Introduction to the basics of AI - S9

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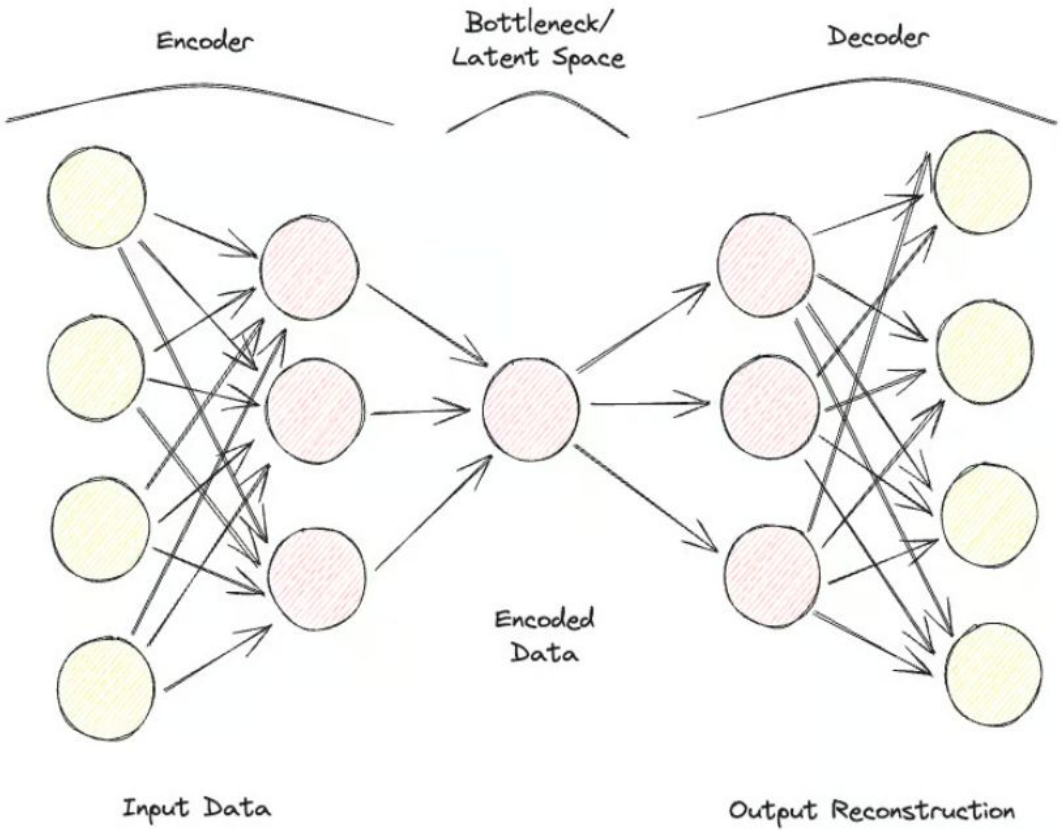
Outline for today’s course

