



**Craft.AI**

Conférence Nationale sur les Applications  
Pratiques de l'Intelligence Artificielle  
(Evènement affilié à PFIA 2022)  
30 Juin - 1er Juillet 2022, Saint-Étienne,  
France

# **XAI et information géographique: application aux reconstructions paléoenvironnementales**

01/07/2022

Bastien Zimmermann, Matthieu Boussard, Nicolas Boulbes, Sophie Grégoire

# Introduction:

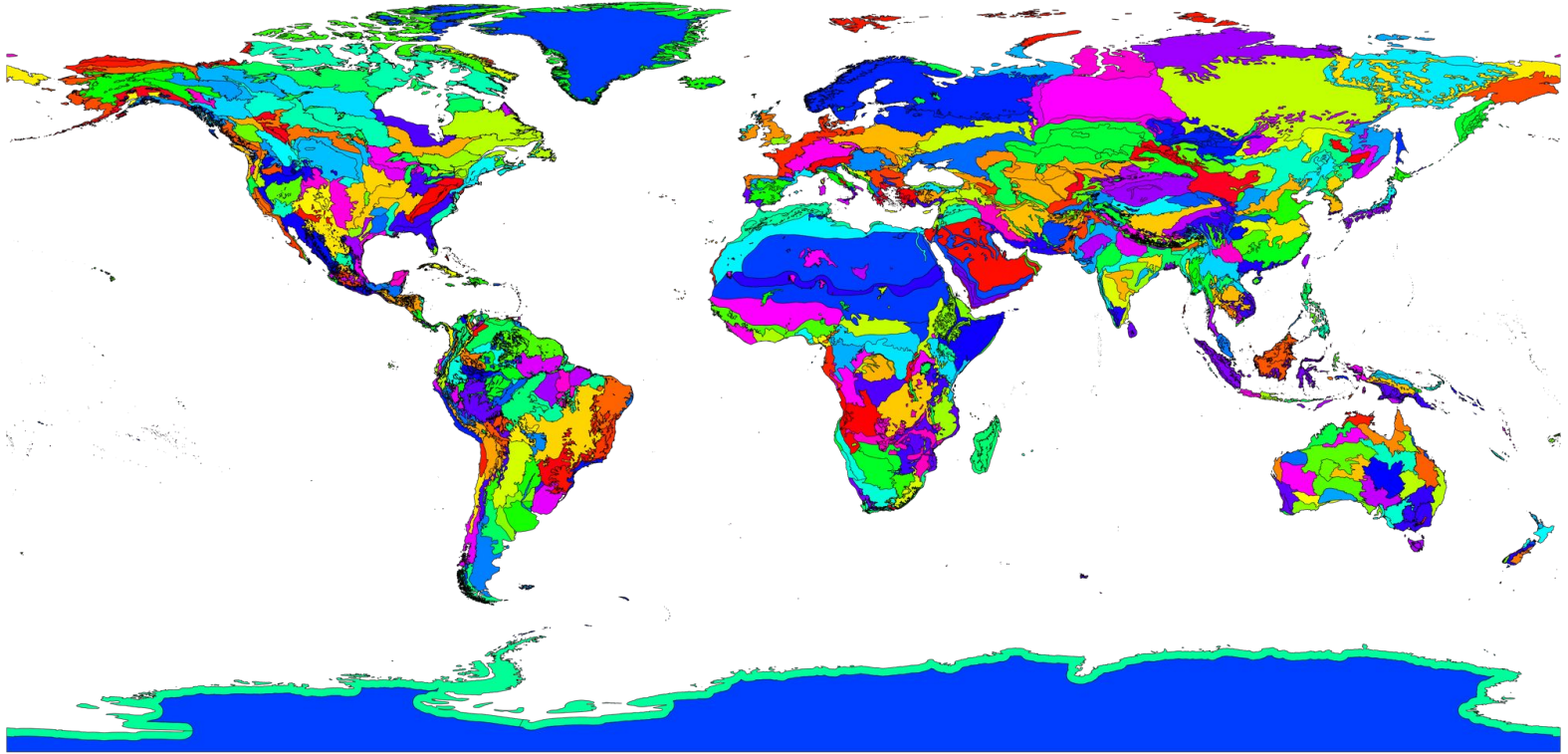
- **Grotte de la Caune de l'Arago à Tautavel**
  - **54 ans de fouilles et d'études multidisciplinaires**
  - **Séquence stratigraphique de 15m - 690 000 et 90 000 ans BP**
  - **55 niveaux archéologiques**
- **Notre problématique : la reconstruction Paléoenvironnementale**
  - **Données fauniques**
  - **L'actualisme**
  - **XAI pour les archéologues**

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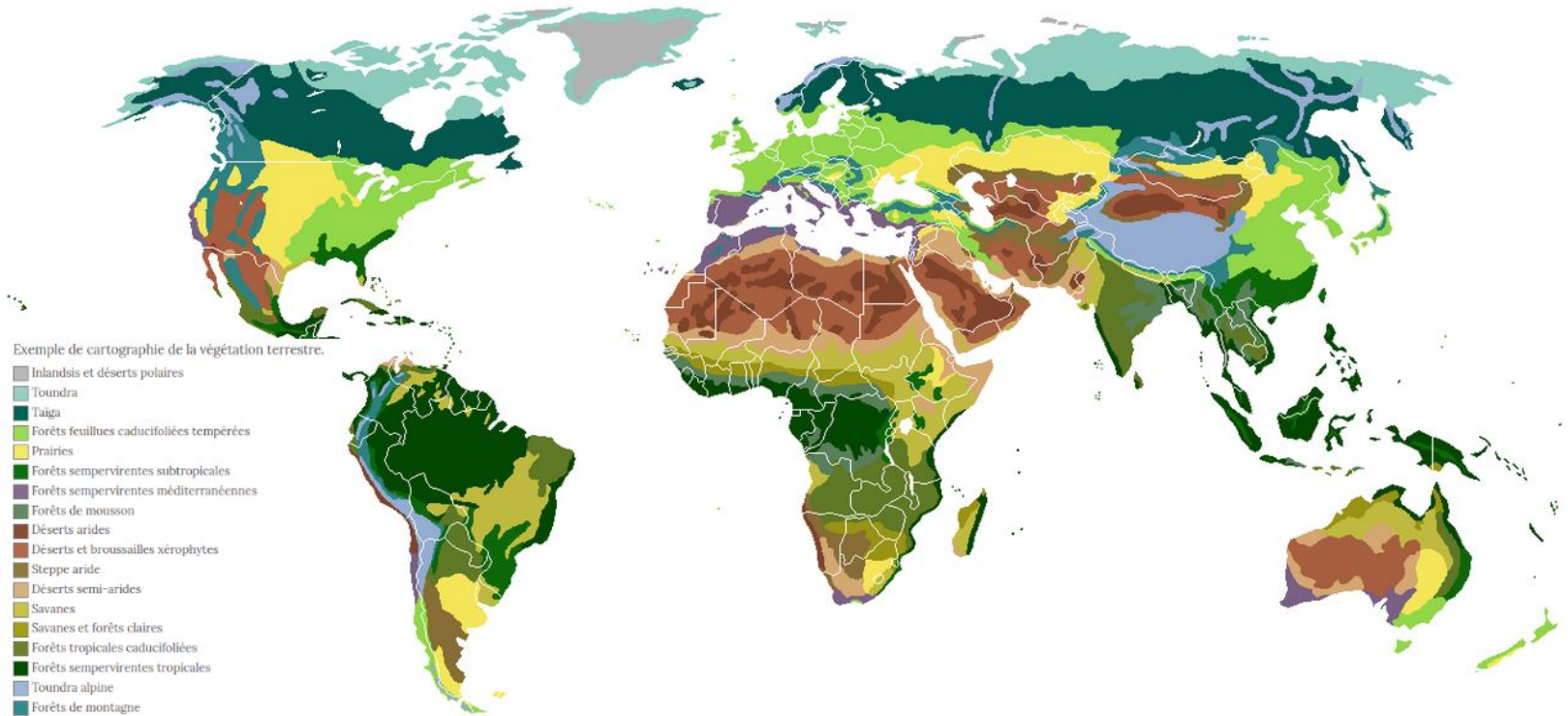
# Contexte et Objectif

