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Classificação de cubo de dados de observação da Terra usando séries temporais com o pacote SITS

Gilberto Câmara, Rolf Simões,
Felipe Carvalho

XX SBSR
Simpósio Brasileiro de Sensoriamento Remoto

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AMAZONIA**

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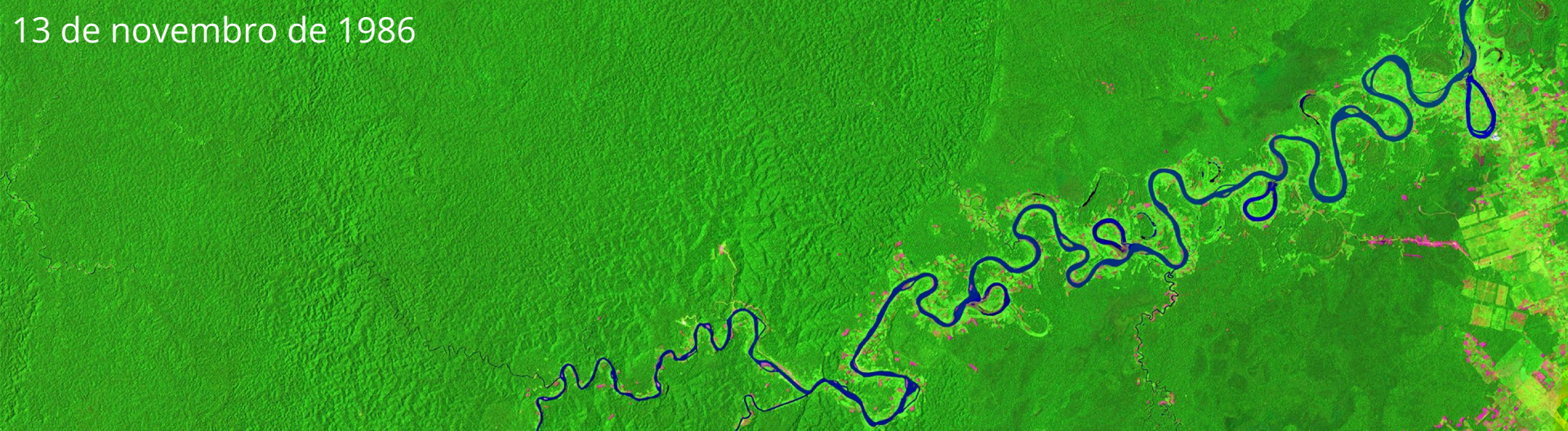
BNDES



MINISTÉRIO DA
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GOVERNO FEDERAL
BRASIL
UNIÃO E RECONSTRUÇÃO

13 de novembro de 1986



Mudança na cobertura da Terra



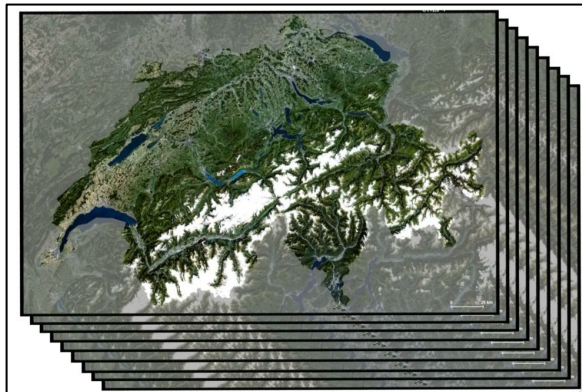
30 de outubro de 2016

Imagens: Landsat (Pucallpa, Peru)

