1. Who are you (mini-bio) and what do you do professionally? If you are on a team, please complete this block for each member of the team.

Lucas Robinet. *I am in my first year of doctoral studies in Toulouse at the CRCT and the IRT Saint-Exupéry. My topic is the multimodal analysis of cancer patients' data and more specifically of glioblastoma data using deep learning.*

Ziad Kheil. *Currently a PhD student at the CRCT, I work on deep learning based medical image registration with a focus on thoracic images. Particularly in the case of 4D-CT phase registration, as well as multi-modal image registration.*

2. What motivated you to compete in this challenge?

The multimodal aspect of the task, but also and above all the idea of being able to manipulate WSI and the resulting challenges.

3. High level summary of your approach: what did you do and why?

We trained a ResNet to predict relapse, ulceration and breslow on low resolution images. Then concatenate the imagery embedding with a clinical embedding, obtained from dense layers. We used a focal loss to handle class imbalance and help the model learn on difficult examples that are often present in WSI.

4. Do you have any useful charts, graphs, or visualizations from the process? *No*.

5. Copy and paste the 3 most impactful parts of your code and explain what each does and how it helped your model.

- *The use of three losses, a focal loss on the relapse, a cross entropy on the breslow and on the ulceration to stabilize the training and obtain a latent space containing this information.*
  - The results are extremely tight, the study ablation conducted allowed us to improve the performance of our model by choosing the best hyper-parameters. As our model is quick to train and infer, this study could be as exhaustive as possible
- *A logical phenomenon in the dataset was that older patients were more likely not to relapse within five years due to various factors. Since our model is based on standardized ages, it did not necessarily encode this information. Giving it to him directly allowed a slight improvement of the model.*

6. Please provide the machine specs and time you used to run your model.

- CPU (model): *AMD EPYC 7502P*
- GPU (model or N/A): *NVIDIA GeForce 2080 Ti*

- Memory (GB): *64 (cpu) / 11 (gpu)*
- OS: *Ubuntu 20.04*
- Train duration: *30 minutes*
- Inference duration: *5 minutes*

7. Anything we should watch out for or be aware of in using your model (e.g. code quirks, memory requirements, numerical stability issues, etc.)?

The seed for training our image feature extractor was not fixed. This has been corrected in the code template but it may explain the possible slight differences with the submitted scores.

8. Did you use any tools for data preparation or exploratory data analysis that aren't listed inyour code submission?

No.

9. How did you evaluate performance of the model other than the provided metric, if at all?

Score AUC, precision, recall, f1-score, model calibration.

10. What are some other things you tried that didn't necessarily make it into the final workflow (quick overview)?

Patch extraction, attention models, oversampling, cells segmentation, ensemble learning. Fractal and second-order patch analysis.

11. If you were to continue working on this problem for the next year, what methods or techniques might you try in order to build on your work so far? Are there other fields or features you felt would have been very helpful to have?

Work at multiple scales of resolution. Unfortunately, we could not do it because of a too small storage space.

12. What simplifications could be made to run your solution faster without sacrificing significant accuracy?

Our solution is already pretty quick

13. (optional) Whole Slide Images can be challenging to work with due to their size and the significant variation in their contents. What techniques and/or tools did you find helpful for working with WSIs and why?

OTSU filtering and working with HSV images instead of RGB. HSV images allow to select only part containing cancerous cells. Analysis on fractal dimensions.