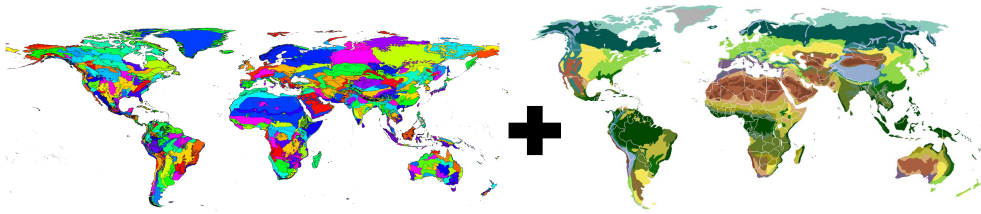
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# Ecoregions



# Biomes





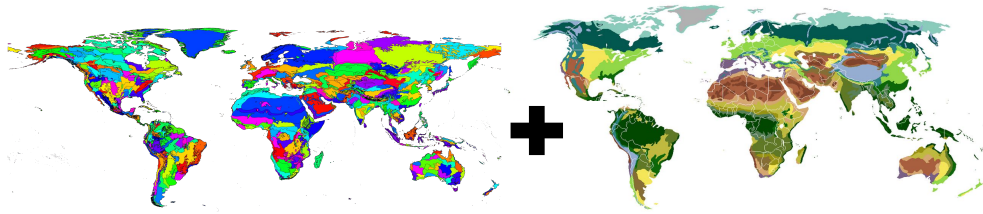
**trained  
Machine Learning  
model**

Données: Animaux vivant  
dans chaque ecoregion

Labels (Biomes)

Données d'entraînement

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trained  
Machine Learning  
model

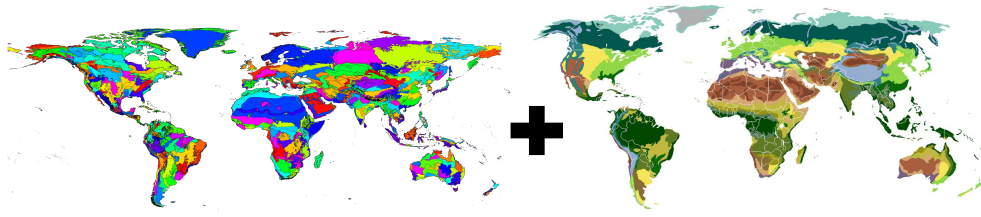
Données: Animaux vivant  
dans chaque ecoregion

Labels (Biomes)

Données d'entrainement



Données: de couches  
archéologiques:  
Restes d'animaux  
trouvés par couche.

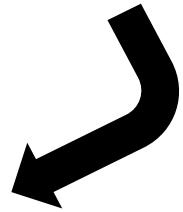


Données: Animaux vivant dans chaque ecoregion

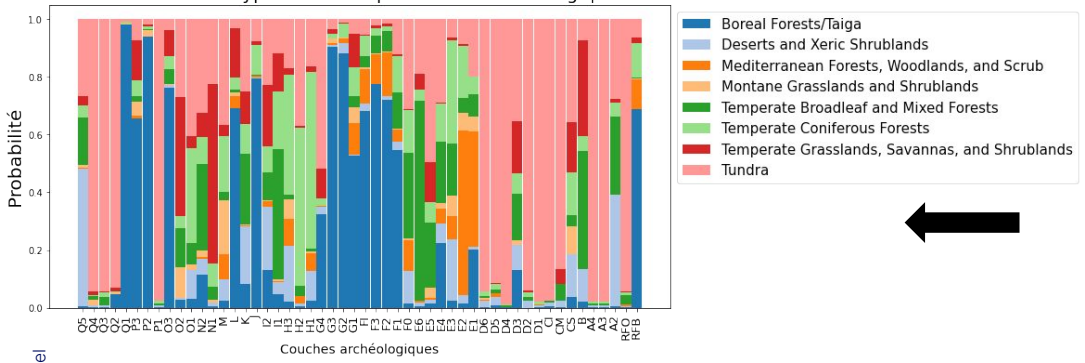
Labels (Biomes)

Données d'entraînement

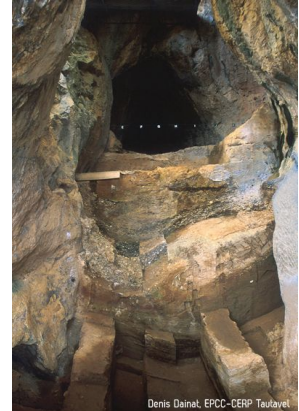
trained Machine Learning model



Probabilité de type de Biome par couche archéologique



Resultat: Prédiction de Biome pour chaque couche archéologique.



Données: de couches archéologiques: restes d'animaux trouvés par couche.



## **Contribution:**

- **Montrer les apports de l'explicabilité (XAI) à la reconstruction de paléoenvironnements.**
- **Apport des SIG à la richesse des explications**
- **Résultats expérimentaux:**
  - **Relation entre qualité des données et Valeurs de Shapley**
  - **Analyse globale**
  - **Inspection d'espèces animales pertinentes**

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# Explications centrées sur les données

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# Valeurs de Shapley

- Répartition équitable des gains aux joueurs.
- Défini par le triplet  $(F, u, E)$ :
  - Fonction de suppression:  $F$
  - Fonction d'utilité:  $u$
  - Fonction de synthèse:  $E$



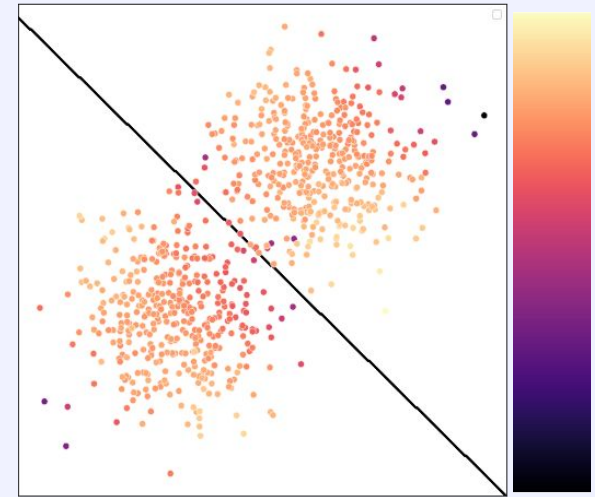
## Reference

*From local explanations to global understanding with explainable AI for trees,*  
S. Lundberg et al., 2020.  
Nature Machine Intelligence

# Data Shapley

- Métrique d'attribution de valeur à un point de donnée
- Dépend de:
  - Algorithme d'entraînement
  - Métrique de performance

$$\phi_i = \sum_{S \subseteq D \setminus \{i\}} w(S) (u(S \cup \{i\}) - u(S))$$



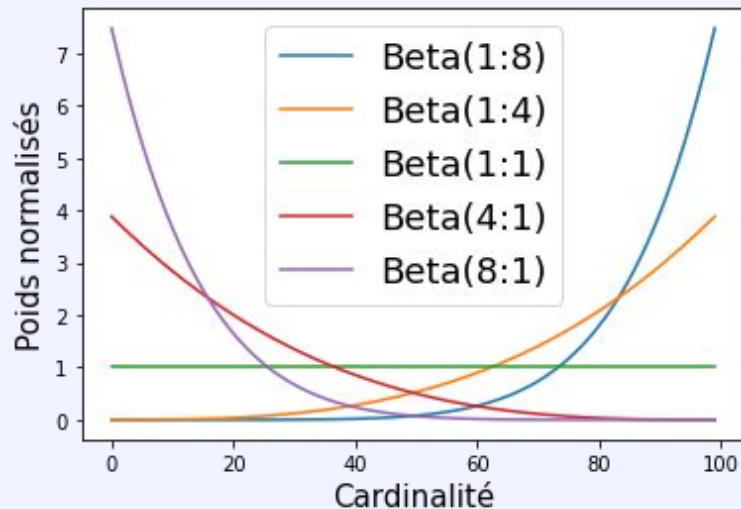
## Reference

*Data Shapley: Equitable Valuation of Data for Machine Learning.*  
Ghorbani, A., Zou, J., 2019.  
ICML

