

Diffusion Models as Artists

Are we Closing the Gap between **Humans** and Machines?



Victor Boutin, Thomas Fel, Lakshya Singhal, Rishav Mukherji, Akash Nagaraj, Julien Colin, Thomas Serre

ICML 2023

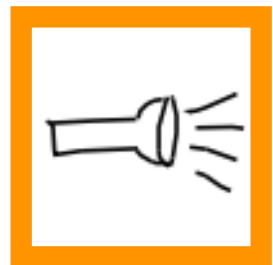
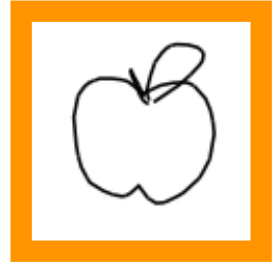


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One-Shot Drawing Task (LAKE ET AL 2015)

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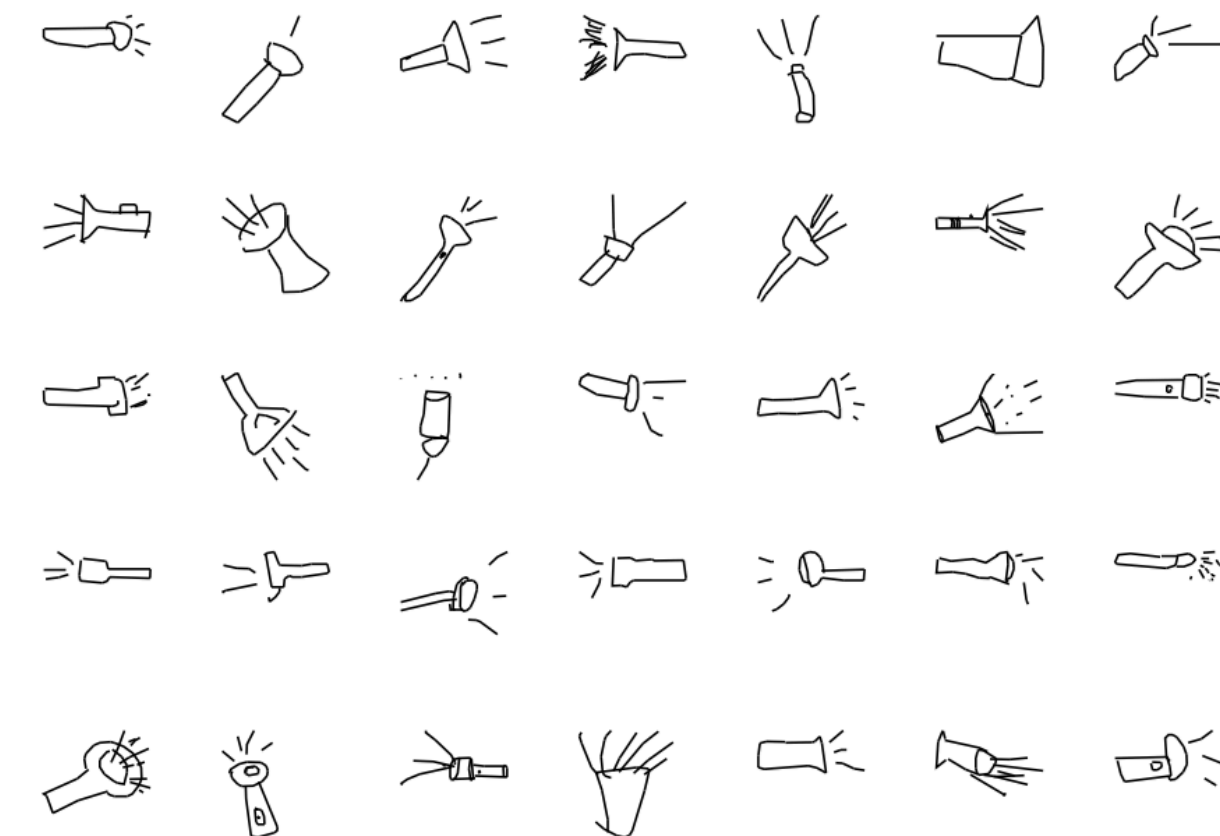
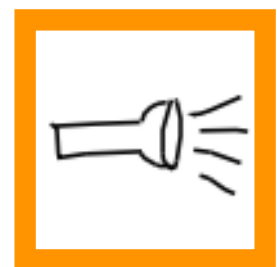
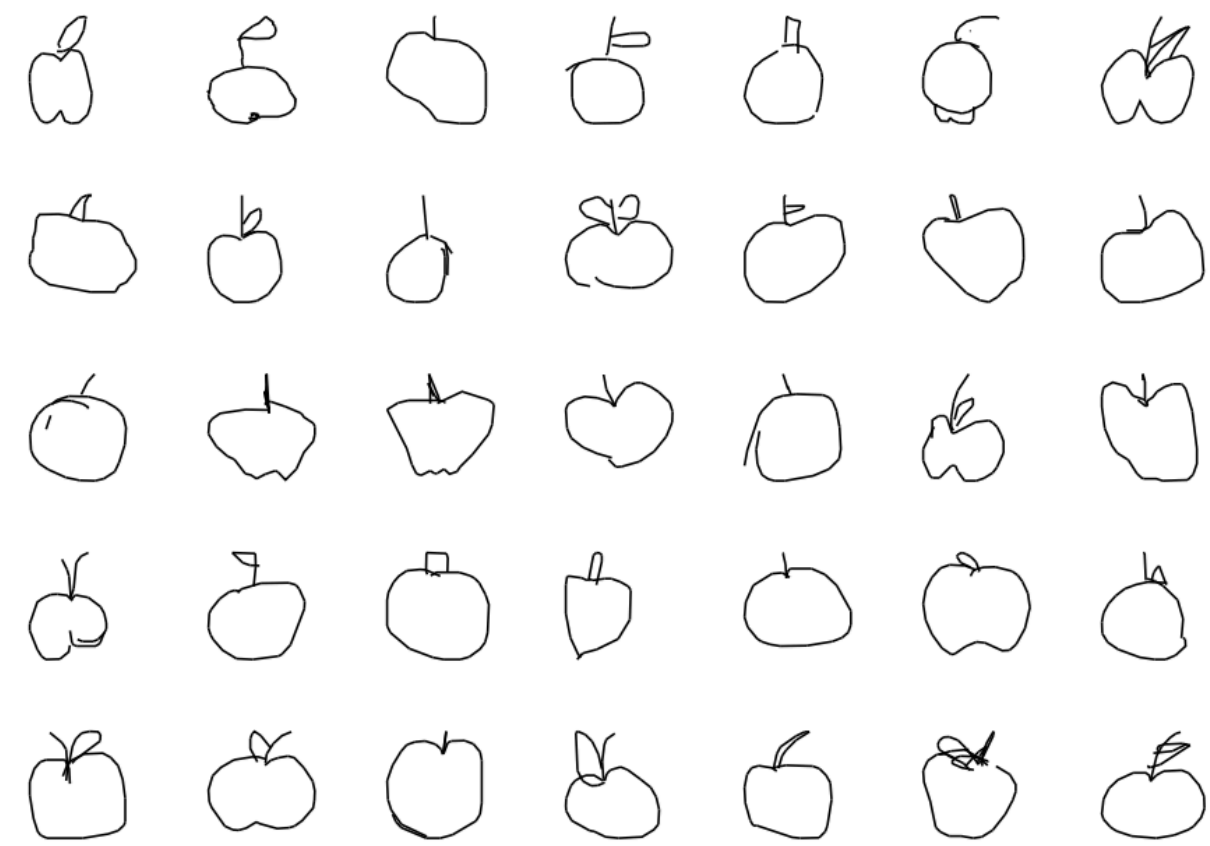
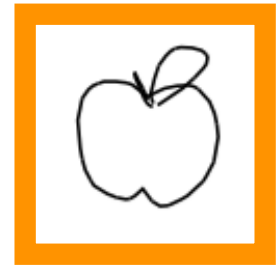
Exemplars



One-Shot Drawing Task (LAKE ET AL 2015)

Training

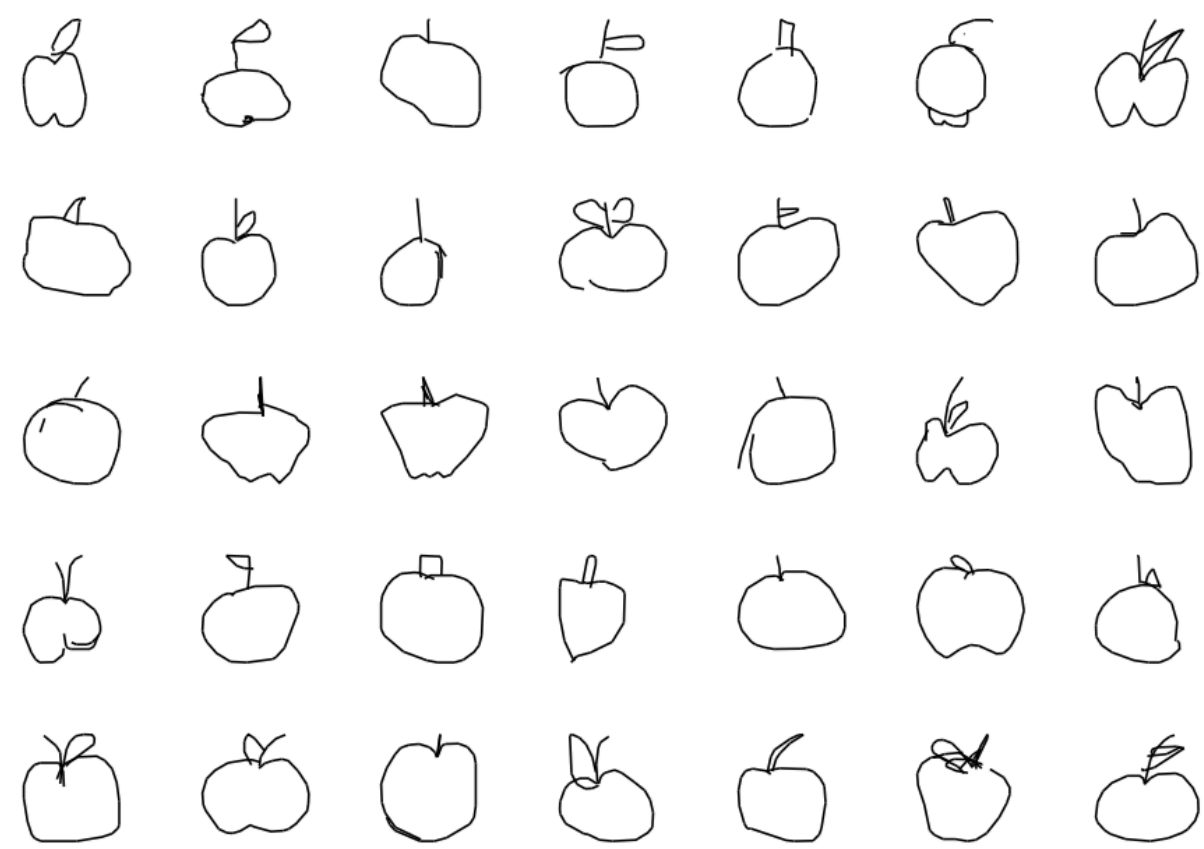
Exemplars



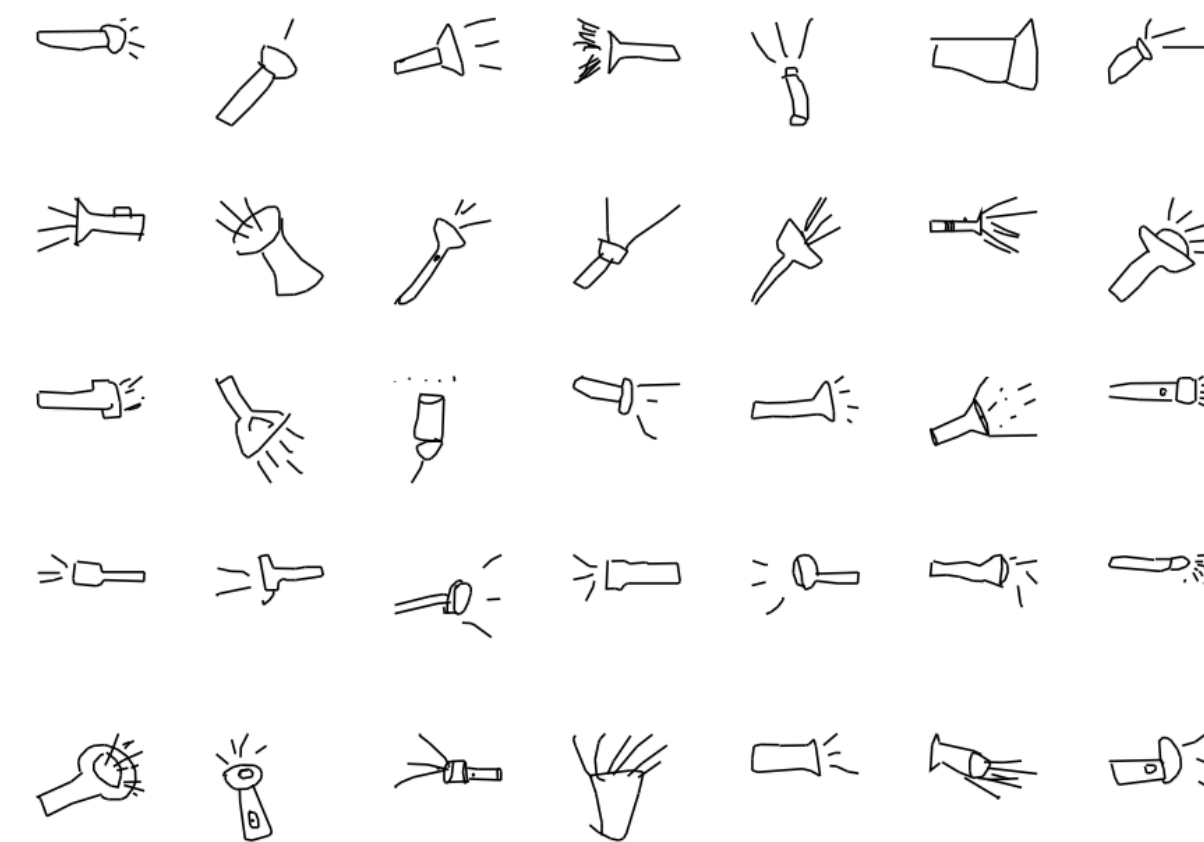
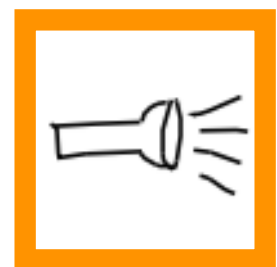
One-Shot Drawing Task (LAKE ET AL 2015)