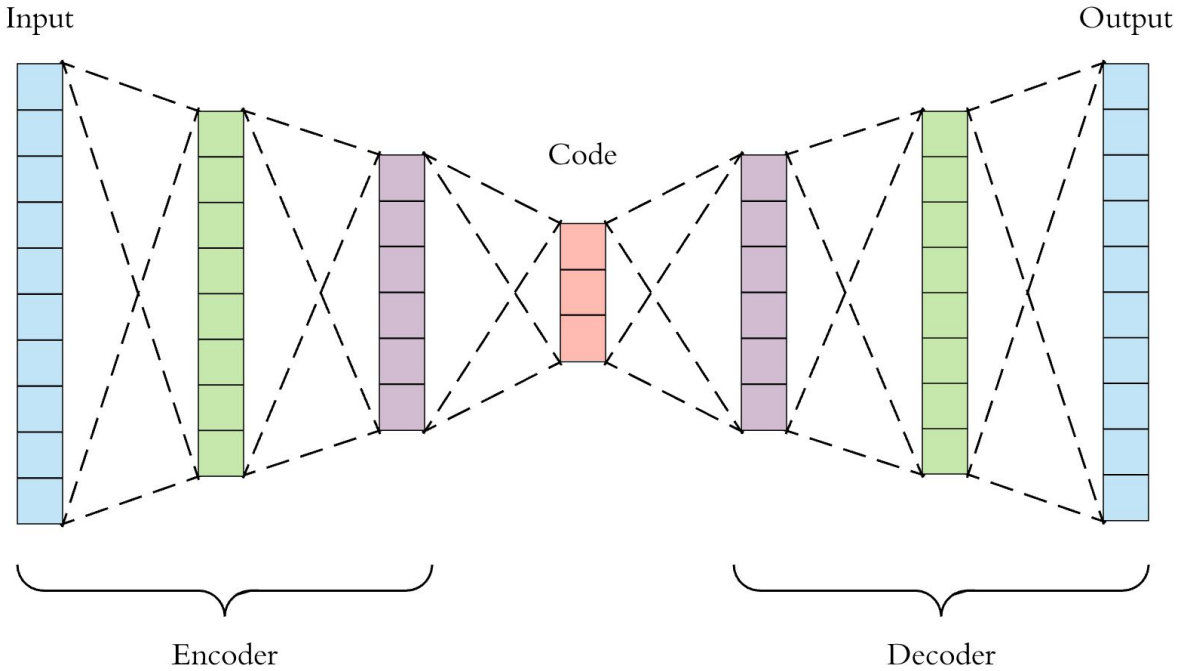
- Auto-Encoders
- CNN-Based Encoder-Decoder
- RNN-Based Encoder-Decoder
- Implementation

