The end of mathematical modeling?

“GANs” vs “ODEs”

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Artificial intelligence

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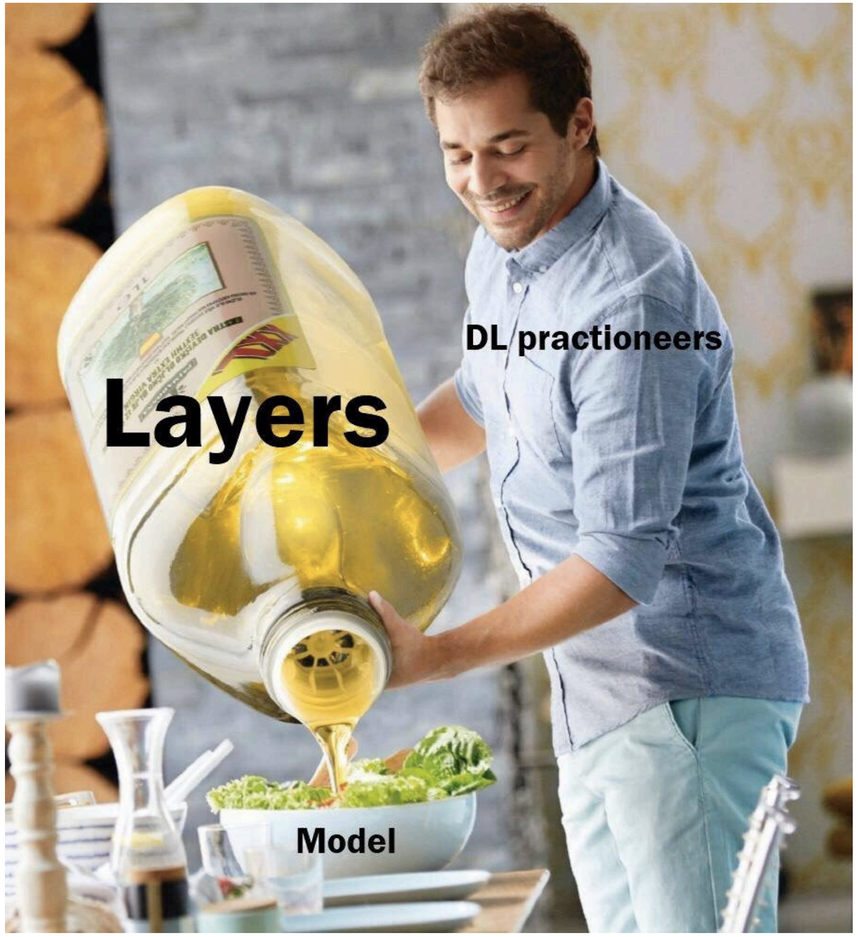
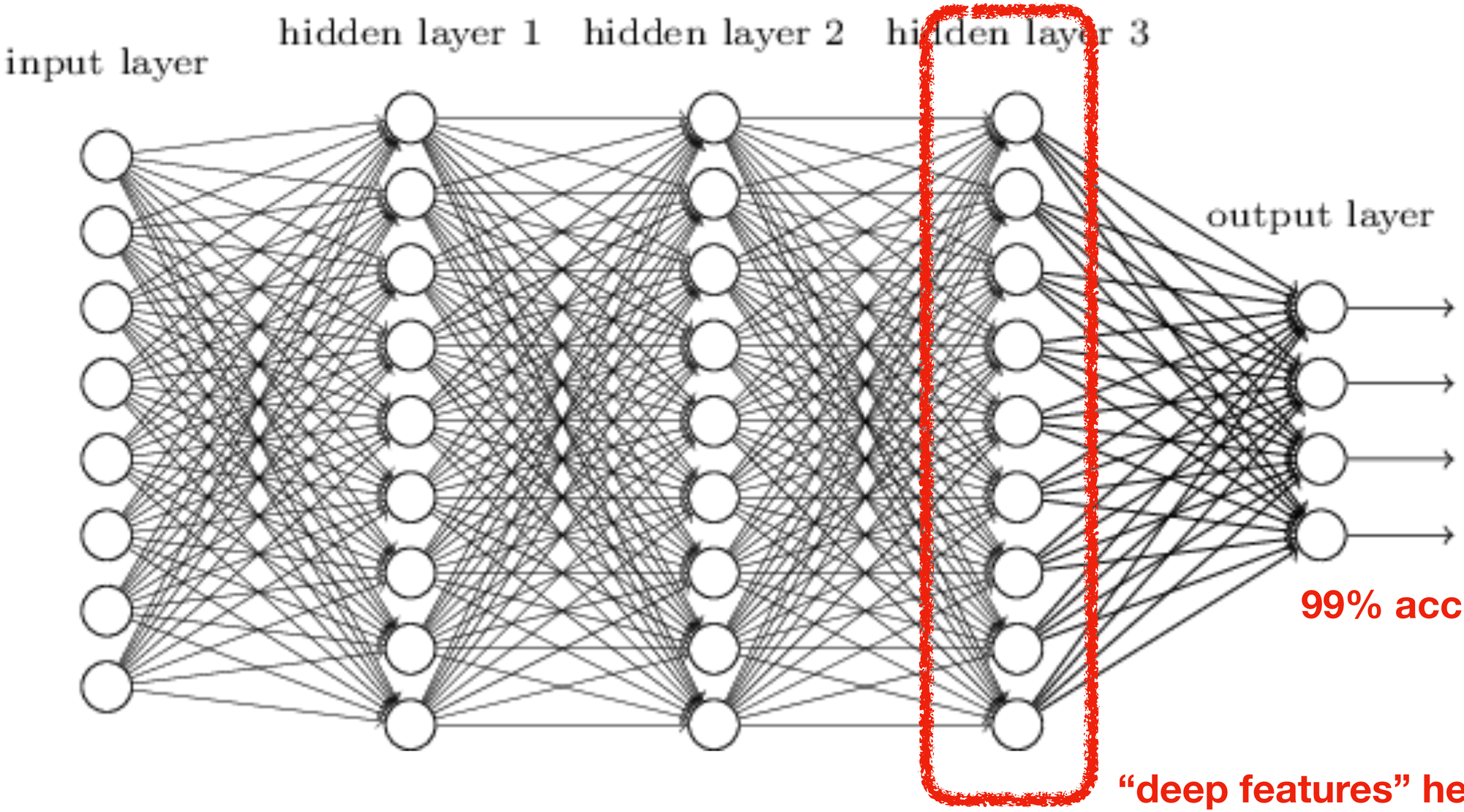
Healthcare