Training

Exemplars



Variations



Testing

New exemplars



Variations

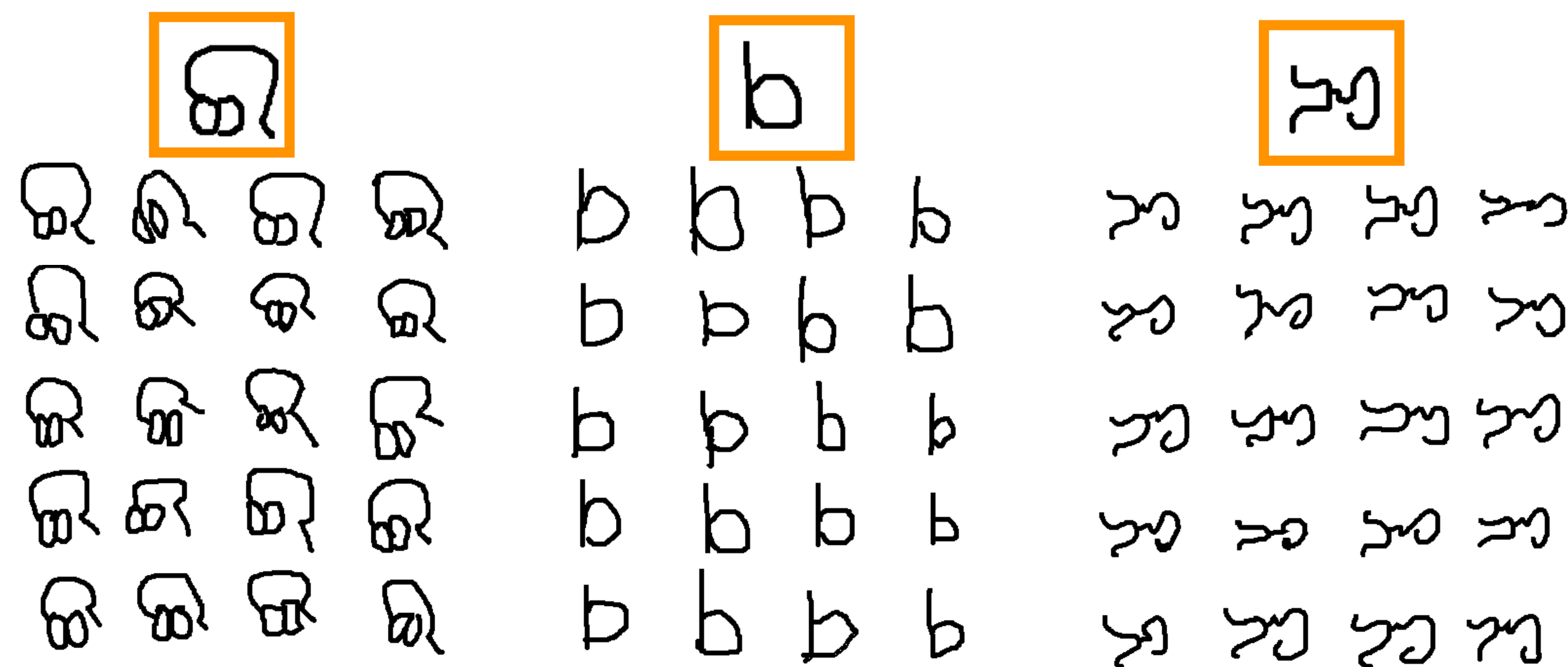
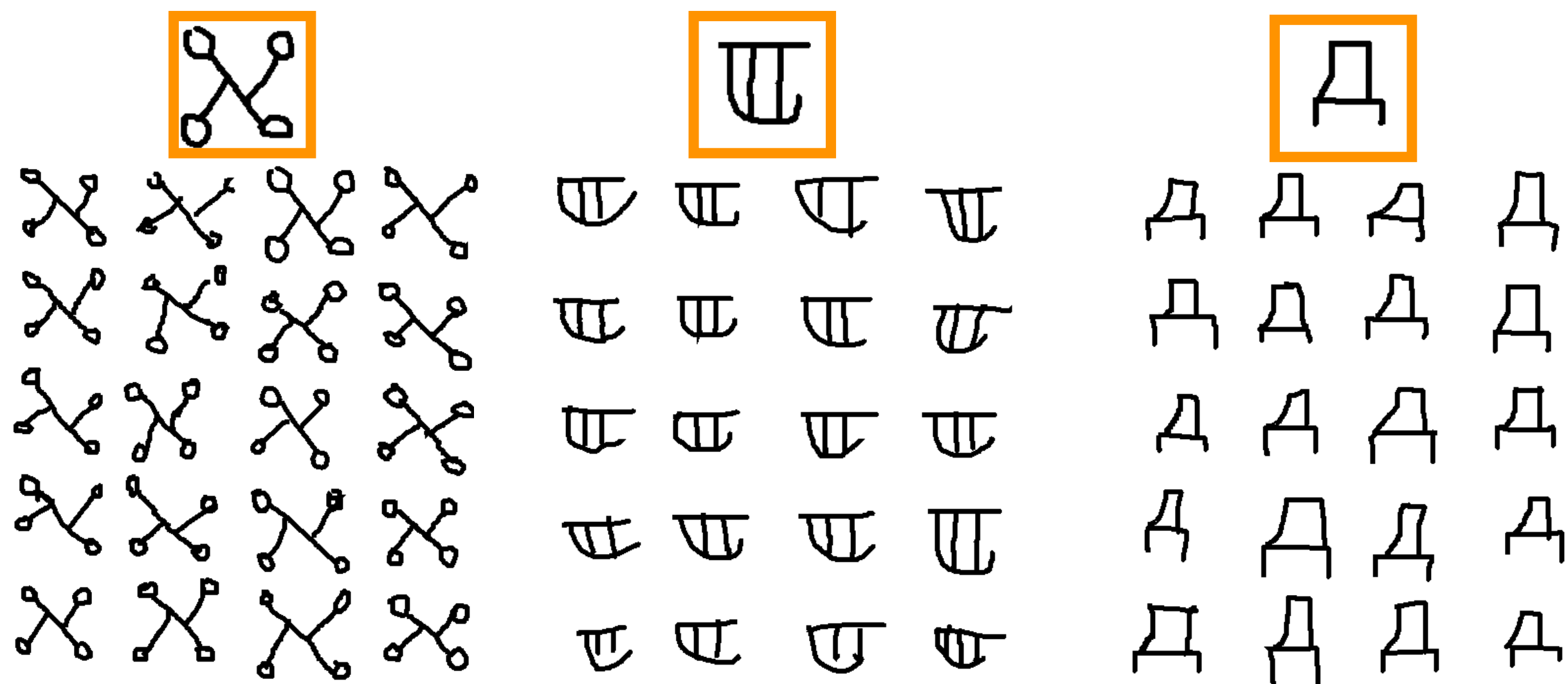
?



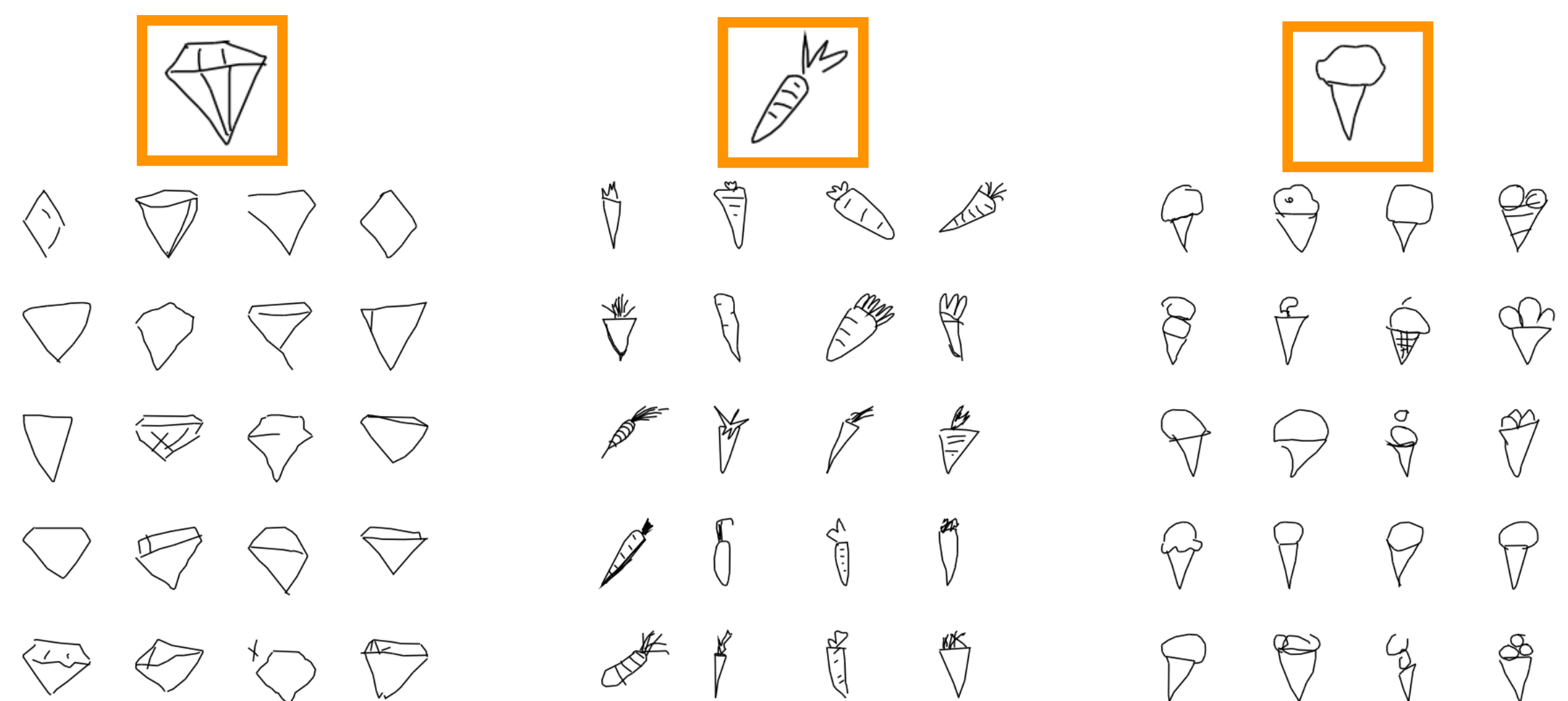
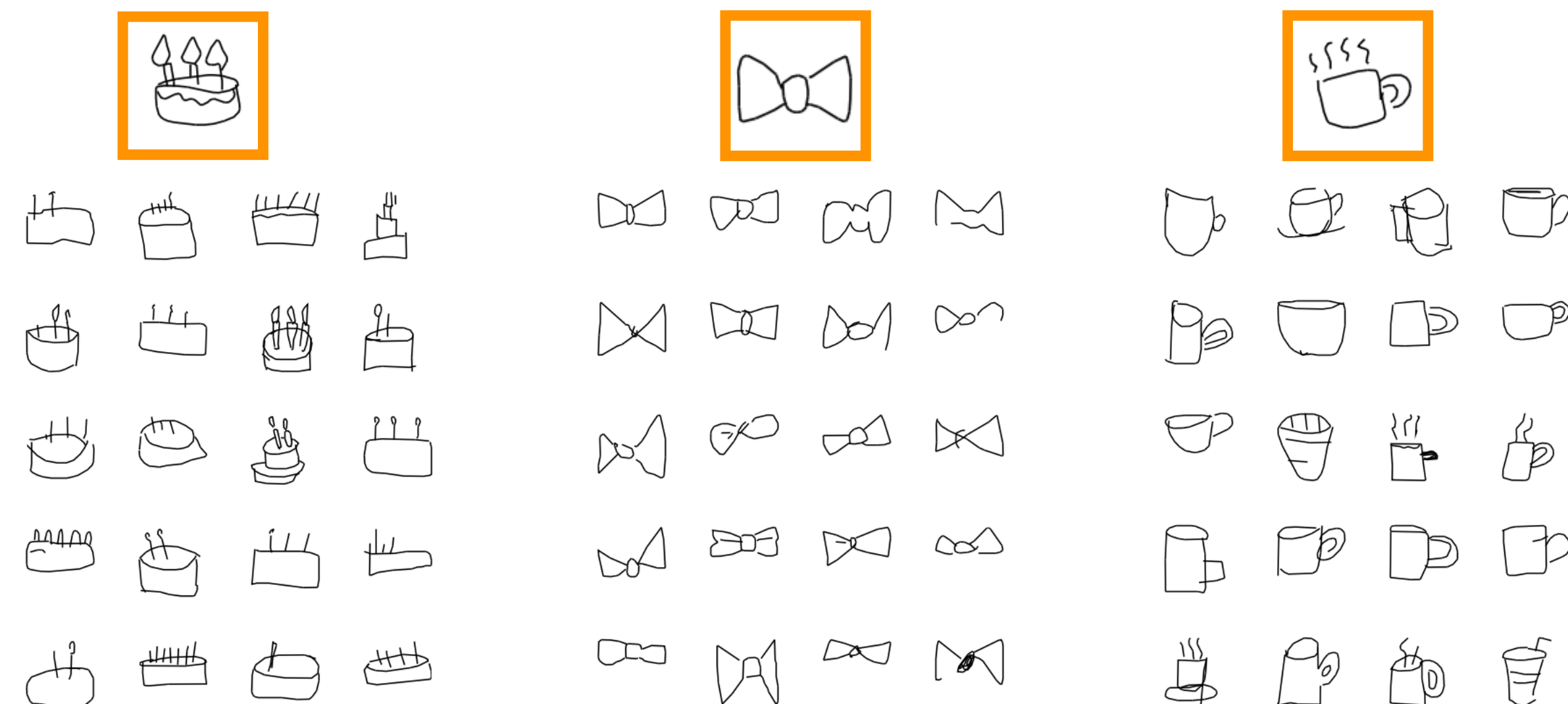
?

One-Shot Drawing Task (LAKE ET AL 2015)

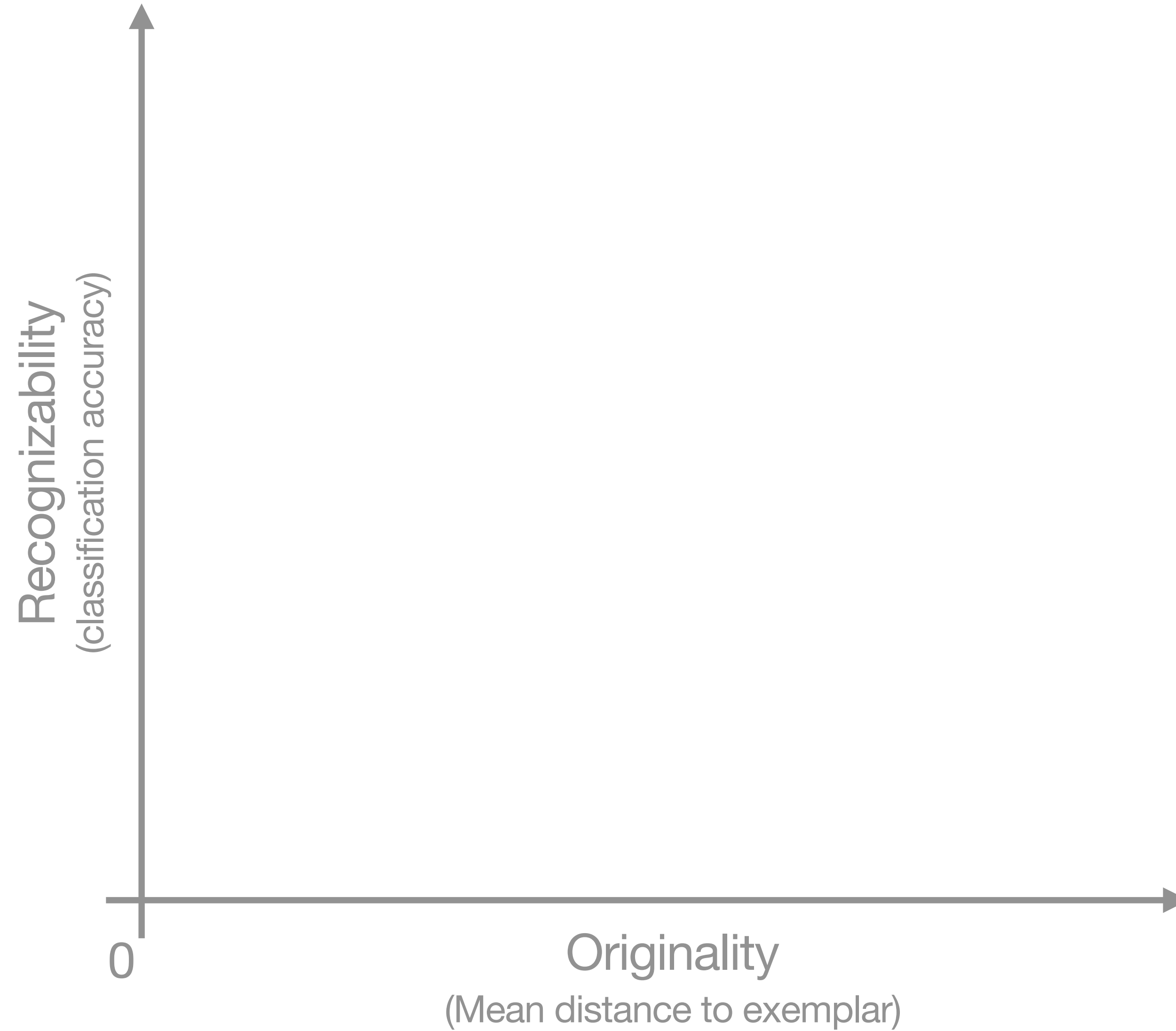
Omniglot (LAKE ET AL 2015)