Auto-Encoders



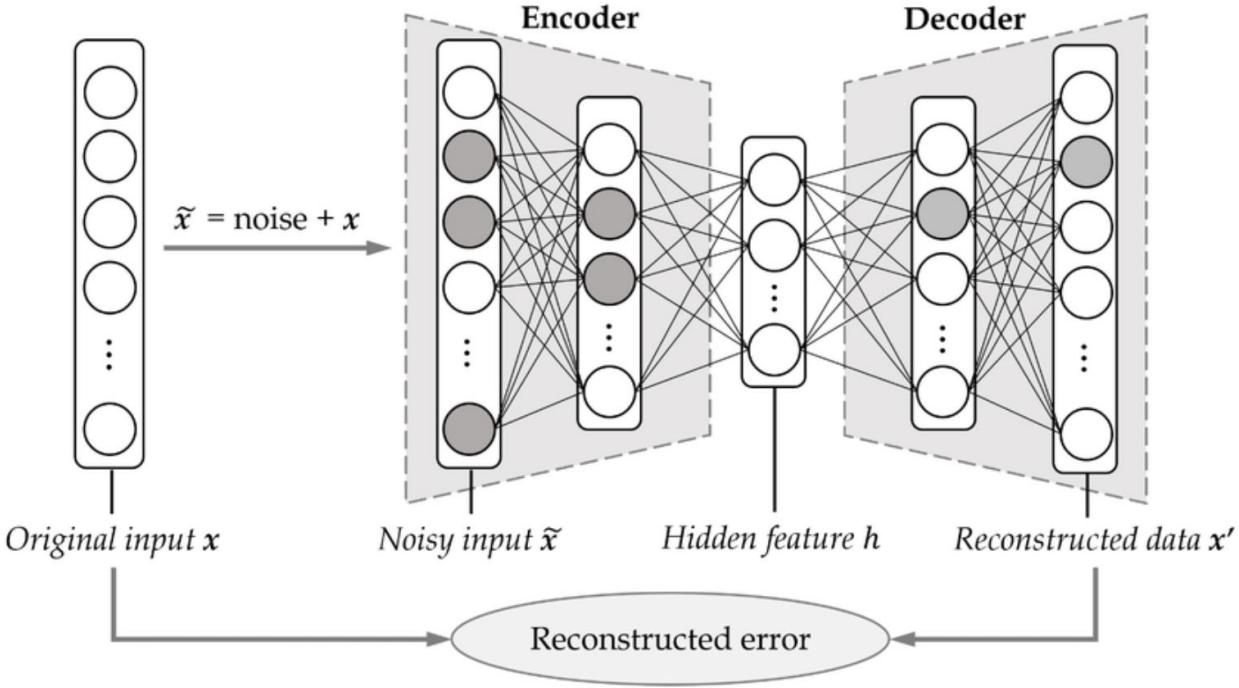
Auto-Encoders Types

- Vanilla Auto-Encoders



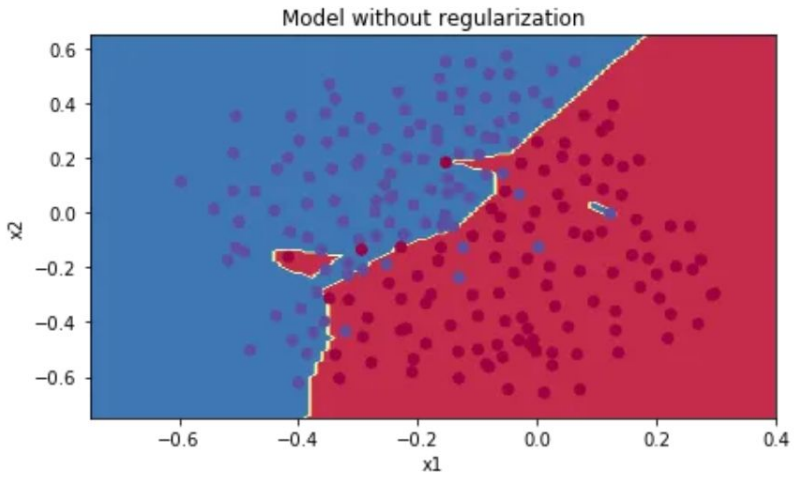
Auto-Encoders Types

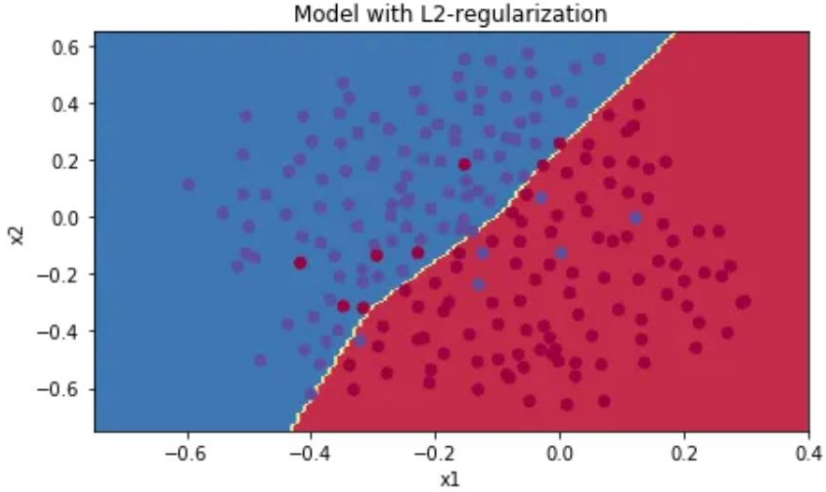
- Denoising Auto-Encoders



Auto-Encoders Types

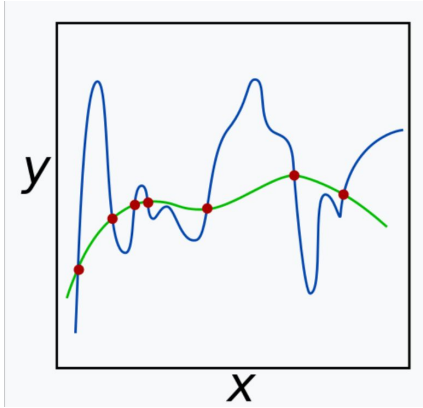
- Sparse Auto-Encoders → Reminder of Regularization

