Artificial intelligence for monitoring RT response in soft-tissue sarcomas

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Soft-tissue Sarcomas

- Soft tissue sarcomas are rare tumors that affect connective tissue:
  - Muscles
  - Nerves
  - Blood vessels
  - Adipose tissue
- Soft tissue sarcomas can occur mainly in the lower and upper limbs
- Survival 5 years from diagnosis depends on many factors; but considering all the stages of severity, it is around 55%
- How to cure: surgery, chemotherapy, radiotherapy. The latter is often done before surgery and has been shown to reduce the risk of local disease relapses by 50%

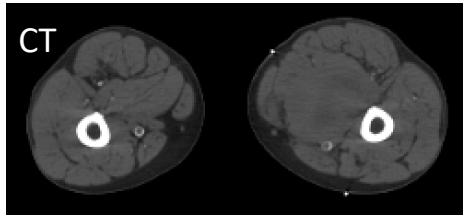
GOAL

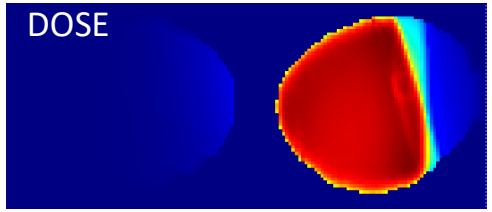
The **goal** of the proposed study is to apply a **retrospective exploratory** MR-CT-based **radiomics** and **dosiomic** analysis to **investigate** clinical outcomes in patients affected by **soft-tissue sarcoma**, from images.

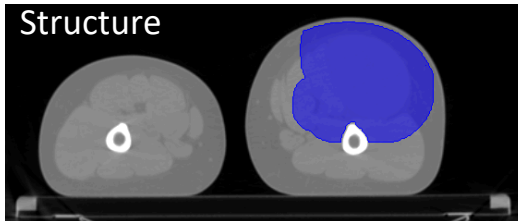
Features from MR-CT scans will be associated with loco-regional recurrence-free after intensity modulated radiotherapy.

Data available:

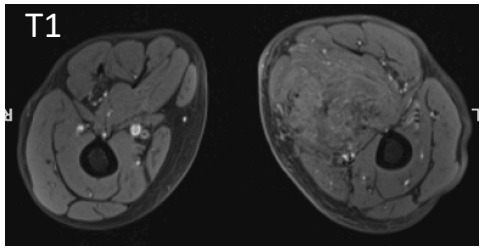
- 72 radiotherapy treatment plans with corresponding CTs, dose distributions and tumors segmentation

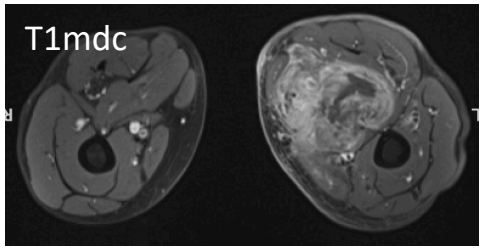


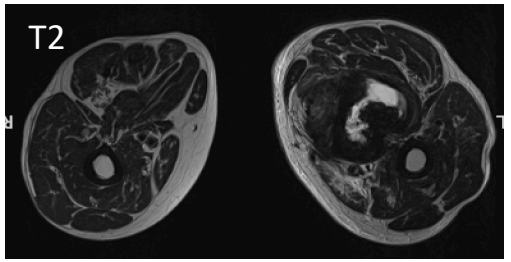




- 72 diagnostic MRIs carried out after radiotherapy treatment (T1, T1mdc, T2)
- 36 diagnostic MRIs carried out before radiotherapy treatment (T1, T1mdc, T2)







Feature extraction from diagnostic MRI (T1w, T2w, F, etc.), CT images and Dose distributions

- First Order Statistics
- Shape based
- Gray Level Co-occurrence Matrix Features
- Gray Level Run Length Matrix Features
- Gray Level Size Zone Matrix Features
- Neighbouring Gray Tone Difference Matrix Features
- Gray Level Dependence Matrix Features

107 features for each image type

Wavelet filtering is avoided in order to not overly magnify the already high number of features extracted, but potentially interesting in resonance images

