

Resampling Augmentation for Time Series Contrastive Learning: Application to Remote Sensing

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July 19th, 2025

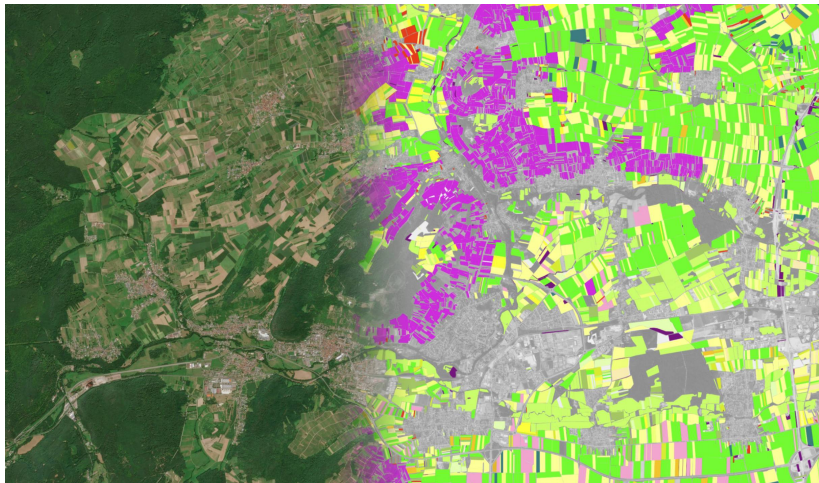


ICML
International Conference
On Machine Learning



Data: pixel-wise remote sensing (S2) time series

Application: cropland classification



Abundant data, few labels

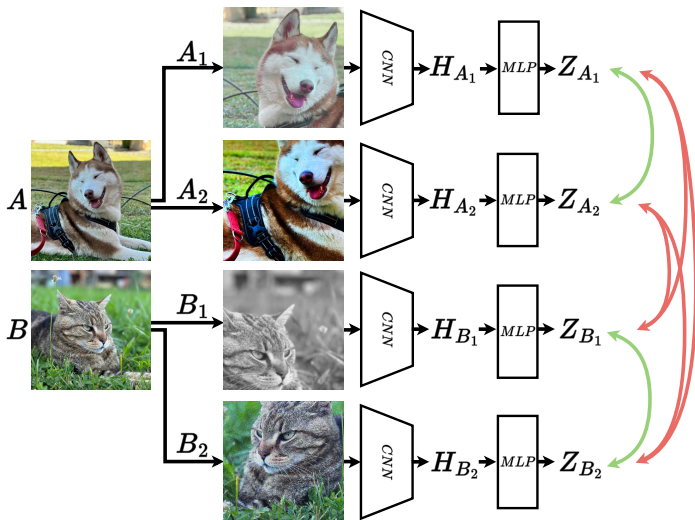
In remote-sensing time series:

- Worldwide acquisition every 5 days since 2017 by Sentinel-2
⇒ virtually "unlimited" unlabeled data
- Expert annotations are costly
⇒ few labeled samples in comparison

Self-Supervised Learning: leveraging unlabeled data

- **Self-Supervised Learning:** learn a representation without labels
- **Mask Modeling:** predict a masked portion of a sample from the remaining visible part (e.g. Masked Autoencoders, ViT, BERT, GPT)
- **Contrastive learning:** brings similar samples —created through augmentations— closer in the embedding space

Contrastive learning with SimCLR [Chen et al., 2020]¹



¹Chen, T. et al. (2020). A simple framework for contrastive learning of visual representations. ICML.

Contrastive SSL is challenging for time series

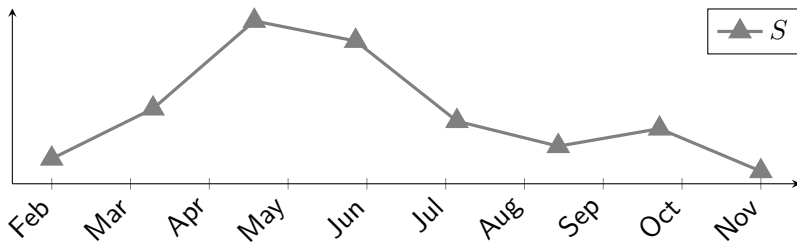
Diversity in time series dataset makes it hard to design universal, effective augmentations for contrastive learning [Liu et al., 2024]²

²Liu, Z. et al. (2024). Guidelines for Augmentation Selection in Contrastive Learning for Time Series Classification. arXiv:2407.09336.