# Beta-Shapley

- Métrique d'attribution de valeur à un point de donnée
- Change la fonction de synthèse i.e. le schéma de poids et le rendre sensible à la cardinalité.

$$\phi_i = \sum_{S \subseteq D \setminus \{i\}} w_{\alpha, \beta}(S) (u(S \cup \{i\}) - u(S))$$



## Reference

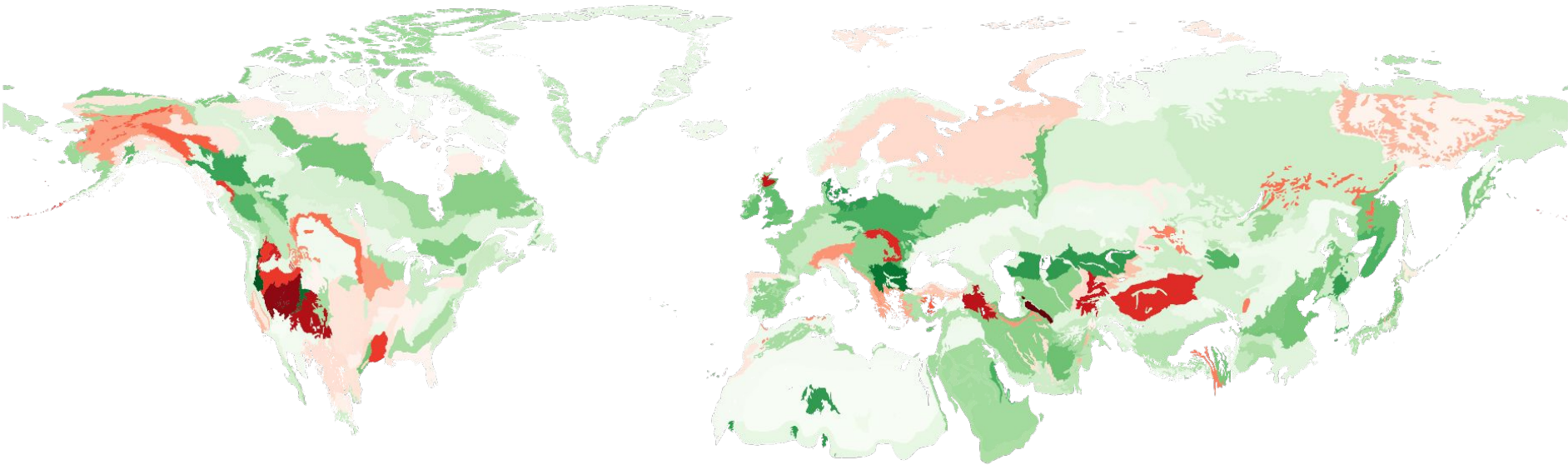
*Beta shapley : a unified and noise-reduced data valuation framework for machine learning.*

Yongchan Kwon and James Zou.  
AISTATS 2022

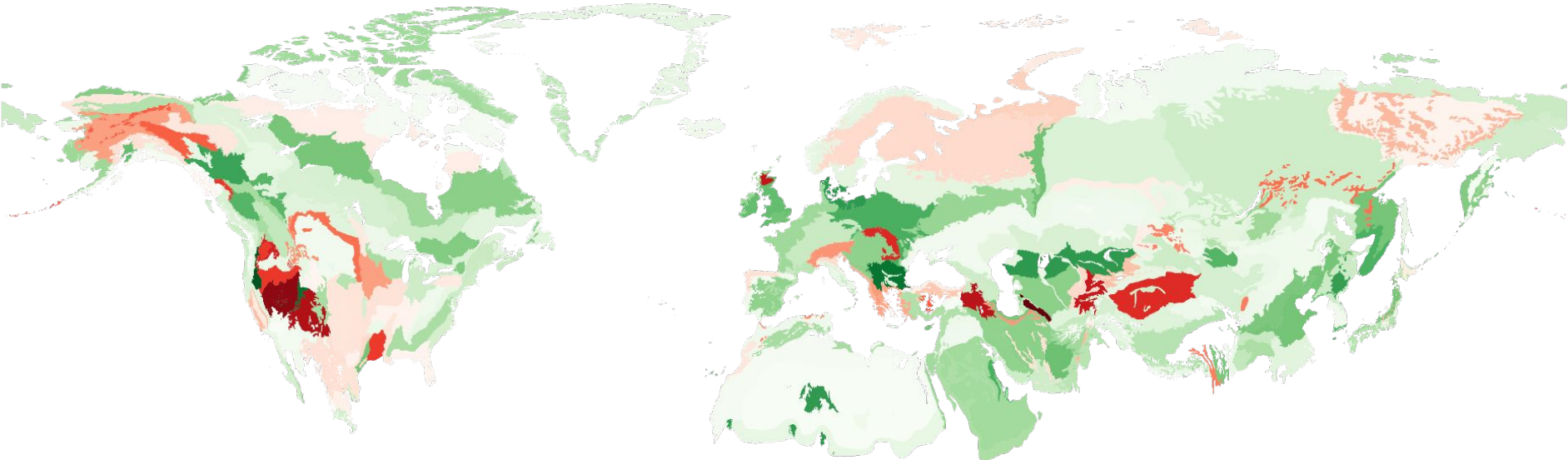
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# Résultats

# Data Shapley value



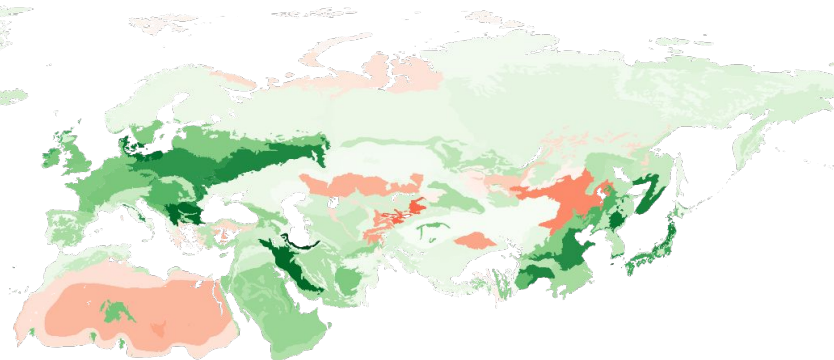
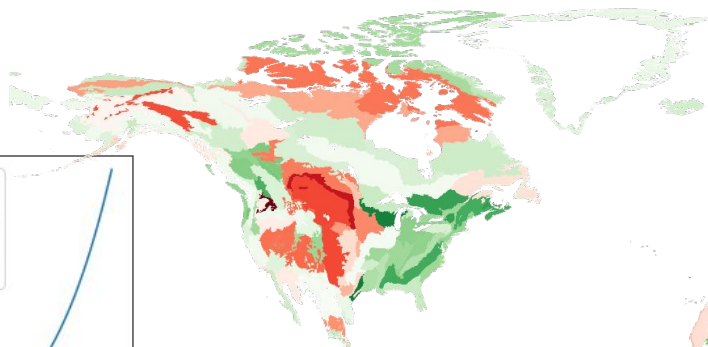
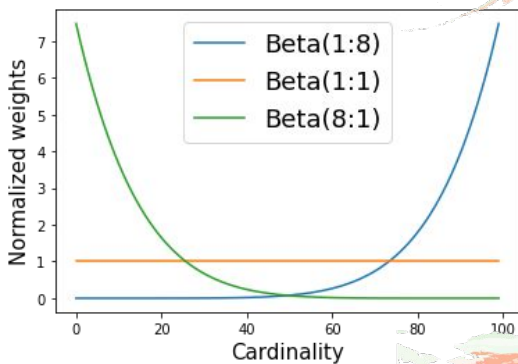
# Data Shapley value ( Beta(1:1) )