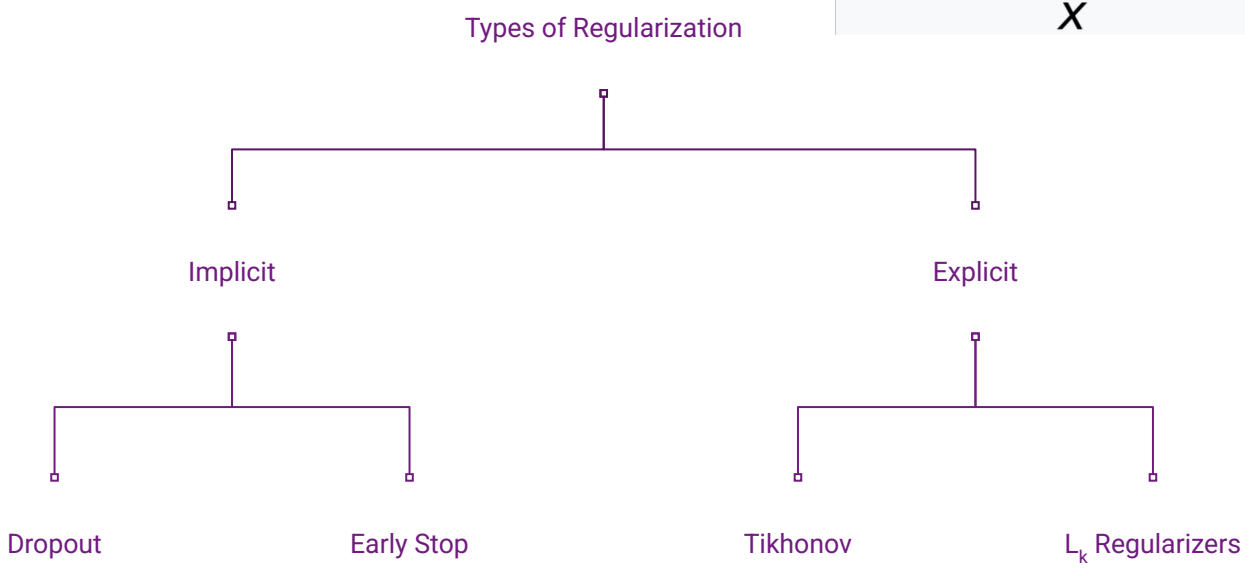




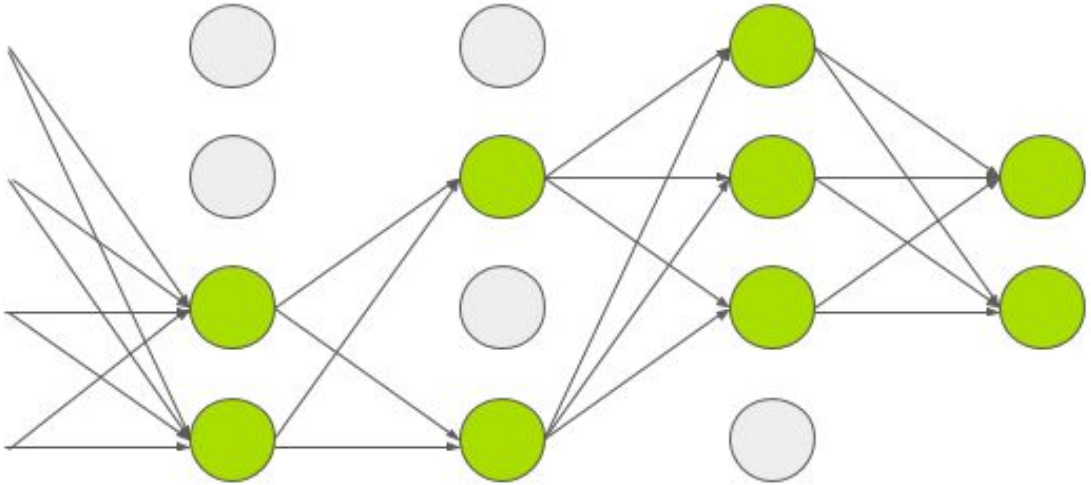
Auto-Encoders Types

- Sparse Auto-Encoders → Reminder of Regularization





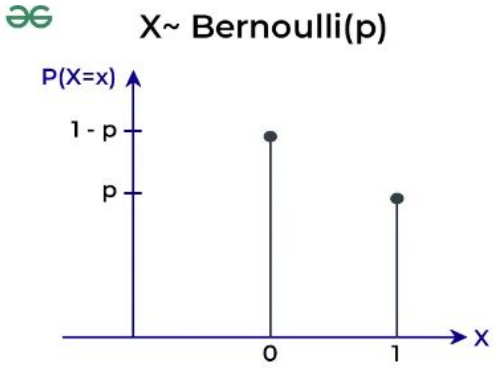
Implicit Regularization: Dropout



Explicit Regularization Terms

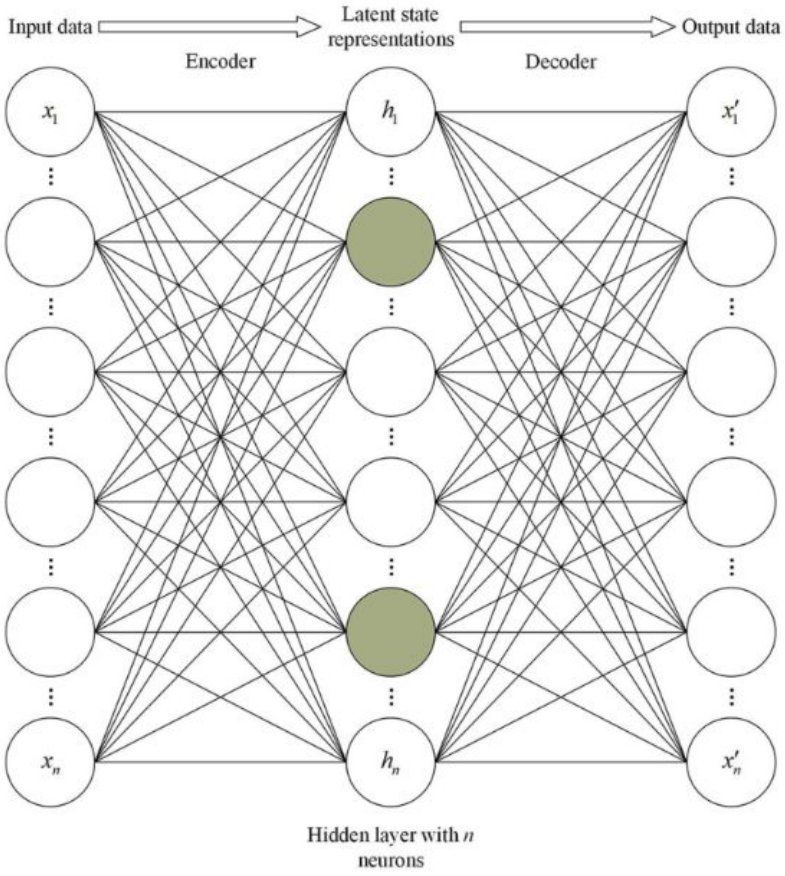
- L_2/Tikhonov $J(W;X,y) + \lambda \cdot ||W||^2$ $w_i = w_i - \eta \left(\frac{\partial \text{Loss}}{\partial w_i} + 2\lambda w_i \right)$
- LASSO/L1 $J(W;X,y) + \lambda \cdot ||W||$ $w_i = w_i - \eta \left(\frac{\partial \text{Loss}}{\partial w_i} + \lambda \text{sign}(w_i) \right)$
- Kullback-Leiber Divergence Regularization

$$J_{\text{sparse}}(W,b) = J(W,b) + \beta \sum_{j=1}^{s_2} \text{KL}(\rho || \hat{\rho}_j)$$