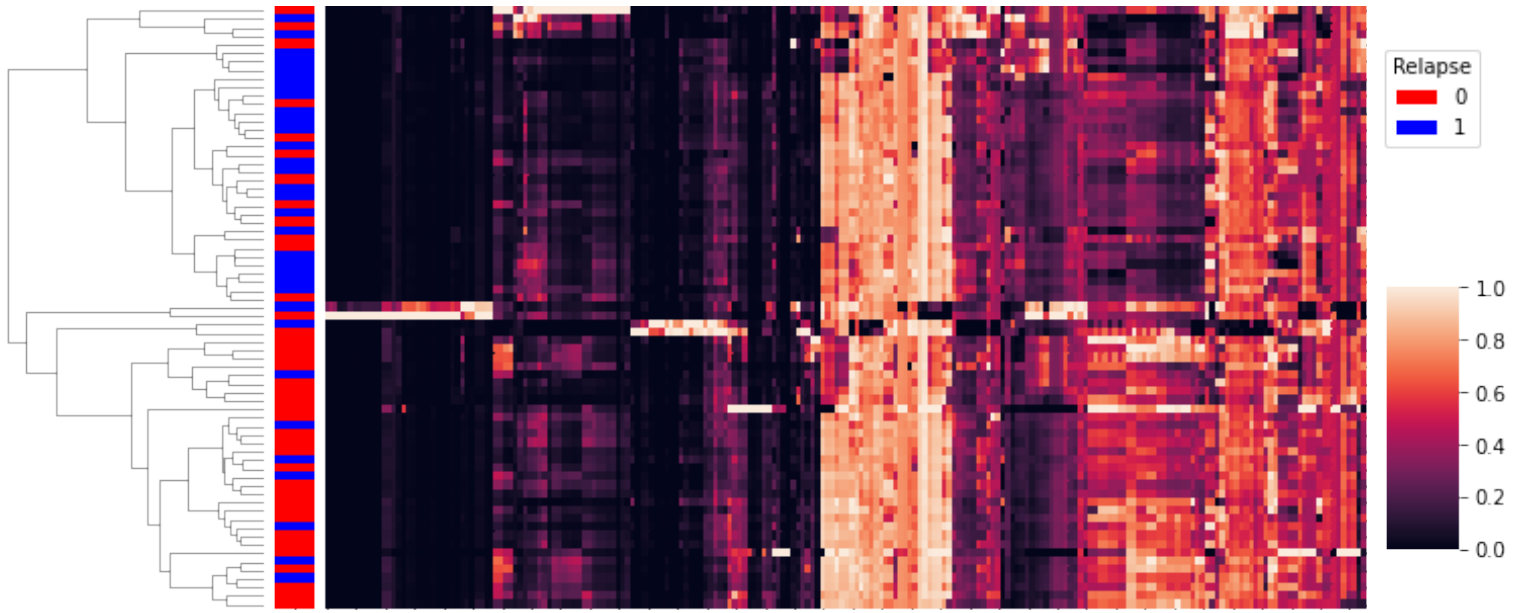
Preliminary results 1

- Hierarchical clustering as an unsupervised classification; all available features were considered
- Clustering output was associated with relapse as indicated by clinicians and accuracy was chosen as evaluation metric