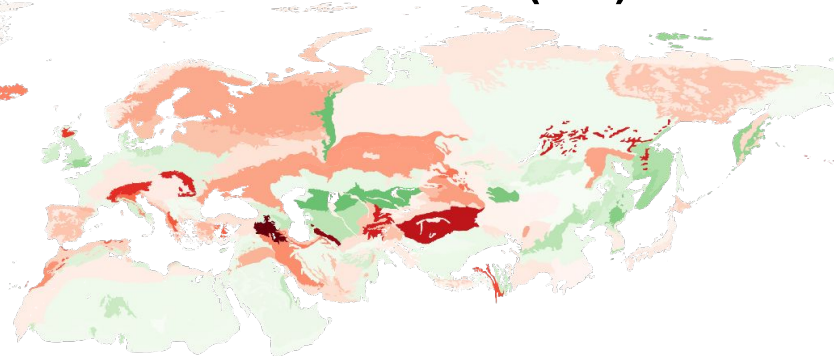
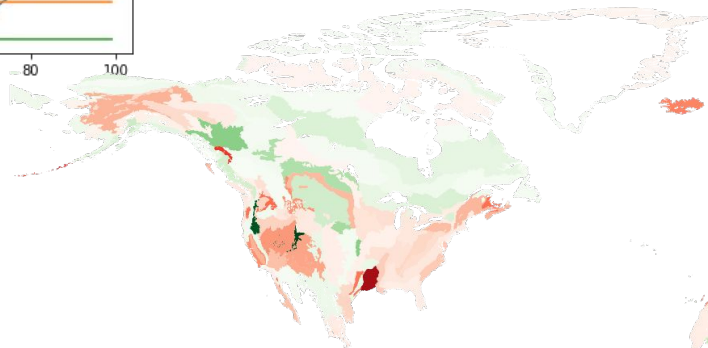


# Beta Shapley Values

Beta(8:1)



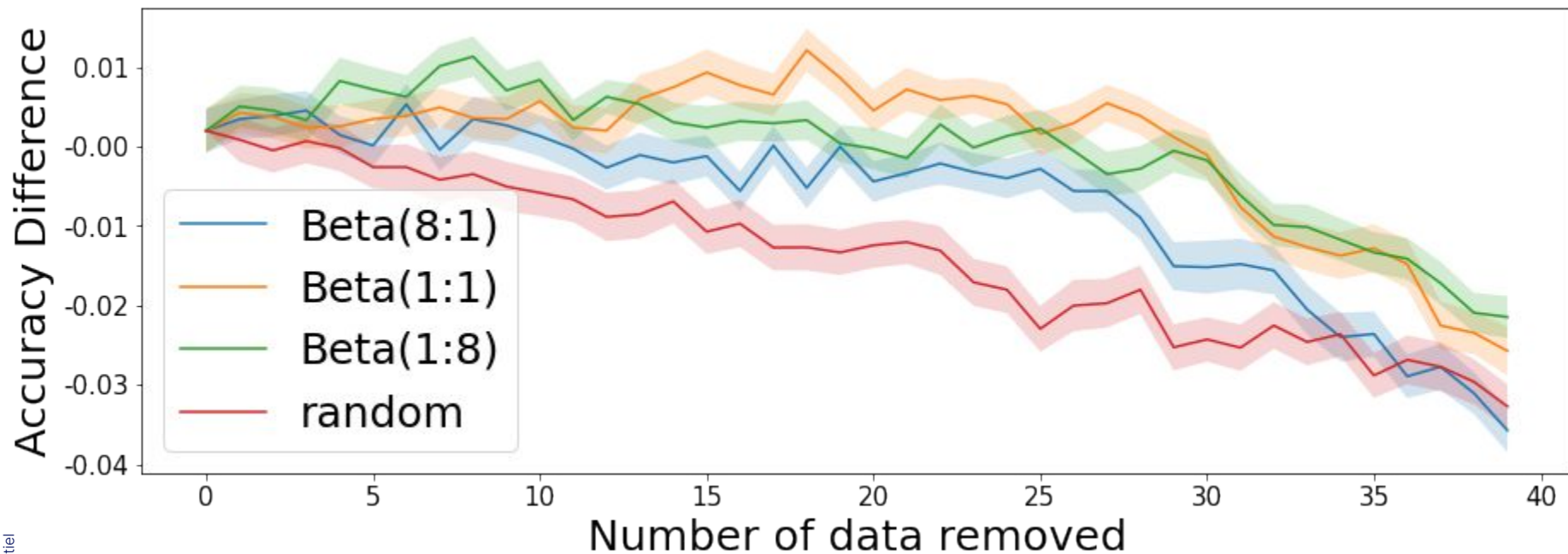
Beta(1:8)



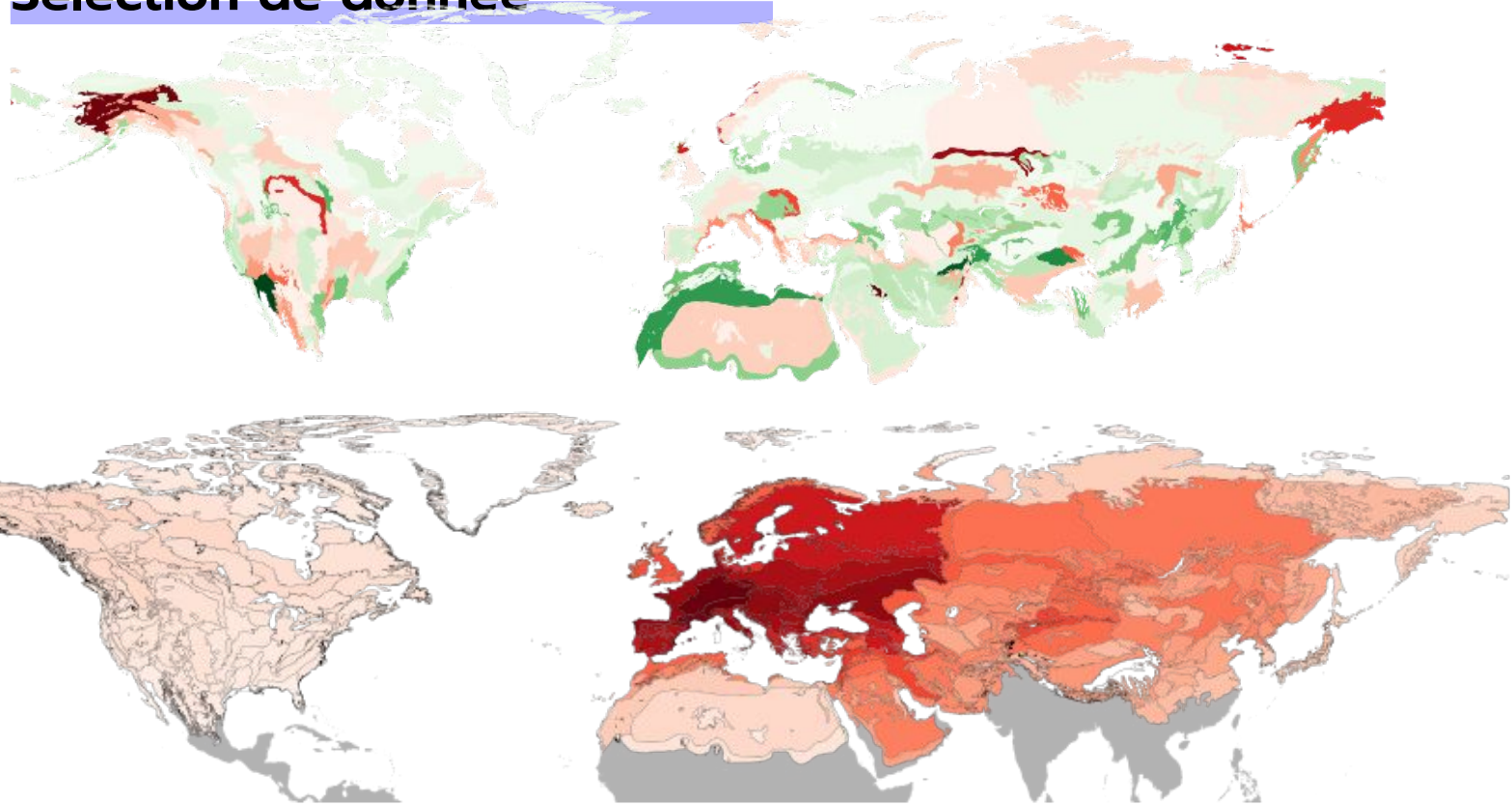
An aerial photograph of a mountain valley during autumn. The hills are covered in trees with vibrant yellow and orange foliage. A small village with several houses is visible in the lower left. The sun is shining from the upper right, creating a bright glow and lens flare effects across the scene.