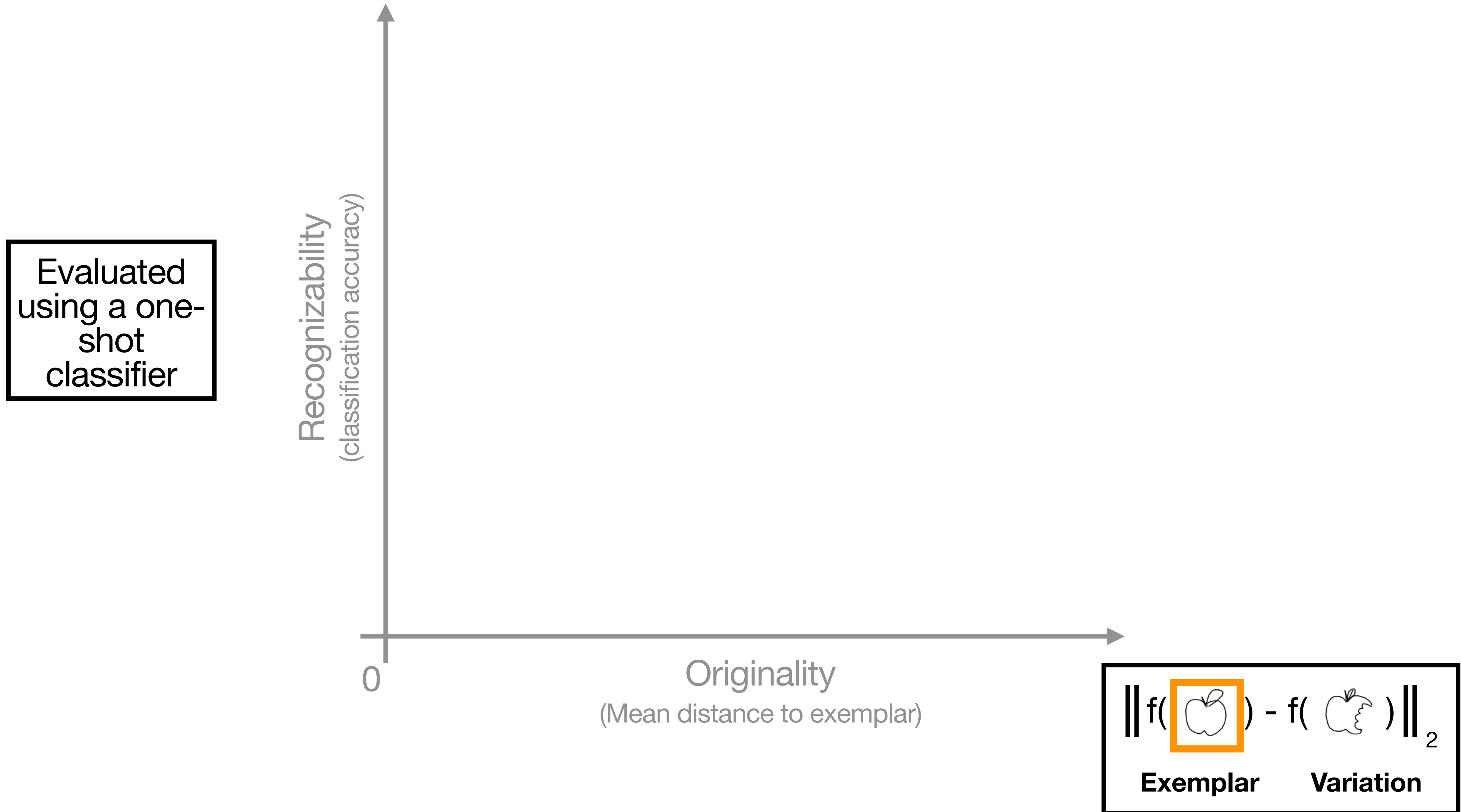
Quick, Draw ! (HA ET AL 2017)



Task Evaluation : Originality vs Recognizability (BOUTIN ET AL 2022)

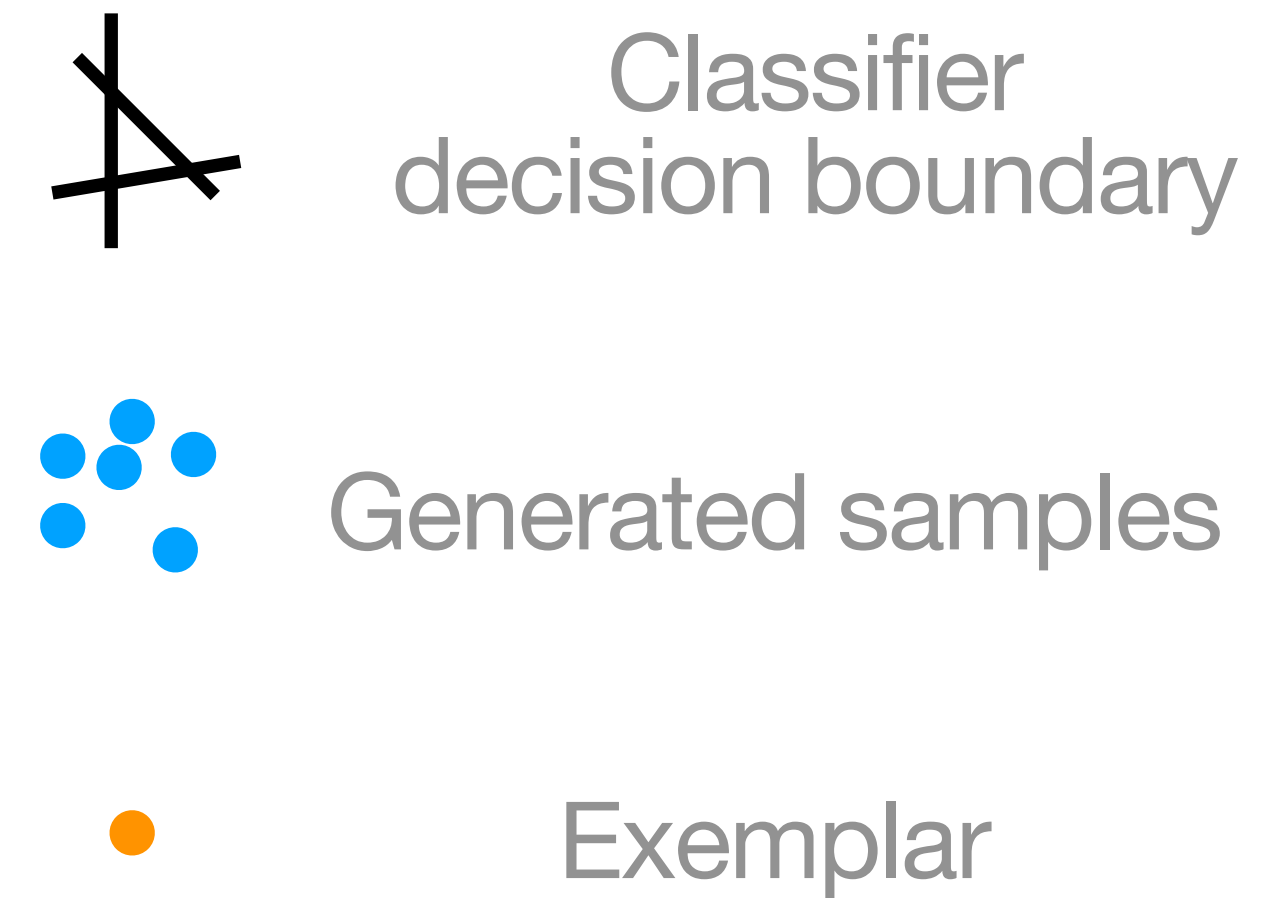
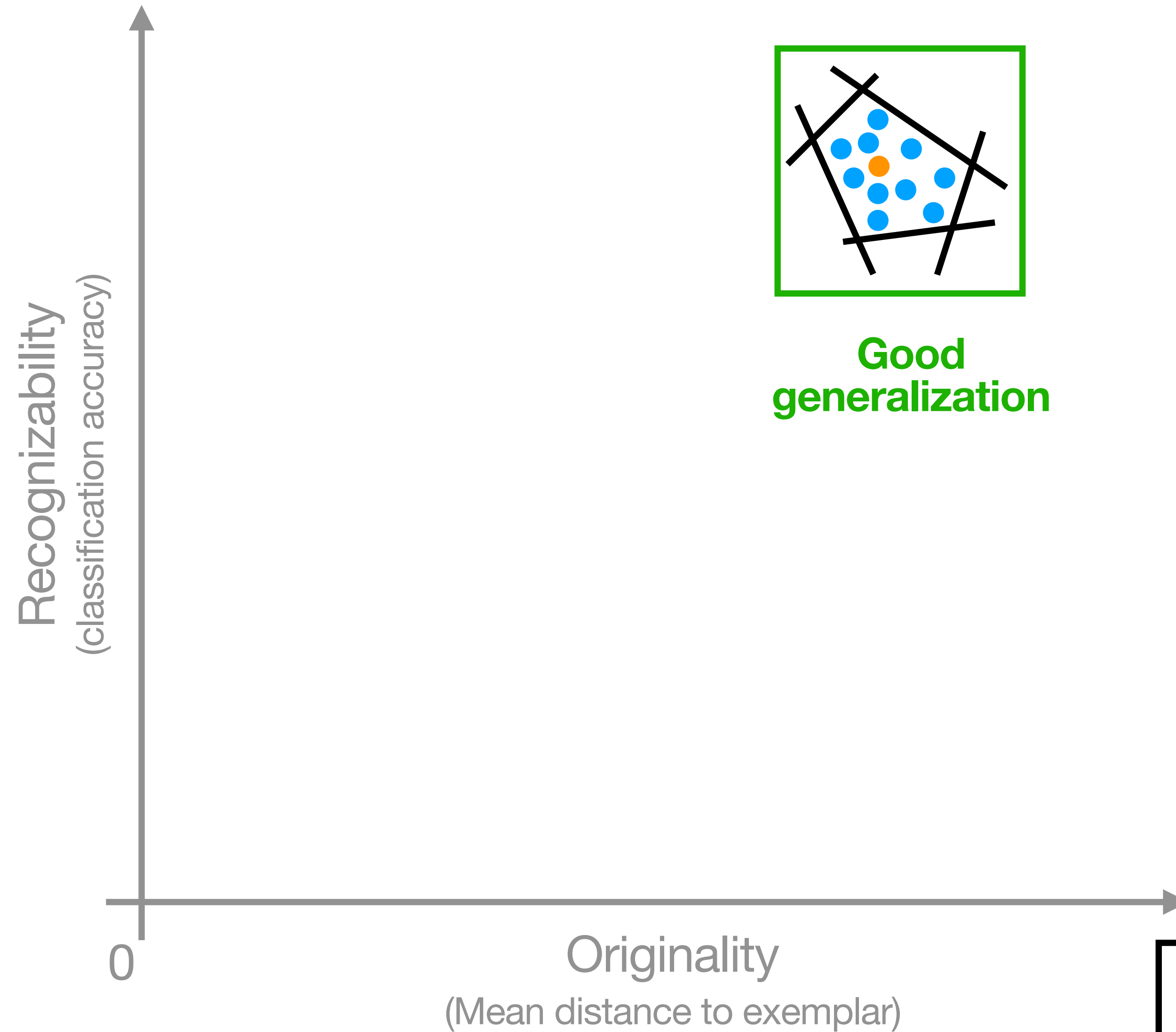


Task Evaluation : Originality vs Recognizability (BOUTIN ET AL 2022)



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Evaluated using a one-shot classifier

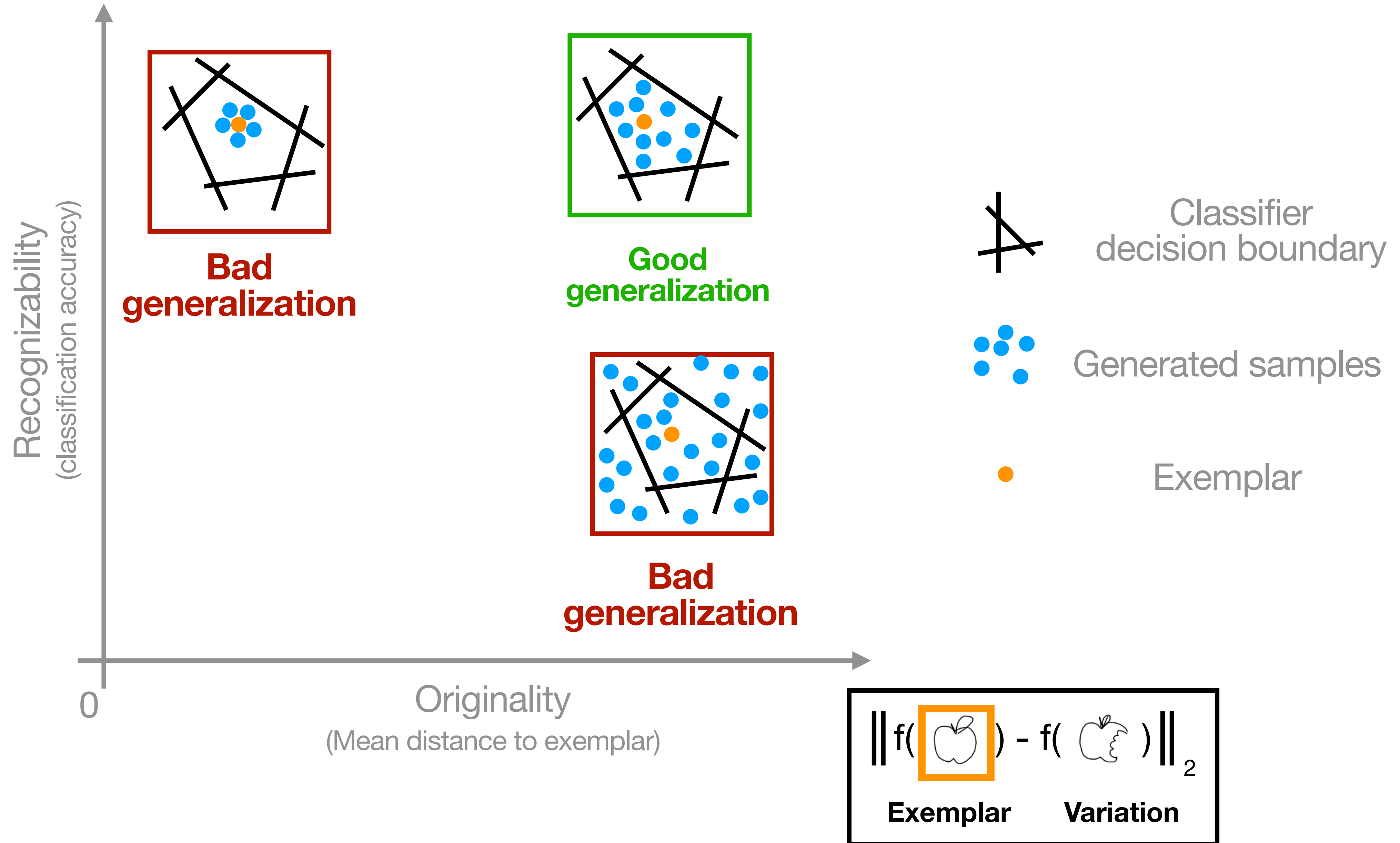


$$\| f(\text{Exemplar}) - f(\text{Variation}) \|_2$$

Exemplar Variation

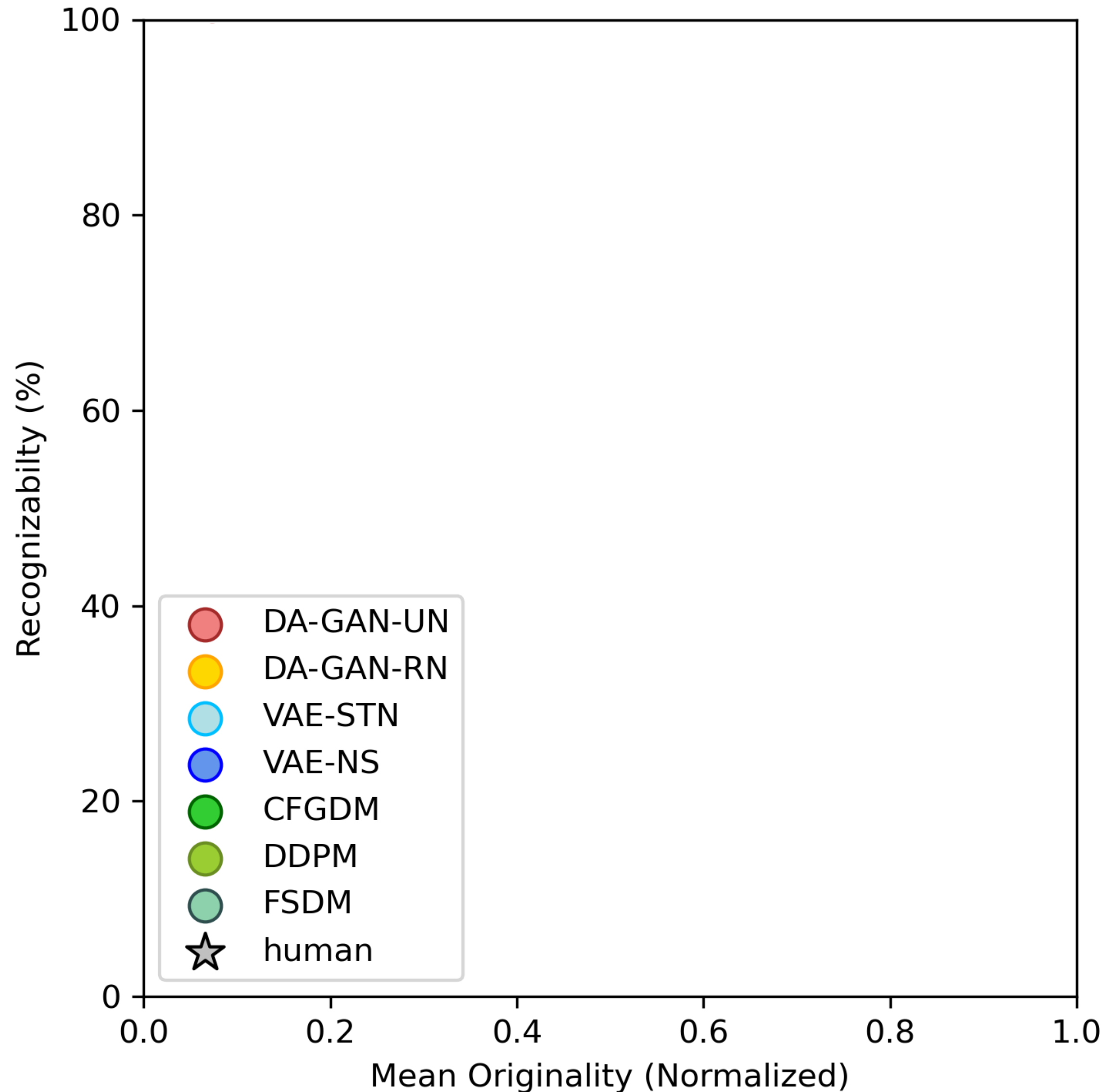
Task Evaluation : Originality vs Recognizability (BOUTIN ET AL 2022)