- Presence of two well separated clusters in the dendrogram

- Classifications based on hierarchical clustering returned an accuracy of 0.704

- Very high value,
- possible overfitting occurrence

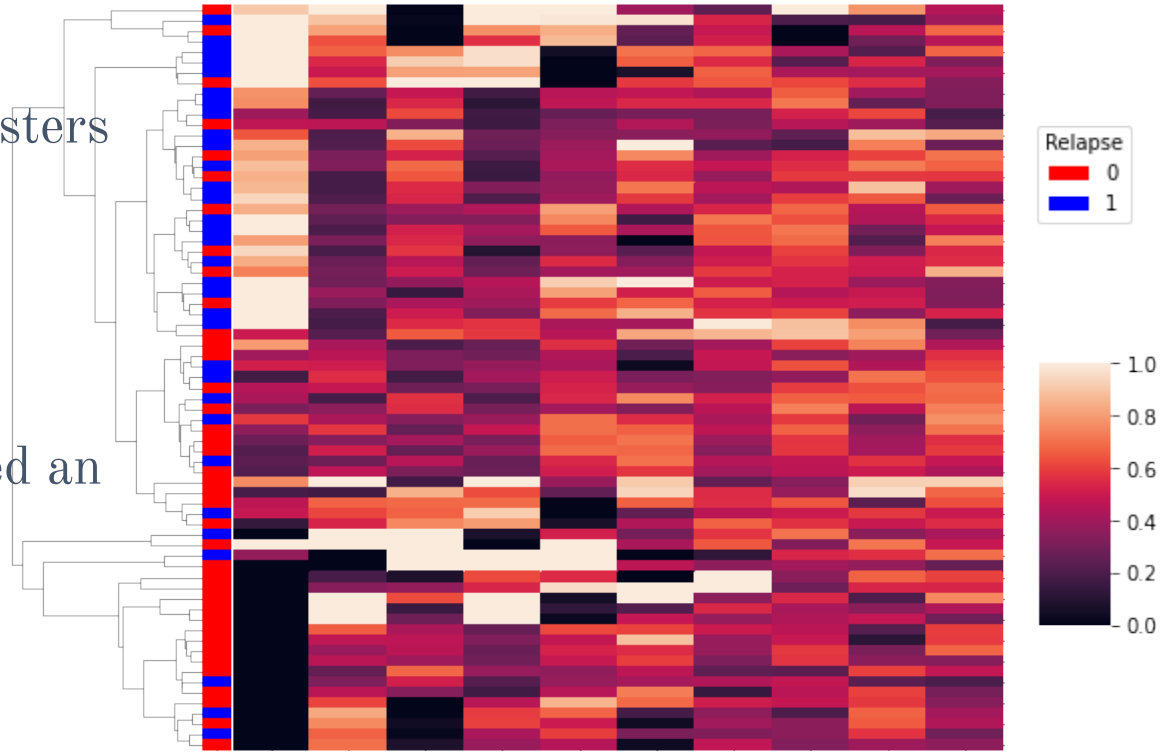


Preliminary results 2

- Hierarchical clustering as an unsupervised classification
- Dimensionality reduction with PCA - 10 components

- The patients are still grouped in two clearly visible clusters on the dendrogram with a significant concentration of relapse 0 or 1, respectively

- Classifications based on hierarchical clustering returned an accuracy of 0.606

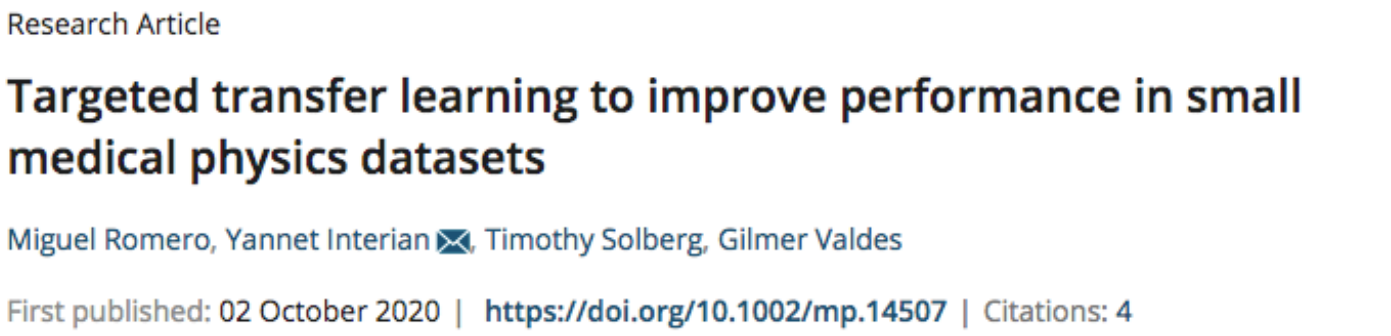


Preliminary results 3

- Another way to select features was to use Sequential-Feature-Selector. Based on a cross-validation score, at each iteration, the worst feature was removed one by one
- The procedure was repeated until the desired number of features was reached
- The best 10 features belong to dose distributions and T1mdc and T2 weighted MRIs. All of them can be seen as describing two fundamental properties: homogeneity and heterogeneity of the underlying microstructure
- In particular they take into account spatial rate of change, heterogeneity in texture patterns, small size zones with high gray-level values, disparity in intensity values among neighboring voxels, relationship between occurrences of pairs with similar intensity values and occurrences of pairs with differing intensity values, complexity of the texture and shape/size of the volume

Future plans

- Exploiting deep learning technologies: impossible with the modest number of available patients ????
- A promising approach is that of transfer learning, taking advantage of popular convolution neural networks like DensNet and ResNet



Research Article

Targeted transfer learning to improve performance in small medical physics datasets

Miguel Romero, Yannet Interian ✉, Timothy Solberg, Gilmer Valdes

First published: 02 October 2020 | https://doi.org/10.1002/mp.14507 | Citations: 4

https://doi.org/10.1002/mp.14507

- Two strategies: using pretrained networks on very very large and general dataset as ImageNet, using pretrained networks trained on problems that are similar to the target task but with fewer images (e.g., using CT/MRI pretrained networks for CT/MRI target tasks)

- Grazie per l'attenzione!

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