# Beta Shapley et qualité des données

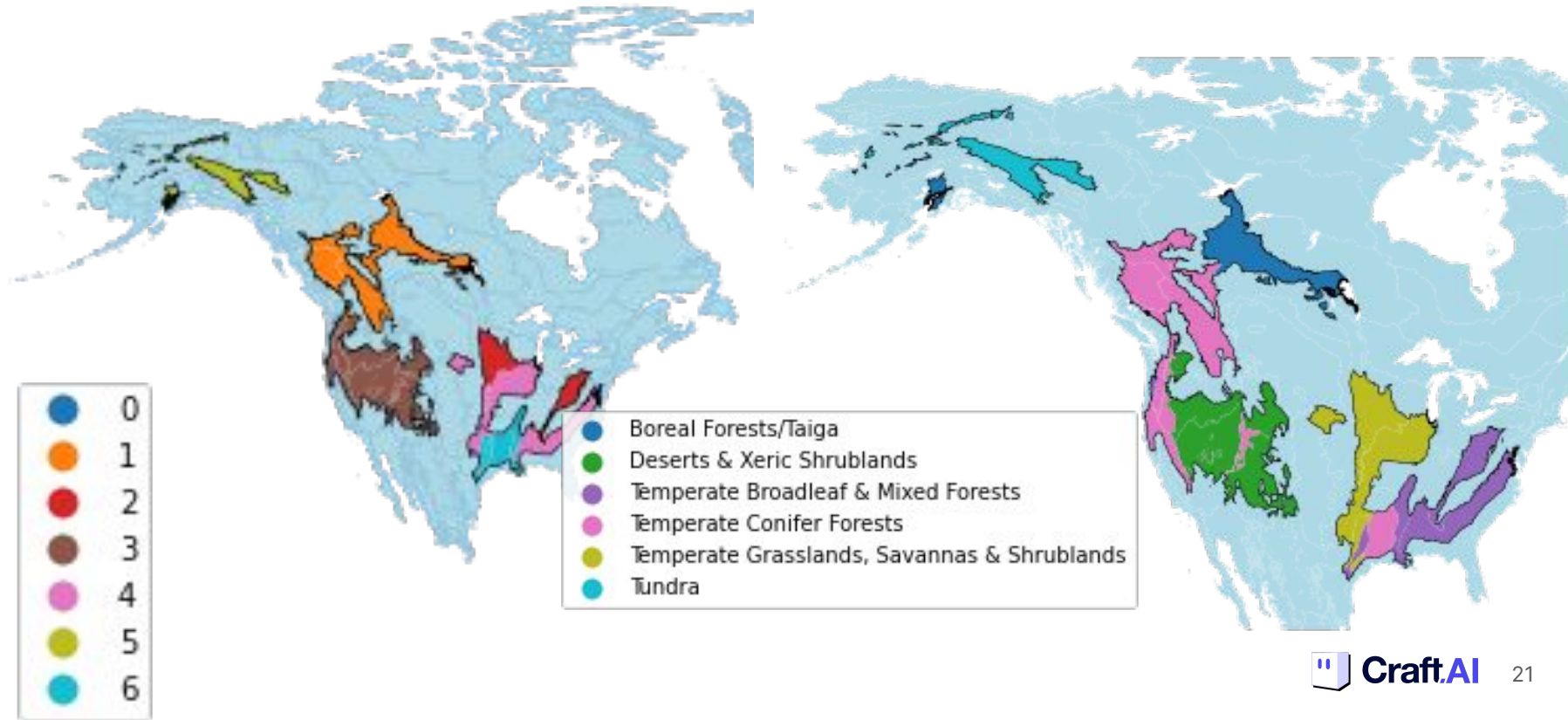
# Suppression de données



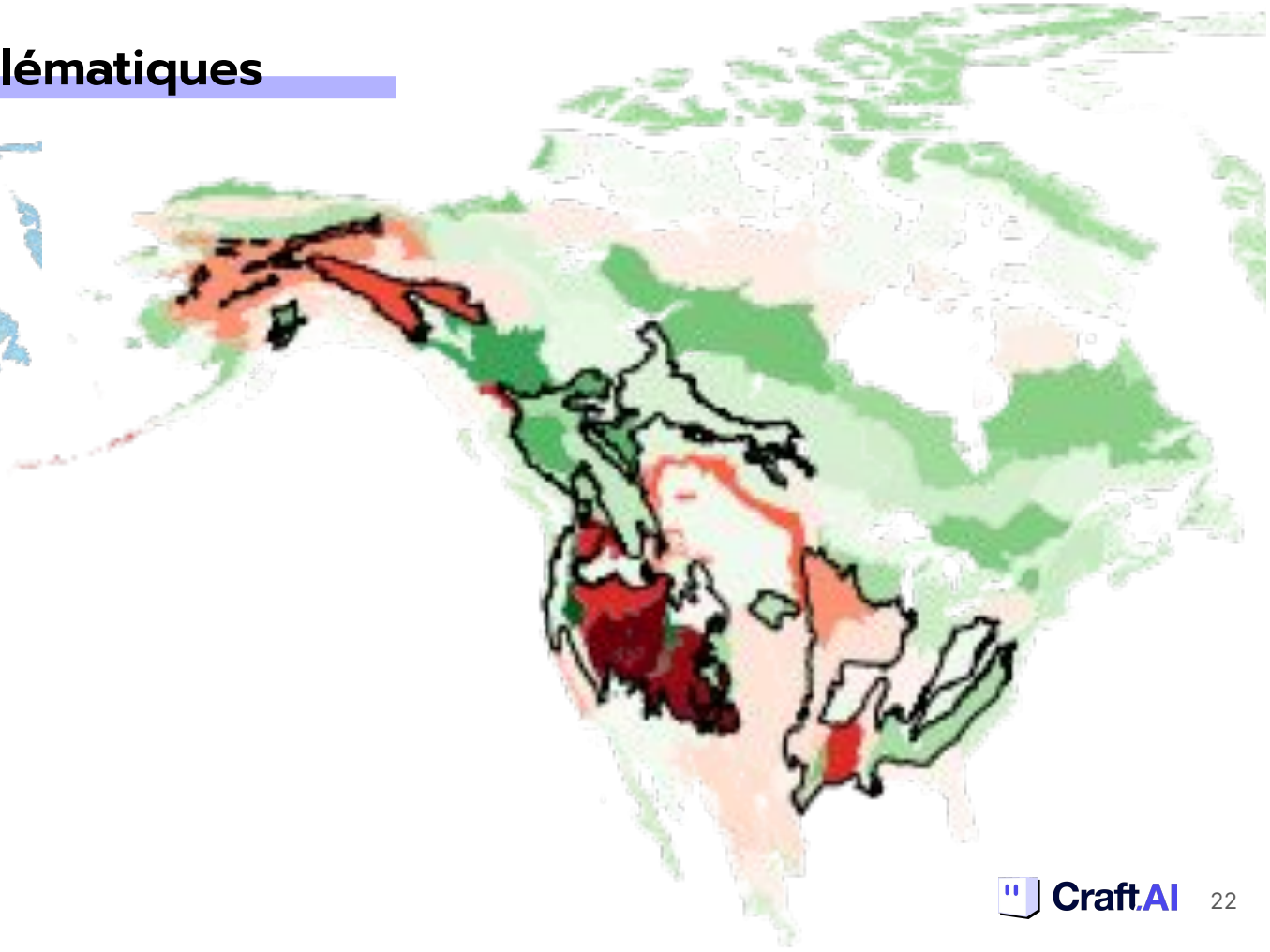
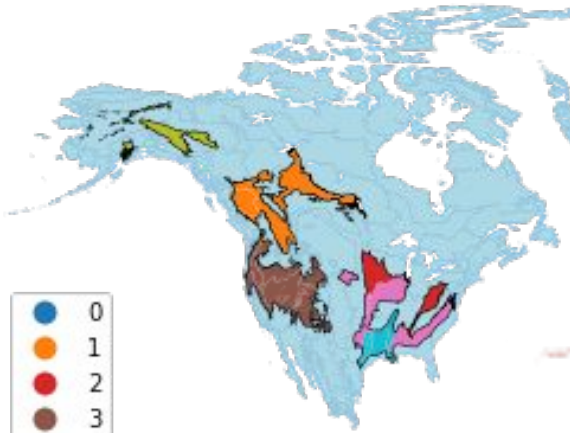
# Sélection de donnée