Evaluated using a one-shot classifier

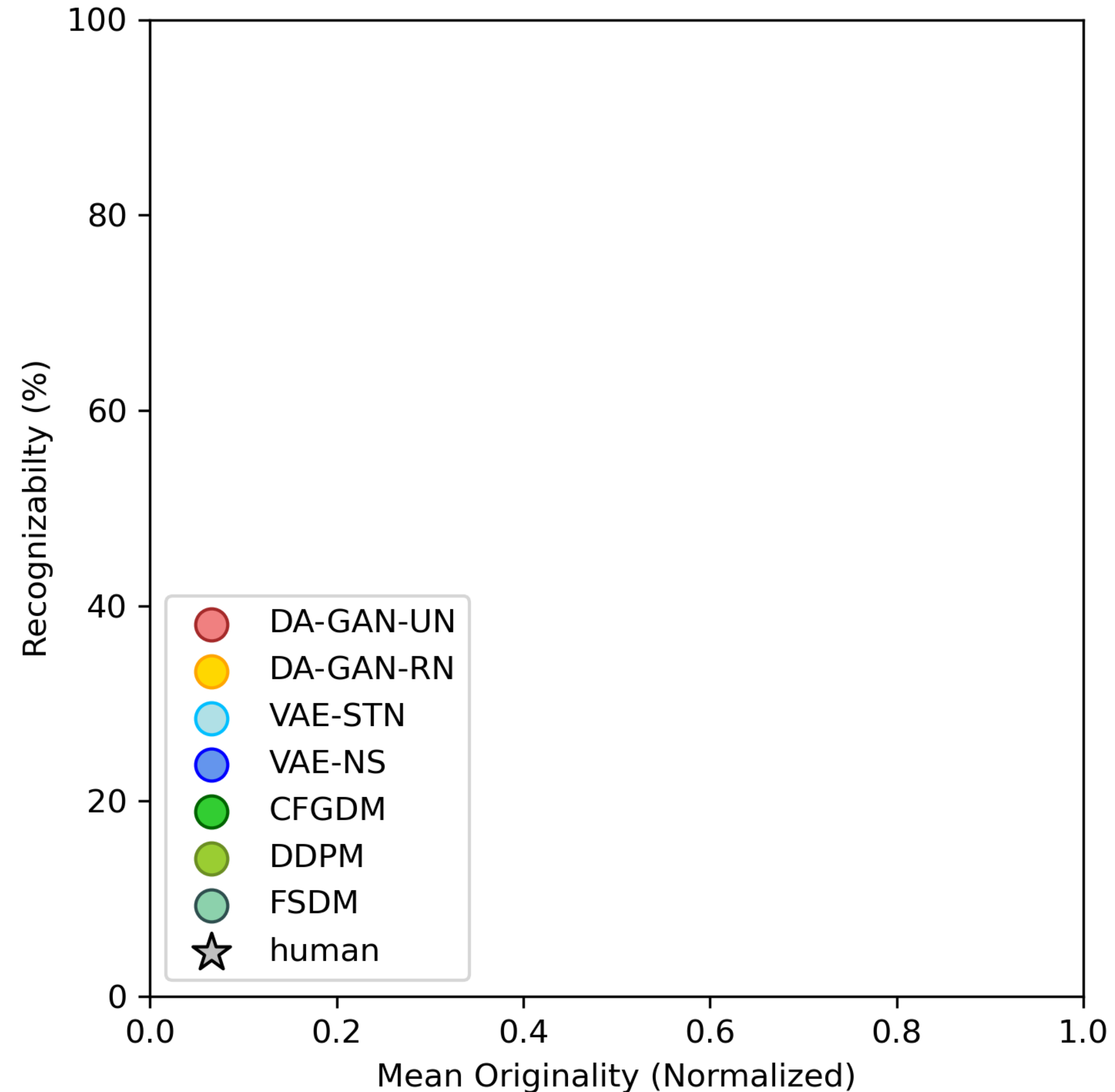


Models in the Originality vs. Recognizability Space (BOUTIN ET AL 2023)

Omniglot

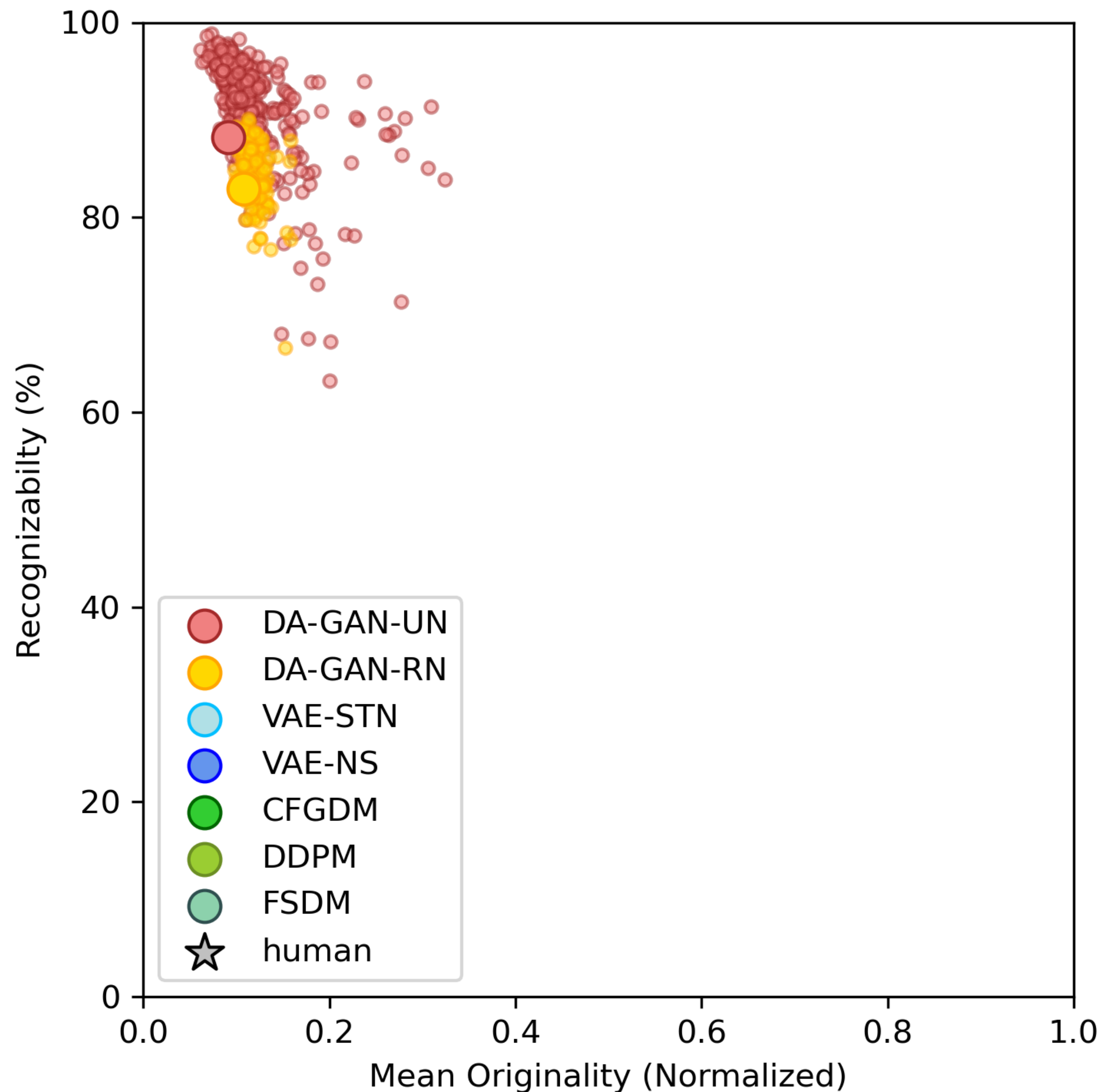


Quick, Draw !

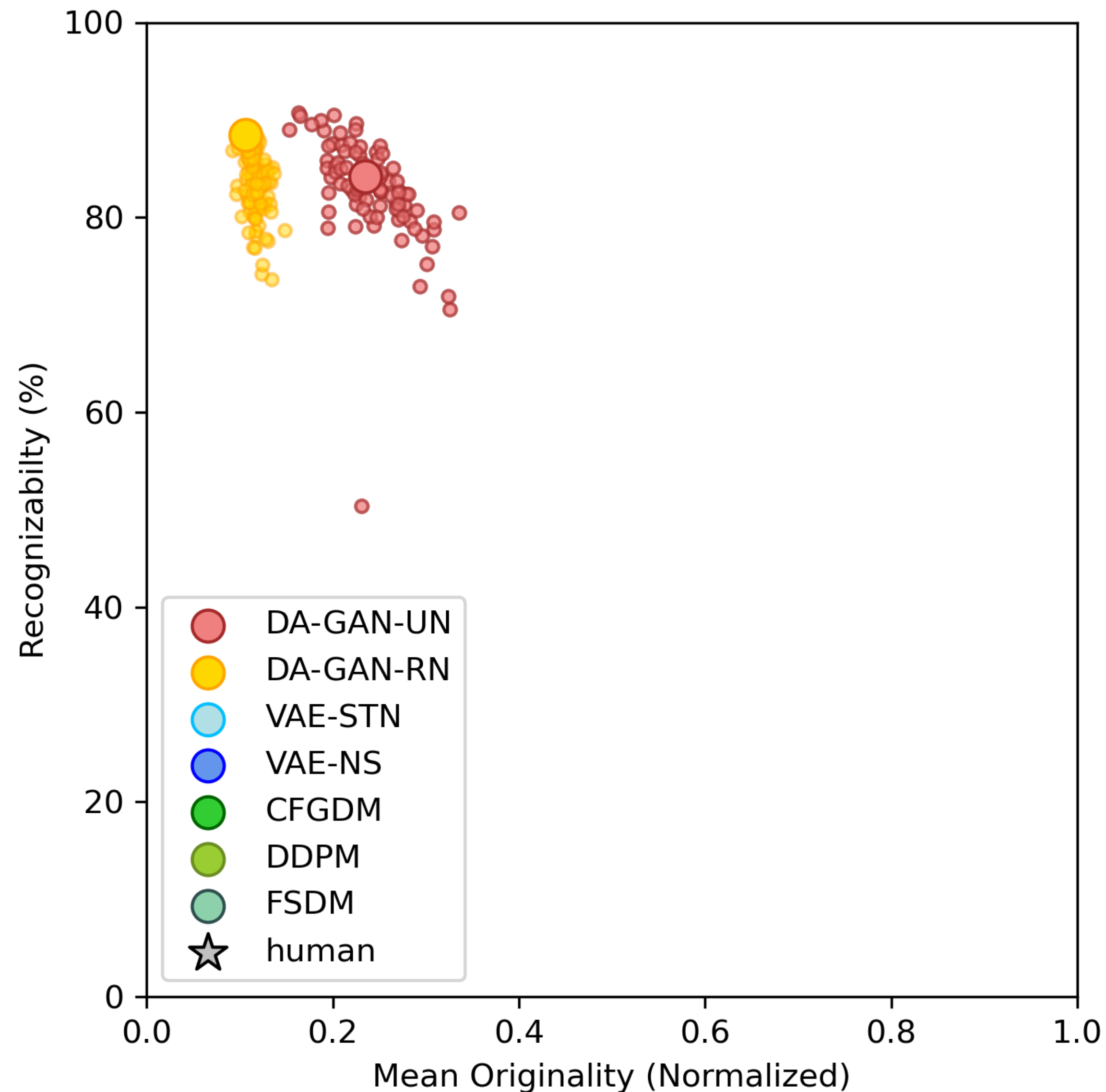


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Omniglot

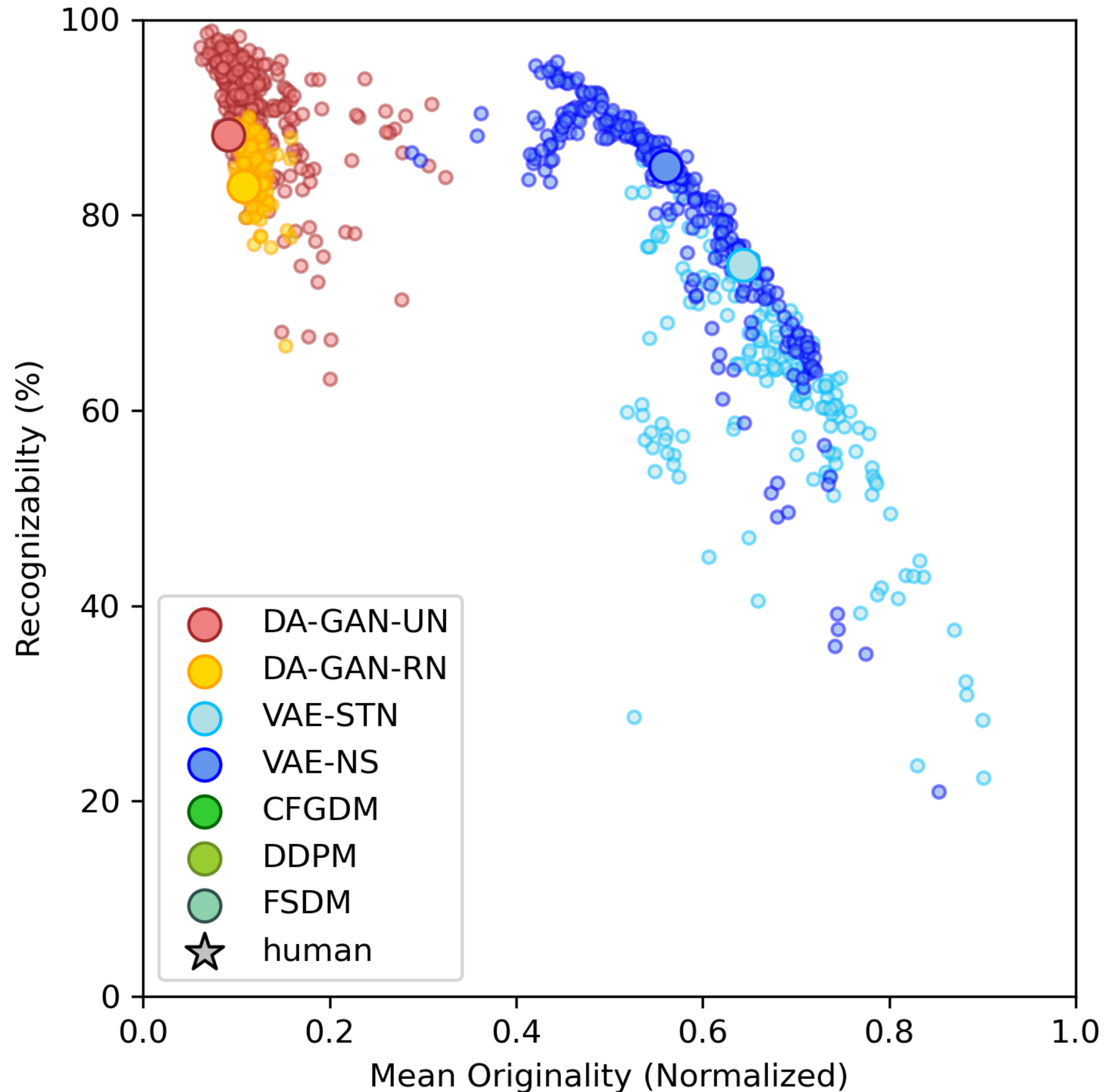


Quick, Draw !