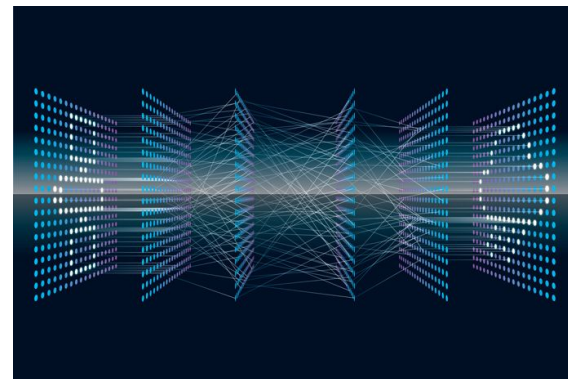
Grandes dados de observação da Terra



Dados de
satélite



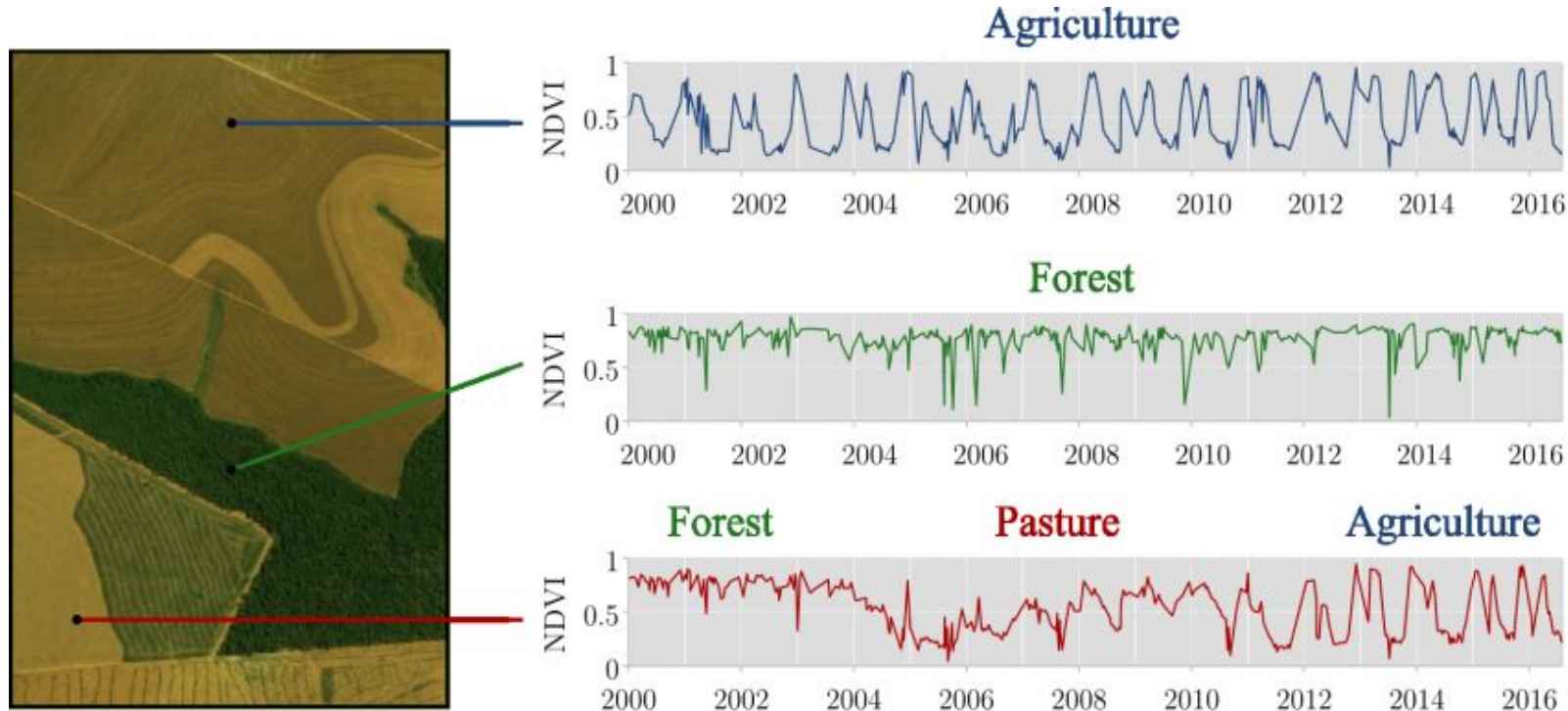
Cubo de
dados



Machine
learning

images: NASA, Swiss Data Cube, ECMWF

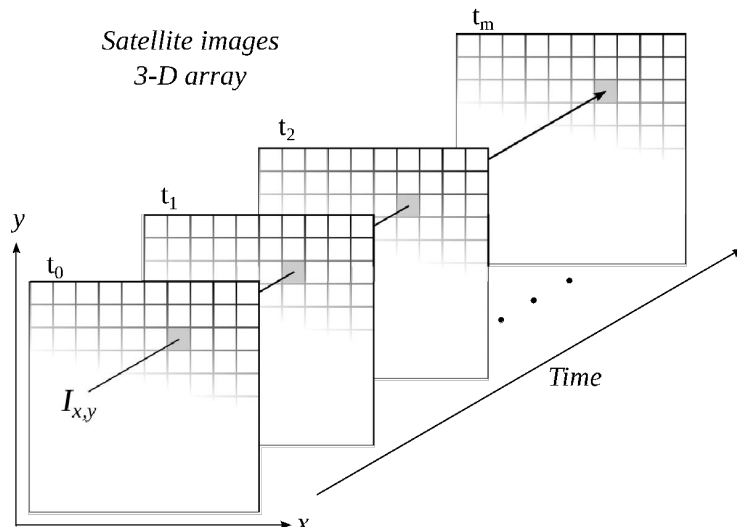
Séries Temporais de Imagem de Satélite



Como classificar a cobertura da terra usando séries temporais?

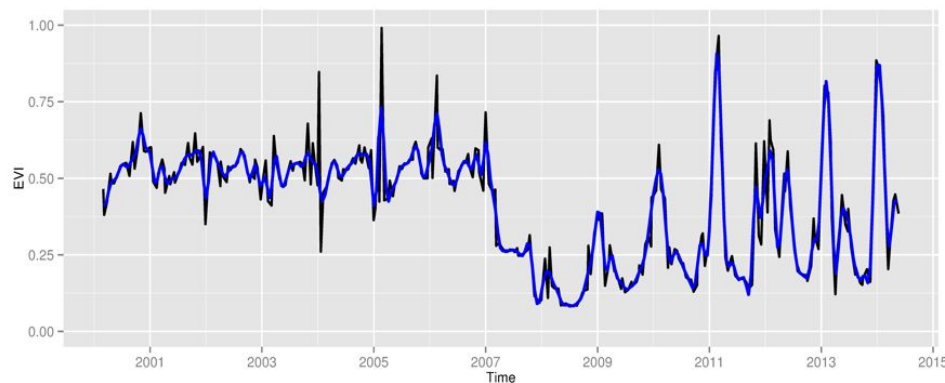
graphics: Maus, Victor

"Space first, time later" ou "time first, space later"?