# Données problématiques



# Données problématiques

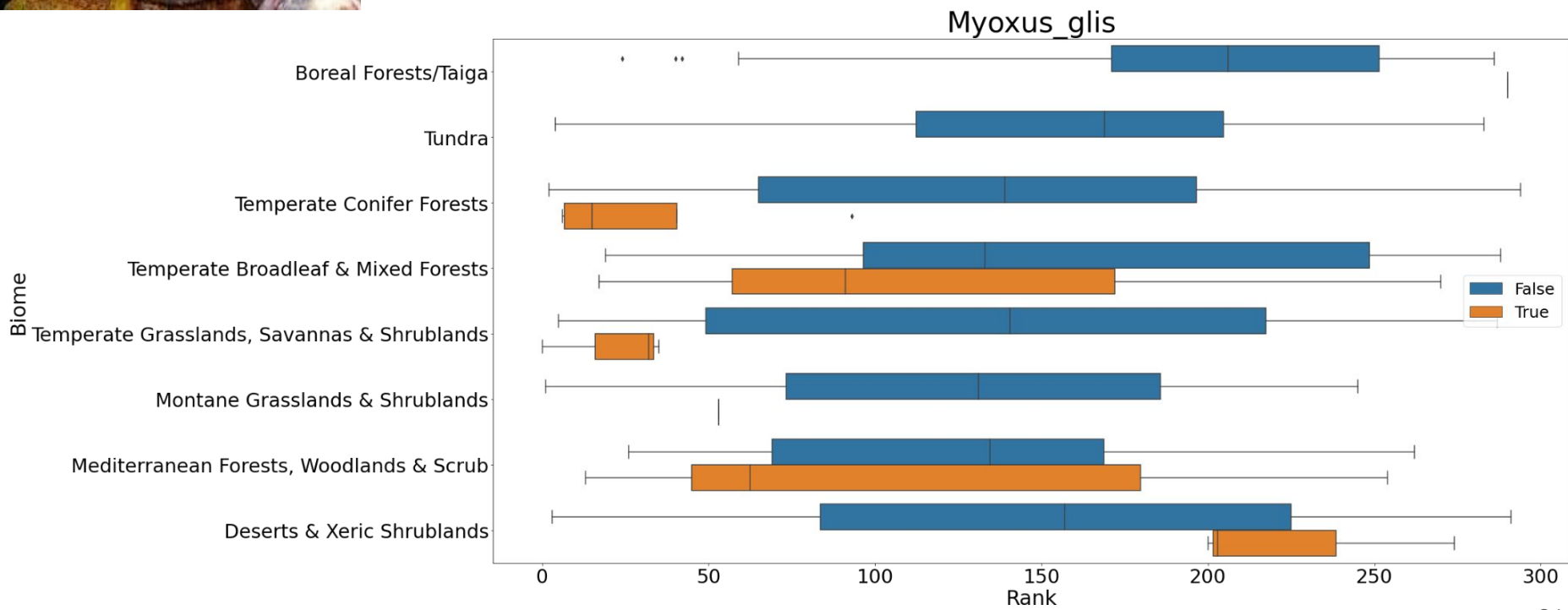


An aerial photograph of a mountain valley during autumn. The hills are covered in trees with vibrant yellow, orange, and red foliage. A small village with several houses is visible in the lower left. The sun is shining from the upper right, creating a bright glow and lens flare effects across the scene.

