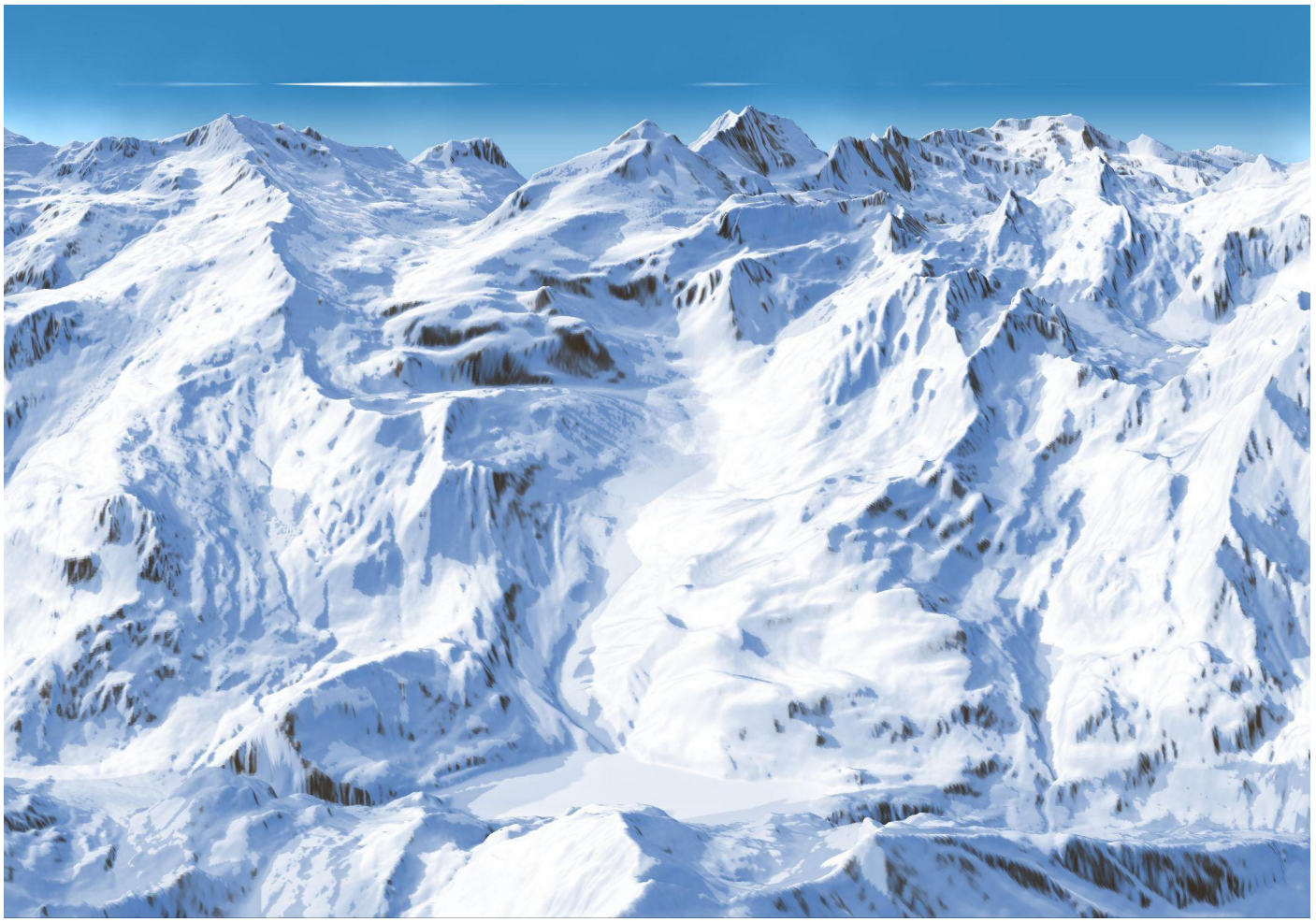
Various projects for the rendering of stylized panorama maps

The internships will take place in the Maverick team at Inria Grenoble and be supervised by Nolan Mestres, Fabrice Neyret, Joelle Thollot, Kenneth Vanhoey and Romain Vergne, depending on the specific chosen projects.