Space first: classificar imagens;
comparar resultados no tempo

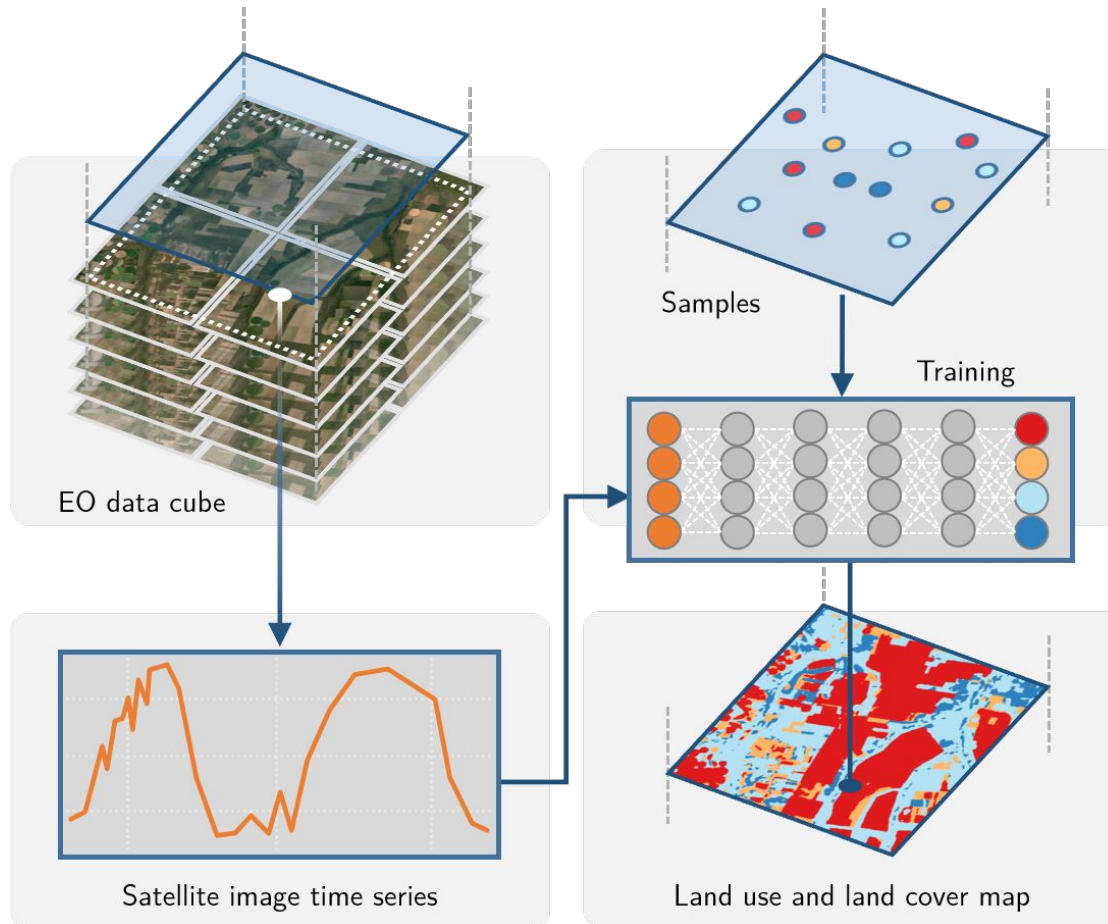
Time first: classificar séries
temporais; juntar resultados
para obter mapas



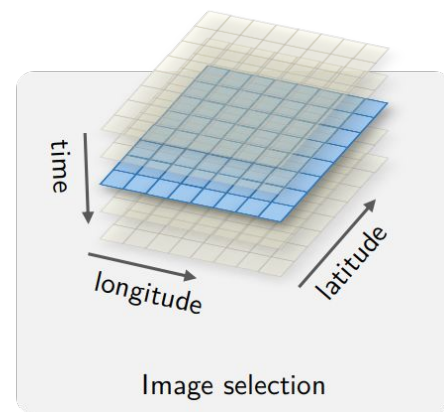
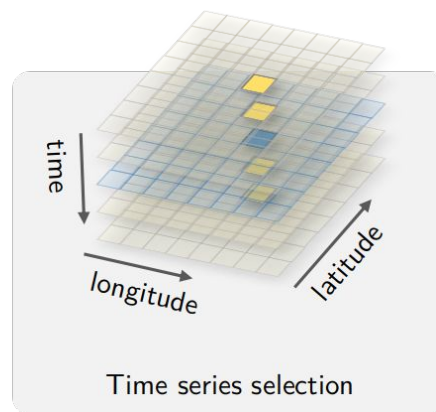
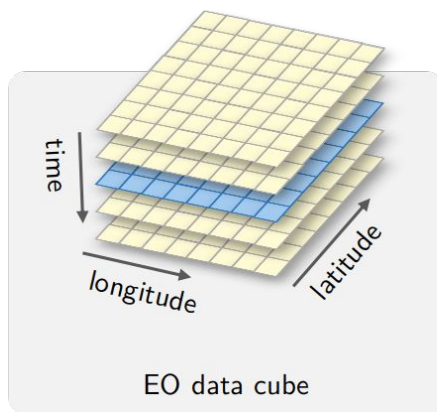
graphics: V Maus, author



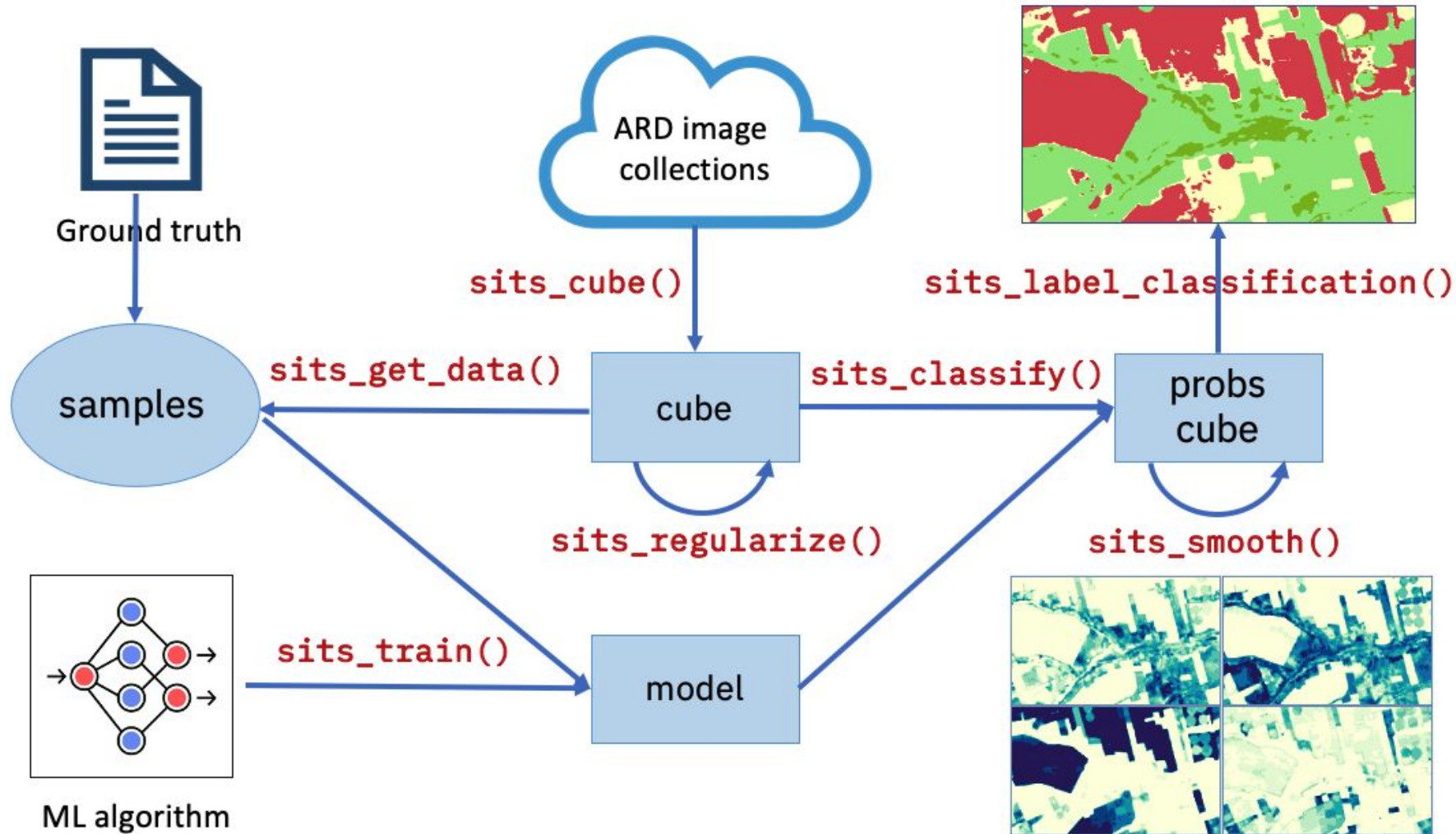
Classificação de cubo de dados usando sits



