The internal structure of deep neural networks can model material similarity, even without training with human data

The role of objective and subjective measures in material similarity learning

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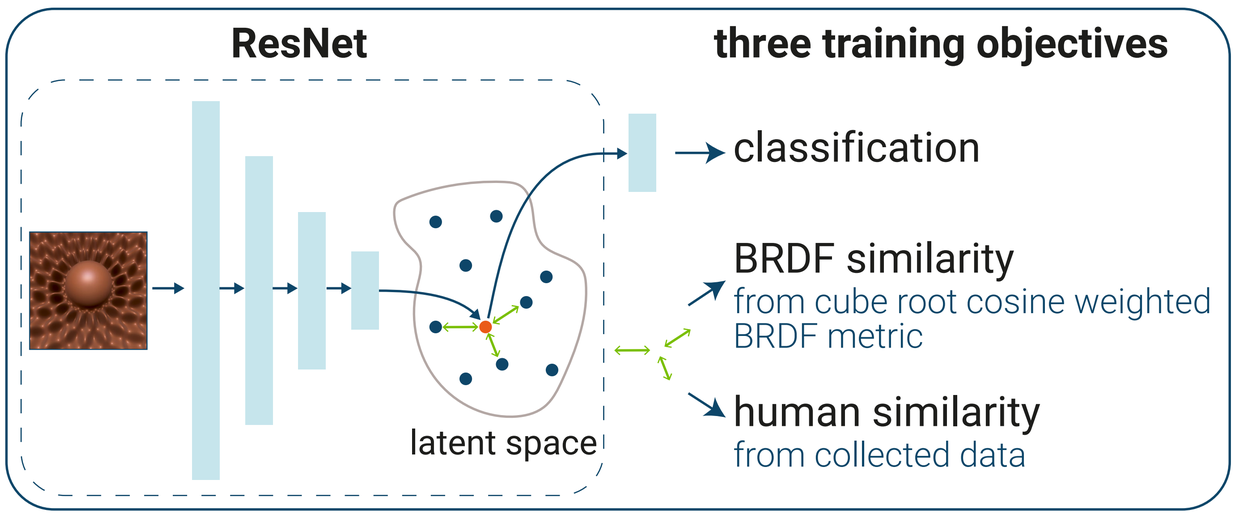
Problem

- **Long standing problem**: measure similarity between materials that aligns with human perception.
- [Zhang et al. 2018] show that **deep learning features** can lead to a representation that correlates with perceptual judgements.
- [Lagunas et al. 2019] **train a neural network on human perceptual data** and achieve better results that standard measures.

Are such good perfomances due to the structure of neural networks or to the use of human subjective data?

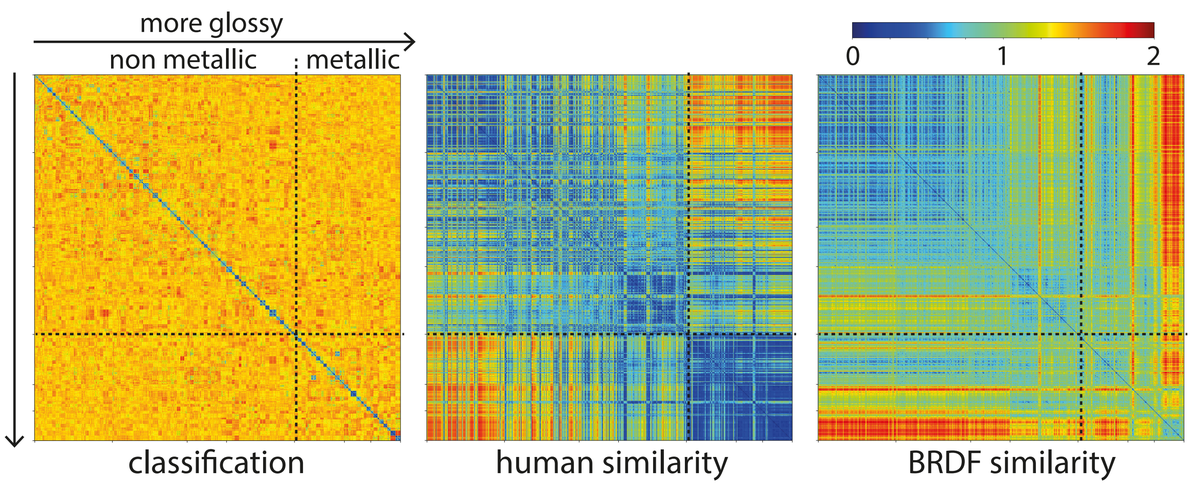
Comparing objective and subjective measures



Results: Shape of the latent space

Representation Dissimilarity Matrices (RDMs)
show the learnt distance between every pair of images

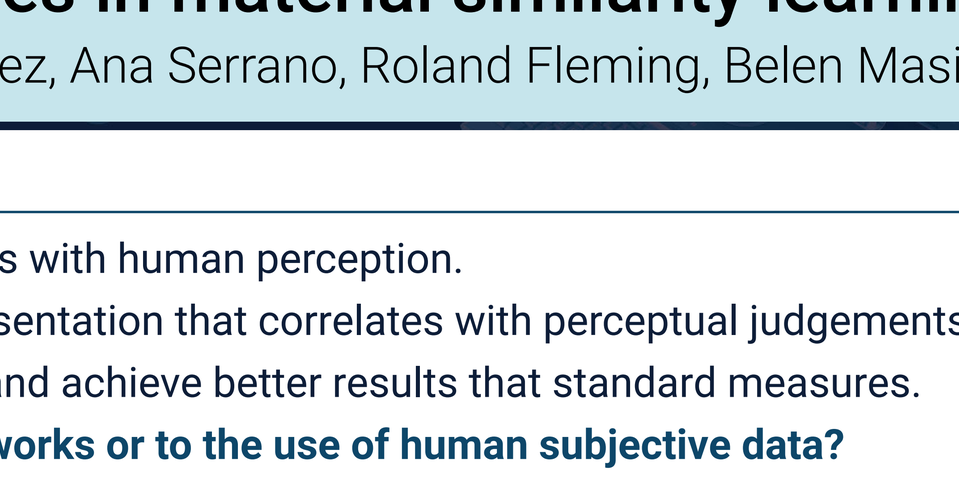
Organized by reflectance property of the material
diffuse to glossy plastic, then rough to glossy metal



- **classification network**
  no relationships between similar materials
- **similarity networks**
  both show clustering of material with similar reflectance, but the exact shape of the space is different

Results: Agreement with human data

Percentage of agreement with human answers



- **Color effect** : important for the classification network
  non-existent for the similarity networks
- **Objective vs subjective measure** :
  -the two similarity networks perform almost equally (~80%)
  -the original BRDF metric does not align well with perception (only 67%)
  -the classification network does not predict material similarity as well as the others

Conclusion and Future Challenges

The structure of the network leads to a representation that aligns well with human perception, even when trained with a metric that does not align very well with it.

But how different is this space from human perception?
What are the relevant difference and what does it tell us about the specificities of human perception?

Lagunas M., Malpica S., Serrano A., Garces E., Gutierrez D., and Masia B.. 2019. A similarity measure for material appearance. ACM Transactions on Graphics (TOG) 38, 4 (2019), 135.
Zhang R., Isola P., Efros A., Shechtman E., and Wang O.. 2018. The unreasonable effectiveness of deep features as a perceptual metric. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition.

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