AI Solutions Architect @ Mawi Solutions

Finance

Researcher @ University of Verona



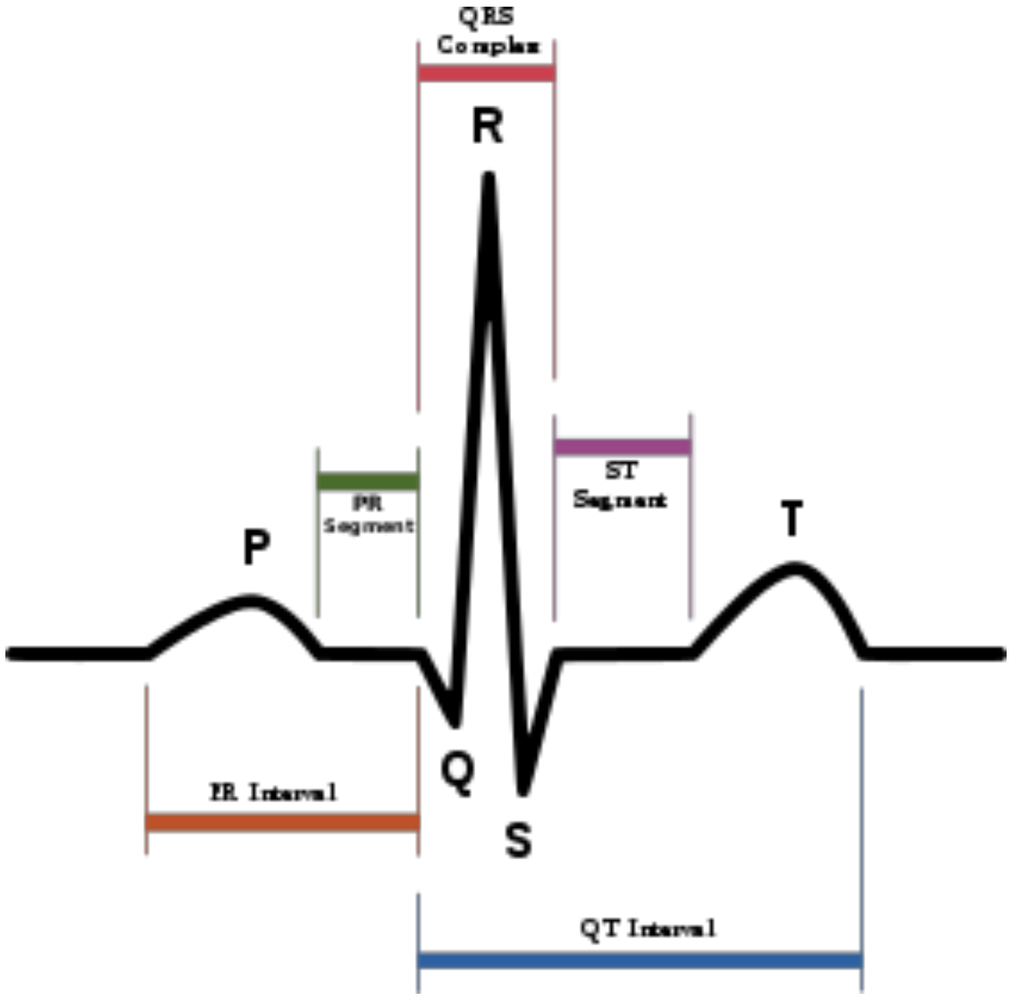


99% accuracy here

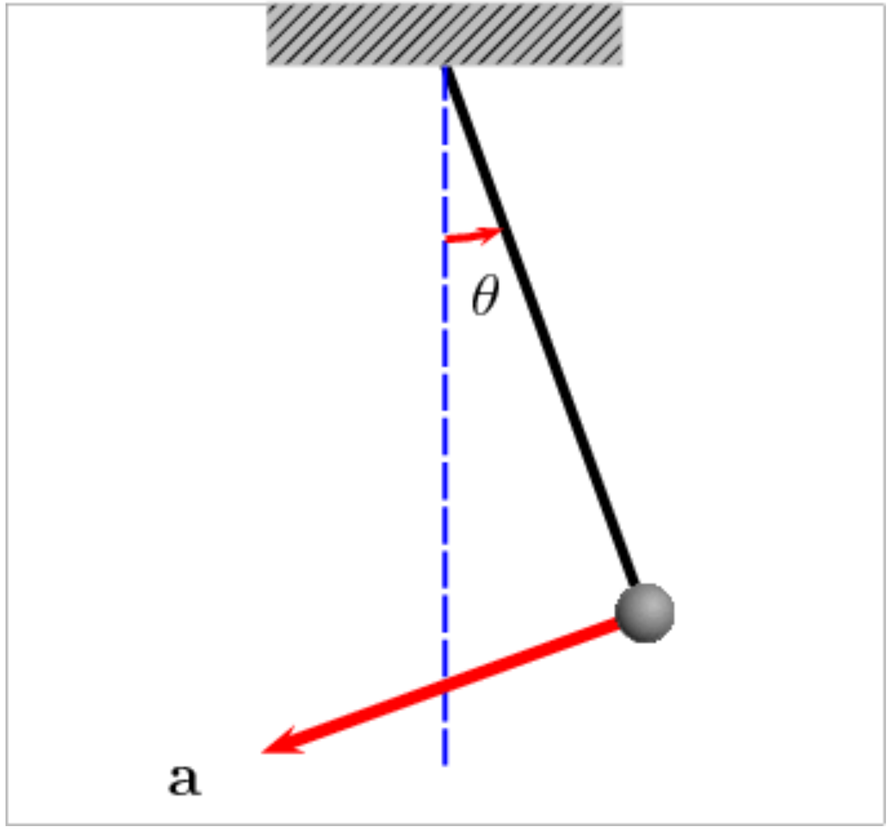
“deep features” here

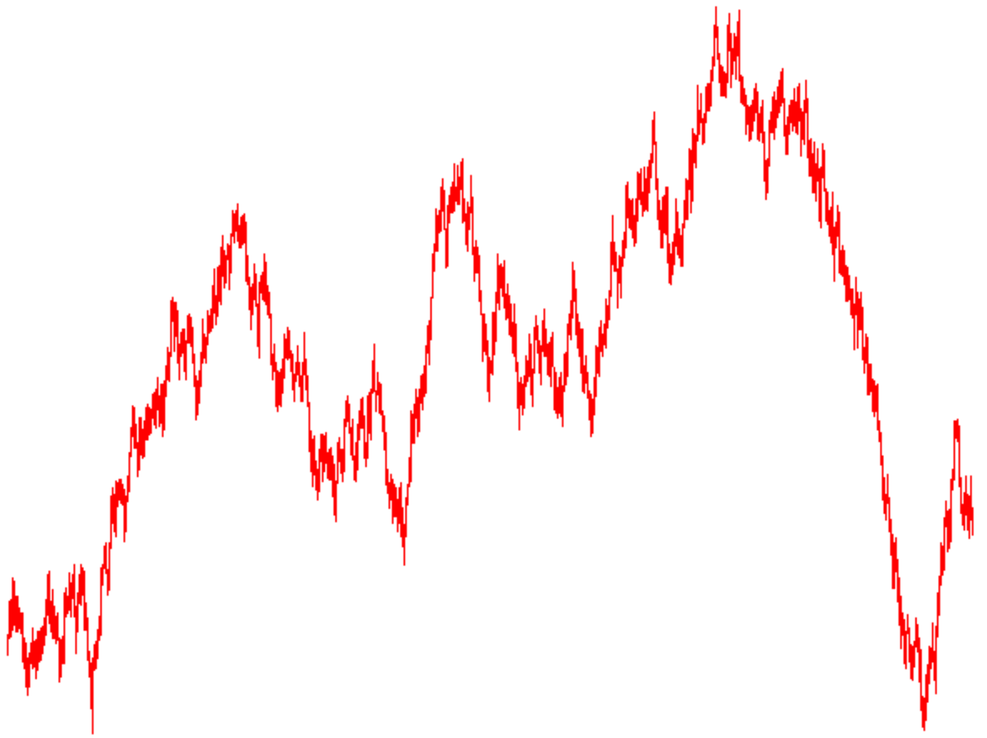
http://neuralnetworksanddeeplearning.com

What kind of model I want	Deep neural nets	Perfect model
Deals with complex data	✅	✅
Accurate in inference tasks	✅	✅
Easy to interpret	❌	✅
Needs a little dataset, better unsupervised	❌	✅ / ✅
Zero-shot reuse in different environments	❌	✅
Allows to generate objects	⚠️	✅
Allows to manipulate objects	❌	✅
Follows up with previous theorems / knowledge	❌	✅



$$f_i = \sum_{i \in P,R,S,T} \left(\pm \frac{d}{dt} \right)^i M_i e^{-\left(\frac{t-t_i}{\sqrt{2}w_i} \right)^2} + \sum_{i \in Q, j=1}^{j=2} M_{ij} e^{-\left(\frac{t-t_{ij}}{w_{ij}} \right)^2} + N_{j,SNR}(t)$$

