Optimal transport for machine learning

Practical sessions

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Data SCience Summer School (DS3) 2018, Paris, France
Course organization

A day in Optimal Transport

09:00 - 10:30 Introduction to OT

11:00 - 12:30 Practical session 1

1. Intro to OT with POT
2. Regularized OT with Sinkhorn
3. Word Mover’s Distance on text

14:00 - 15:30 Advanced OT

16:00 - 17:30 Practical session 2

- Domain Adaptation on digits
- Color grading
- Wasserstein GAN
Get the files

Github repository:
https://github.com/rflamary/OTML_DS3_2018

All files:
https://github.com/rflamary/OTML_DS3_2018/archive/master.zip

Solution for all practical sessions

https://remi.flamary.com/cours/otml/solution_[NUMBER].zip

Where [NUMBER] is replaced by the integer part of the value of the Wasserstein distance obtained in Practical Session 1 Part 1 using the Manhattan/Cityblock ground metric.
Required Python libraries

Install POT (Python Optimal Transport)

- On Anaconda (in terminal):
  
  ```bash
  conda install -c conda-forge pot
  ```

- With pip (requires C compiler):

  ```bash
  pip install pot
  ```

- Test install by executing:

  ```python
  import ot
  ```

Install Keras (optional, only for WGAN session)

- On anaconda (in terminal):

  ```bash
  conda install -c conda-forge keras
  ```

- With pip (requires C compiler):

  ```bash
  pip install keras
  ```
Part 1: Intro to OT with POT

- File: 0_Intro_OT.ipynb
- Problem of Cafés and Bakeries (in Manhattan).
- Visualize the problem (on the map and in matrix form).
- Solve OT with different ground metrics.
- Interpret the OT matrix.
Part 2: Implement Sinkhorn [Cuturi, 2013]

- File: 0_Intro_OT.ipynb
- Implement the Sinkhorn-Knopp loop.
- Interpret the OT matrix.
Part 3: Word Mover’s Distance [Kusner et al., 2015]

- File: 4_WMD.ipynb
- Reproduce figure above.
- Interpret the OT matrix on words.
- Perform regression for sentence similarity.
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   • Domain Adaptation on digits
   • Color grading
   • Wasserstein GAN
Domain adaptation with OT [Courty et al., 2016]

- File: 1_DomainAdaptation.ipynb
- Adapting between MNIST and USPS digits datasets.
- Solve OT and apply approximate Monge Mapping.
- Look at displaced samples and train classifier.
Domain adaptation with OT [Courty et al., 2016]

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Practical Session 2

Color Grading [Ferradans et al., 2014]

- File: 2_ColorGrading.ipynb
- Adapt between paintings from Gustav Klimt and Egon Schiele.
- Represent image as distribution of pixels in 3D.
- Compute OT and apply approximate Monge mapping.
- Reconstruct image.
Practical Session 2

**Color Grading [Ferradans et al., 2014]**

- File: 2_ColorGrading.ipynb
- Adapt between paintings from Gustav Klimt and Egon Schiele.
- Represent image as distribution of pixels in 3D.
- Compute OT and apply approximate Monge mapping.
- Reconstruct image.
Wasserstein GAN [Arjovsky et al., 2017]

- File: 3_WGAN.ipynb
- Requires Keras and knowledge of neural networks.
- Design and learn Wasserstein GAN for 2D samples.
- Implement both original WGAN and improved WGAN (gradient penalty [Gulrajani et al., 2017]).
- Convergence in few minutes on laptops.


*Pattern Analysis and Machine Intelligence, IEEE Transactions on.*


**Regularized discrete optimal transport.**

*SIAM Journal on Imaging Sciences, 7(3).*


**Improved training of wasserstein gans.**


**From word embeddings to document distances.**