Contact: joelle.thollot@inria.fr



Espace Killy (Tignes – Val-d'Isère): our current results from Nolan Mestres' PhD thesis

Context

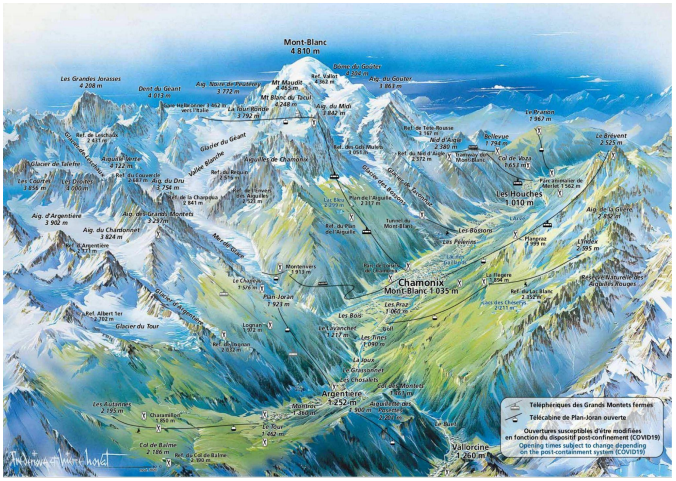
Panoramas are a specific type of map that transcends the boundary between cartography and art. They are excellent pictorial devices for visualizing landscapes, especially ski areas, for which the panorama has become a cartographic standard. However, very few artists or cartographers are able to draw visually pleasant and efficient panoramas. Indeed, a realistic view, or even a photograph, of a landscape does not provide the same legibility as a map. Therefore, drawing a panorama requires specific skills: the ability to understand and represent a landscape in 3D in a style that lies in between a painting and a 2D map.

With the availability of full GIS (geographic information systems), we now have access to cartographic data that can be used to produce panoramas using a computer. The recent progress in computer graphics research allows the production of realistic renderings of 3D landscapes. However, the specific style of the best panoramists is still not fully reproduced by the scientific community.

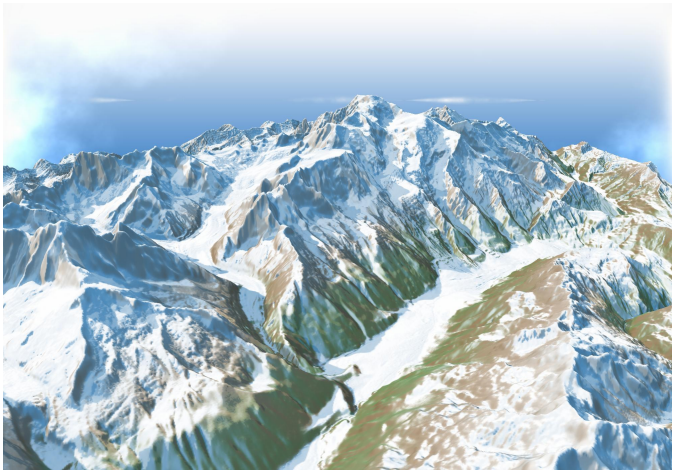
In this project, our goal is to design a process to produce panoramas starting from cartographic and topographic data as can be provided by IGN or OpenStreetMap. For that, we collaborate with Arthur Novat in order to understand and formalize the various steps of the drawing of a panorama. Arthur is the son of Pierre Novat who founded The Atelier Novat in the 60's that became the French standard for mountain panoramas.