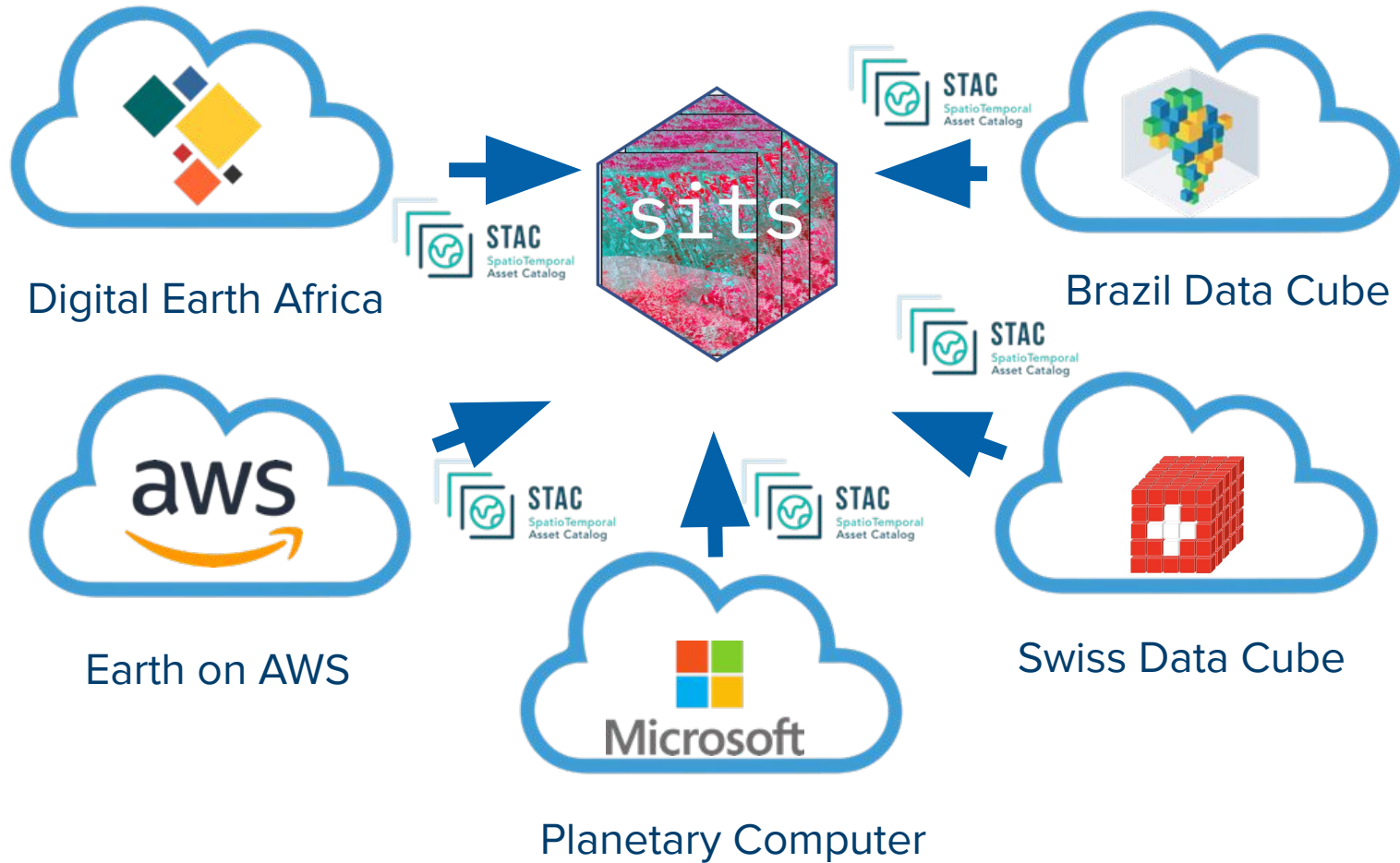
O que é um cubo de dados?