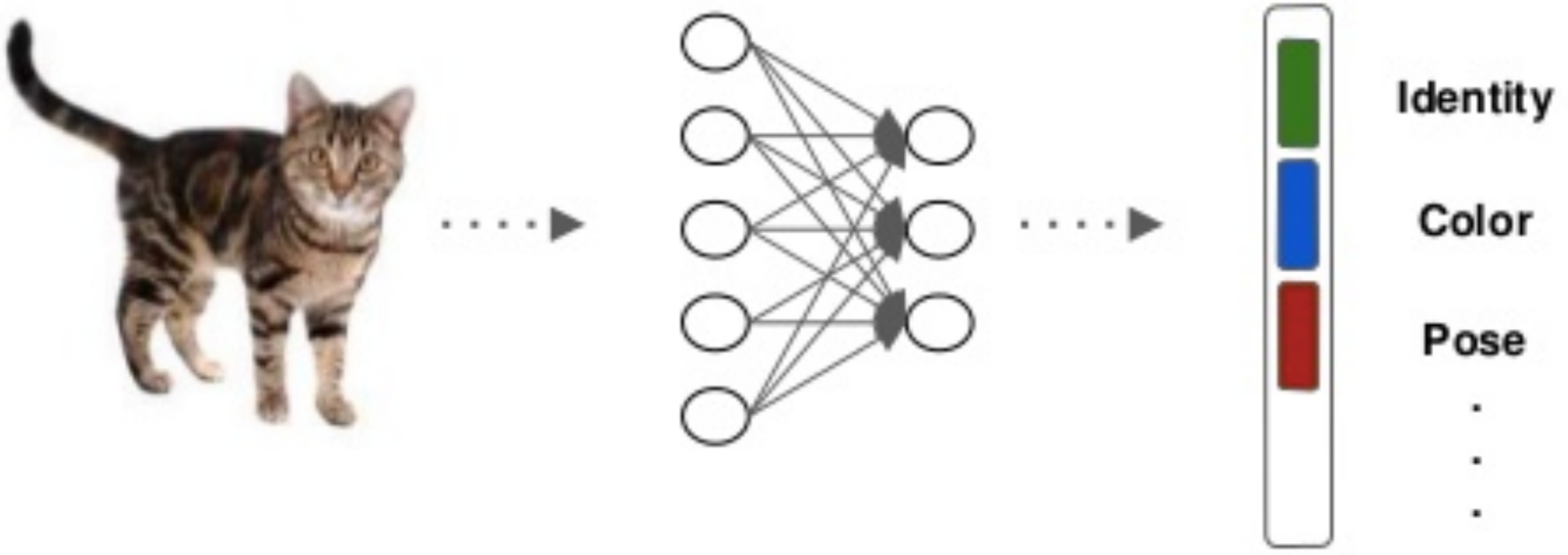




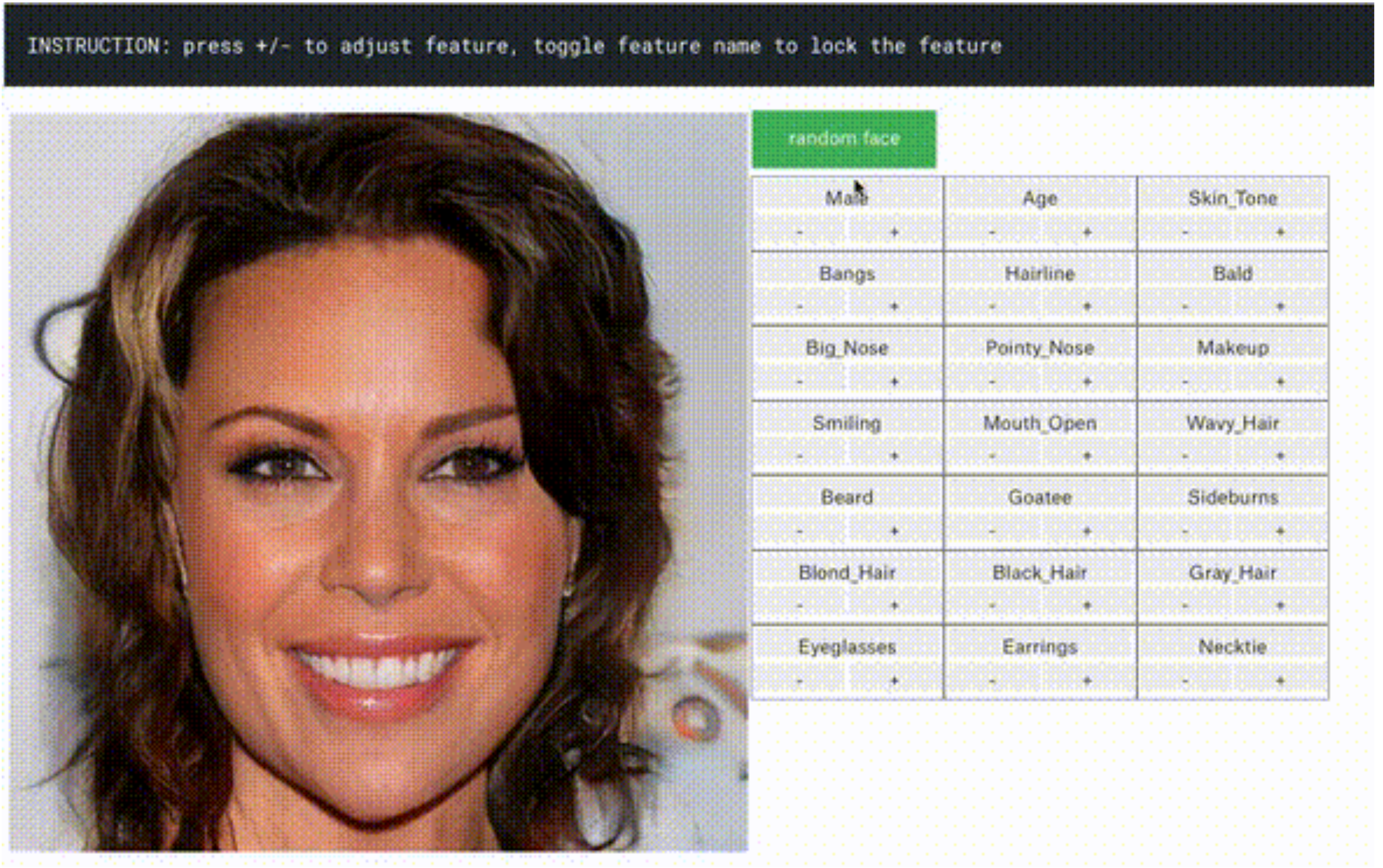
$$\frac{d^2\theta}{dt^2} + \frac{g}{\ell}\sin\theta = 0$$

$$X_t = \mu t + \sigma W_t$$

What kind of model I want	Deep neural nets	“classical modeling”
Deals with complex data	✅	❌
Accurate in inference tasks	✅	⚠️
Easy to interpret	❌	✅
Needs a little dataset, better unsupervised	❌	✅ / ⚠️
Zero-shot reuse in different environments	❌	✅
Allows to generate objects	⚠️	✅
Allows to manipulate objects	❌	✅
Follows up with previous theorems / knowledge	❌	✅