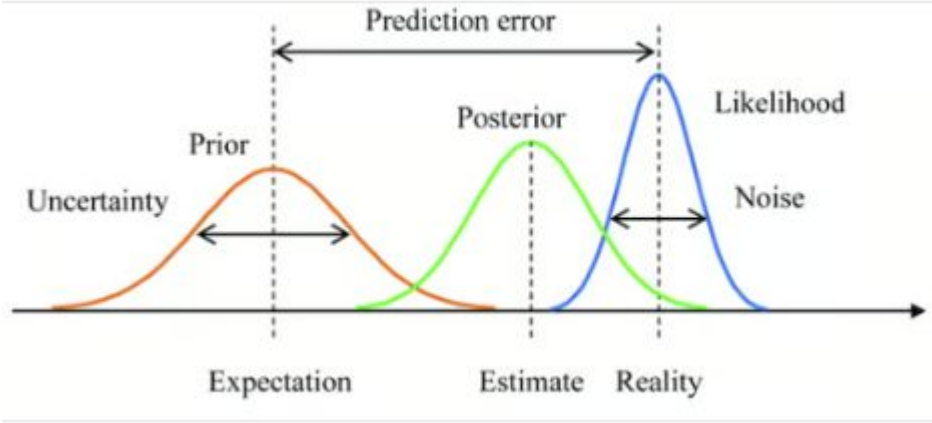


$$D_{\text{KL}}(P \parallel Q) = \sum_{x \in \mathcal{X}} P(x) \log \left(\frac{P(x)}{Q(x)} \right)$$