Cubo de dados = partição regular do espaço e do tempo

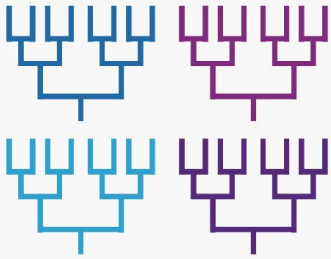


Acesso a cubos de dados com STAC

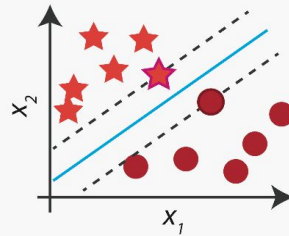


Métodos de Aprendizagem de Máquina suportados pelo sits

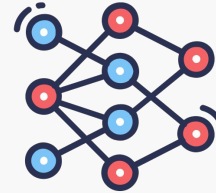
Random forests



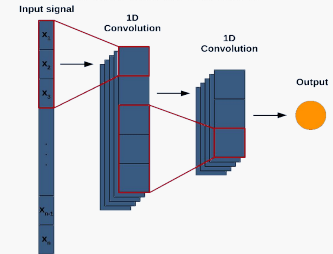
Support vector machines



Multilayer perceptrons

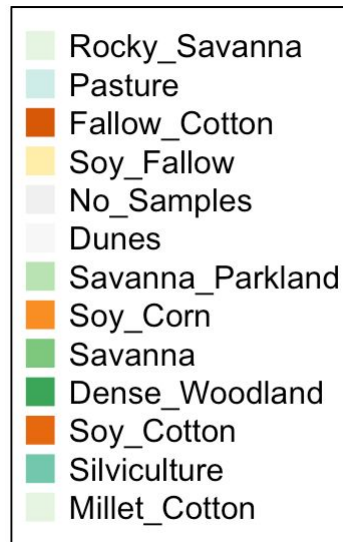
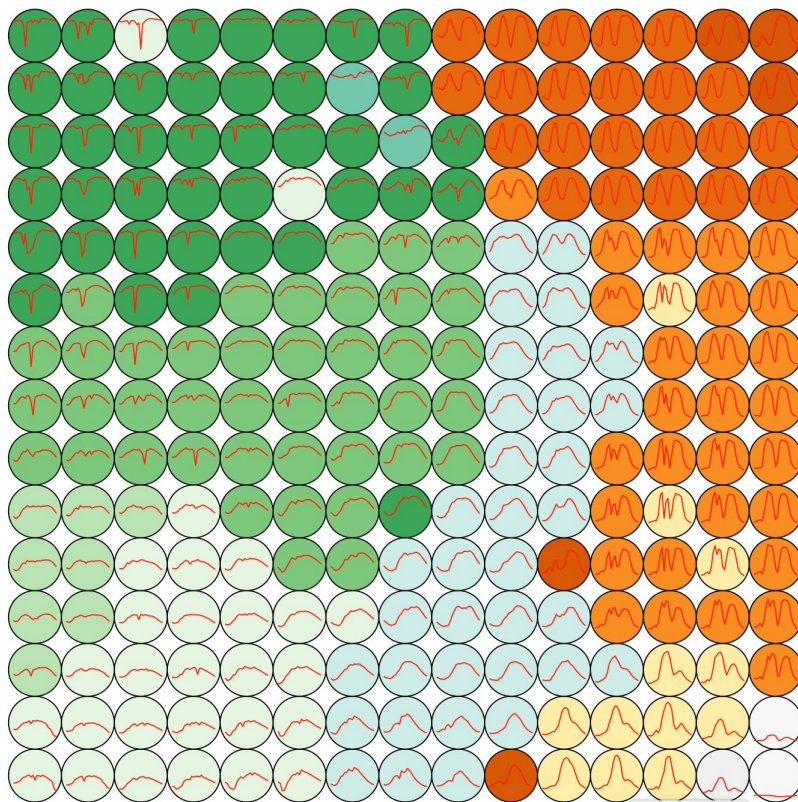


1D convolutional neural networks



- Extreme gradient boosting
- Deep Residual Networks

- Temporal attention encoders
- Lightweight temporal attention encoders



Santos et al. (2021)

SOM – Mapas auto-organizados

Space later: suavização Bayesiana



Sentinel-2 data (08/2021)