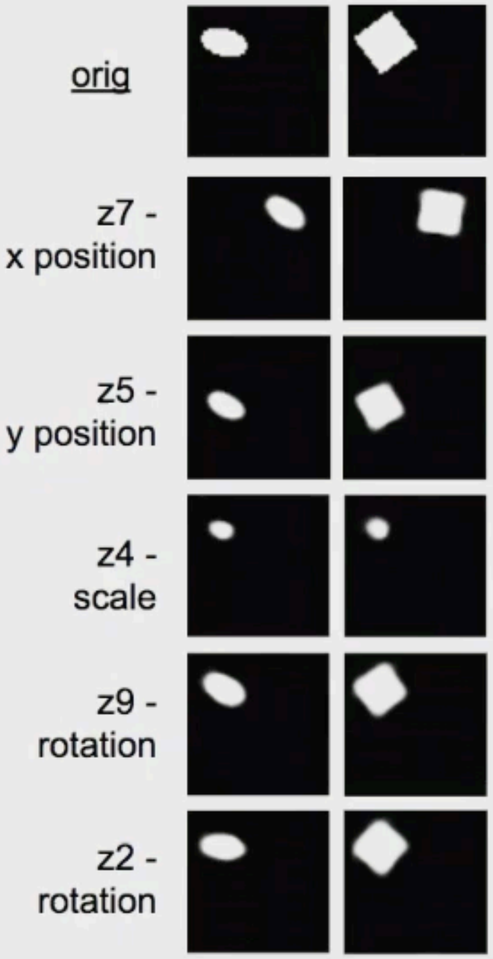


Emily Denton - Unsupervised Learning of Disentangled Representations from Video - Creative AI meetup



