transactions on Image Processing* 30 (2021): 3513-3527.

Tasks

- Provide an overview of the literature in the field.
- Compare state-of-the-art approaches regarding their methodology.
- Address the challenges of integrating causality into image.

Literature

- Chen, Jin, et al. "Spatial-temporal causal inference for partial image-to-video adaptation." Proceedings of the AAAI Conference on Artificial Intelligence. Vol. 35. No. 2. 2021.
- Wu, Peng, and Jing Liu. "Learning causal temporal relation and feature discrimination for anomaly detection." *IEEE Transactions on Image Processing* 30 (2021): 3513-3527.

Supervisor

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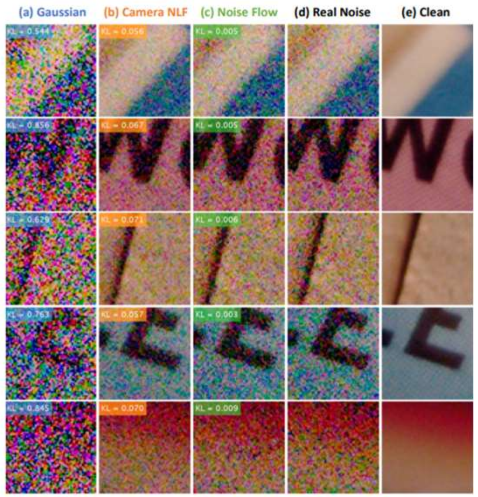
Bildverbesserung mittels normalisierender Flüsse

Normalisierende Flüsse oder auch Normalising Flows (NFs) bilden ein wertvolles Werkzeug in der statistischen Inferenz sowie für probabilistische Modellierungen. Sie ermöglichen es flexible Wahrscheinlichkeitsverteilungen über kontinuierliche Zufallsvariablen zu konstruieren. Eine von vielen Anwendungen ist die Verbesserung von Bildern.



Abdelhamed, Abdelrahman, Marcus A. Brubaker, and Michael S. Brown. "Noise flow: Noise modeling with conditional normalizing flows." *Proceedings of the IEEE/CVF International Conference on Computer Vision*. 2019.

Aufgaben

- Verstehen der Funktionsweise normalisierender Flüsse
- Zusammenstellen einer Übersicht verschiedener “state of the art” Anwendungen von NFs in der Bildverbesserung

Literature

- Abdelhamed, Abdelrahman, Marcus A. Brubaker, and Michael S. Brown. "Noise flow: Noise modeling with conditional normalizing flows." *Proceedings of the IEEE/CVF International Conference on Computer Vision*. 2019.
- Jo, Younghyun, Sejong Yang, and Seon Joo Kim. "Srflow-da: Super-resolution using normalizing flow with deep convolutional block." *Proceedings of the IEEE/CVF conference on computer vision and pattern recognition*. 2021.

Supervisor

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Motion Planning

Topic description

Motion planning, also known as path planning, is a fundamental problem in robotics and automation. It involves determining a feasible path for a robot or an autonomous agent to move from its current state to a desired goal state while avoiding obstacles and adhering to constraints such as kinematic and dynamic limitations.

Tasks

- Provide an overview of the literature in the field.
- Compare the state-of-the-art approaches.

Literature

- Garrett, Caelan Reed, et al. "Integrated task and motion planning." *Annual review of control, robotics, and autonomous systems* 4 (2021): 265-293.

Supervisor

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