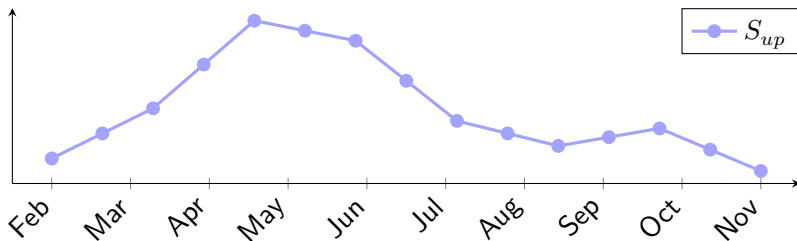
Contribution: Remote Senging Time Series Augmentation

We propose a simple augmentation that resamples a time series into two sub-series

Resampling - 1. Upsampling

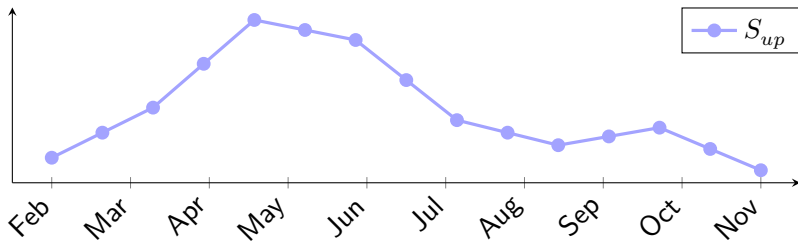


(a) Original time series

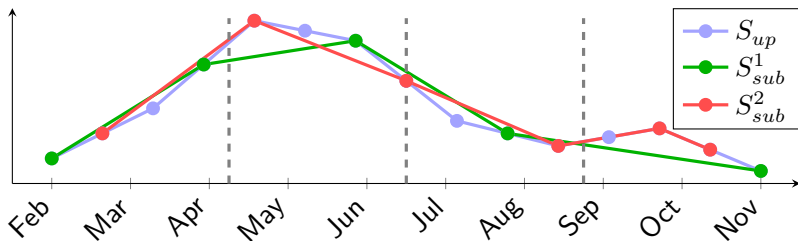


(b) Upsampled time series

Resampling - 2. Subsampling

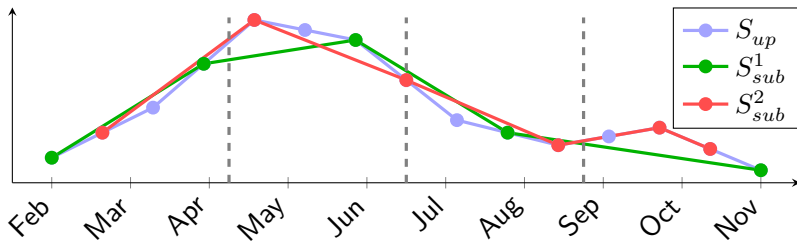


(a) Upsampled time series

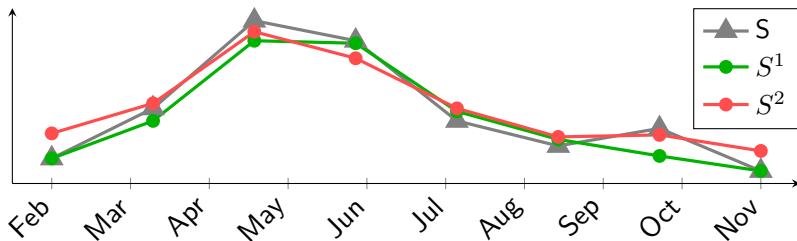


(b) Subsampled time series

Resampling - 3. Optional alignment back to original size

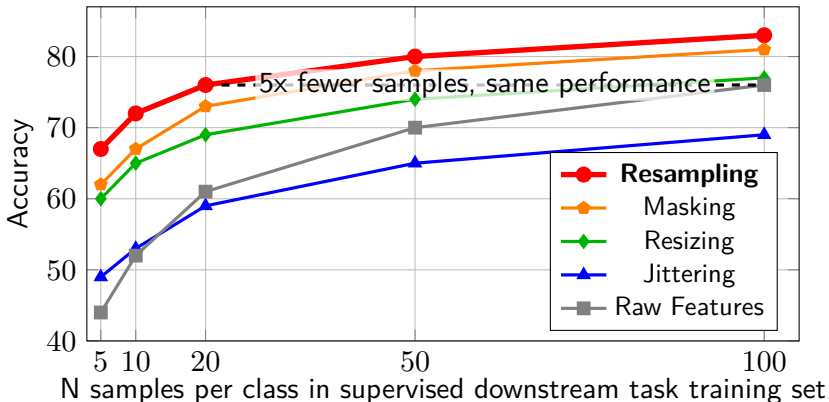


(a) Subsampled time series



(b) Interpolated and aligned time series

Results - Test accuracy on FranceCrops [Saget et al., 2024]³



³Saget, A. et al. (2024). Learning from few labeled time series with segment-based self-supervised learning: application to remote-sensing. SPAICE2024.

Conclusion

⇒ Contrastive learning is a powerful tool to leverage large amounts of unlabeled data, if we adapt it appropriately.

Future directions:

- Evaluate this augmentation under standard supervised training
- Test on other domains: what are the limits?
- Explore generative / mask-based SSL methods
- Incorporate spatial information