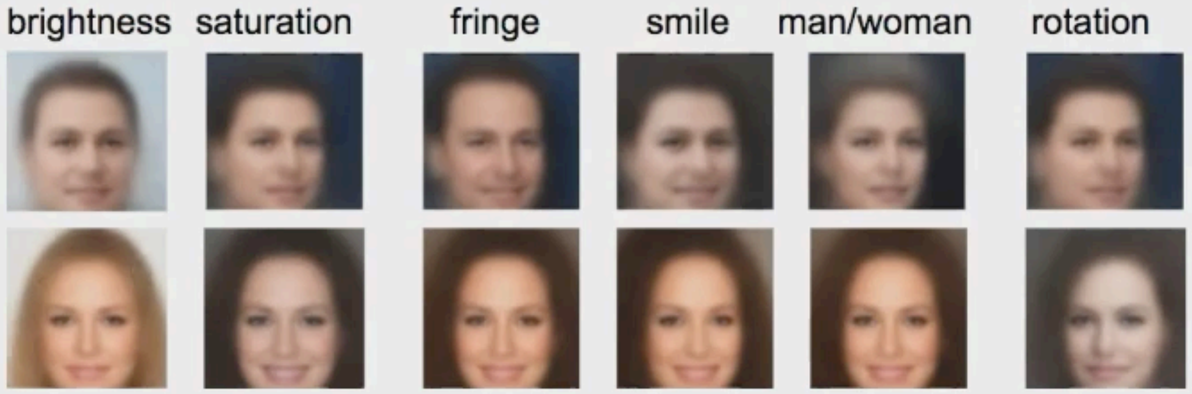
TL-GAN: transparent latent-space GAN

dSprites

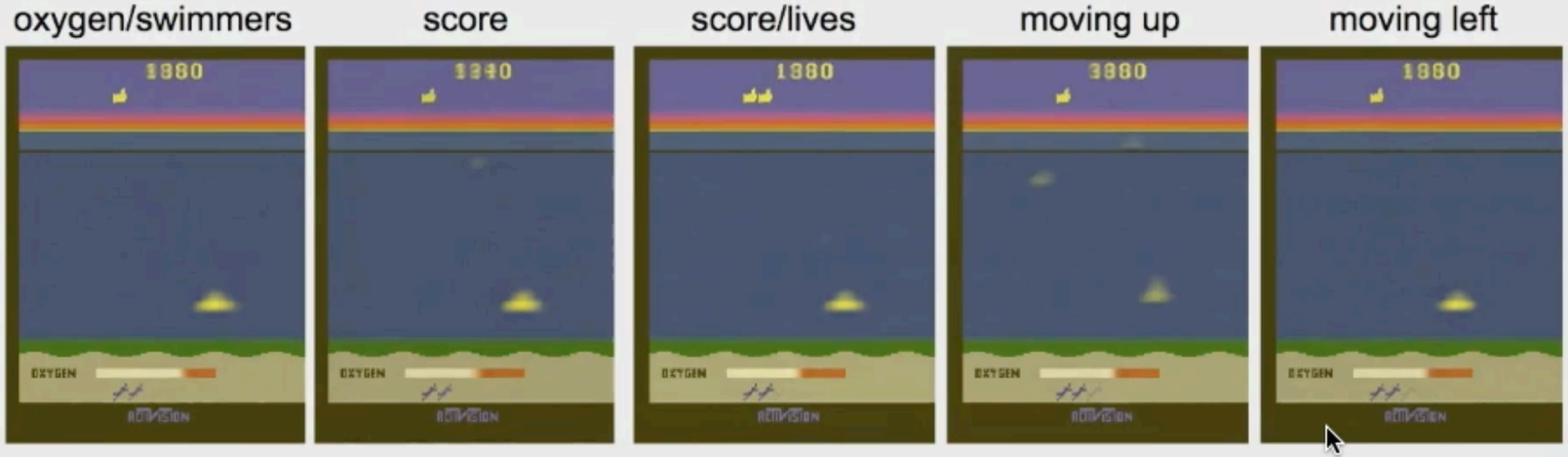


Matthey et al. 2017

CelebA



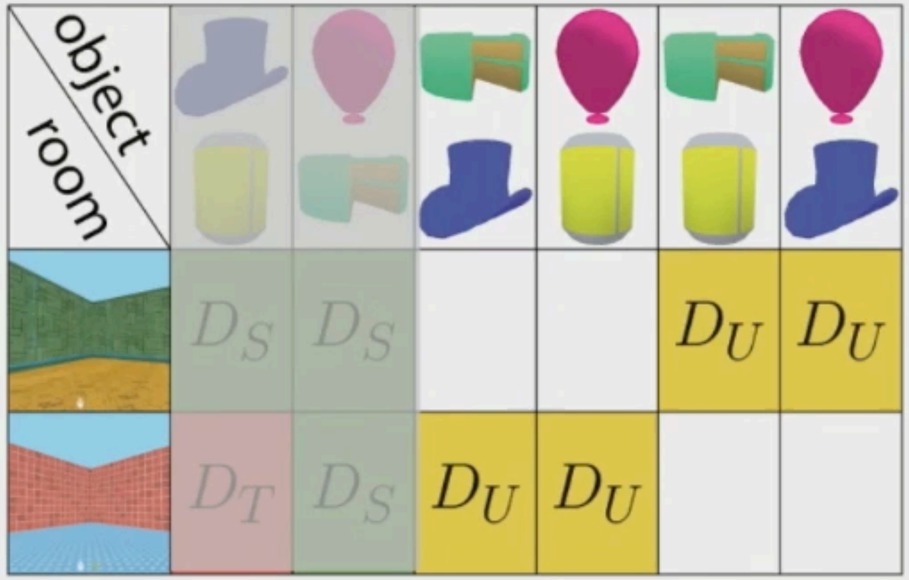
Atari: SeaQuest



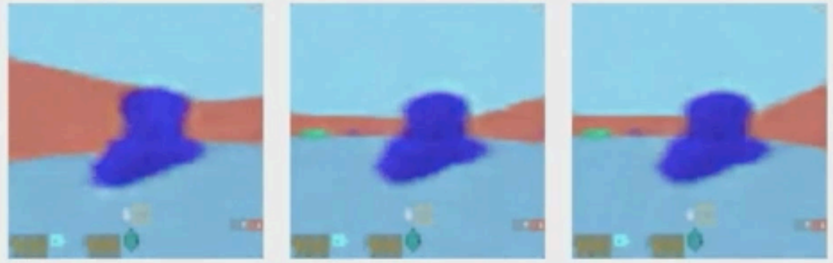
Loic Matthey: Learning and leveraging disentangled representations for RL