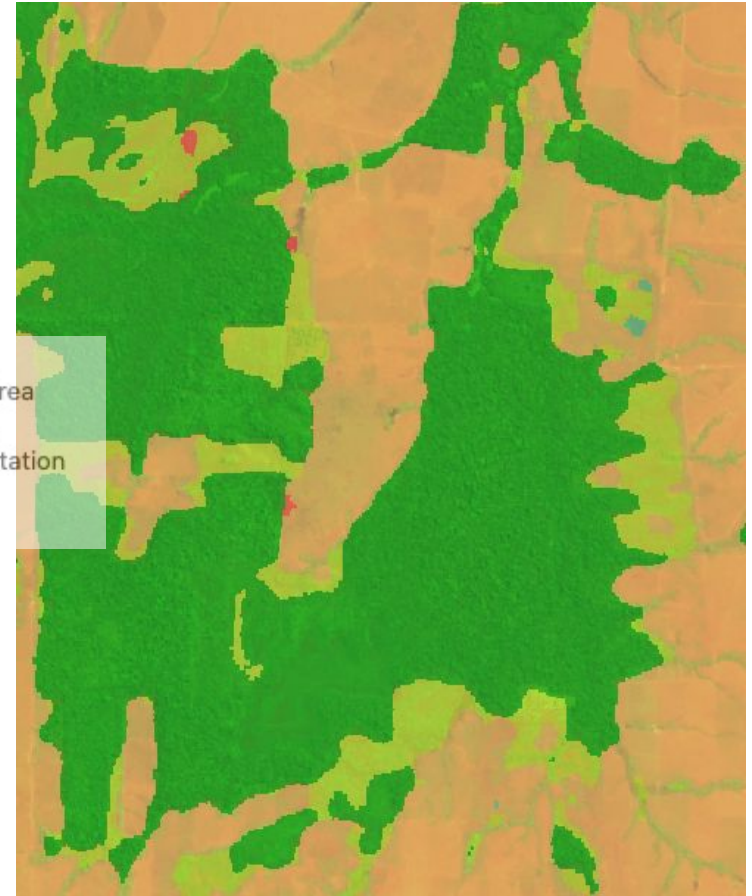


Time-first: classificação

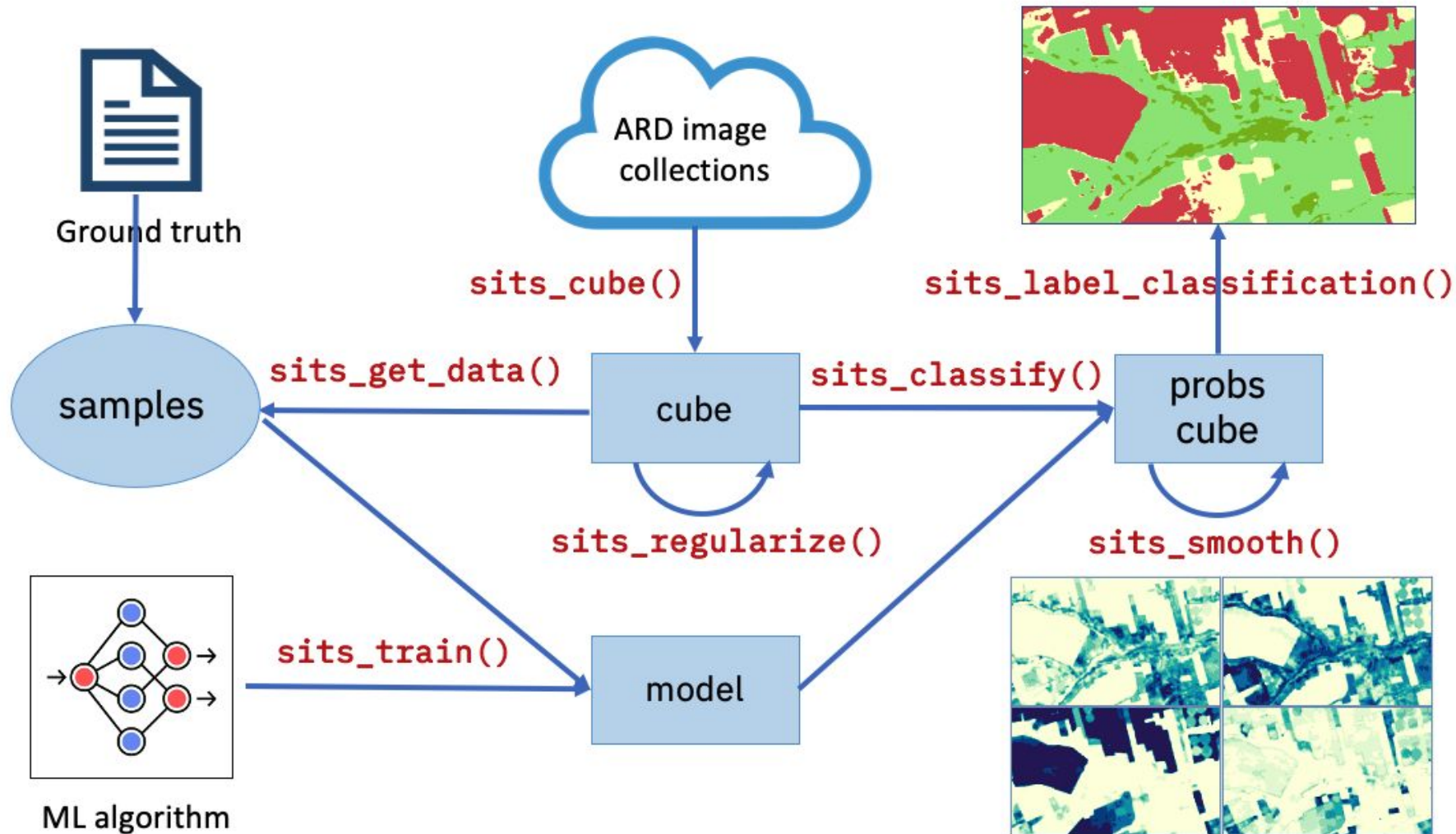
Space later: suavização Bayesiana



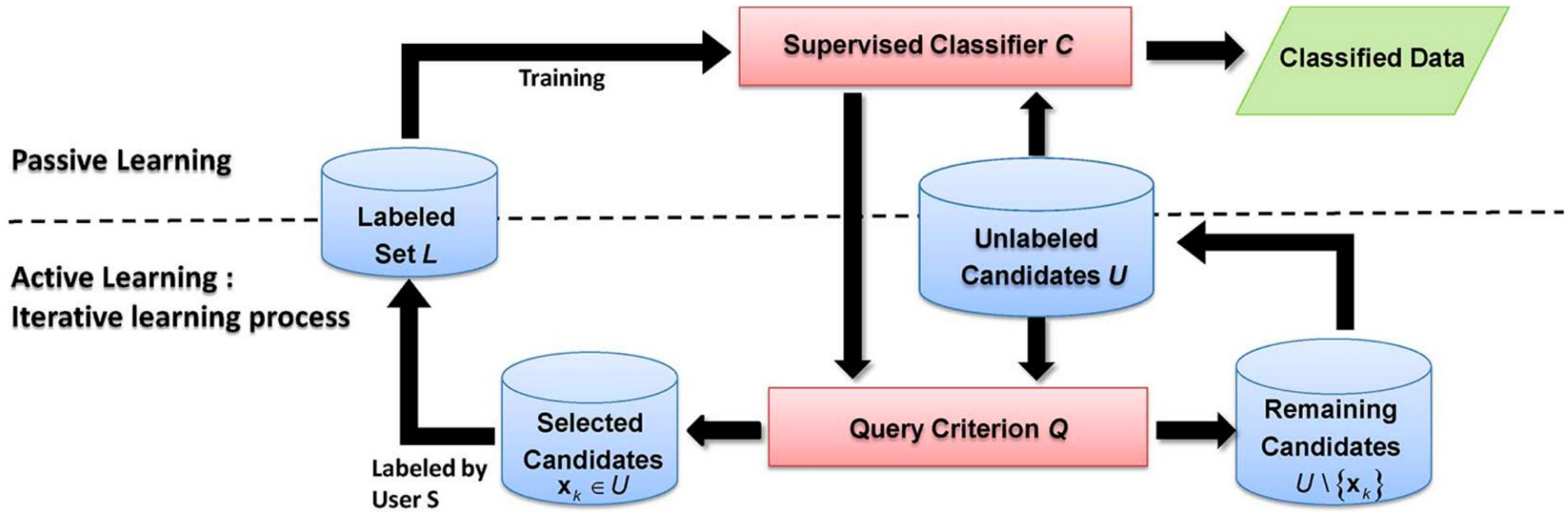
Sentinel-2 data (08/2021)



