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
Johanna Delanoy, Manuel Lagunas, Ignacio Galve, Diego Gutierrez, Ana Serrano, Roland Fleming, Belen Masia

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 than standard measures.

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

COMPARING OBJECTIVE AND SUBJECTIVE MEASURES

- **ResNet**
- **three training objectives**
  - classification
  - BRDF similarity
  - human similarity

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

RESULTS: AGREEMENT WITH HUMAN DATA

- **Color effect**: important for the classification network
- **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 differences and what does it tell us about the specificities of human perception?