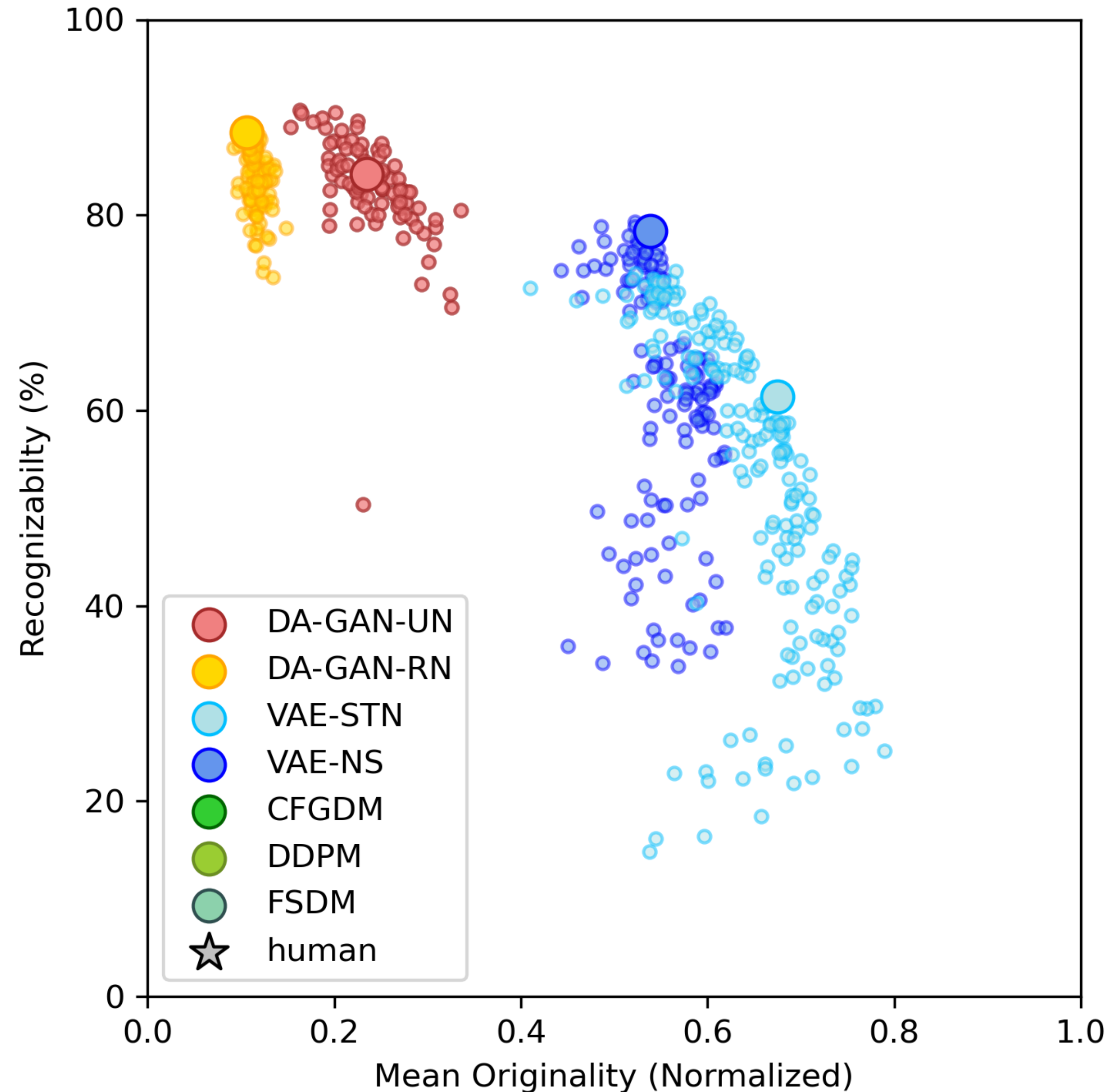


Models in the Originality vs. Recognizability Space (BOUTIN ET AL 2023)

Omniglot

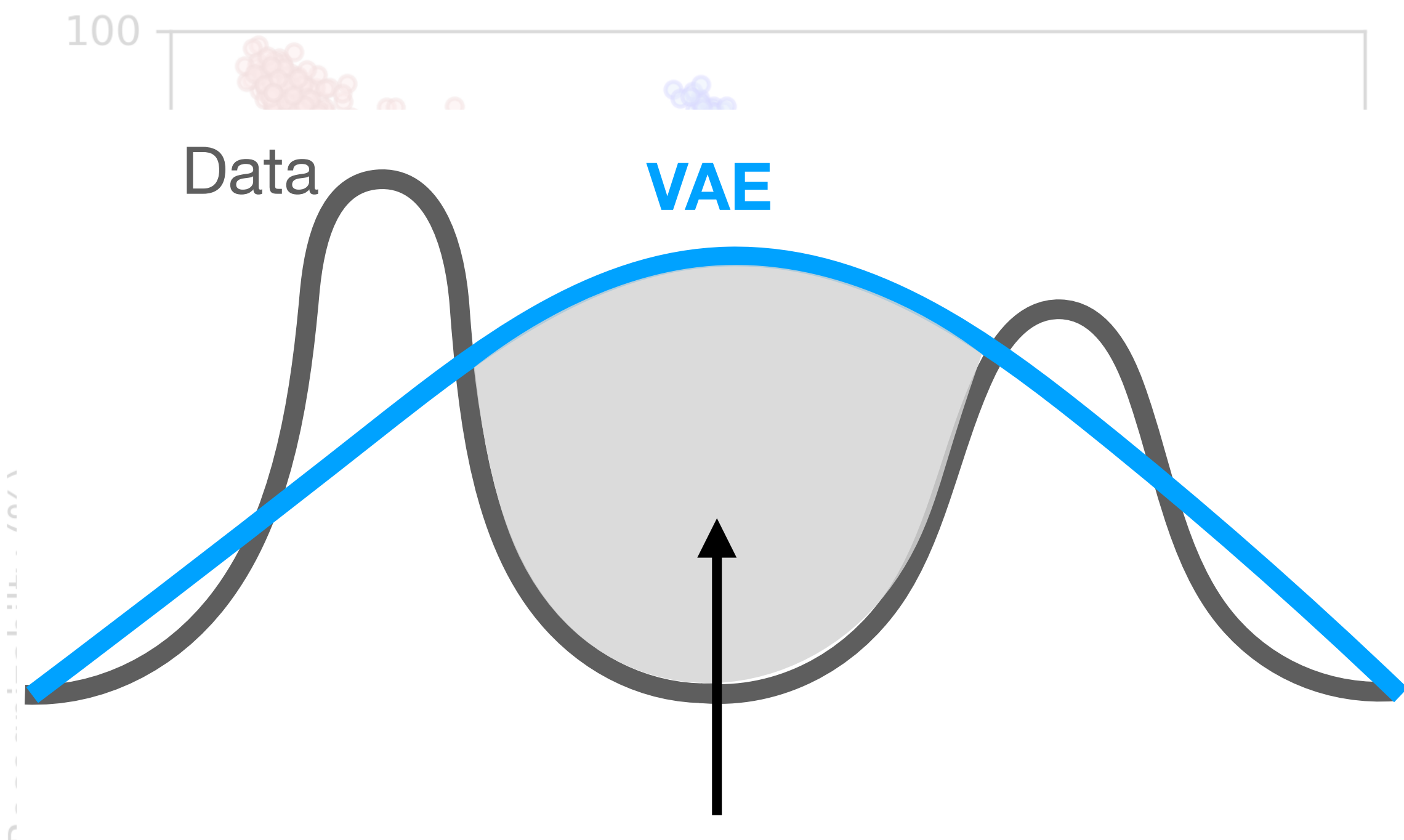


Quick, Draw !



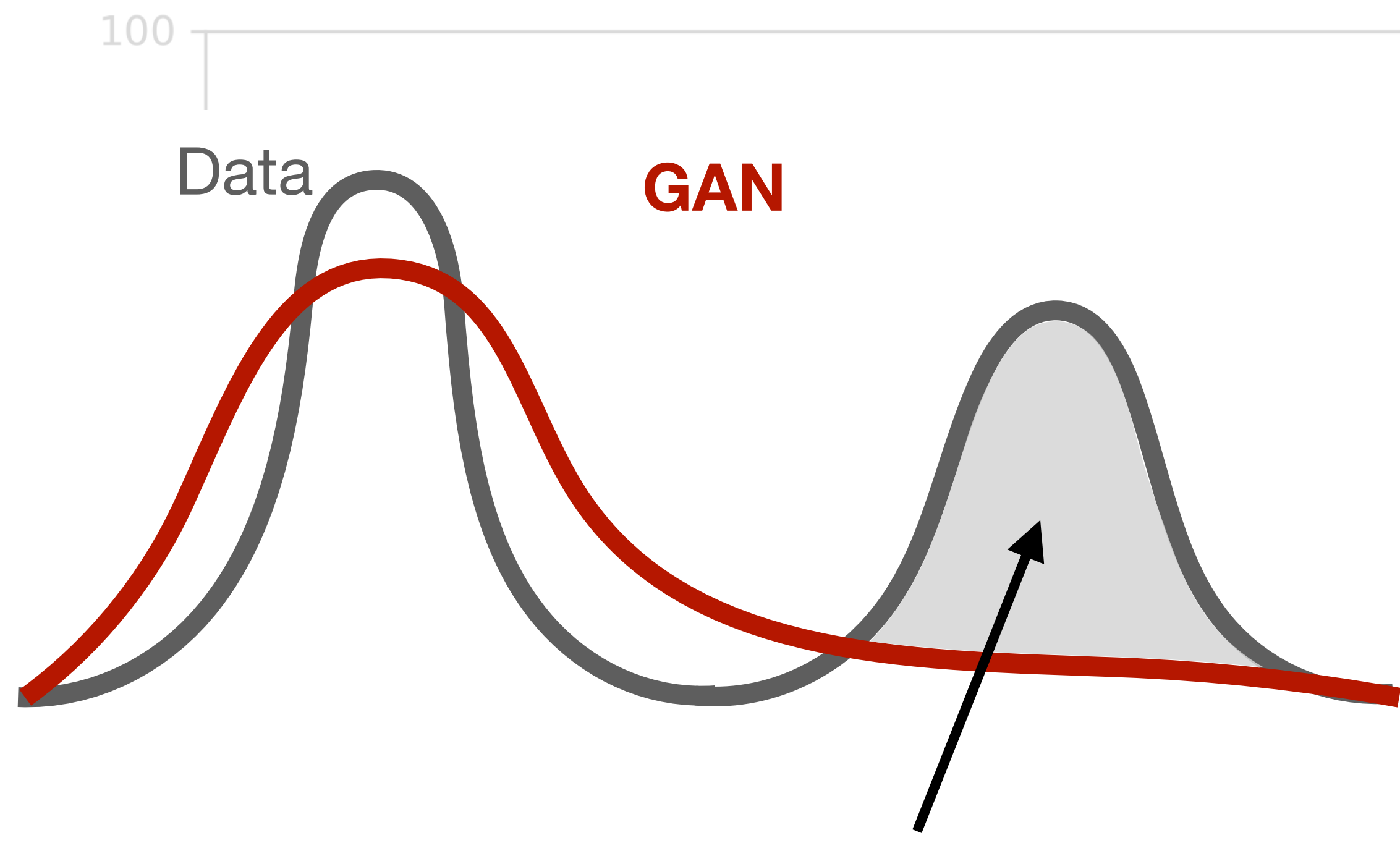
Models in the Originality vs. Recognizability Space (BOUTIN ET AL 2023)

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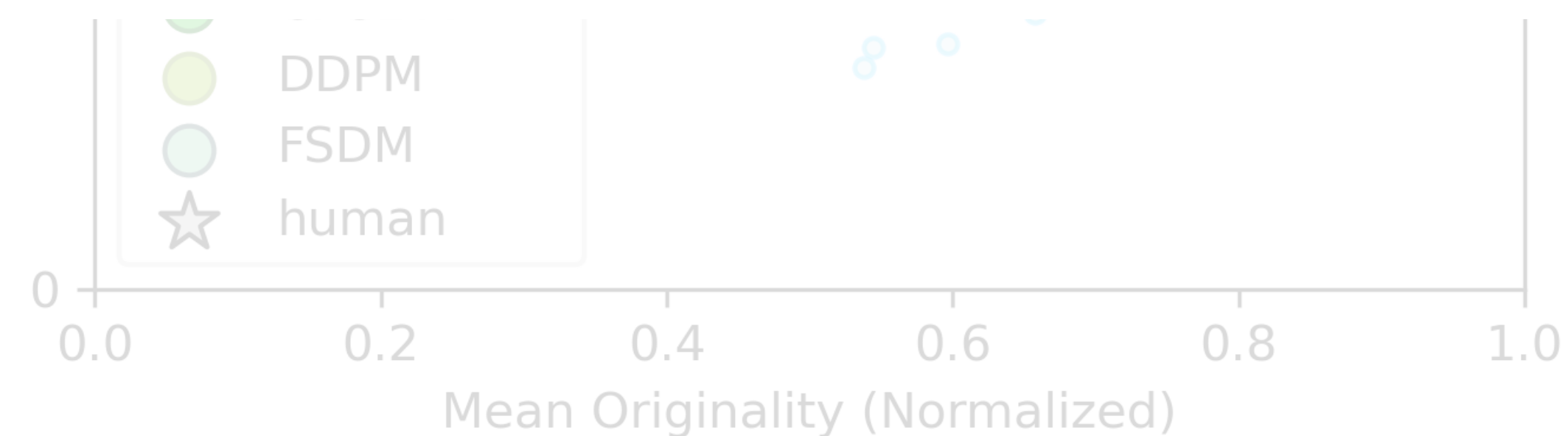
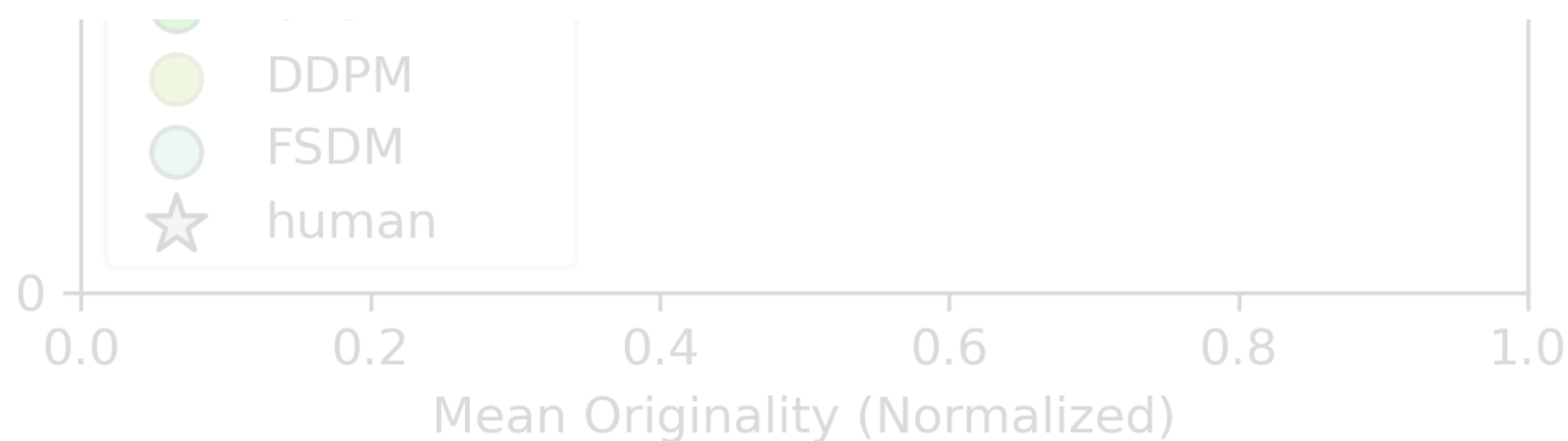
VAE over-generalizes

Quick, Draw !