Loic Matthey: Learning and leveraging disentangled representations for RL

Learn representation on
held-out combinations of data

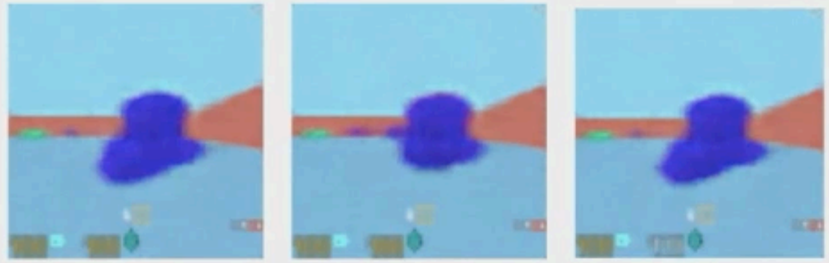


Environment



Main object

Score



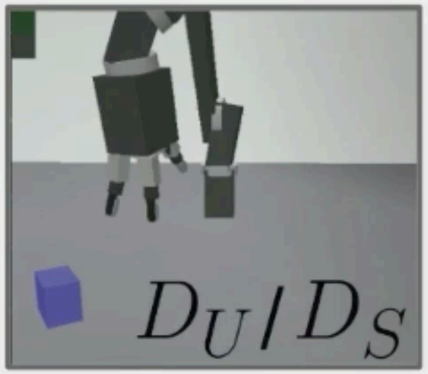
Background objects

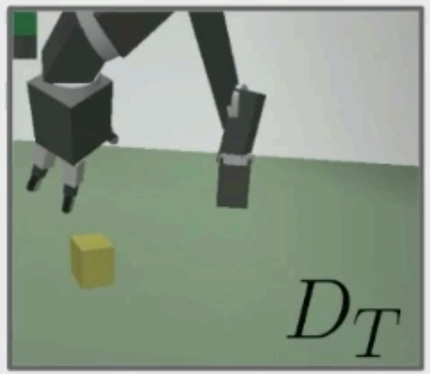
DeepMind

Loic Matthey: Learning and leveraging disentangled representations for RL

Learn to control a Jaco arm to reach to objects

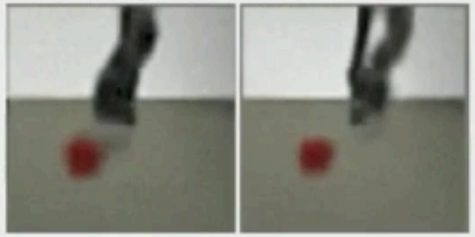
sim2sim





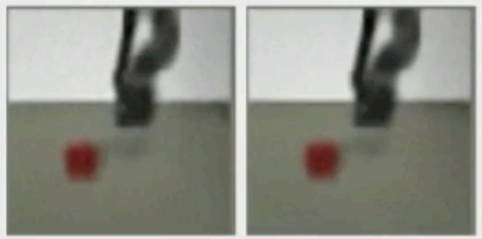
arm

left/right up/close



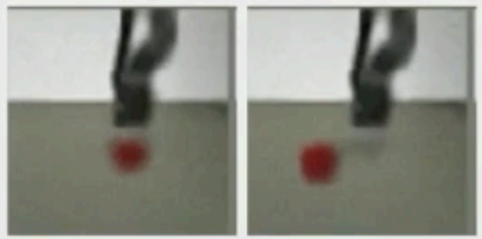
camera

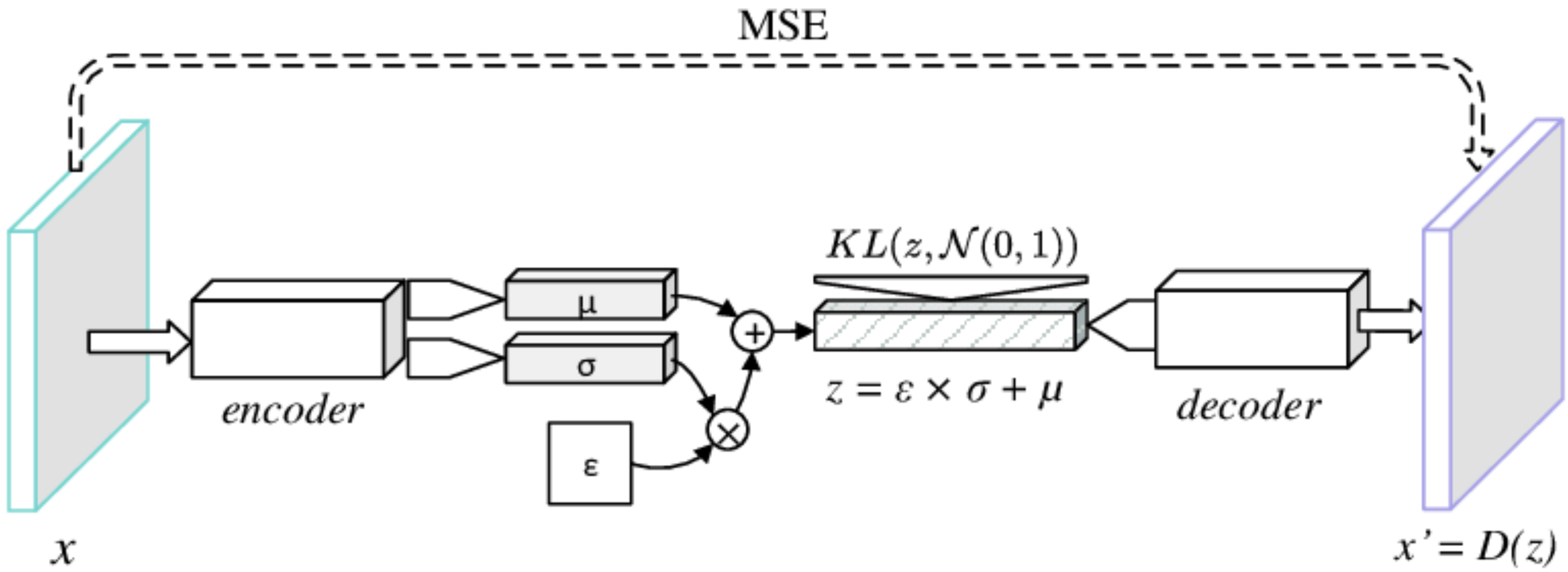
vertical horizontal



object

left/right close/far





Unsupervised Learning for Concept Detection in Medical Images: A Comparative Analysis

$$\mathcal{L}(\theta, \phi; \mathbf{x}, \mathbf{z}, \beta) = \mathbb{E}_{q_\phi(\mathbf{z}|\mathbf{x})}[\log p_\theta(\mathbf{x}|\mathbf{z})] - \beta\, D_{KL}\big(q_\phi(\mathbf{z}|\mathbf{x}) \parallel p(\mathbf{z})\big)$$

reconstruction

disentanglement, β > 1

$$\mathcal{L}(\theta, \phi; \mathbf{x}, \mathbf{z}, \beta) = \mathbb{E}_{q_\phi(\mathbf{z}|\mathbf{x})}[\log p_\theta(\mathbf{x}|\mathbf{z})] - \beta\, D_{KL}\big(q_\phi(\mathbf{z}|\mathbf{x}) \parallel p(\mathbf{z})\big)$$