Chamonix panorama examples

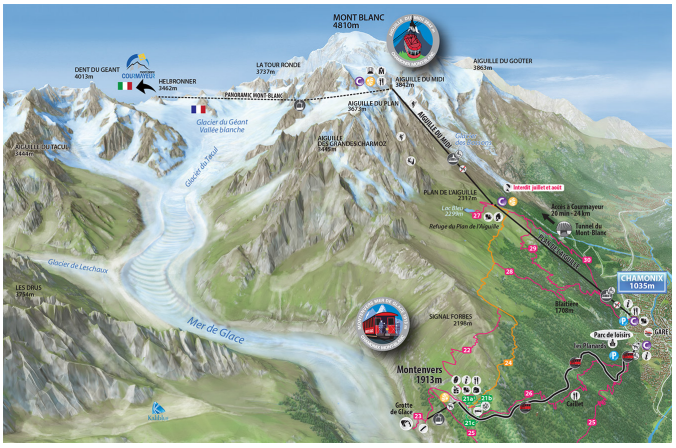
In the following, we show several panoramas of the same place: Chamonix. The panorama by Atelier Novat (top left) was drawn manually in 1992. The bottom row displays panoramas that have been generated by a computer, based on GIS data, by the Kaliblue company. The computer generated images are not fully automatized (they are partially manually reworked) and are less detailed and aesthetic than the manual drawing. However, they are easier and faster to update, e.g. when a ski track is created, and can be adapted to produce a summer version of the panorama. The last one (top right) is the current result we are able to produce: the stylized shading is computed in real-time but we are not able to automatically draw the roads, buildings and trees.



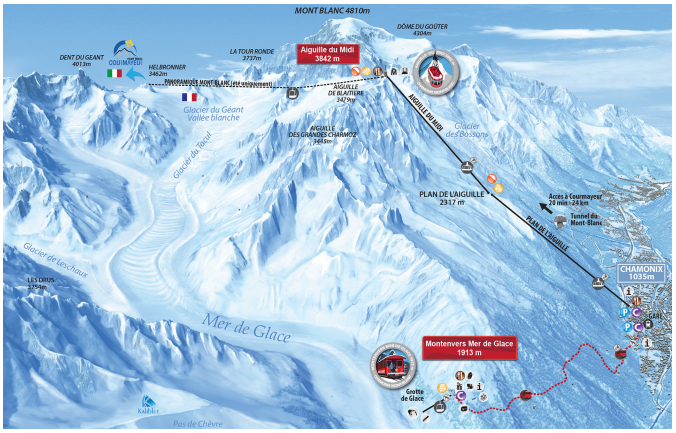
Panorama hand painted by atelier Novat



Chamonix: Our result



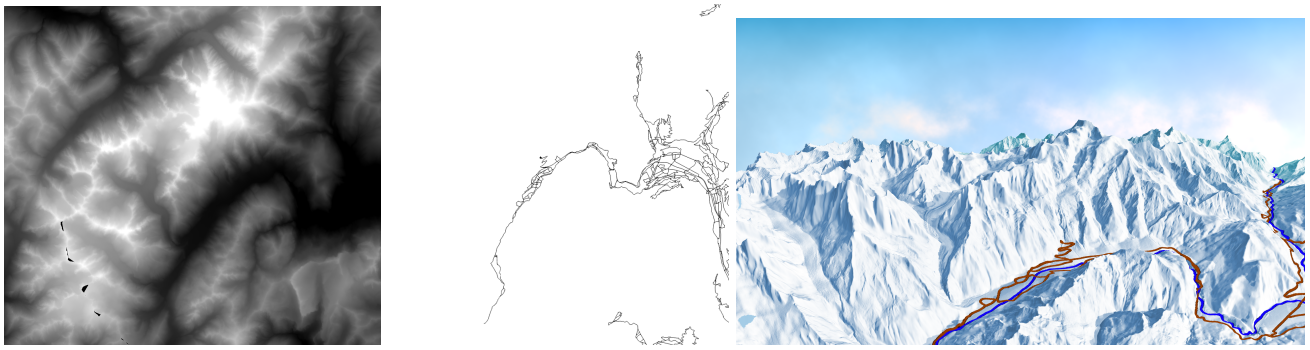
Summer panorama produced by Kaliblue



Winter panorama produced by Kaliblue

Our current results

We have designed a method to compute the shading and shadows of the panorama starting from the height map of the terrain. This technique works in real time on the GPU. We have also designed a simple deformation method to give a panoramic impression and previous interns have worked on the drawing of various cartographic visual elements.



Heightmap + roads = panorama

As shown on this video https://www.youtube.com/watch?v=OdVGMJlblQM, the lighting and colors are controllable.

Internships projects

The following sections present different possible research projects.
Please contact us to discuss the topics of your interest.

Drawing cartographic elements: trees, rock, roads, buildings

Some open research questions remain to obtain a full realtime solution to draw all the cartographic elements that exist on a mountain panorama map. Last year interns worked on various aspects of this problem and obtained very encouraging results. Their work will serve as a good starting point to go further.

Generalization - Levels of Detail

Based on the data available in GIS systems, we can obtain a lot of detailed information about the roads, rivers, forest zones, etc… However, as for classic 2D maps, these data have to be filtered, smoothed and abstracted in order to keep only the meaningful information for the map usage. This problem is known as the generalization problem in cartography, whereas in computer graphics we use the term LoD (level of detail).

One research question will be: how to generalize GIS data in the context of 3D panoramic maps? For example, as opposed to 2D maps, we will probably need to take into account the viewpoint to decide how to generalize. Of course, a second problem will appear if we want to move the viewpoint in real time: how can we avoid abrupt changes in the generalization process?

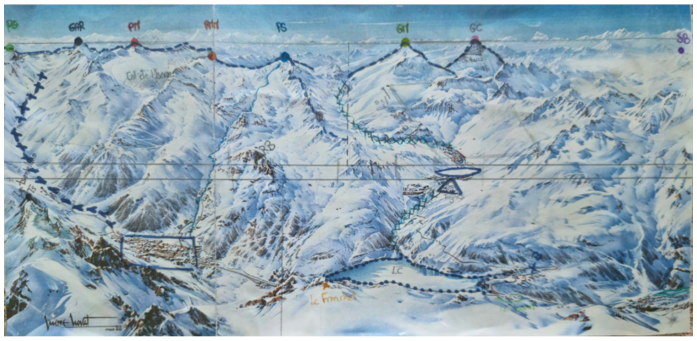
Rendering

Once we are able to compute generalized data, we need to devise a solution to draw them. This rendering step is not trivial as soon as we aim at a stylized result, as is the case in the hand drawn panoramas.

The drawing of the cartographic elements of the panorama is complex because it is not done in a realistic way. For example the trees do not follow the perspective rule: they keep more or less the same size on screen even if they are very far from the viewpoint. Actually they are drawn to indicate the nature of the terrain (e.g. this is a forest) but also the direction of the slope (they are aligned with the slope). Both information are typical cartographic information more than photographic ones. Similarly, the buildings, roads and other man-made elements are drawn in a very specific style that we want to reproduce.

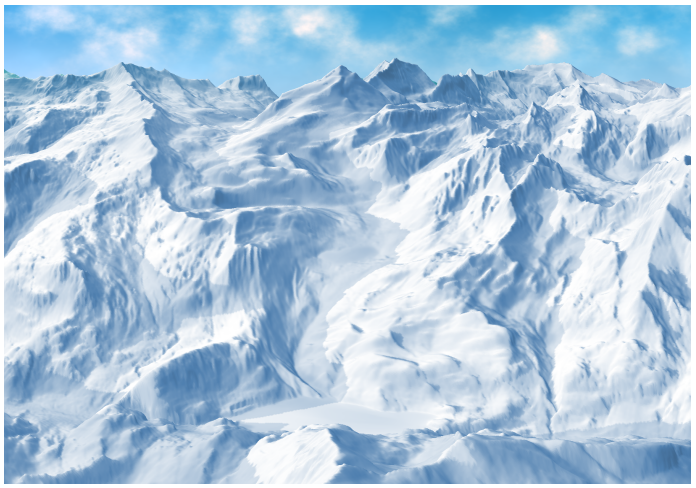
All these elements have been well described by previous year interns, Nathan Resbiscoul and Antoine Richermoz. Some preliminary rendering techniques have been designed. The goal here will be to push this body of work further. Ideally, all the rendering techniques should be controllable. For example we may want the rendering to vary depending on the season. And again, care will have to be taken to be able to move the viewpoint as continuously as possible.