Spacer-later: suavização



Active learning: “user-in-the-loop”

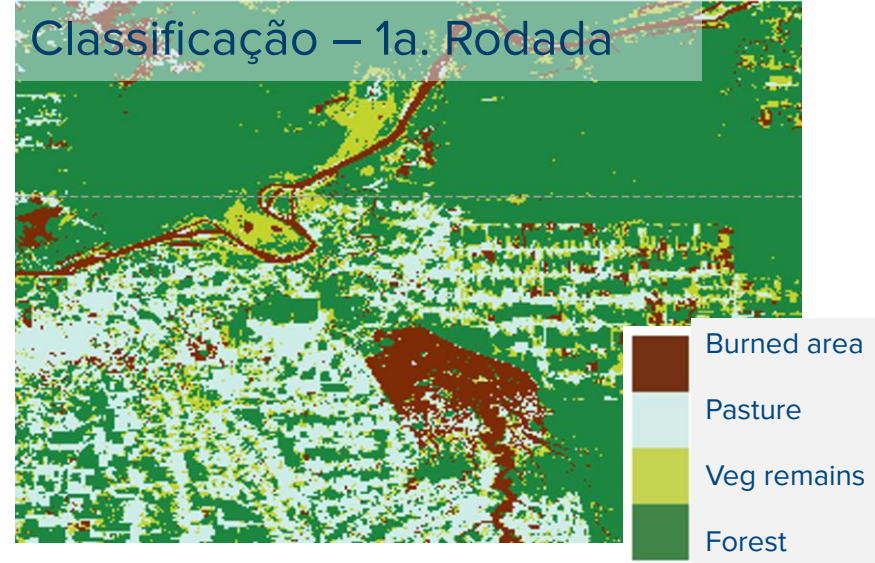


Crawford et al. (2014)