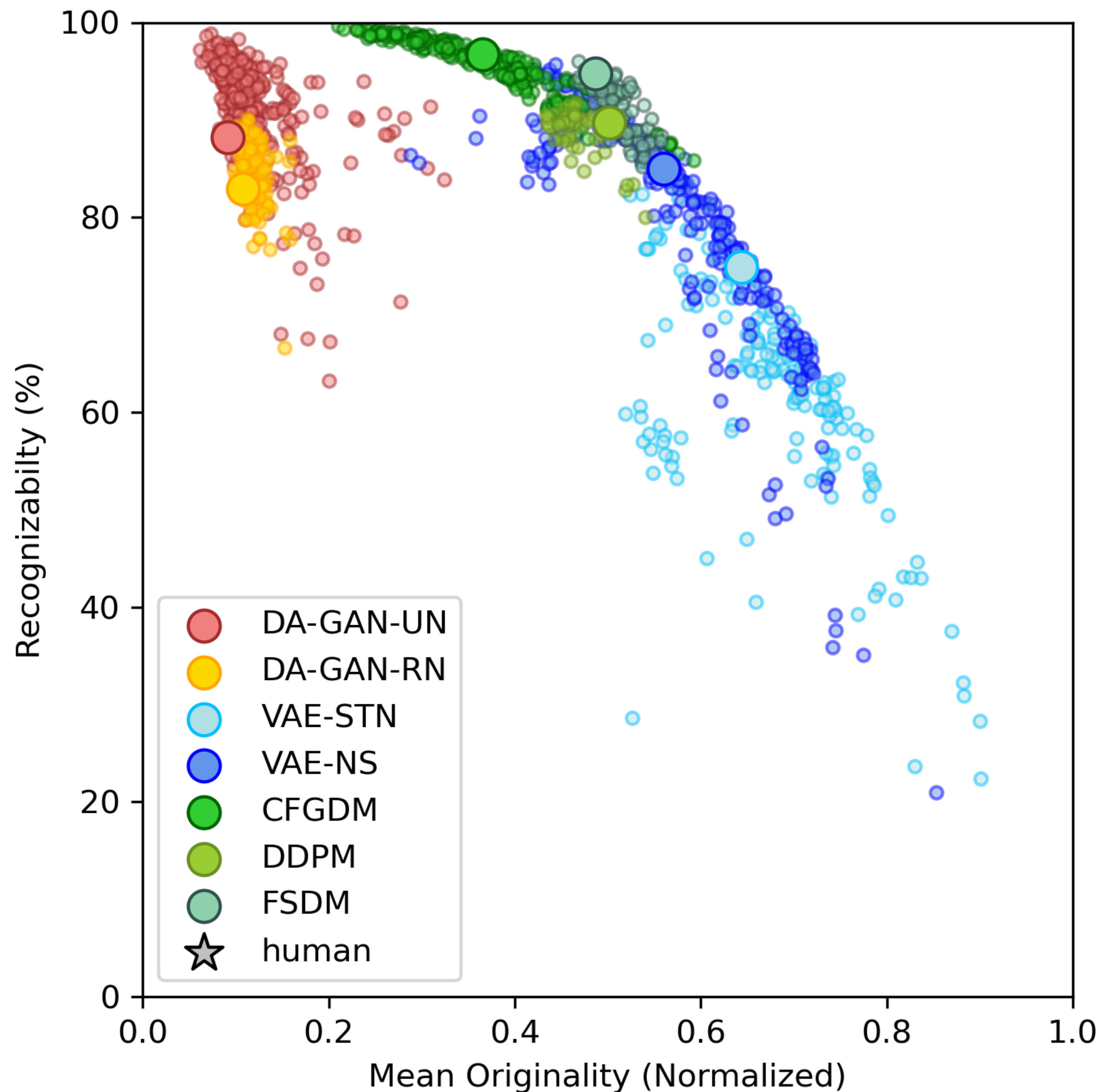
GAN drops modes

(LUCAS ET AL 2019)

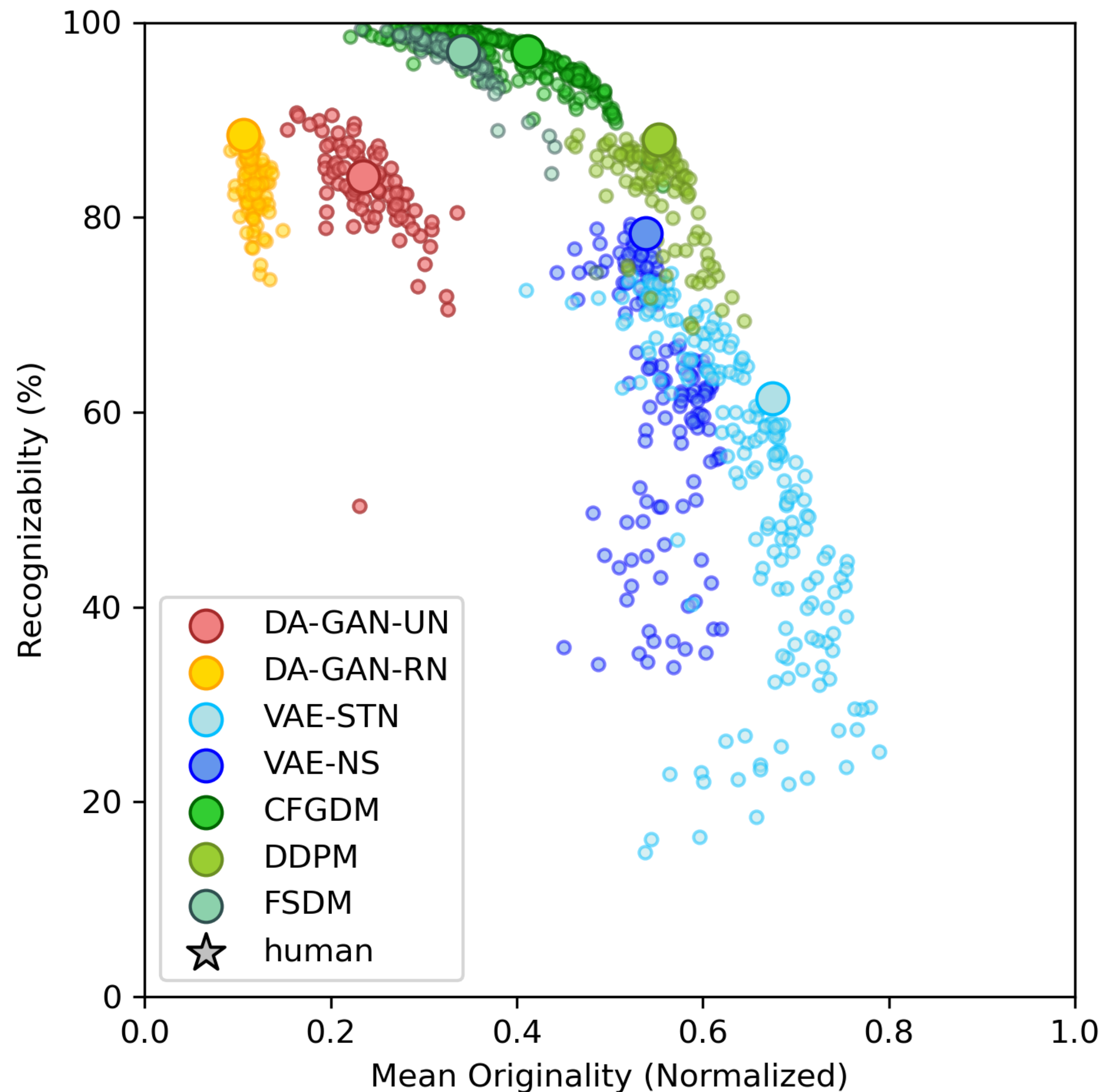


Models in the Originality vs. Recognizability Space (BOUTIN ET AL 2023)

Omniglot

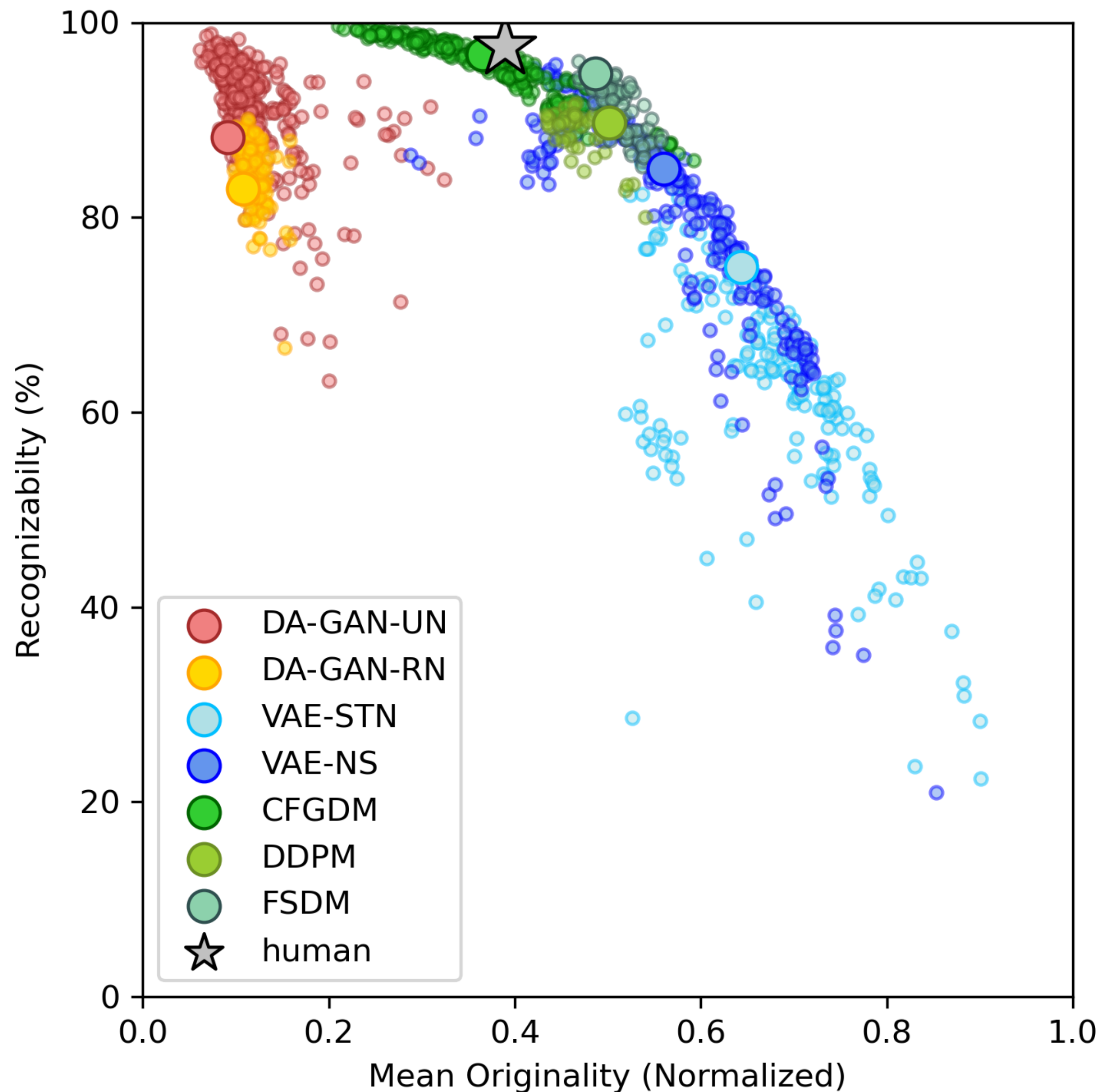


Quick, Draw !

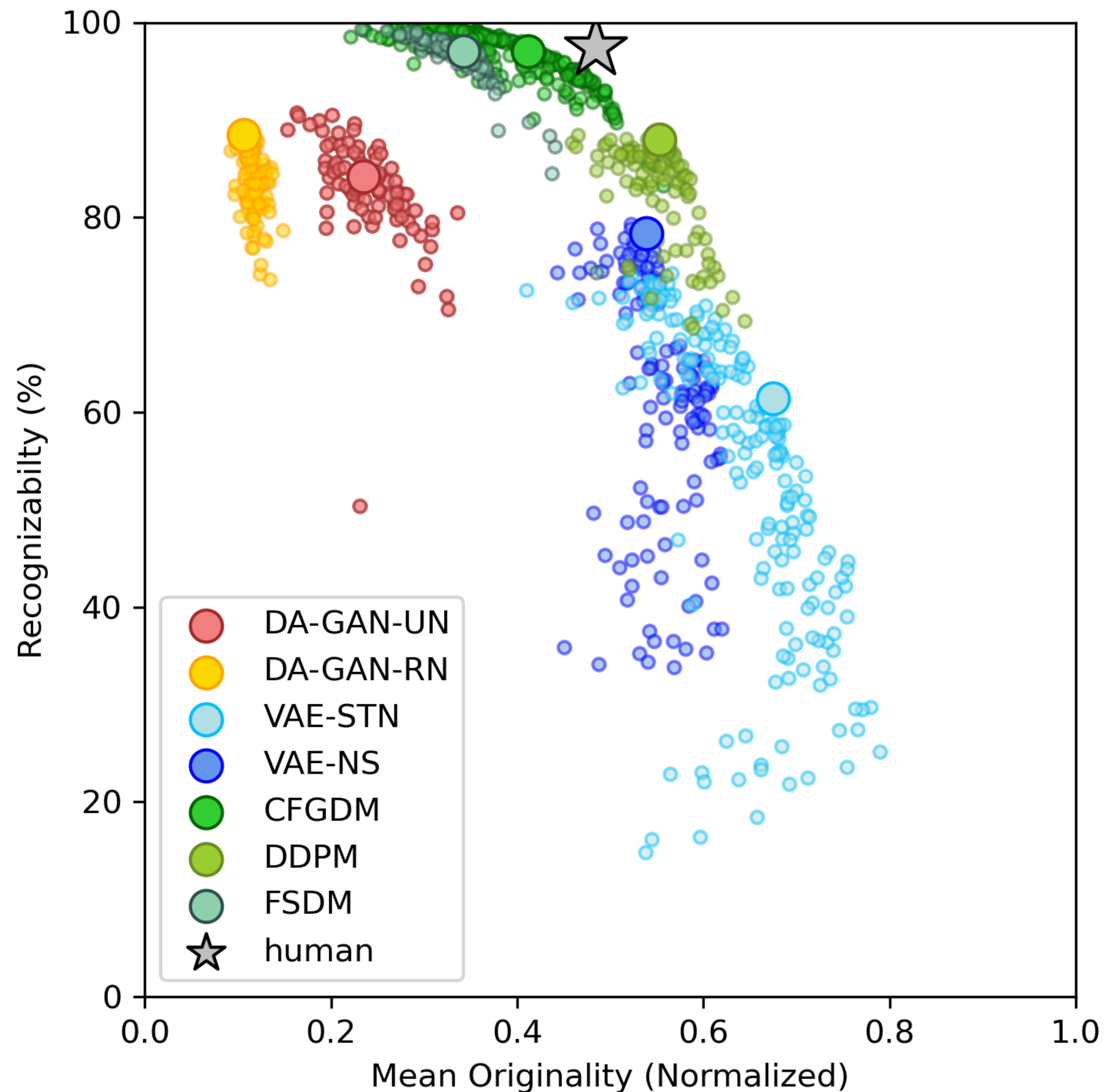


Models in the Originality vs. Recognizability Space (BOUTIN ET AL 2023)

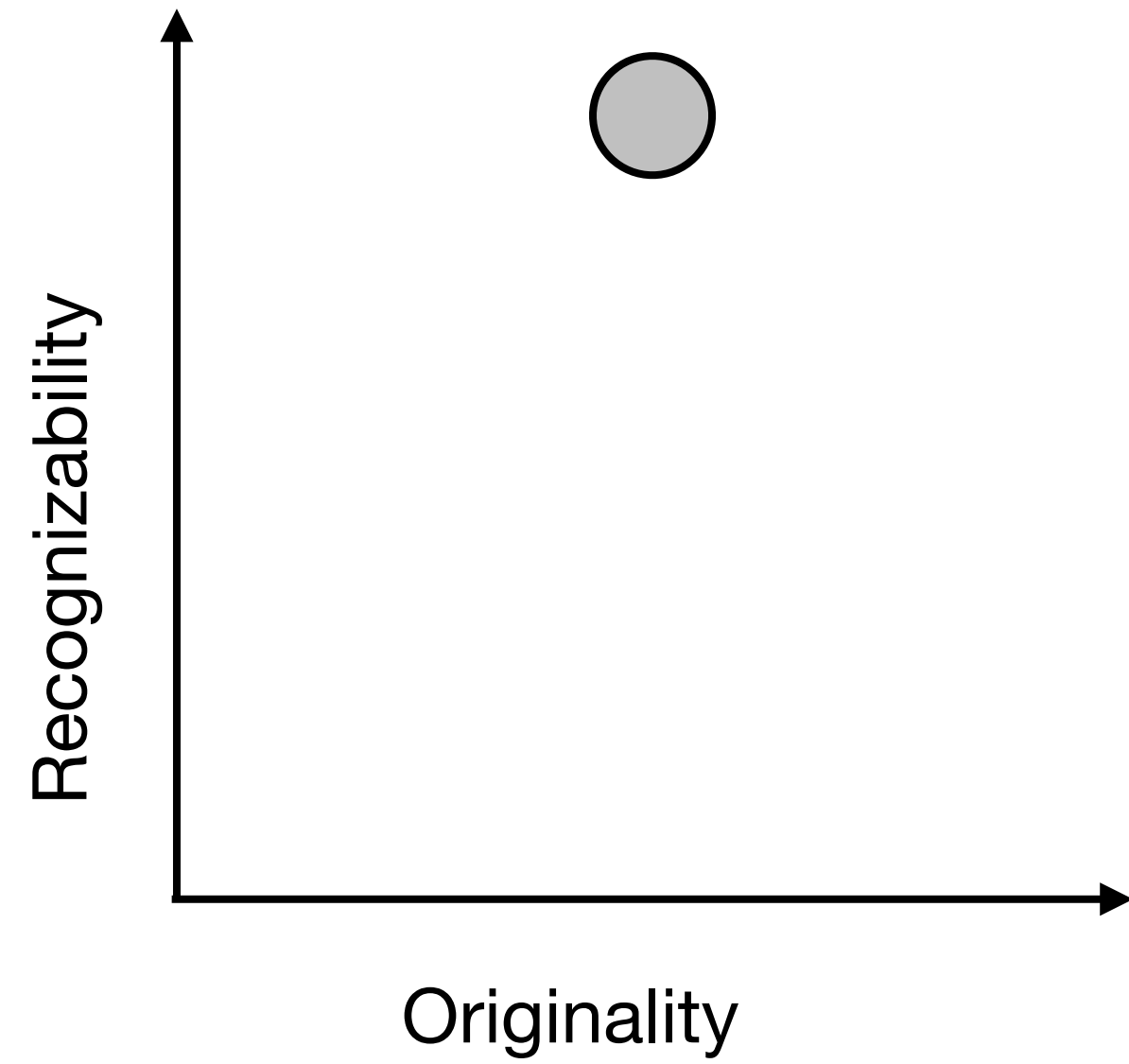
Omniglot



Quick, Draw !