Terrain deformation



Novat panorama

Corresponding 2D map



Resulting deformed panorama

Fatmap 3D perspective view

One characteristic feature of hand-made panoramas is their deformation compared to a standard perspective view. Indeed, when representing a ski station, one wants to show all the ski tracks, even if one mountain would hide them in real life. The same is true for hiking or biking trails which can have circular shapes and provide even more constraints for a proper deformation.

Last year we experimented with various deformations for a specific terrain: espace Killy shown above. During her internship, Oumayma Boulmane proposed to use two cylindrical cameras, interpolated between the foreground and the background, to produce a global panoramic deformation.

We would like to extend this approach to local terrain constraints. Based on user marks indicating which parts of the relief should be visible, exaggerated or attenuated, our goal will be to design an optimization algorithm in order to deform the terrain in such a way that all the constraints are respected when viewed from a given camera.

Part of this problem is a Human Computer Interface problem (how does a naive user indicate where and what to deform) and the second part is an optimization problem so as to devise partly automatic computations (how to model the user constraints, what optimization approach is the best to solve them). These two questions can be treated separately as a First step.

On top of this, there is a modelization problem in order to define what are the criteria to express, and under which form, in order to produce a result that conforms to what we expect. It includes the avoidance of various artifacts and visually unpleasing features (like visible cracks or seams between terrain areas), but also a control over the tendency of optimizations to leak into very unexpected "solutions" when dealing with paradoxical constraints.

Bibliography

Panoramas

- Tom DAUER. The Alps: In Panoramic Paintings. ISBN: 978-3-7913-8587-7
- Tom PATTERSON. A view from on high: Heinrich Berann’s panoramas and landscape visualization techniques for the us national park service. Cartographic Perspectives, (36): 38–65, 2000.
- Tom PATTERSON. Looking closer: A guide to making bird’s-eye views of national park service cultural and historical sites. Cartographic Perspectives, (52):59–75, 2005.
- Margarita BRATKOVA, Peter SHIRLEY and William B THOMPSON. Artistic rendering of mountainous terrain. ACM Trans. Graph., 28(4):102–1, 2009.
- R. BALZARINI and M. MURAT. The effectiveness of panoramic maps design: A preliminary study based on mobile eye-tracking. International Archives of the Photogrammetry, Remote Sensing & Spatial Information Sciences, 41, 2016.
- S. Alex BROWN and Faramarz SAMAVATI. Real-time panorama maps. In Proceedings of the Symposium on Non-Photorealistic Animation and Rendering, page 6. ACM, 2017.
- Mestres, N. (2022). A Stylistic Study of the Hand-Painted Winter Panorama Maps of Pierre Novat. Cartographic Perspectives, (100). https://doi.org/10.14714/CP100.1753

Stylization overviews in computer graphics

- S. HEGDE, C. GATZIDIS and F. TIAN. Painterly rendering techniques: a state-of-the-art review of current approaches. Comp. Anim. Virtual Worlds, 24: 43-64. 2013.

- David VANDERHAEGHE, John COLLOMOSSE. Stroke Based Painterly Rendering. Paul Rosin; John Collomosse. *Image and Video-Based Artistic Stylisation*, 42, Springer, London, pp.3-21, 2012, Computational Imaging and Vision, 978-1-4471-4518-9.
- Pierre BENARD, Adrien BOUSSEAU, and Joëlle THOLLOT. State-of-the-Art Report on Temporal Coherence for Stylized Animations. Computer Graphics Forum, 30(8):2367–2386, December 2011.

Vector graphics for map making

- Cynthia A. BREWER. Designing Better Maps: A Guide for GIS Users. 2015. Esri Press.
- Cartography Guide
- Hugo LOI. Programmable synthesis of element textures and application to cartography. PhD thesis, Grenoble Alpes, 2015.