# Explications avancées



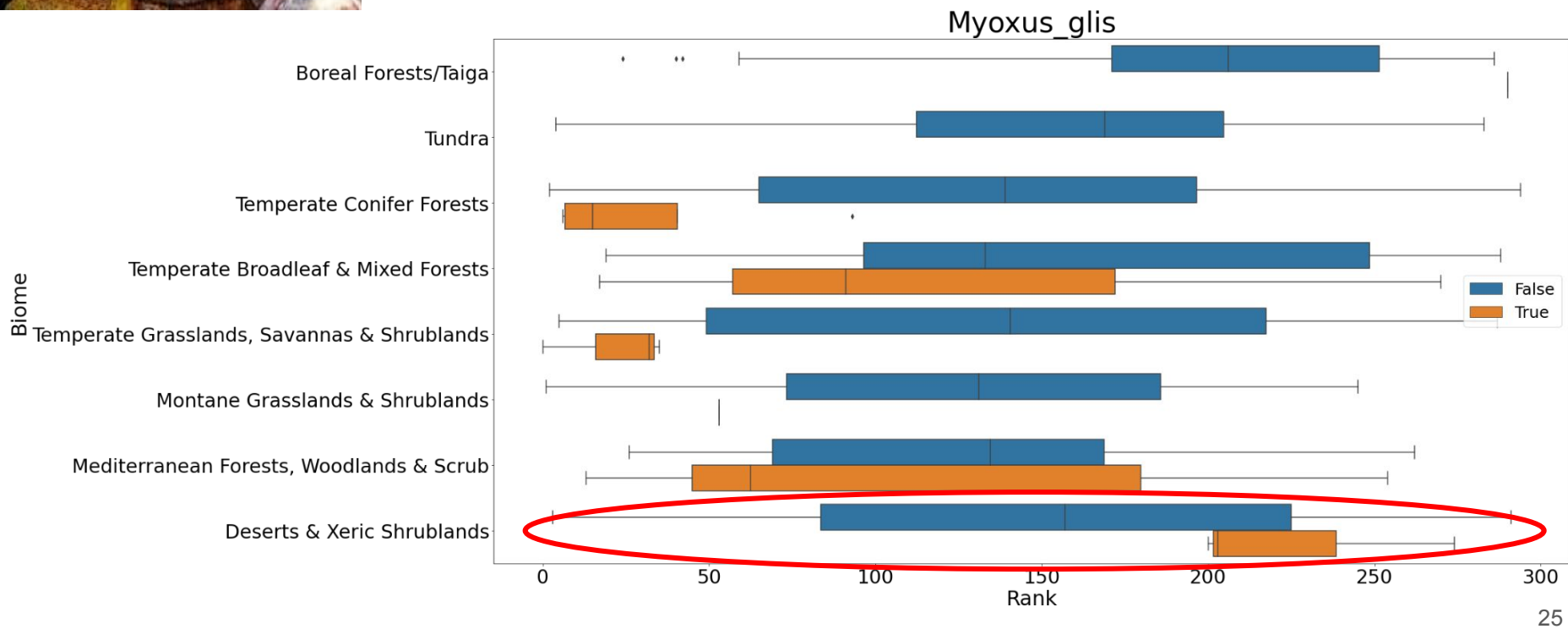
**Myoxus glis - Loir gris**





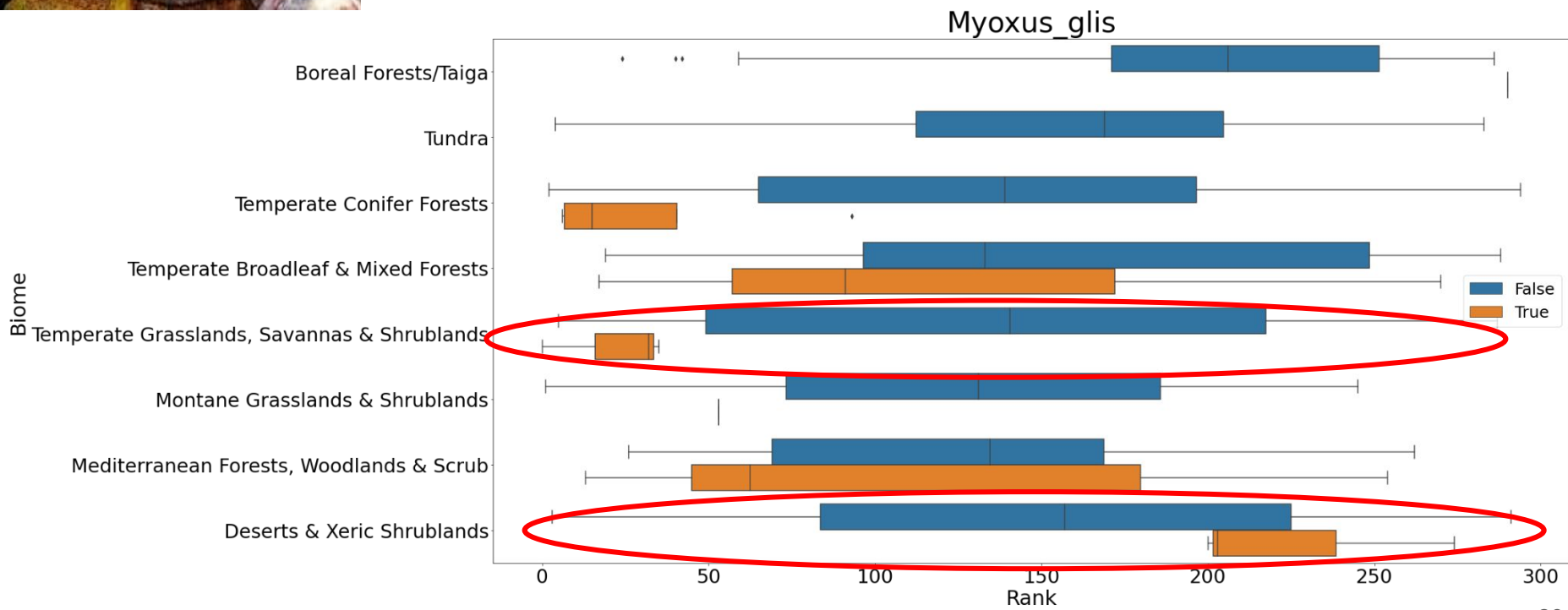


**Myoxus glis - Loir gris**



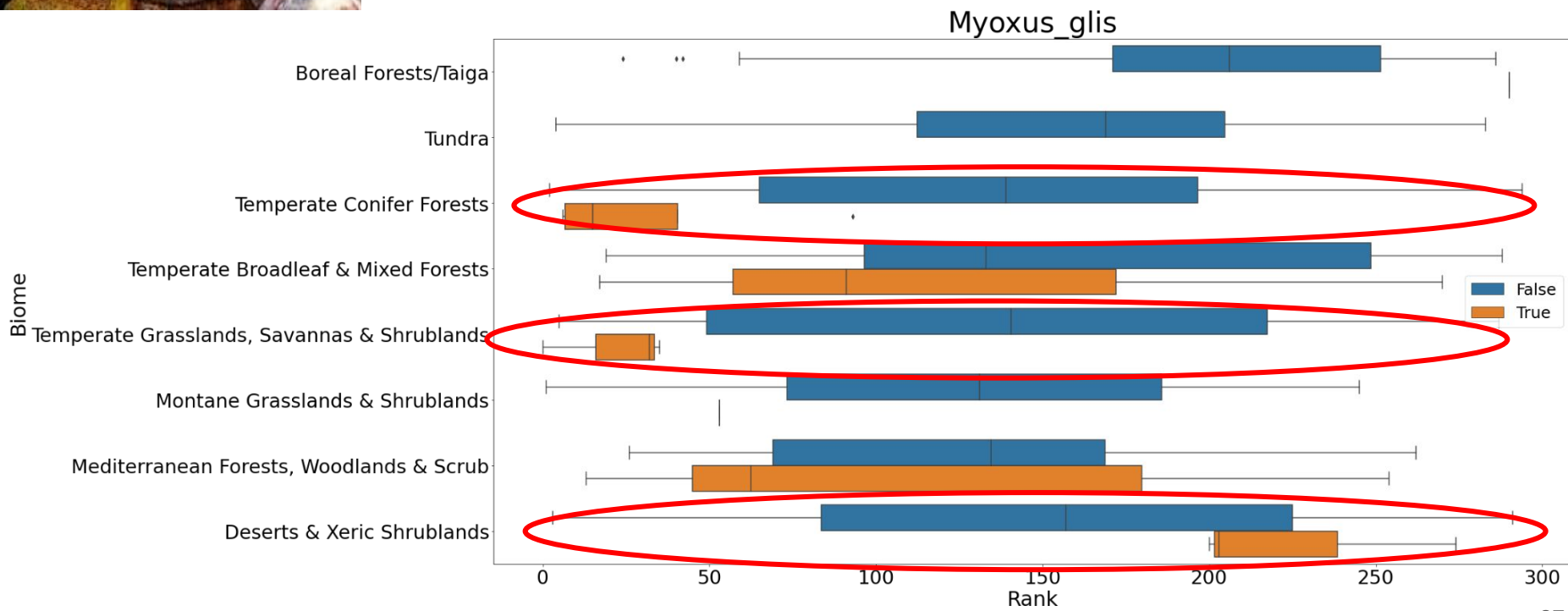


**Myoxus glis - Loir gris**





**Myoxus glis - Loir gris**

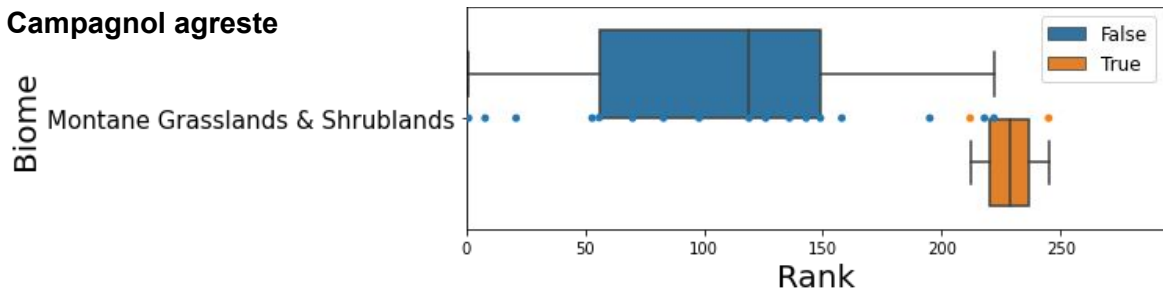




**Microtus Agrestis - Campagnol agreste**



## Microtus Agrestis - Campagnol agreste

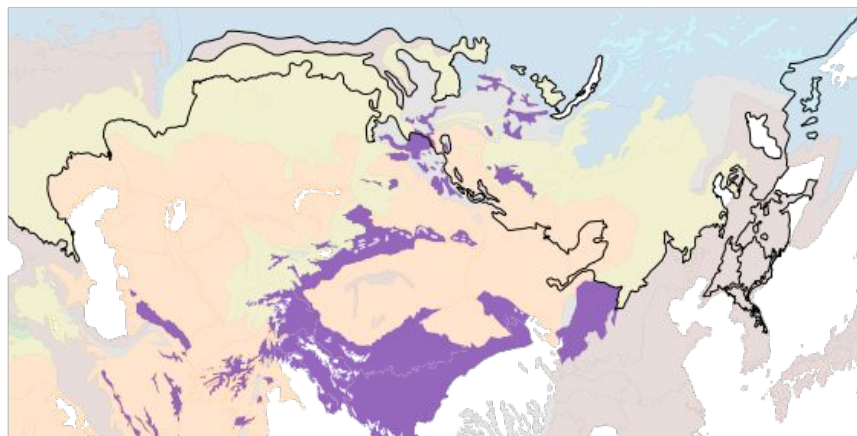
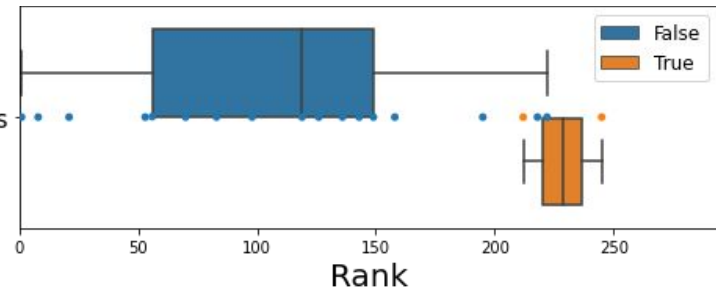