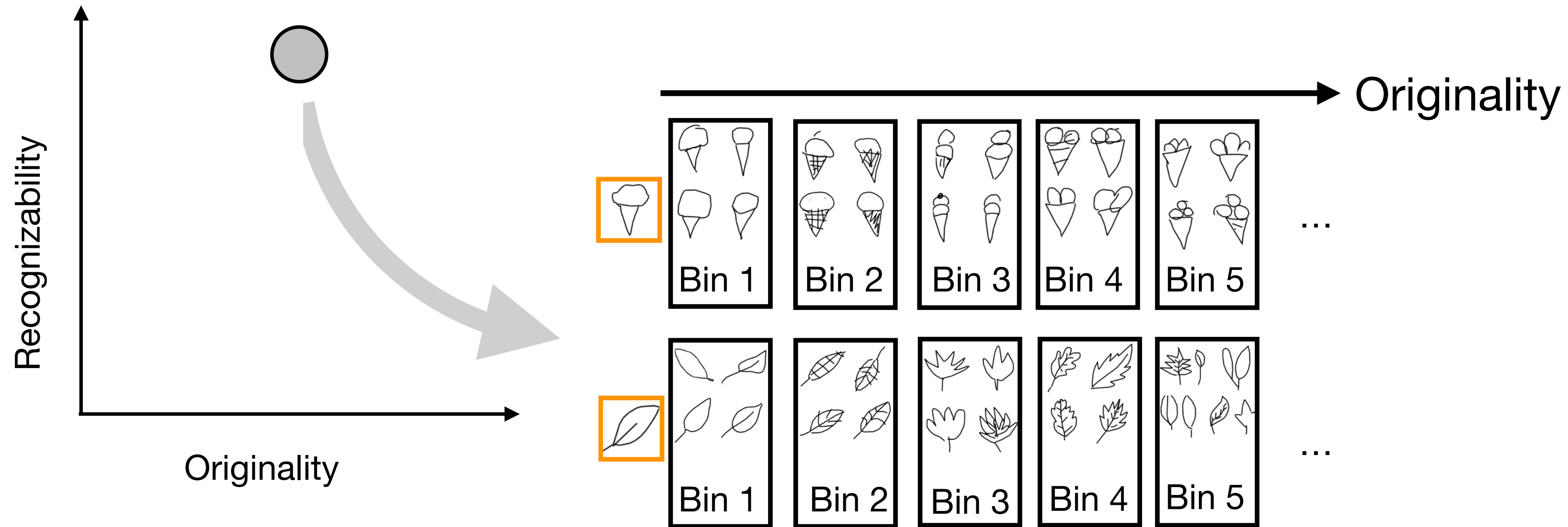


Generalization Curves : Recognizability = f(Originality)



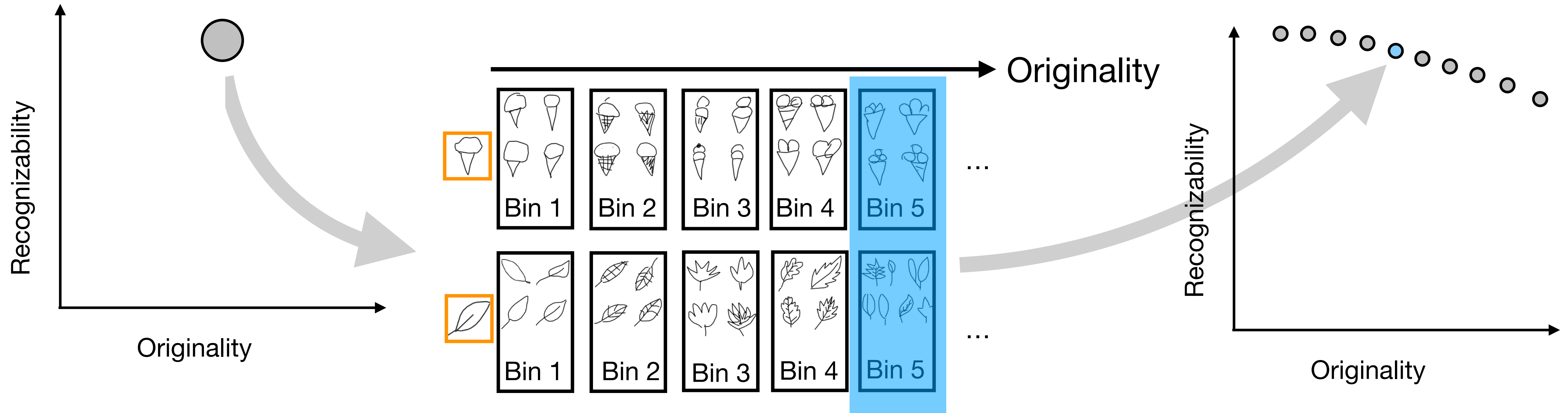
One model = one data point

Generalization Curves : Recognizability = f(Originality)



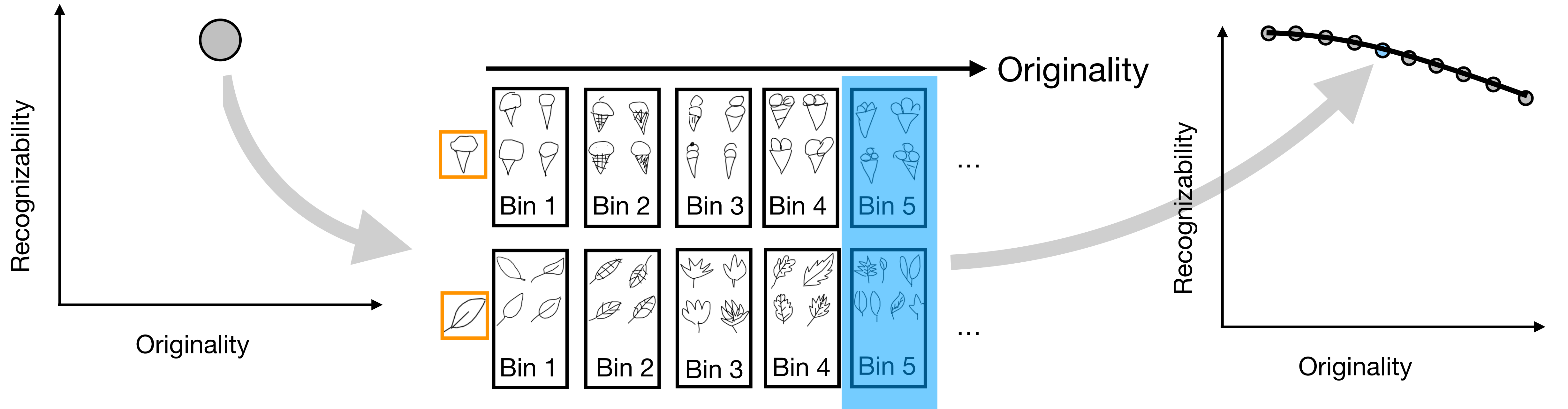
One model = one data point

Generalization Curves : Recognizability = f(Originality)



One model = one data point

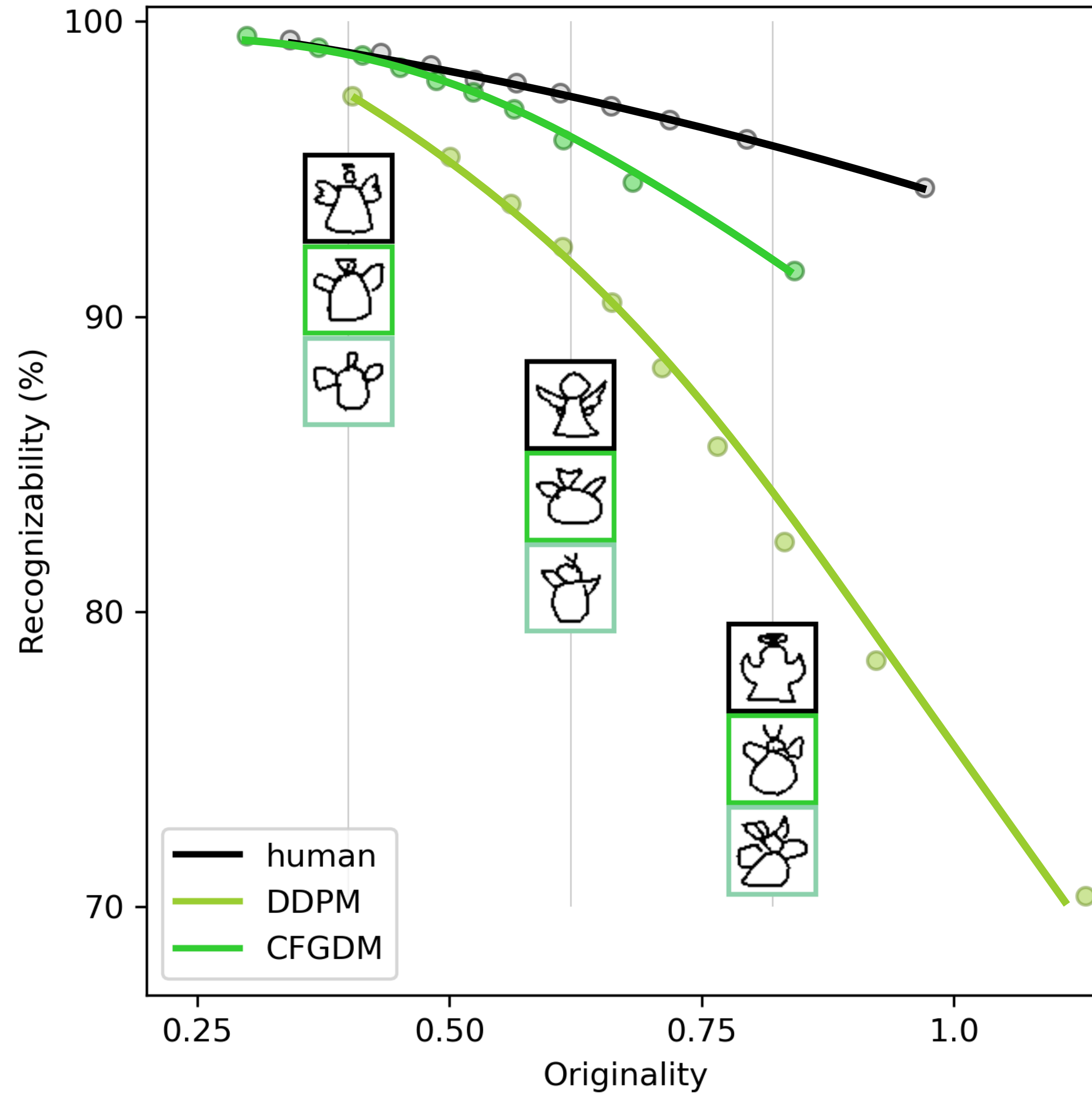
Generalization Curves : Recognizability = f(Originality)



One model = one data point

One model = one curve

Generalization Curves for Diffusion models



Important Features for Humans and Machines

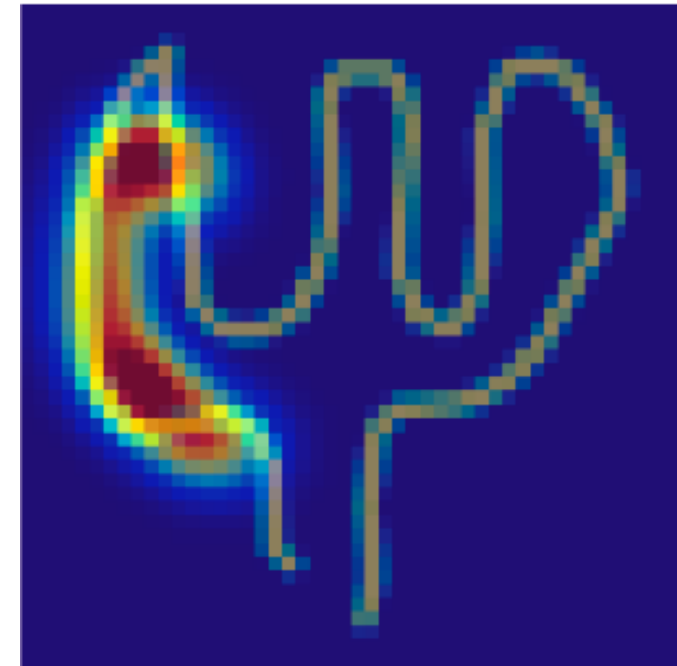
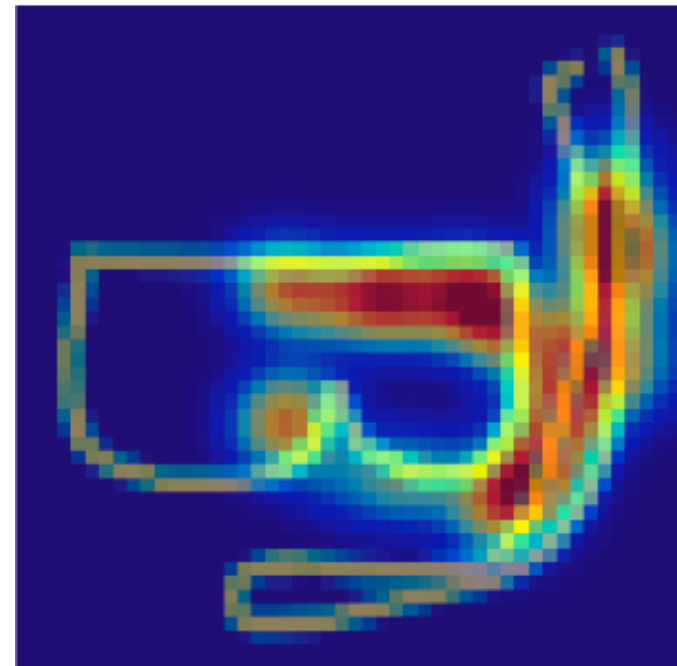
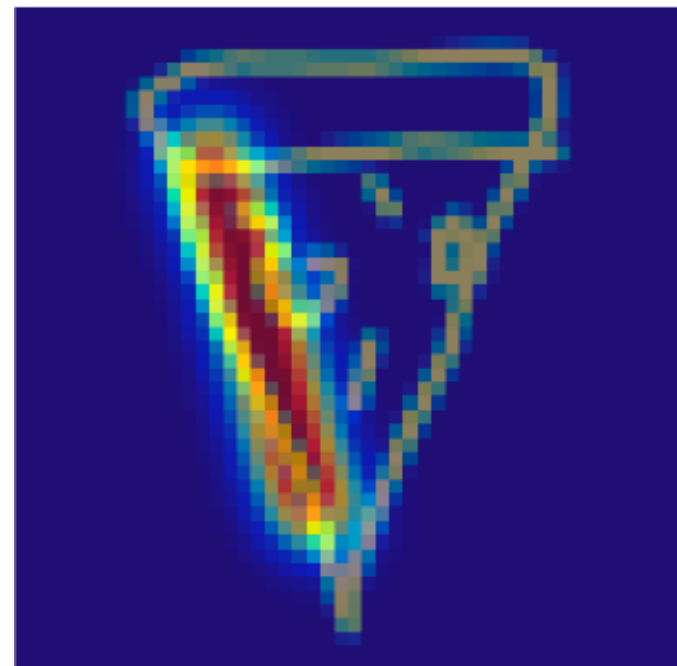
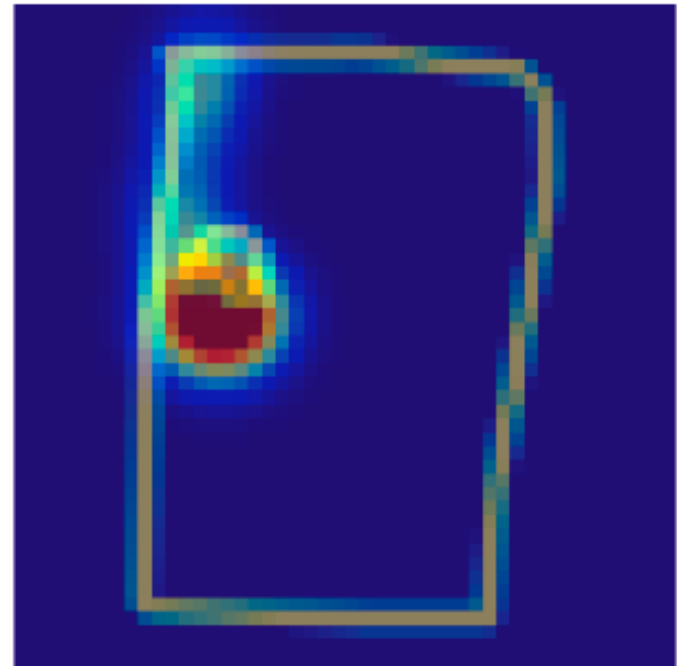
Important Features for Humans and Machines