reconstruction

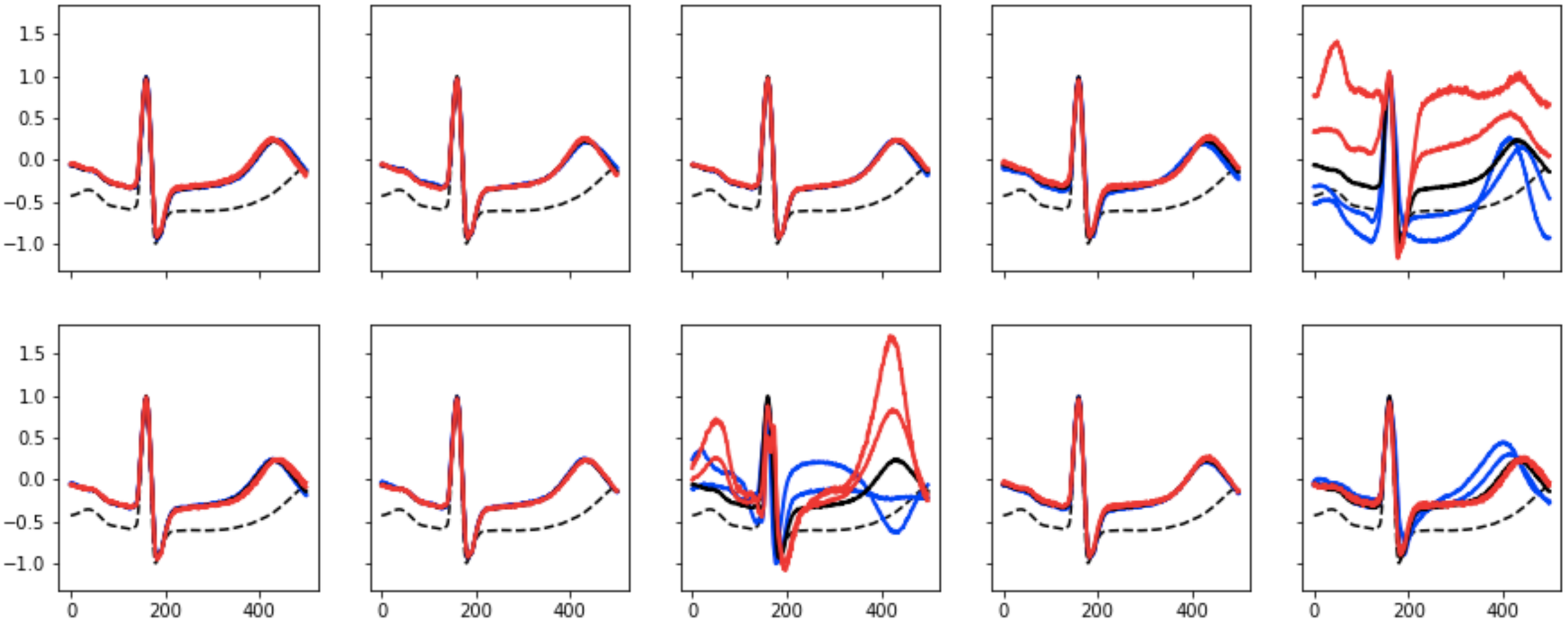
disentanglement, β > 1

$$\mathcal{L}(\theta, \phi; \mathbf{x}, \mathbf{z}, C) = \mathbb{E}_{q_\phi(\mathbf{z}|\mathbf{x})}[\log p_\theta(\mathbf{x}|\mathbf{z})] - \gamma\, |D_{KL}\big(q_\phi(\mathbf{z}|\mathbf{x}) \parallel p(\mathbf{z})\big) - C|$$

reconstruction

disentanglement, γ > 1,
C ~ 25-100

Form / Lead



MLP, MSE loss
50 epochs
lr = 5e-4
C = 25
γ = 100

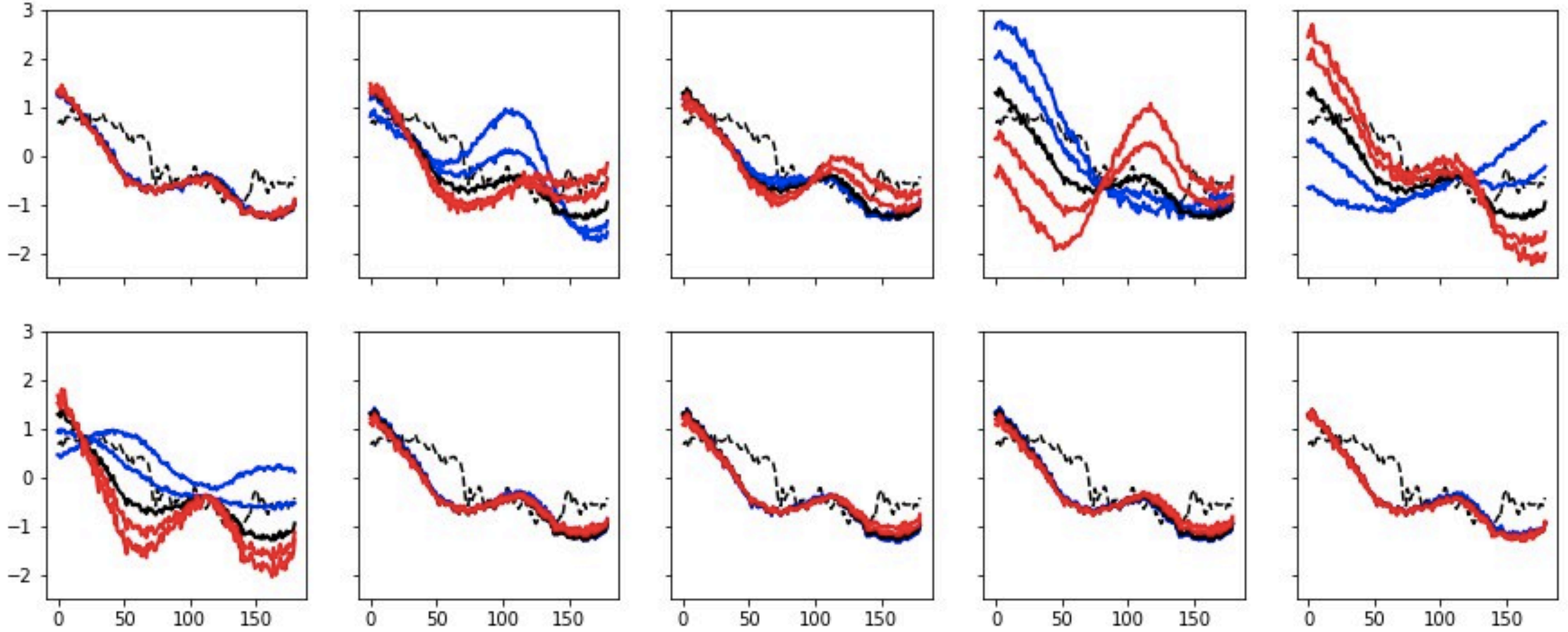
Infarction

Pulse

Mean reversion 3

Mean reversion 1

Trend



Mean reversion 2

MLP, MSE loss
50 epochs
lr = 5e-4
C = 100
γ = 1000

What kind of model I want	“classical modeling”	β-VAE
Deals with complex data	❌	✅
Accurate in inference tasks	⚠️	⚠️
Easy to interpret	✅	✅
Needs a little dataset, better unsupervised	✅ / ⚠️	⚠️ / ✅
Zero-shot reuse in different environments	✅	⚠️
Allows to generate objects	✅	✅
Allows to manipulate objects	✅	✅
Follows up with previous theorems / knowledge	✅	⚠️

What we didn’t talk about:

embedding algebra, metrics, bottleneck distributions, inference

The end of mathematical modeling?

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Medium: @alexrachnog
Alexandr Honchar