## Microtus Agrestis - Campagnol agreste

Biome

Montane Grasslands & Shrublands



- Boreal Forests/Taiga
- Deserts & Xeric Shrublands
- Mediterranean Forests, Woodlands & Scrub
- Montane Grasslands & Shrublands
- Temperate Broadleaf & Mixed Forests
- Temperate Conifer Forests
- Temperate Grasslands, Savannas & Shrublands
- Tundra

Microtus\_agrestis presence

Biome concerned: Montane Grasslands & Shrublands





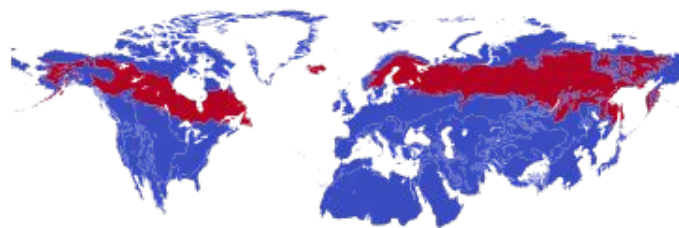
**Turdus merula - Merle noir**



- Boreal Forests/Taiga
- Deserts & Xeric Shrublands
- Mediterranean Forests, Woodlands & Scrub
- Montane Grasslands & Shrublands
- Temperate Broadleaf & Mixed Forests
- Temperate Conifer Forests
- Temperate Grasslands, Savannas & Shrublands
- Tundra

Turdus\_merula living area

Biome concerned: Boreal Forests/Taiga



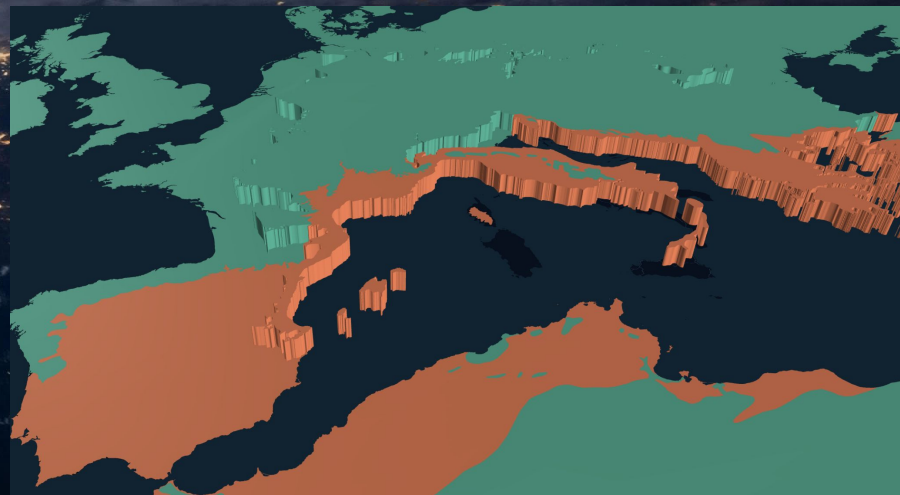
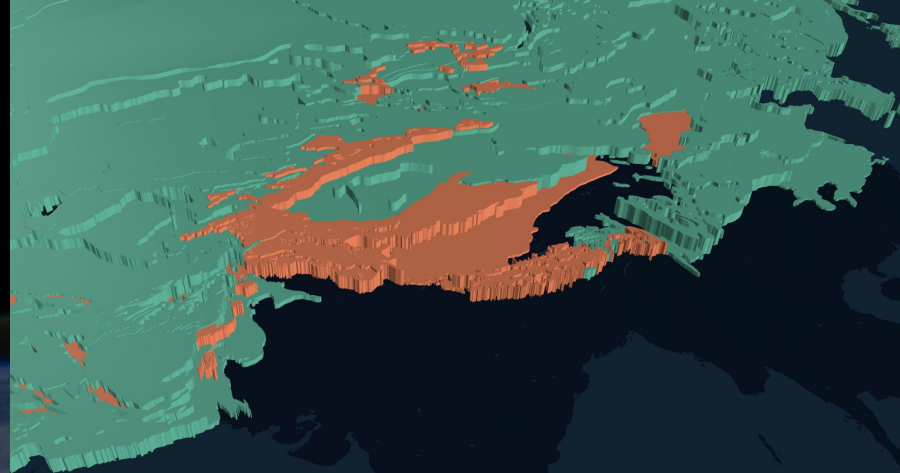
Code disponible:  
<https://github.com/craft-ai/shap-awin>

# Conclusion

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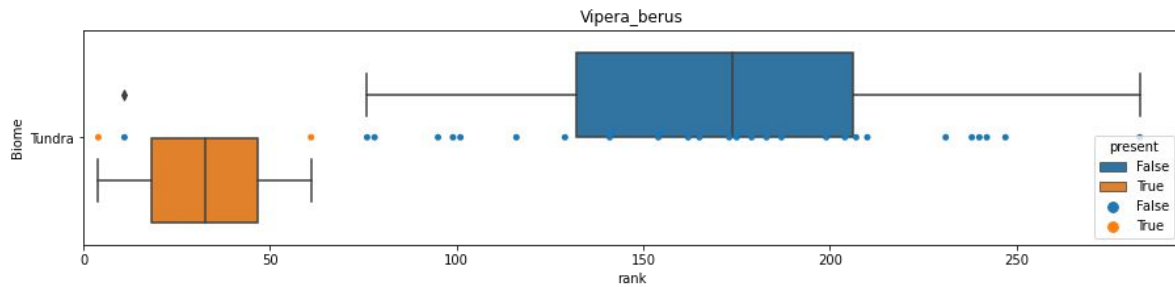


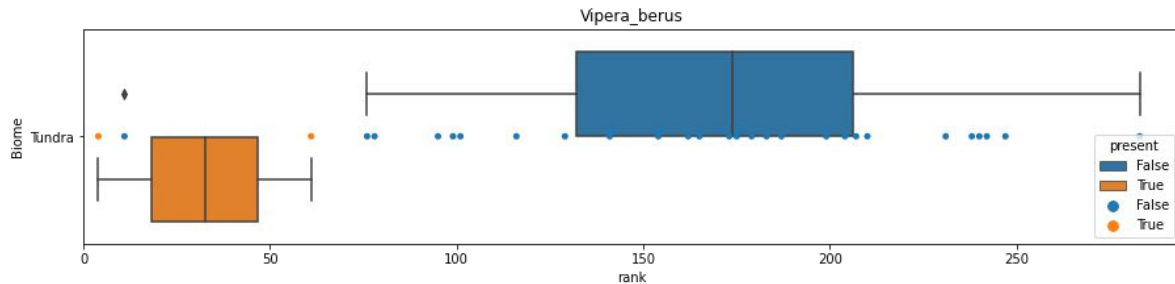
# Come see our Demo





Vipera Berus: Vipère péliade





Vipera\_berus living area

Biome concerned: Tundra