Sparse Auto-Encoders



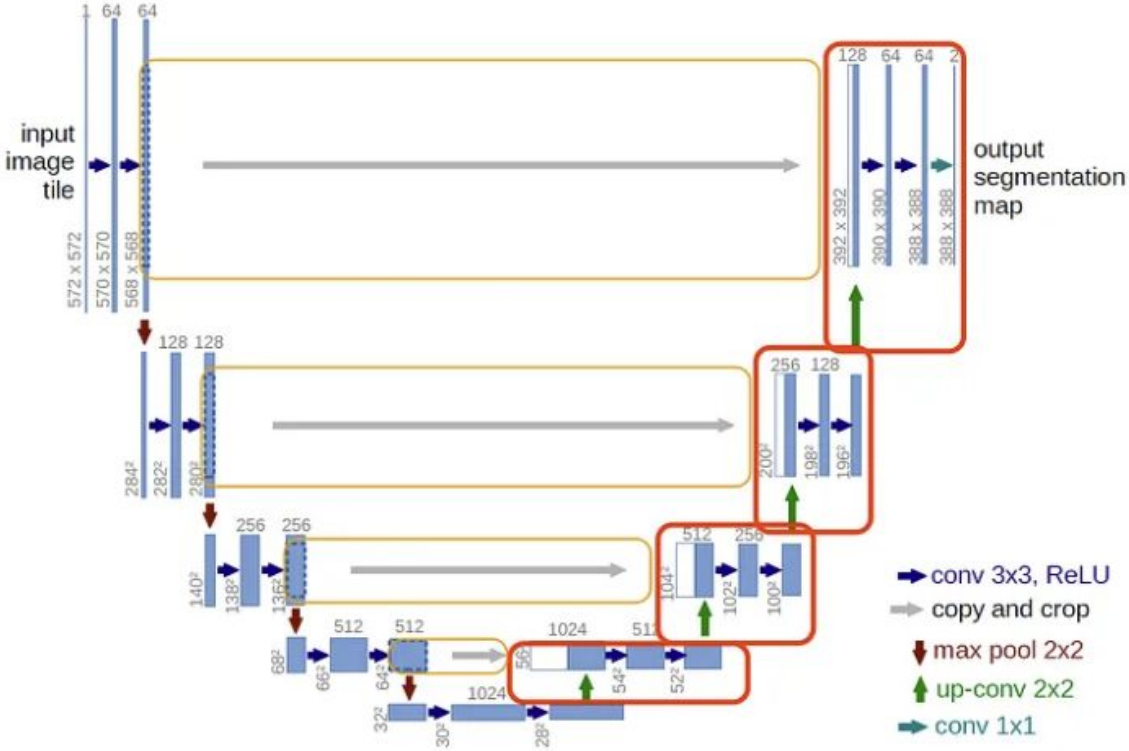
Variational Auto-Encoders



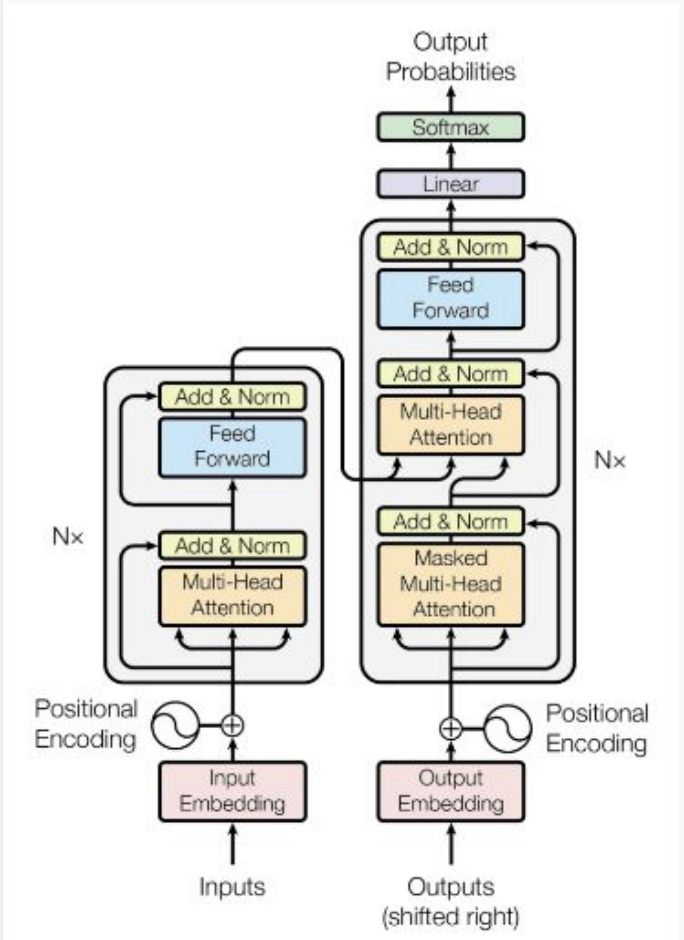
Here is how the process flow looks:

1. The input data x is fed into the encoder, which outputs the parameters of the latent space distribution $q(z|x)$ (mean μ and variance σ^2).
2. Latent variables z are sampled from the distribution $q(z|x)$ using techniques like the reparameterization trick.
3. The sampled z is passed through the decoder to produce the reconstructed data $\hat{x}$, which should be similar to the original input x.

U-Net


input image tile
output segmentation map
conv 3x3, ReLU
copy and crop
max pool 2x2
up-conv 2x2
conv 1x1

Transformer



Tutorials

https://www.geeksforgeeks.org/sparse-autoencoders-in-deep-learning/

https://github.com/Jackson-Kang/Pytorch-VAE-tutorial/tree/master

Resources

https://www.datacamp.com/tutorial/introduction-to-autoencoders

https://medium.com/towards-data-science/understanding-autoencoders-with-an-example-a-step-by-step-tutorial-693c3a4e9836

https://medium.com/@tallaswapna9/types-of-autoencoders-in-deep-learning-383cfecc4d0e

https://www.researchgate.net/figure/The-overall-structure-of-a-denoising-autoencoder_fig2_331620099

https://en.wikipedia.org/wiki/Regularization_(mathematics)

https://medium.com/towards-data-science/understanding-the-scaling-of-l%C2%B2-regularization-in-the-context-of-neural-networks-e3d25f8b50db

https://web.stanford.edu/class/cs294a/sparseAutoencoder.pdf

https://www.researchgate.net/figure/Architecture-of-the-sparse-auto-encoder_fig3_344423909

https://arxiv.org/pdf/1906.02691