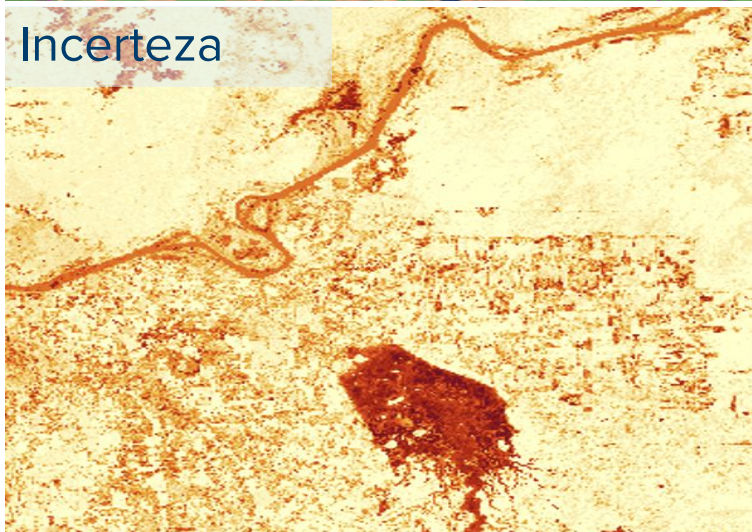
Sentinel-2



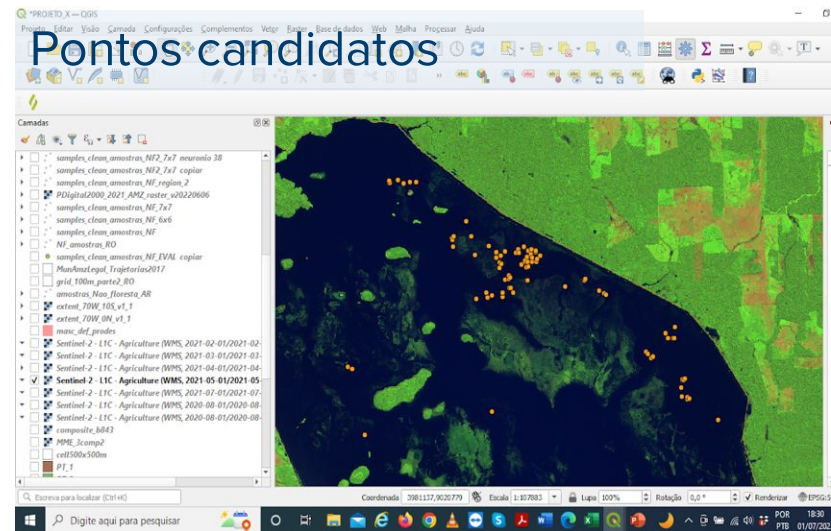
Classificação – 1a. Rodada



Incerteza



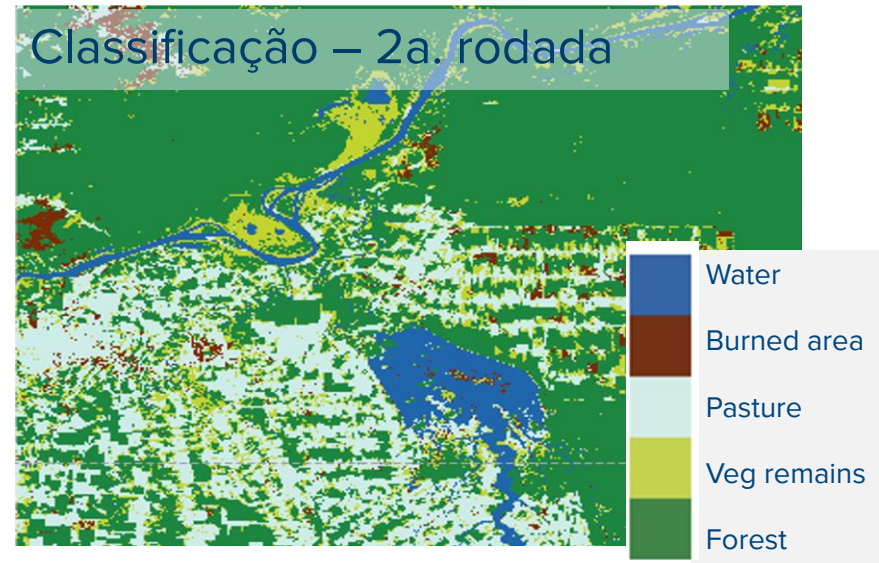
Pontos candidatos



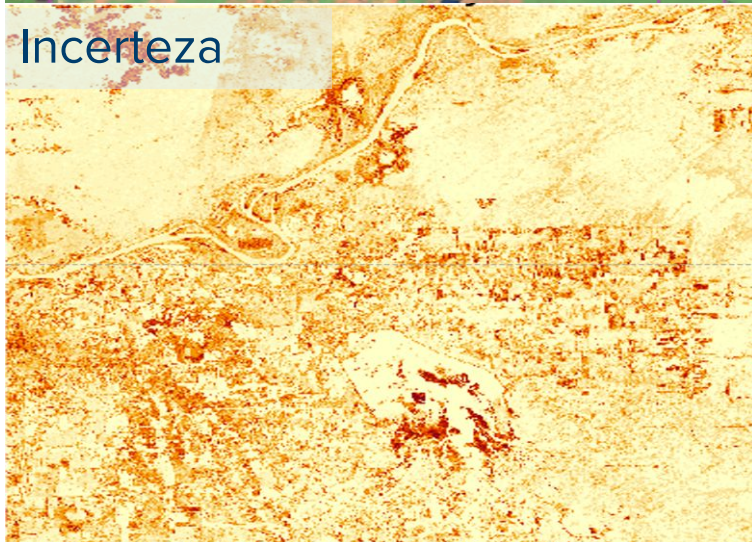
Sentinel-2



Classificação – 2a. rodada



Incerteza

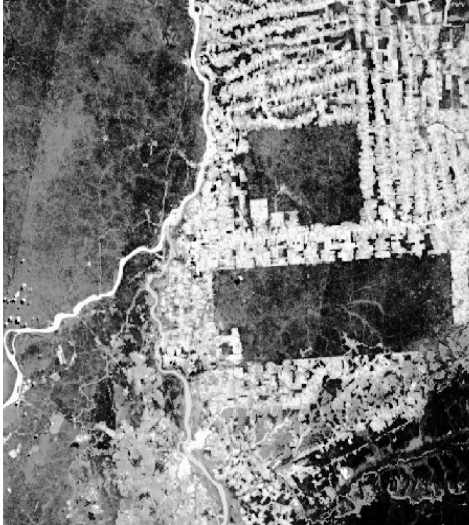


Rotulando novos pontos

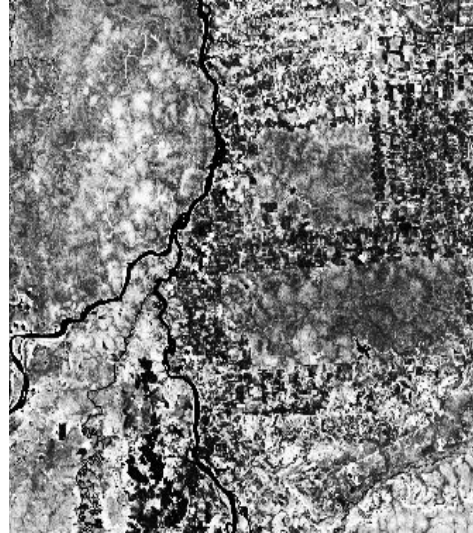


Geração de índices espectrais e modelo linear de mistura

B04



B08



NDVI



```
cube_ndvi ← sits_apply(  
  data = cube,  
  NDVI = (B08 - B04) / (B08 + B04)  
)
```


Estimação de Acurácia

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Review

Good practices for estimating area and assessing accuracy of land change

Pontus Olofsson ^{a,*}, Giles M. Foody ^b, Martin Herold ^c, Stephen V. Stehman ^d,
Curtis E. Woodcock ^a, Michael A. Wulder ^e

^a Department of Earth and Environment, Boston University, 685 Commonwealth Avenue, Boston, MA 02215, USA

^b School of Geography, University of Nottingham, University Park, Nottingham NG7 2RD, UK

^c Laboratory of Geo-Information Science and Remote Sensing, Wageningen University, Droevendaalsesteeg 3, 6708 Wageningen, The Netherlands

^d Department of Forest and Natural Resources Management, State University of New York, 1 Forestry Drive, Syracuse, NY 13210, USA

^e Canadian Forest Service (Pacific Forestry Centre), Natural Resources Canada, Victoria, BC V8Z 1M5, Canada



Food and Agriculture
Organization of the
United Nations

Map Accuracy Assessment and Area Estimation

A Practical Guide



Referências

1. Xu et al., “Towards Interpreting Multi-Temporal Deep Learning Models in Crop Mapping.” Remote Sensing of Environment, 2021.
2. Crawford, Tuia, and Yang, “Active Learning: Any Value for Classification of Remotely Sensed Data? Proceedings of the IEEE, 101, 2013.
3. Monarch, R., “Human-in-the-Loop Machine Learning: Active Learning and Annotation for Human-centered AI”. Manning Publications, 2021.
4. Garnot, Landrieu, et al., “Satellite Image Time Series Classification With Pixel-Set Encoders and Temporal Self-Attention”. IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), 2020.
5. Garnot, Landrieu, et al., “Lightweight Temporal Self-attention for Classifying Satellite Images Time Series”. Arxiv:2007.00586., 2021.
6. Ofori-Ampofo, Pelletier, and Lang, “Crop Type Mapping from Optical and Radar Time Series Using Attention-Based Deep Learning”. Remote Sensing, 2021.