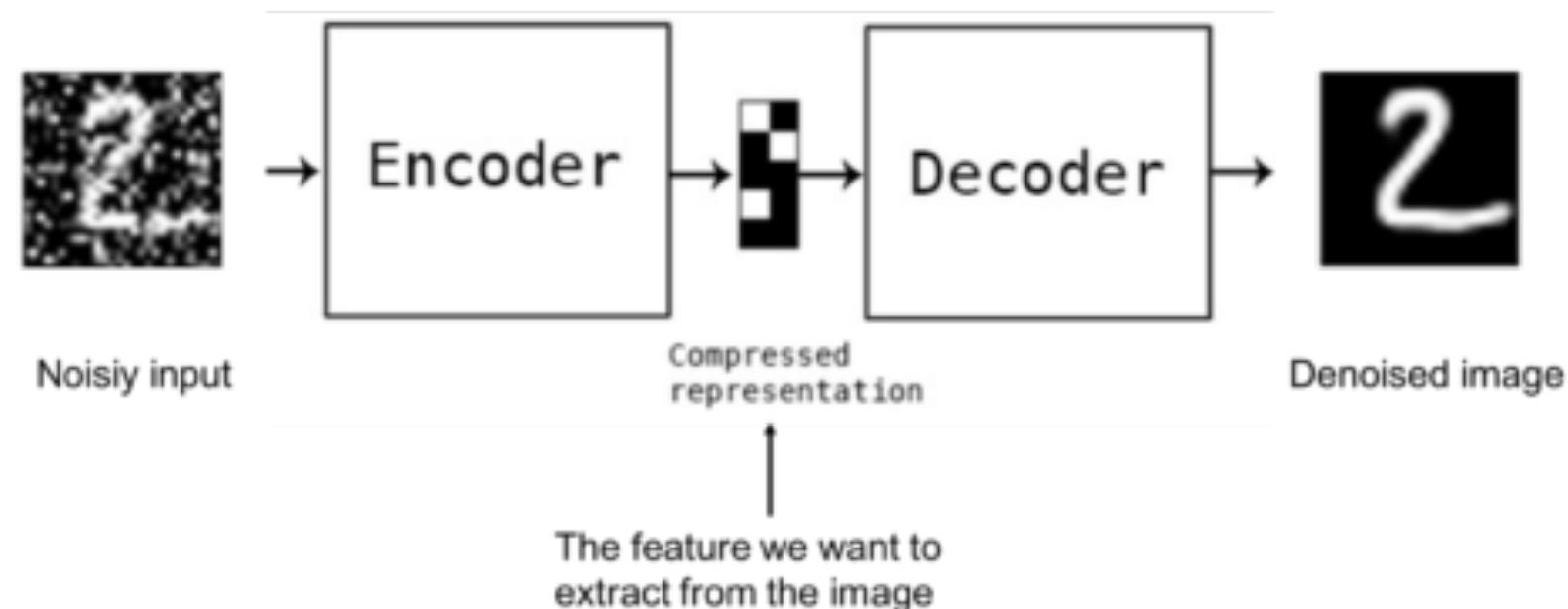
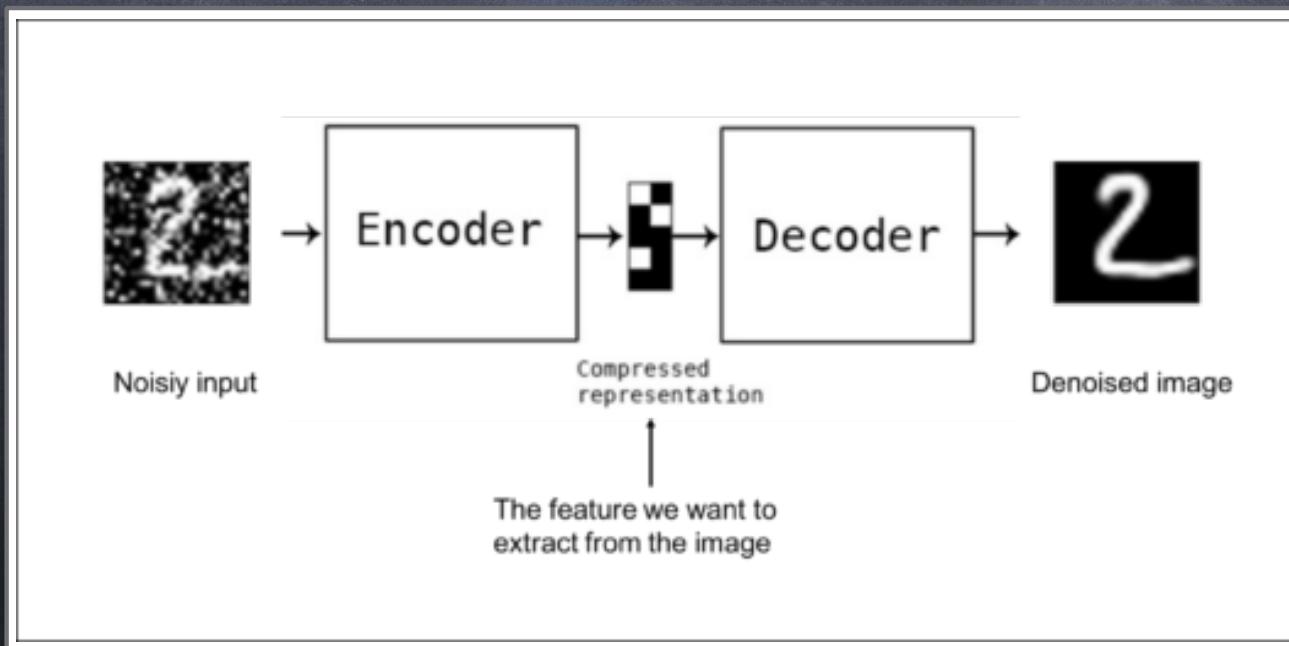


Denoising AE



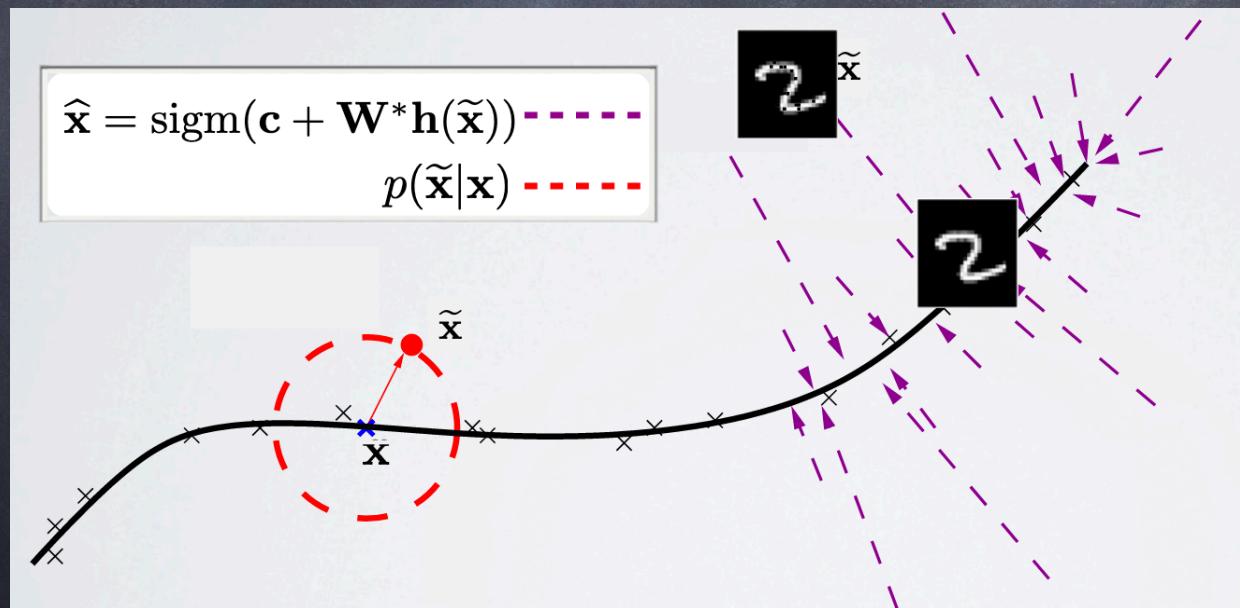
Denoising AE

- Basic autoencoder trains to minimize the loss between x and the reconstruction $g(f(x))$ - risk to learn data (overfit) - memorize the input output relationship
- Denoising autoencoders train to minimize the loss between x and $g(f(x+\omega))$, where ω is random noise.

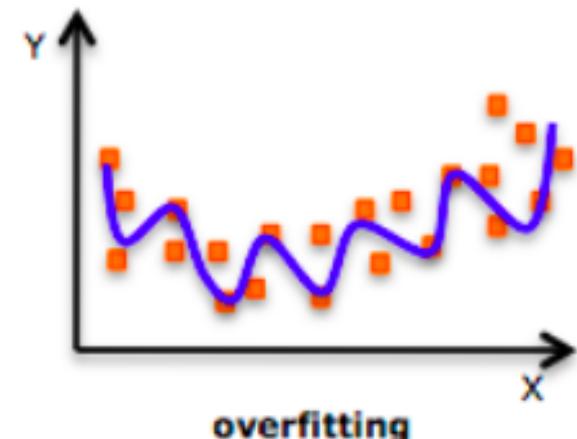
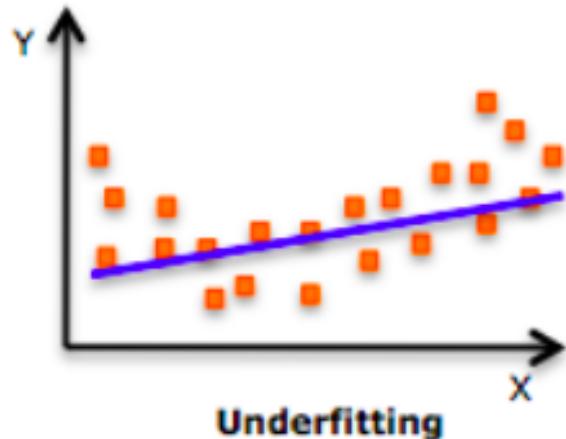


Denoising process is kind of regularization

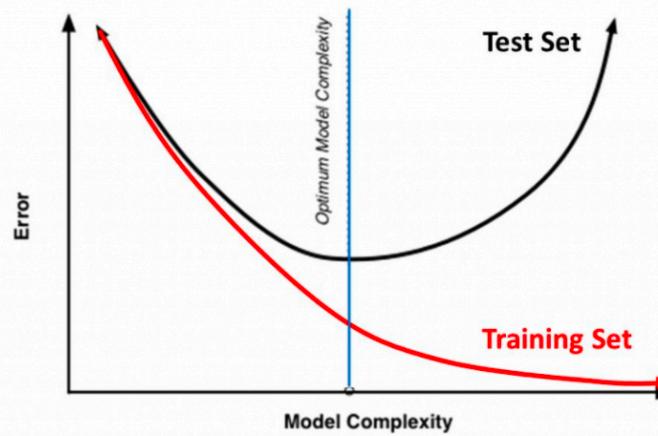
- denoising autoencoder learns a projection from a neighborhood of our training data back onto the training data.



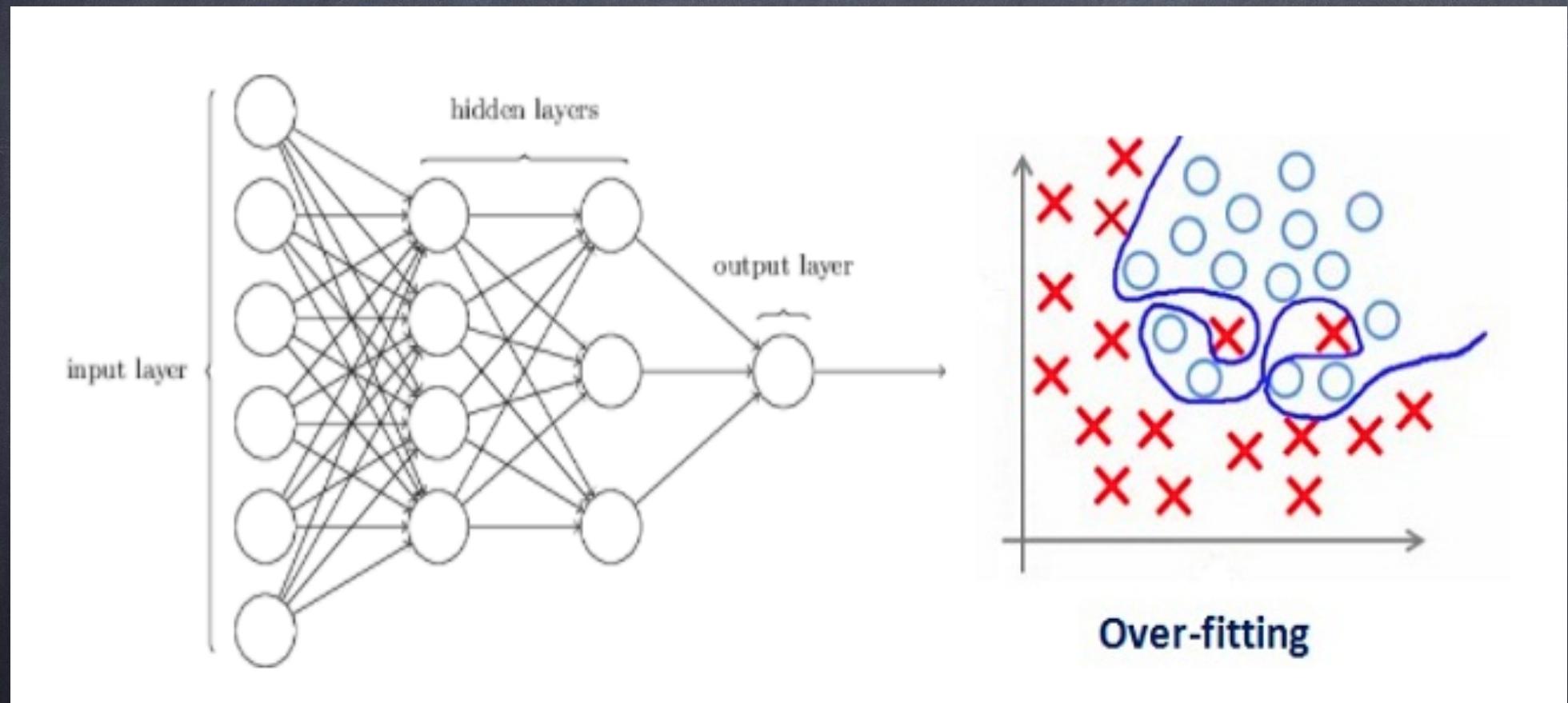
What is regularization



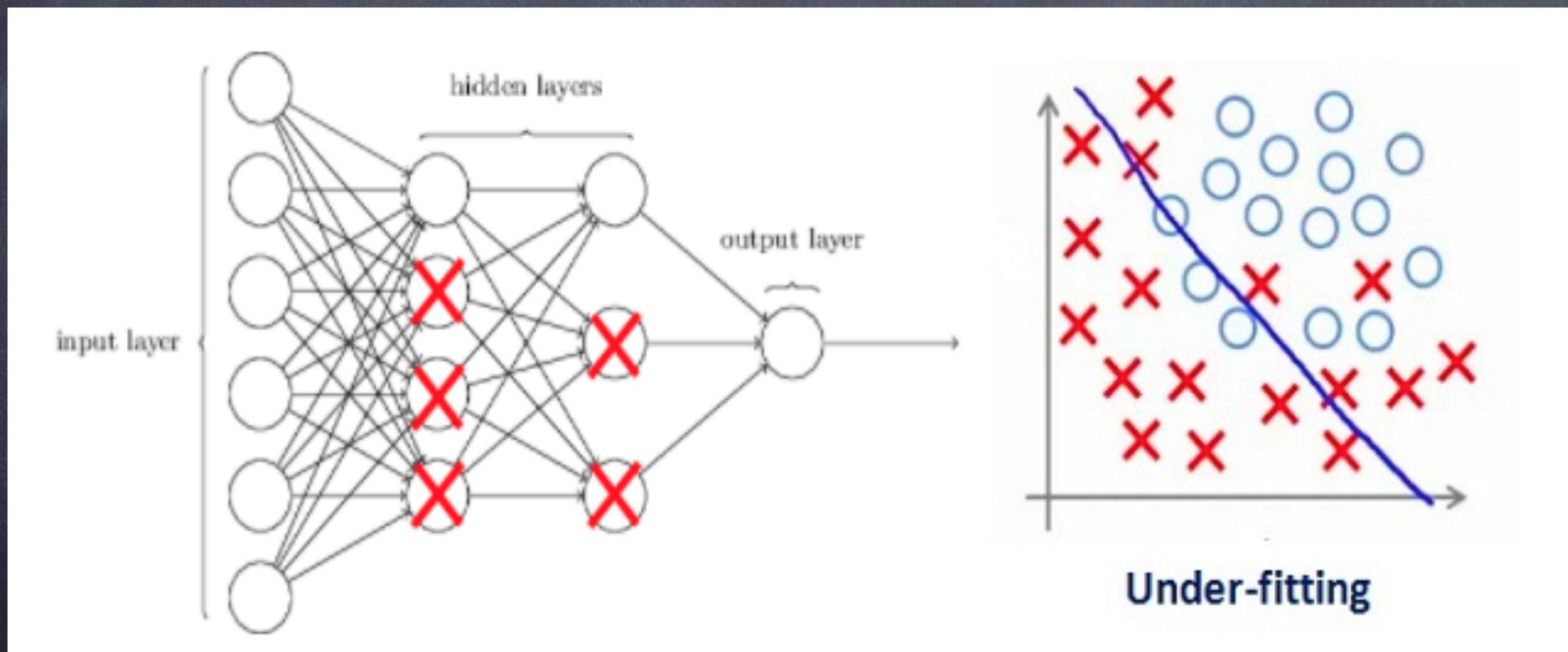
Training Vs. Test Set Error

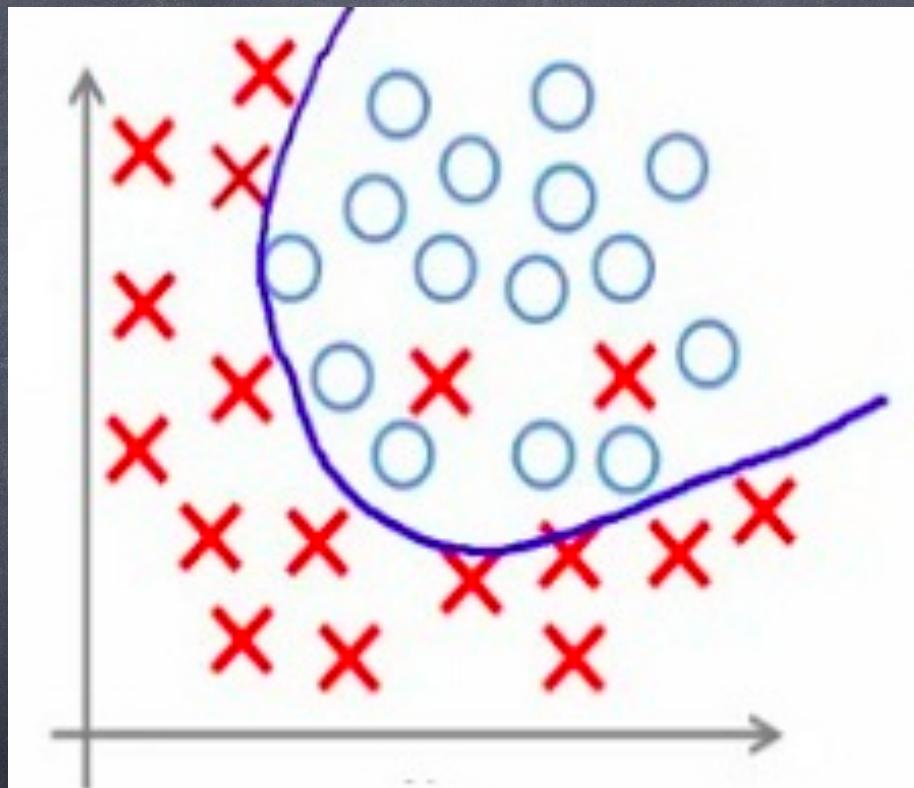


Overfitting



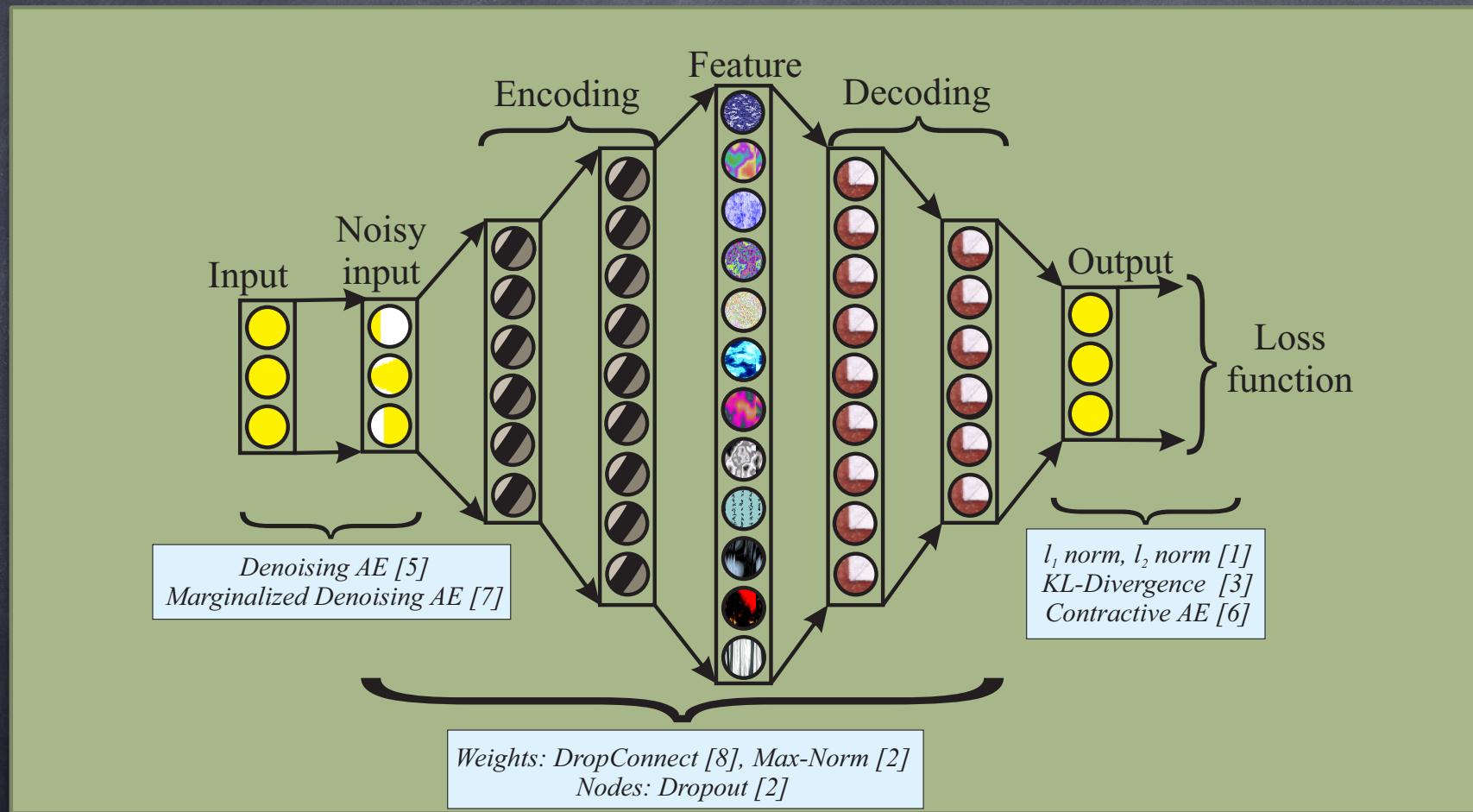
Under-fitting





Appropriate-fitting

Multilayer Auto-encoder: Regularization Approaches



$$0 = b + \sum_{j=1}^n w_j f_j$$

Should we allow all possible weights?
Any preferences?

- Generally, we don't want huge weights
- If weights are large, a small change in a feature can result in a large change in the prediction
- Also gives too much weight to any one feature
- Might also prefer weights of 0 for features that aren't useful

$$\operatorname{argmin}_{w,b} \sum_{i=1}^n loss(yy') + \lambda \text{ regularizer}(w,b)$$

sum of the weights

$$r(w, b) = \sum_{w_j} |w_j|$$

sum of the squared weights

$$r(w, b) = \sqrt{\sum_{w_j} |w_j|^2}$$

$$w_j = w_j + \eta y_i x_{ij} \exp(-y_i(w \cdot x_i + b)) - \eta \lambda w_j$$

learning rate

direction to
update

regularization

constant: how far from wrong

$$w_j = w_j + \eta y_i x_{ij} \exp(-y_i(w \cdot x_i + b)) - \eta \lambda w_j$$

learning rate

direction to
update

regularization

constant: how far from wrong

If w_i is positive, reduces w_i

If w_i is negative, increases w_i

moves w_i towards 0

L1 Regularizer

$$\operatorname{argmin}_{w,b} \sum_{i=1}^n \exp(-y_i(w \cdot x_i + b)) + \|w\|$$

$$\frac{d}{dw_j} \text{objective} = \frac{d}{dw_j} \sum_{i=1}^n \exp(-y_i(w \cdot x_i + b)) + \lambda \|w\|$$

$$= - \sum_{i=1}^n y_i x_{ij} \exp(-y_i(w \cdot x_i + b)) + \lambda sign(w_j)$$

L1 Regularization

$$w_j = w_j + \eta y_i x_{ij} \exp(-y_i(w \cdot x_i + b)) - \eta \lambda \text{sign}(w_j)$$

learning rate

direction to
update

regularization

constant: how far from wrong

If w_j is positive, reduces by a constant

If w_j is negative, increases by a constant

Recall Dropout

Regularization in Autoencoder

- Example: Dropout/DropConnect