- Human importance maps collected using the ClickMe challenge (LINSLEY ET AL 2019)



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Help the AI recognize this drawing before time runs out!

microwave



100 pts  1 min

[Skip this image: it has a strange label or poor quality.](#)

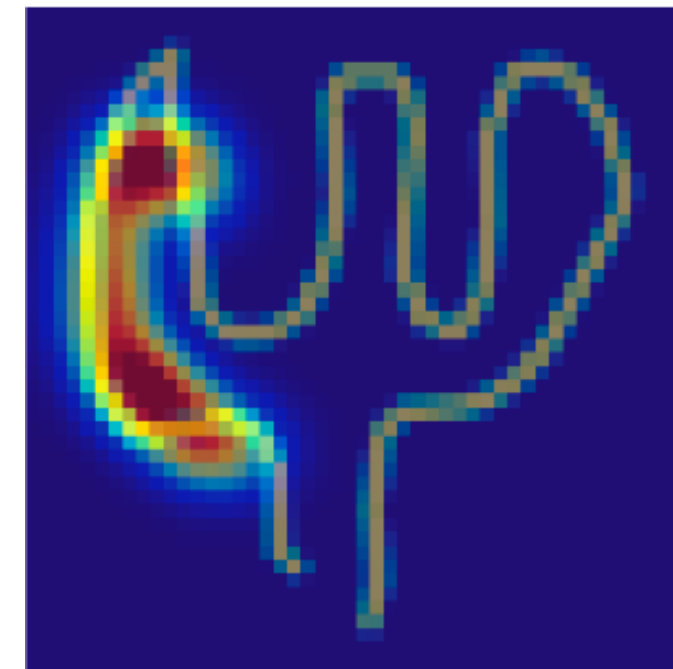
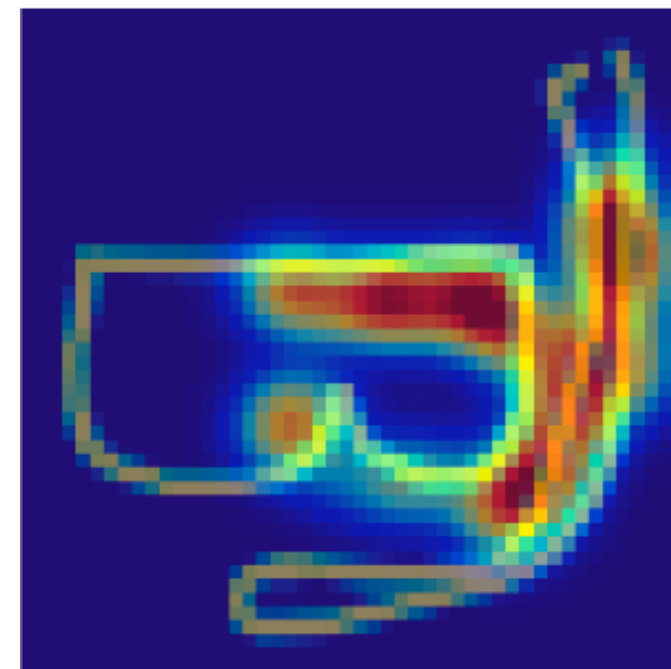
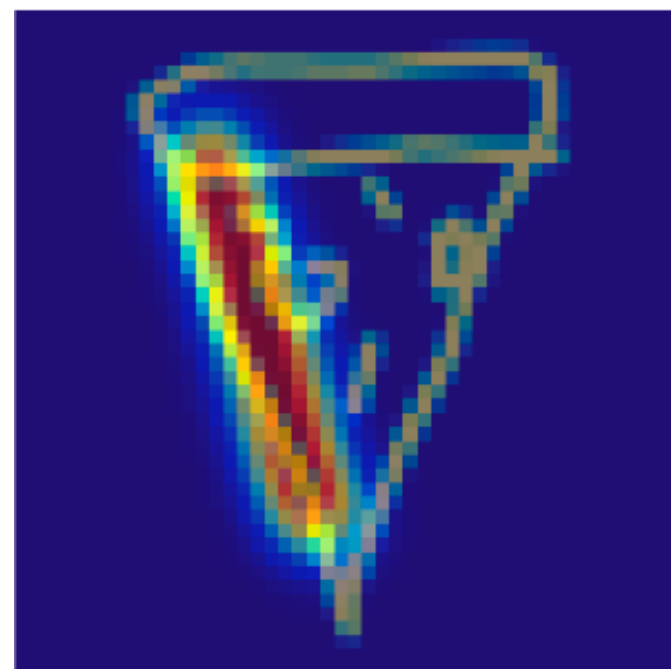
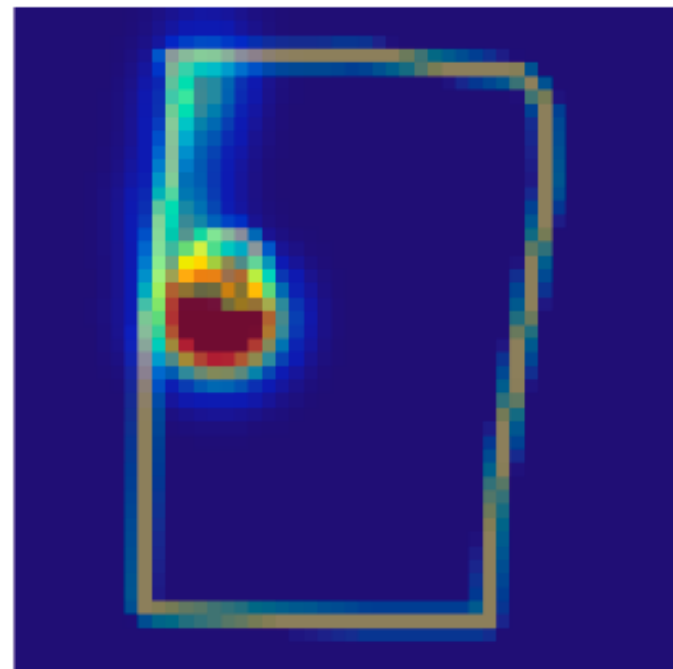
Your score: 3269.46 | High score: 3269.46

Number of images needed until we can improve this AI's recognition:

Progress  0 5000 10000 15000 20000

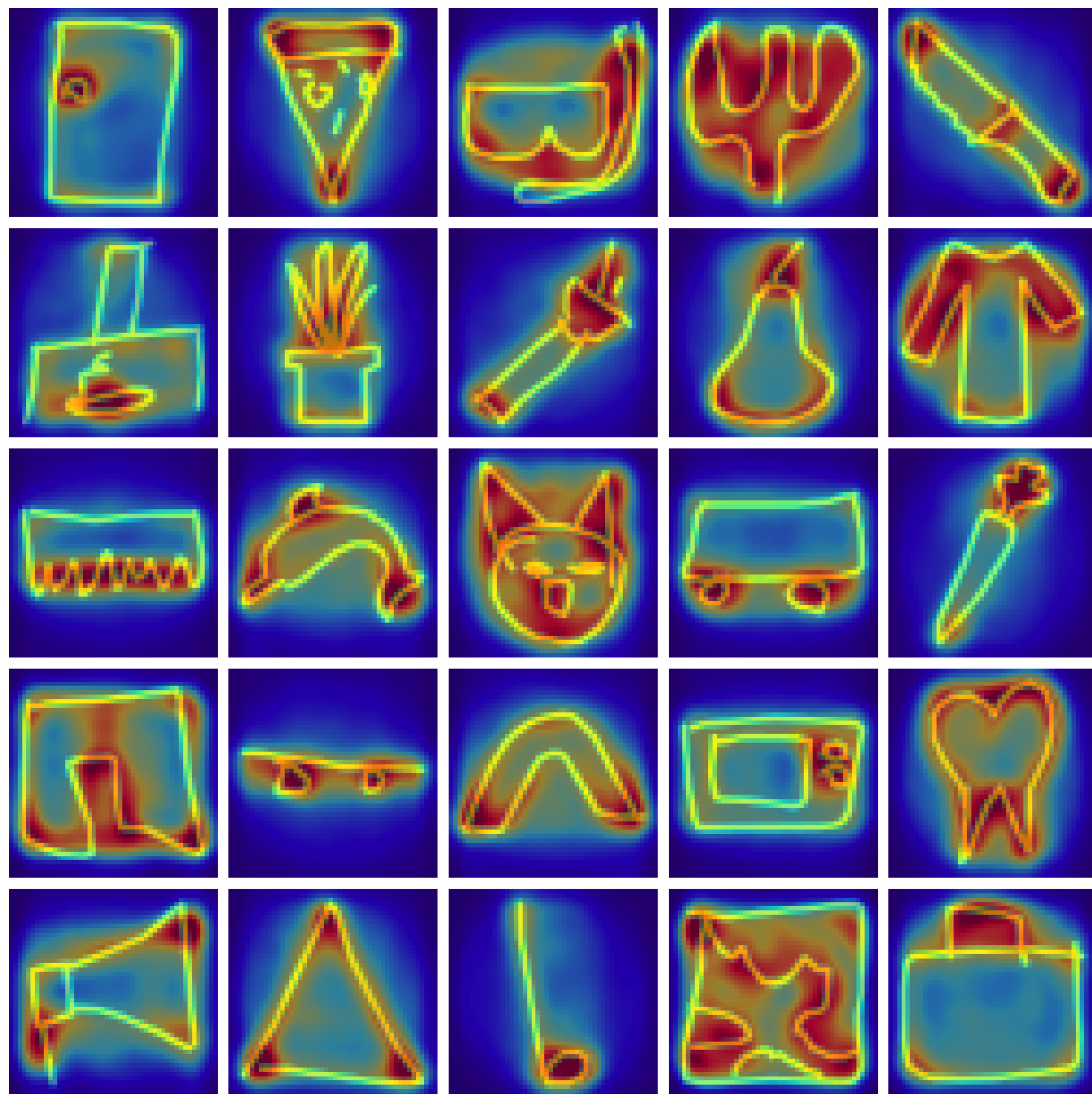
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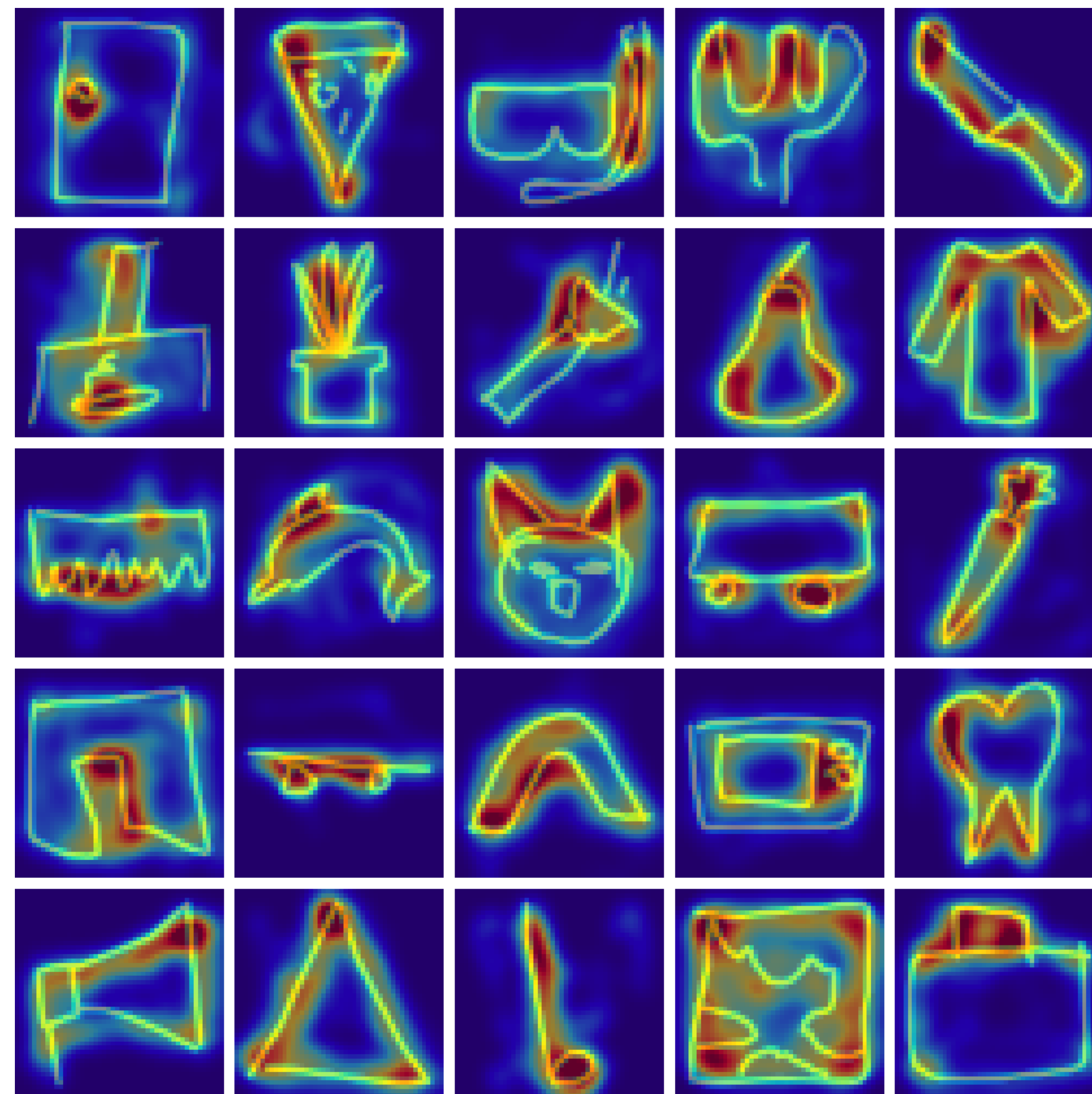


- **CFGDM** importance maps using attribution methods

Important Features for Humans and Machines



CFGDM



human

Conclusion/Discussion

Diffusion models well approximate non-original human drawing

Conclusion/Discussion

Diffusion models well approximate non-original human drawing

BUT fail at modeling original drawings

Conclusion/Discussion

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BUT fail at modeling original drawings

Few localized features = room for creativity ?

Thank you for your attention...



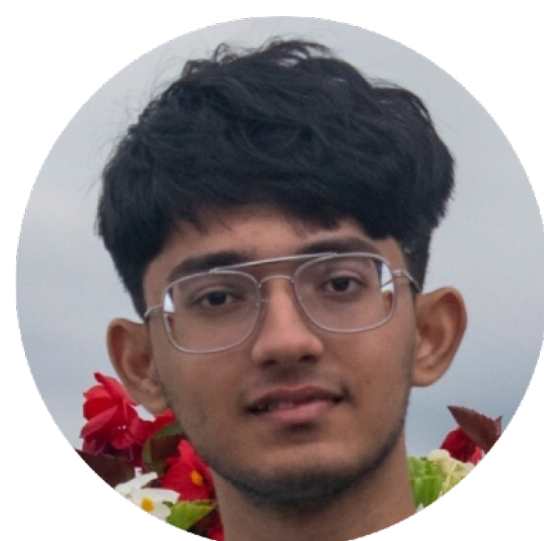
Victor Boutin



Thomas Fel



Lakshya Singhal



Rishav Mukherji



Akash Nagaraj



Julien Colin



Thomas Serre

Come to our poster tomorrow at 2 pm : Hall 1 #434

Fundings:

