



IA WS

Réseaux Antagonistes Génératifs

IA Lab

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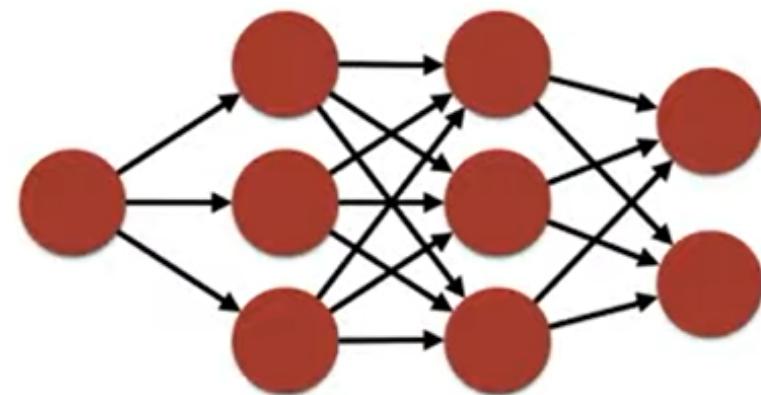
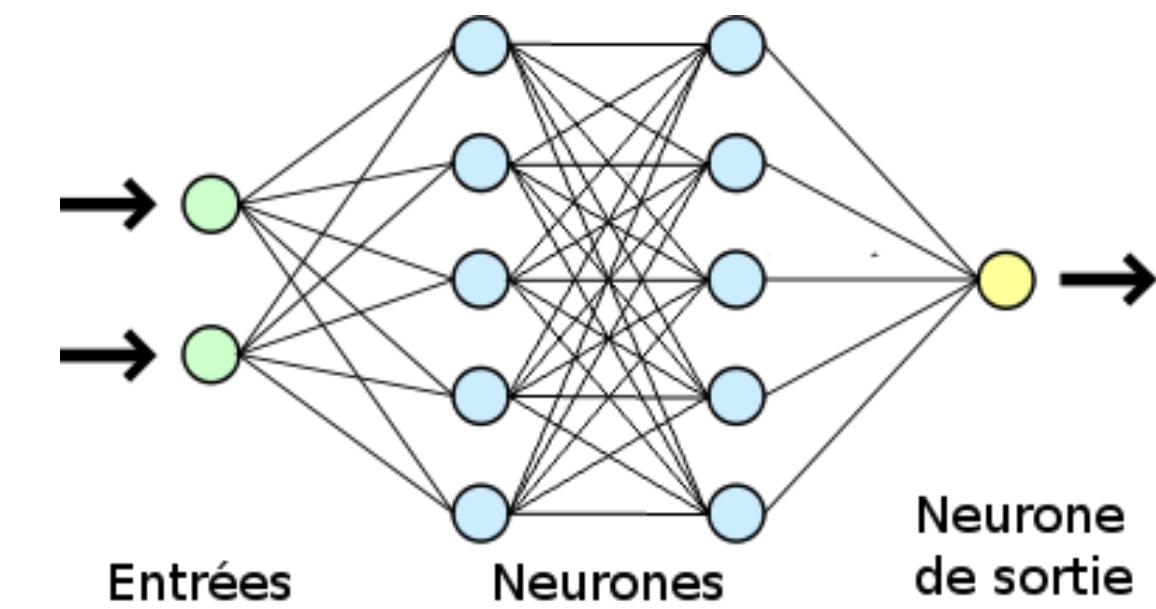
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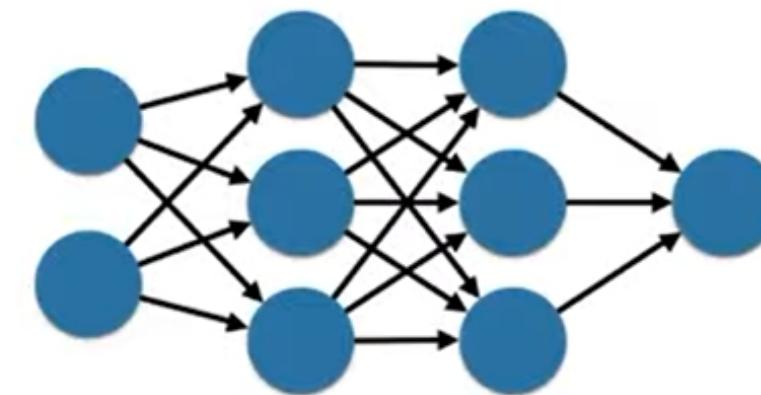
06 Conclusion

Définition

- Type de construction
- Technologie des réseaux neuronaux
- Basé sur 2 réseaux neuronaux



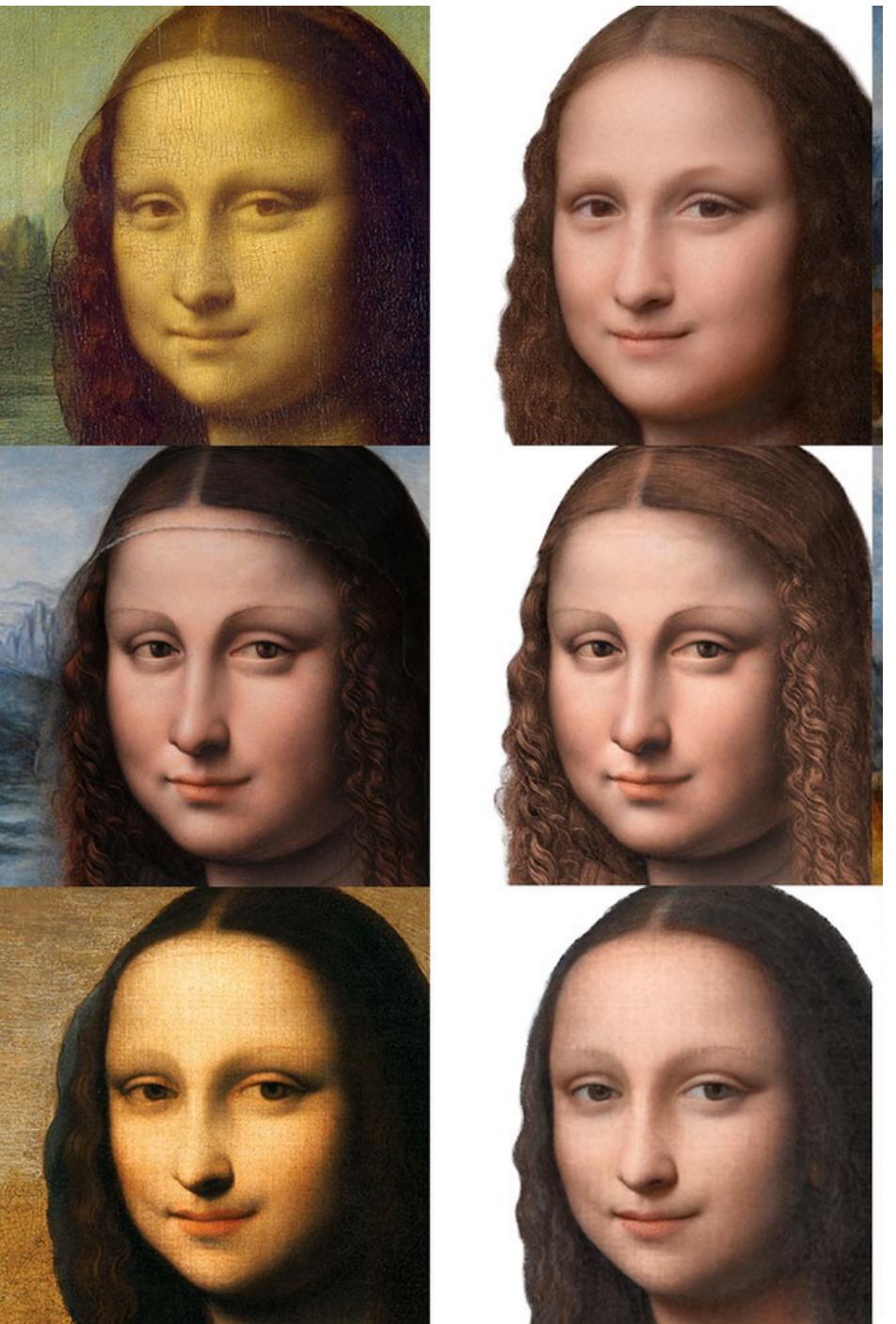
Generator



Discriminator

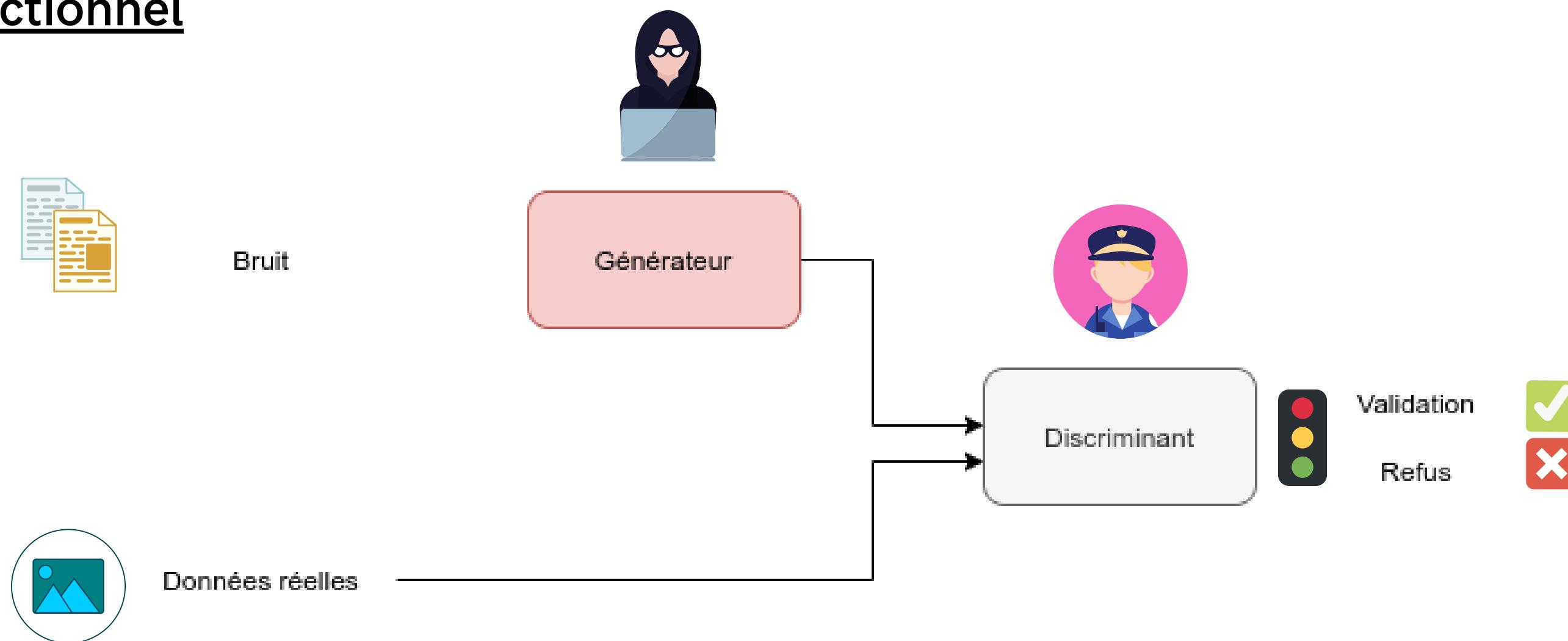
Son utilisation

- Création de données à partir de rien
- Utilisé pour les Deepfakes
- Restauration d'oeuvre d'art



Les étapes

Schéma fonctionnel



Notions clés

Réseau Génératif

GENERATOR
“The Artist”
A neural network trying to
create pictures of cats that
look real.



Réseau Discriminant

DISCRIMINATOR
“The Art Critic”
A neural network examining
cat pictures to determine if
they’re real or fake.



- Utilisé pour les Deepfakes

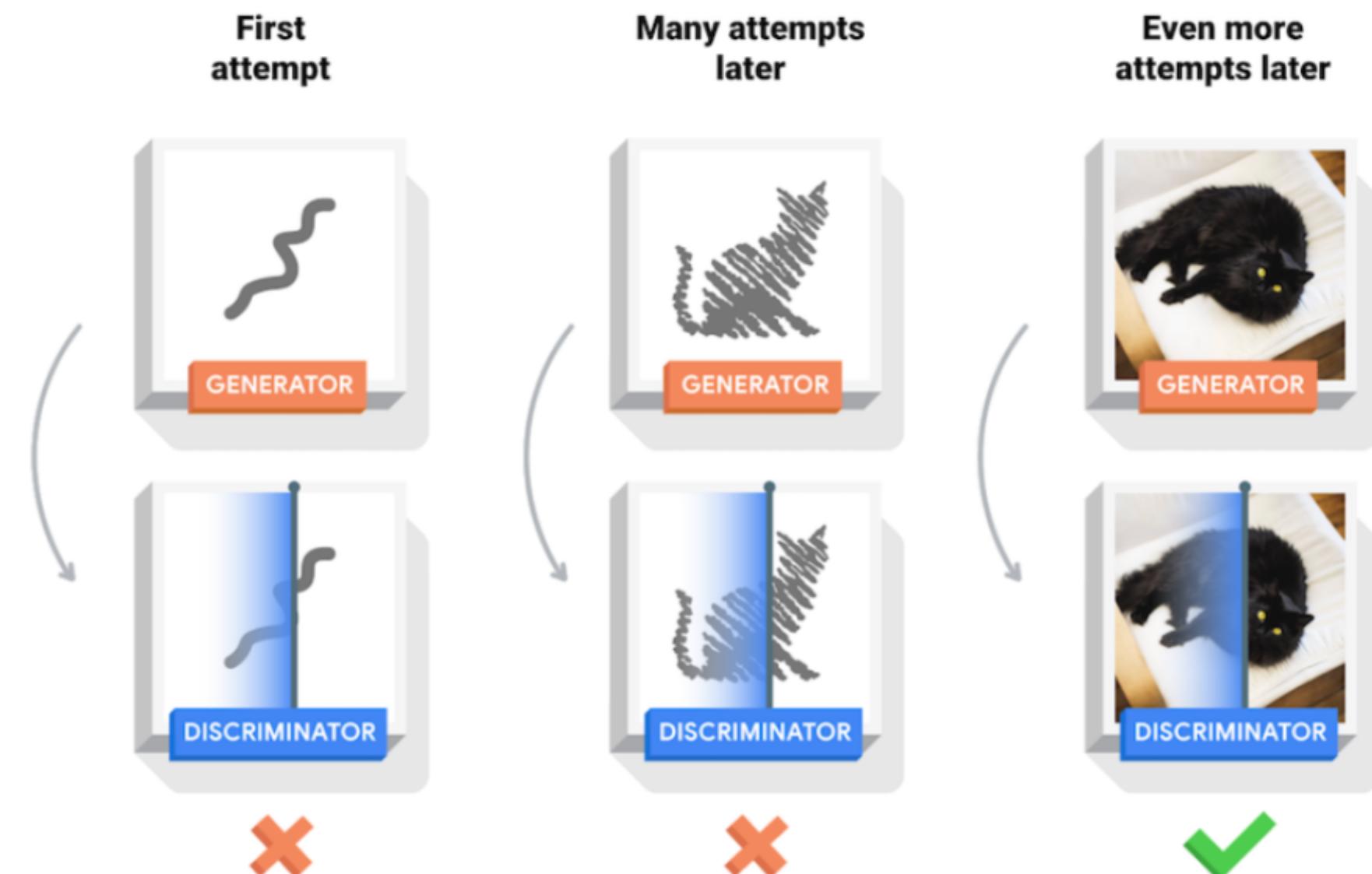
Thousands of real-world
images labeled “CAT”



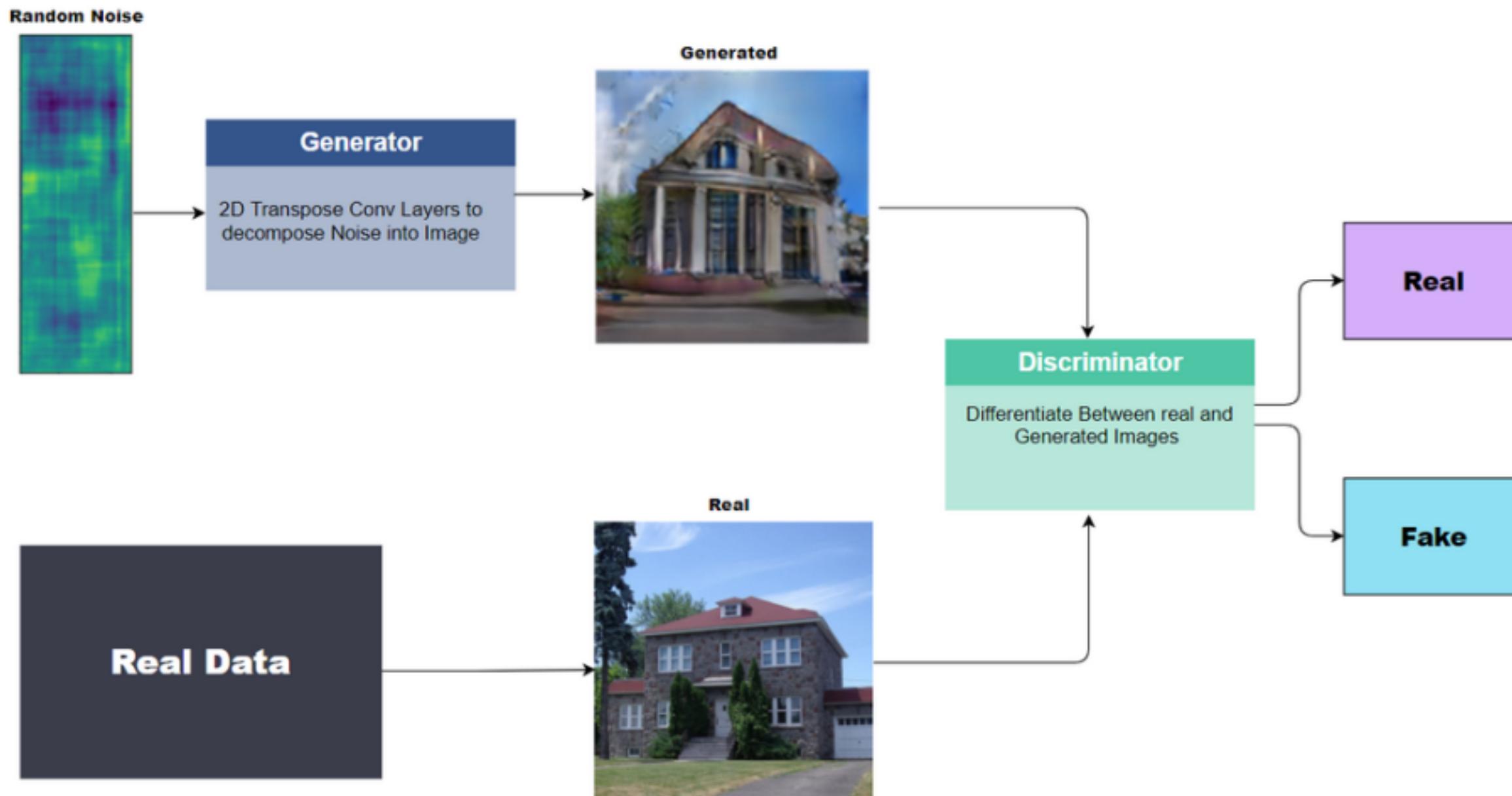
Notions clés

Réseau
Génératif

Réseau
Discriminant



Un exemple concret



Cas d'étude simple les conditions

Images réelles : perso penchés

Opter pour un image simple pour une illustration simple
(ici des personnages penchés de 45°)

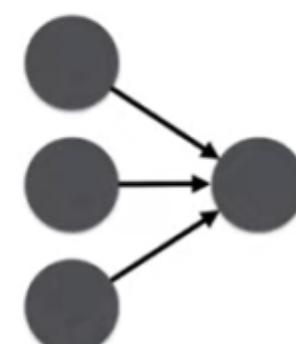


Fenêtre en 2x2

Avantage d'un modèle simplifié
Résolution noir/blanc 2 pixels sur 2 pixels



Réseau neuronne monocouche



La forme la plus simple de réseau de neurones
Une seule couche de noeuds d'entrée

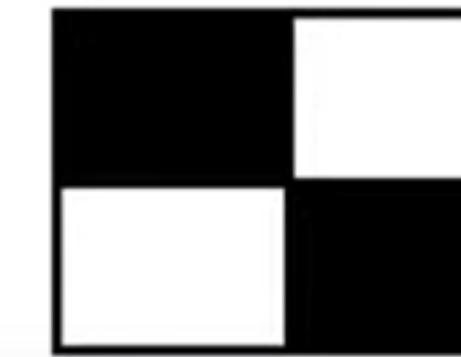


4 Visages

taille 2 pixels sur 2 pixels

Silhouette

sur la fenêtre $2 \times 2 \times 1$



Cas d'étude simple

Les visages



Les bruits



Cas d'étude simple



0 1

0.75	0
0	0.75

1	0.25
0.25	0.75

1	0
0	1

0.75	0
0.25	0.75

Les visages

0.25	0
1	0.75

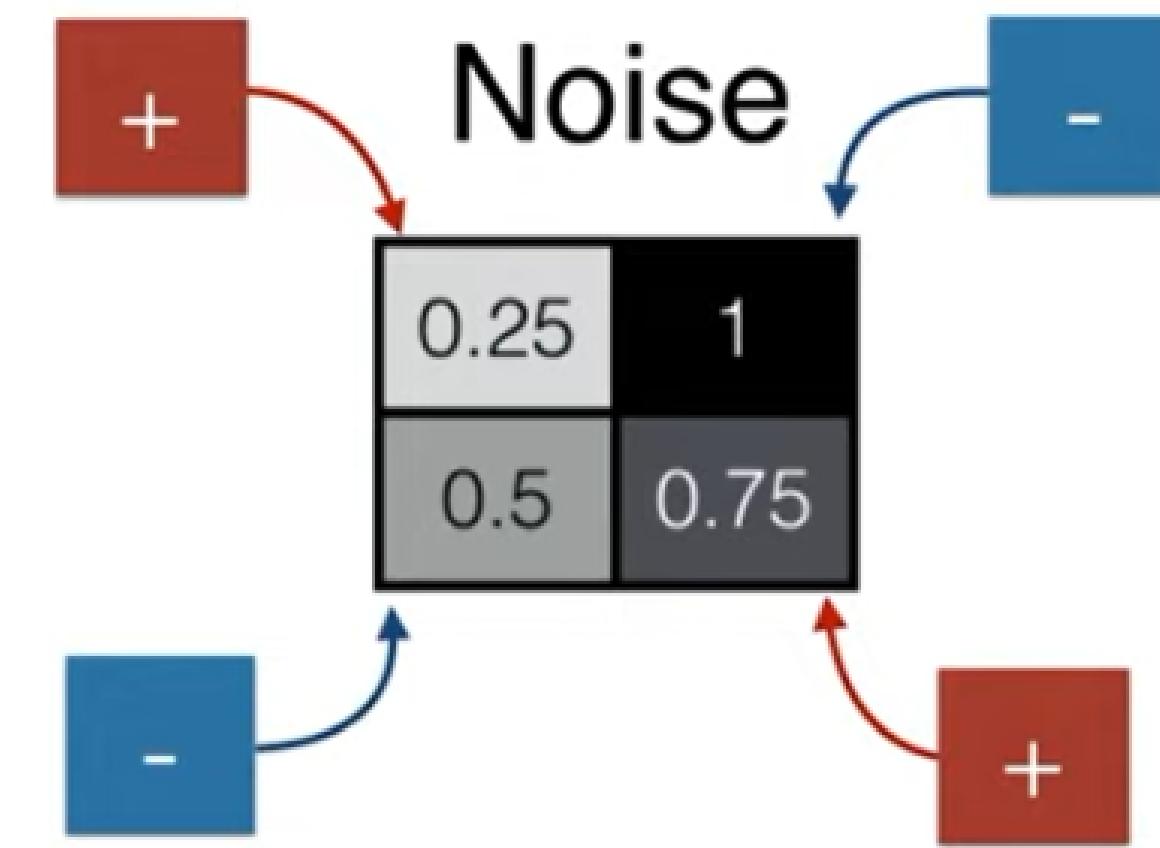
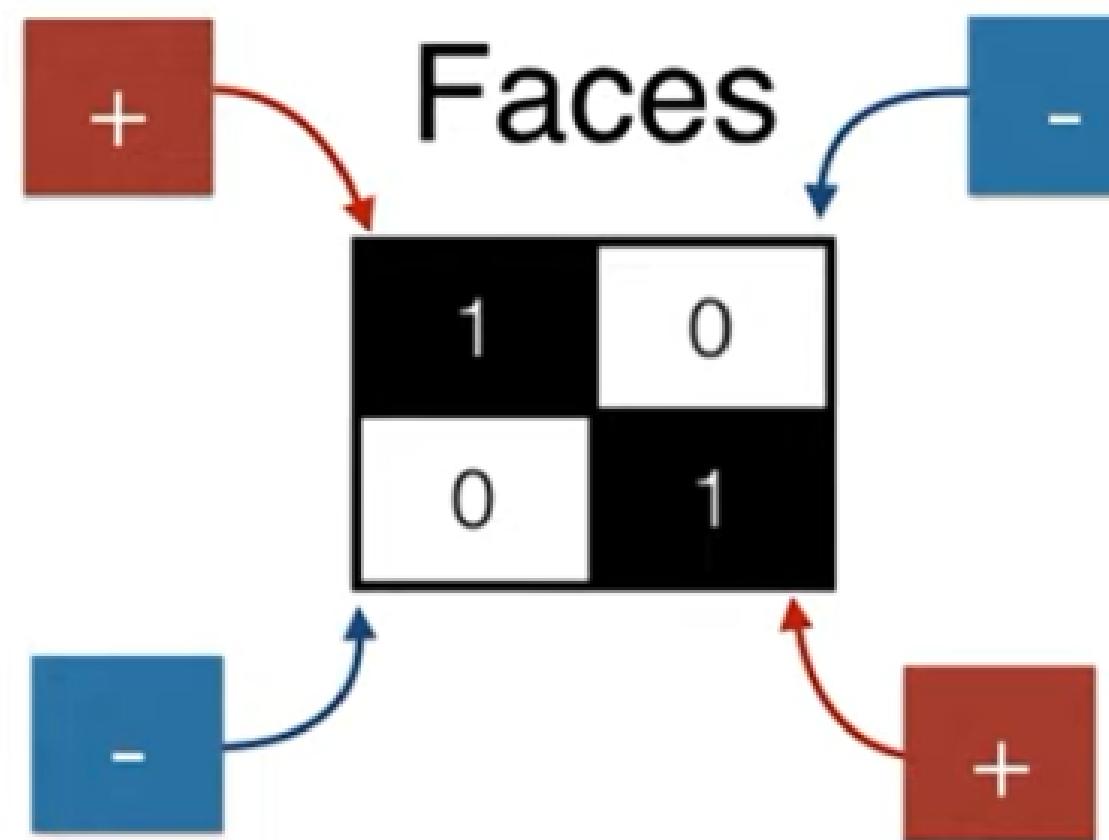
0.25	1
0.5	0.75

0.75	0.5
0.75	0

1	1
0	0.75

Les bruits

Construire le discriminant



$$1 * \textcolor{red}{1} + 0 * \textcolor{blue}{(-1)} + 0 * \textcolor{blue}{(-1)} + 1 * \textcolor{red}{1} \\ = 2$$

Threshold = 1

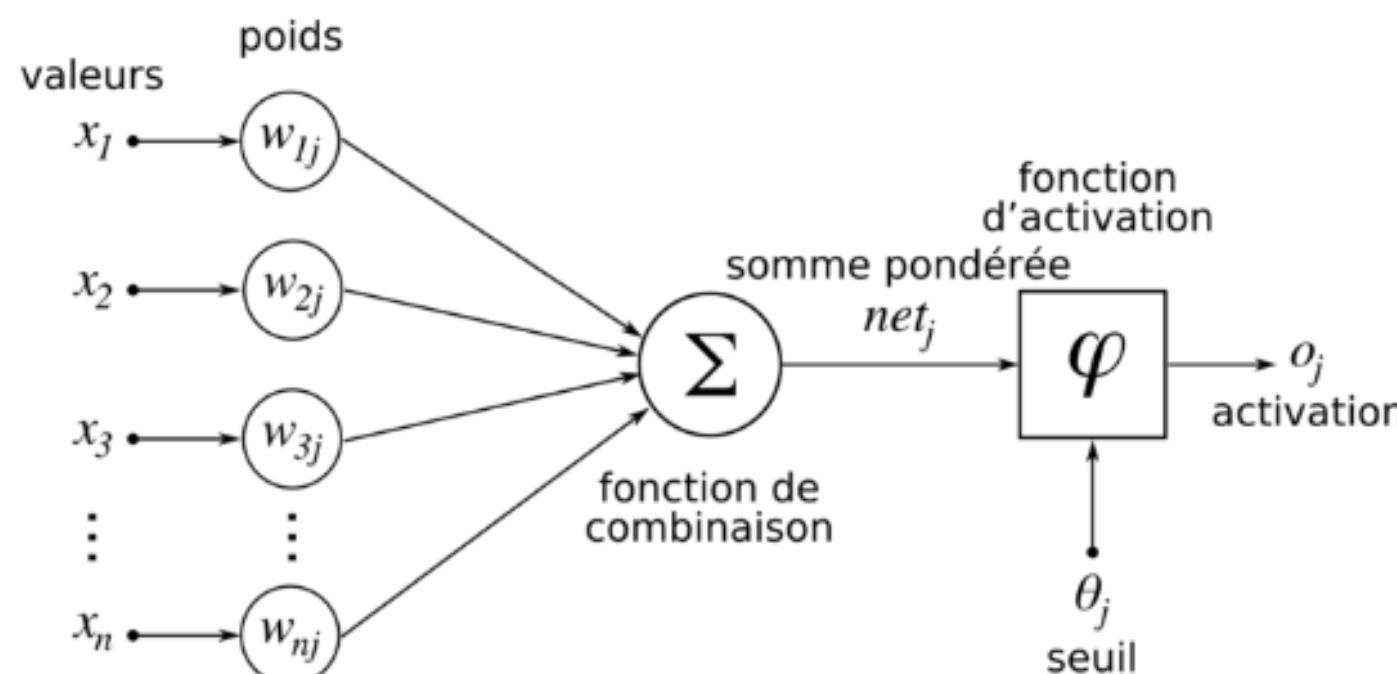
comme > 1 <=> Visage valide

$$0.25 * \textcolor{red}{1} + 1 * \textcolor{blue}{(-1)} + 0.5 * \textcolor{blue}{(-1)} + 0.75 * \textcolor{red}{1} \\ = -0.5$$

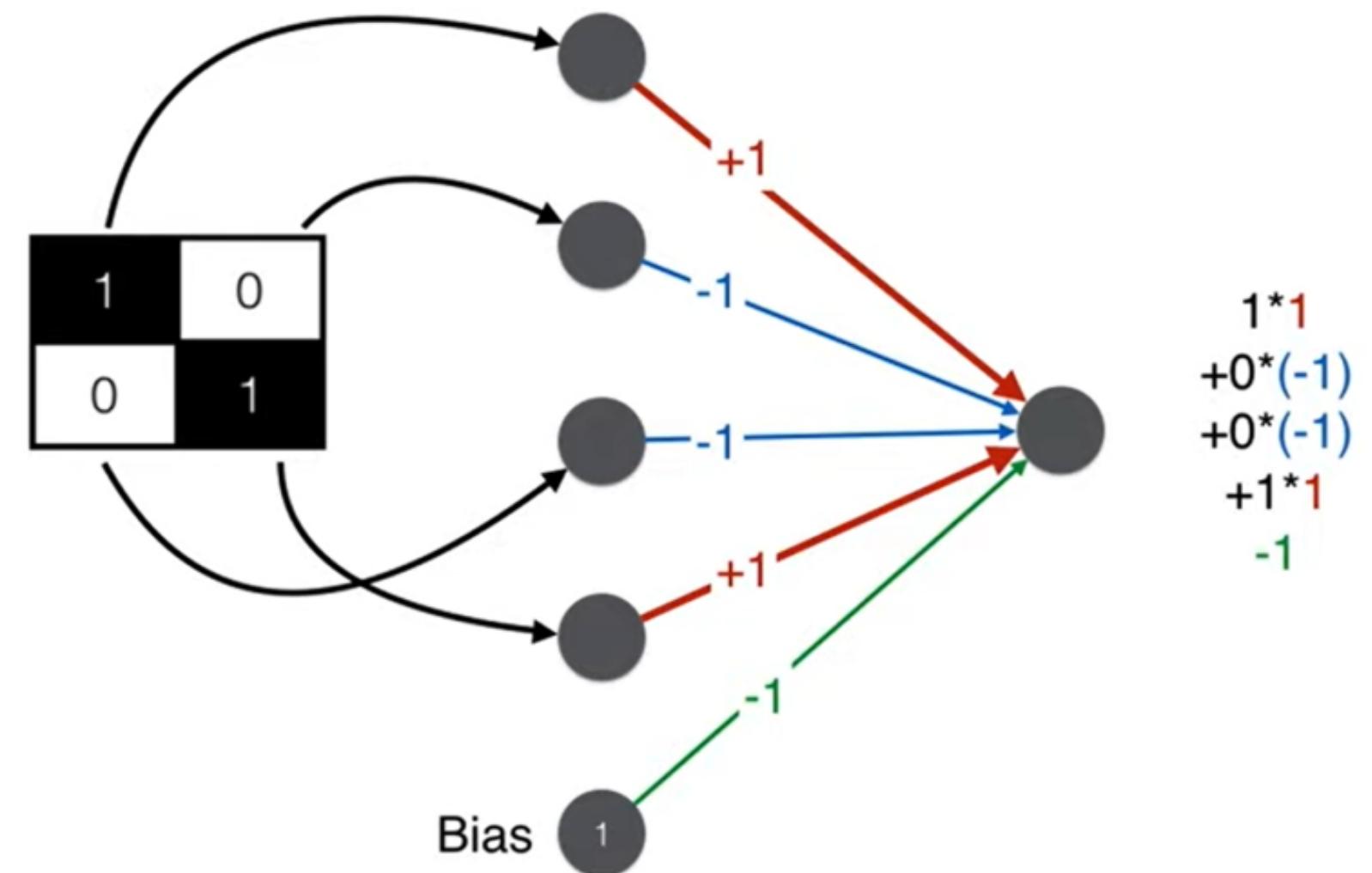
comme < 1 <=> Visage non valide

Construire le discriminant

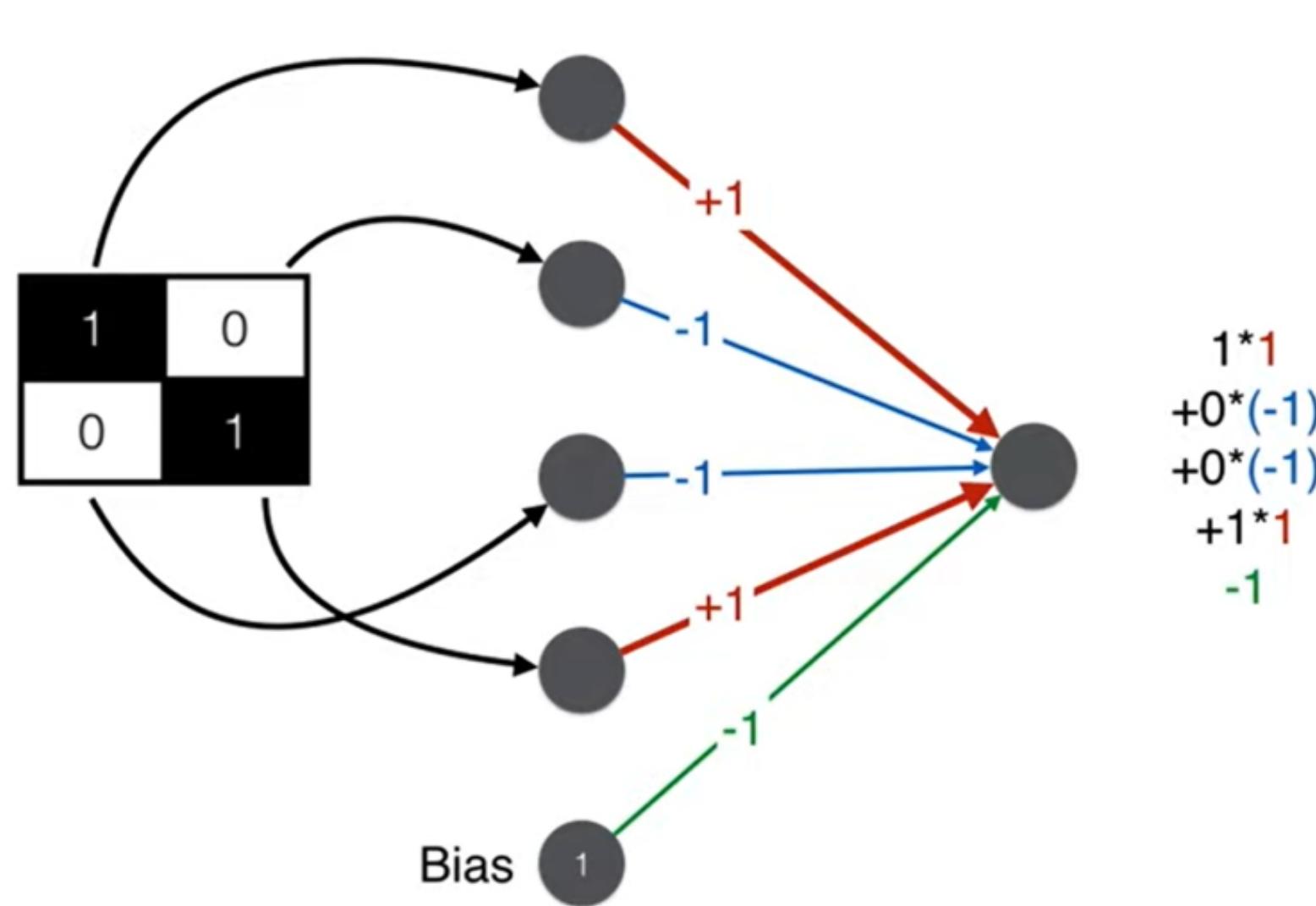
L'ARCHITECTURE D'UN RÉSEAU NEURONAL



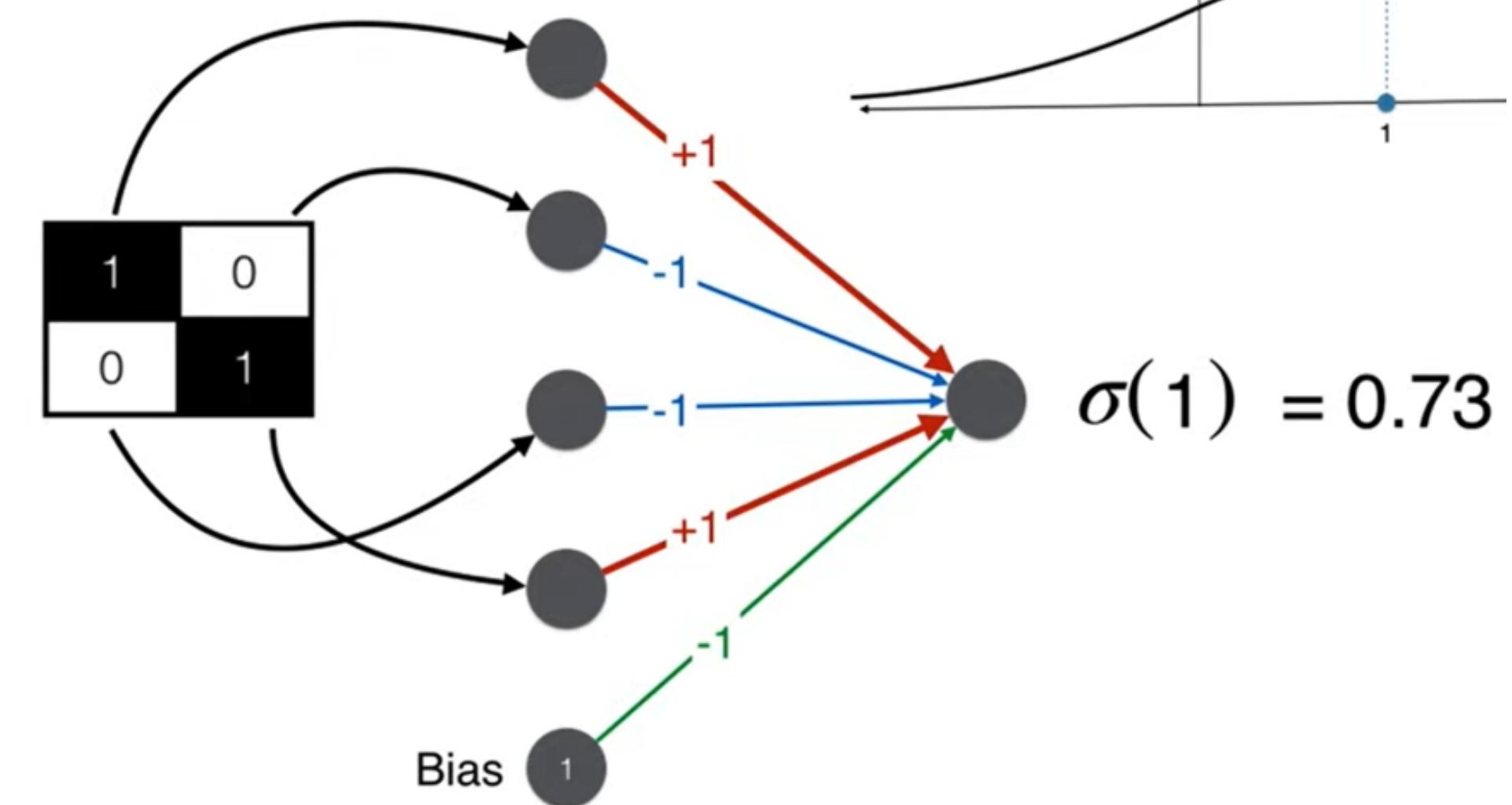
Discriminator



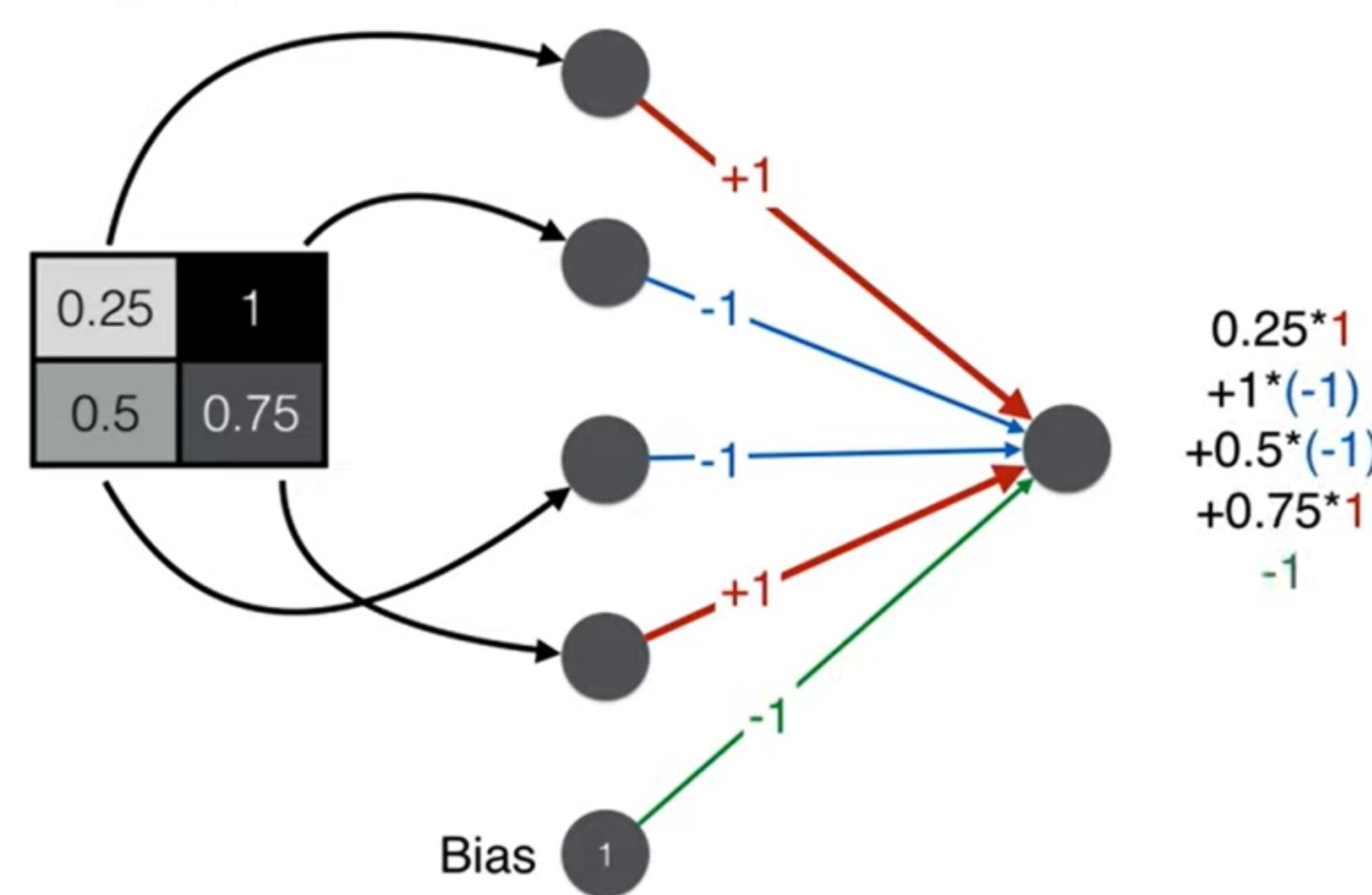
Le cas d'une image proche



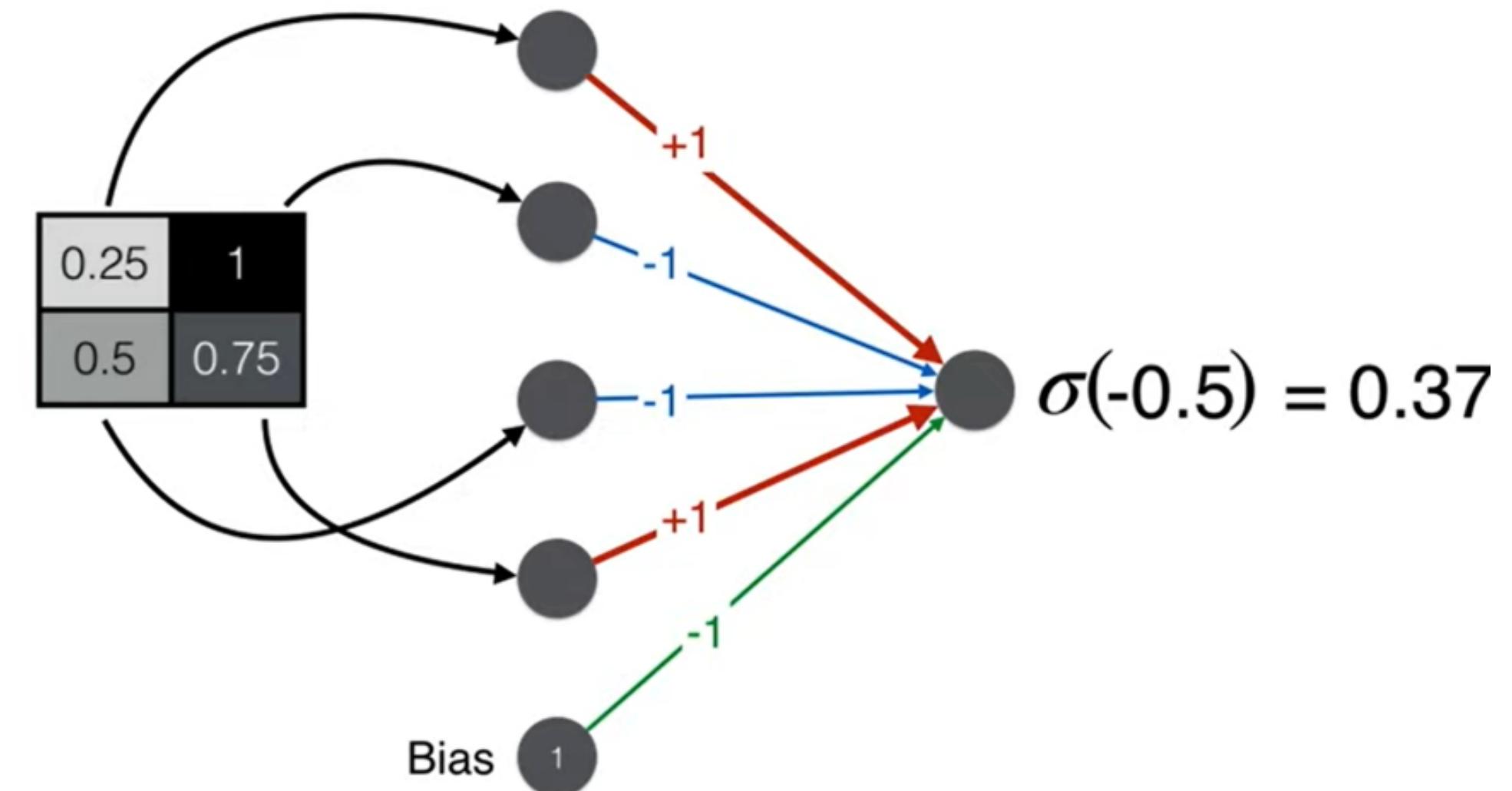
Discriminator



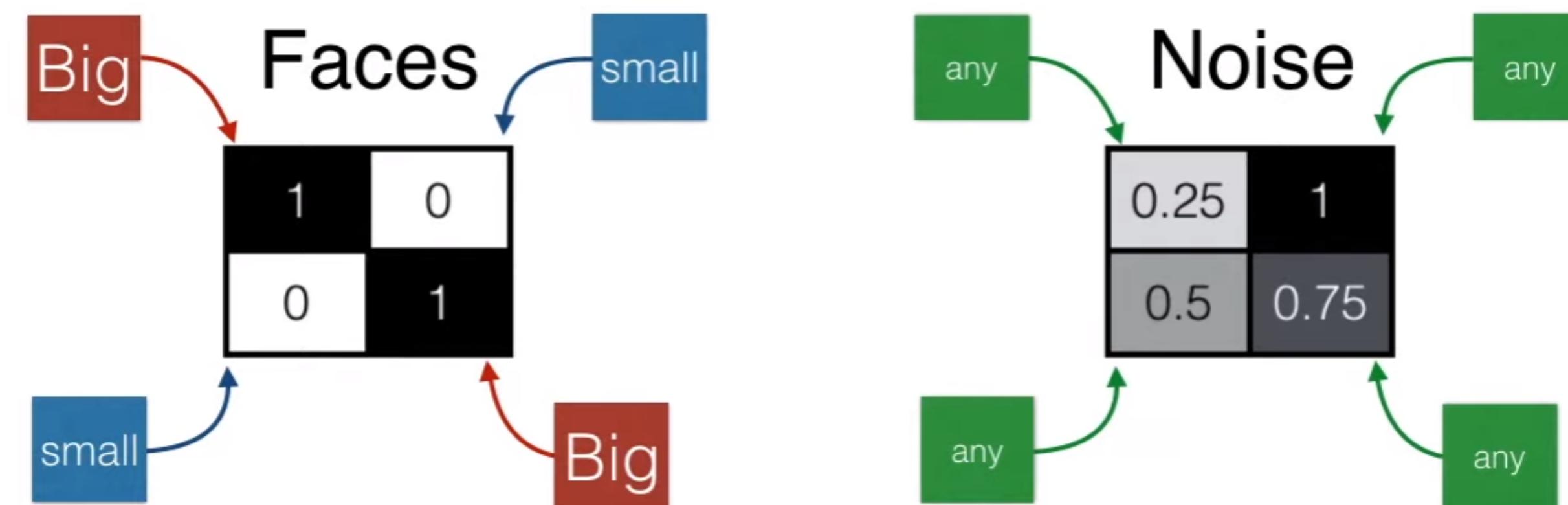
Le cas d'un bruit



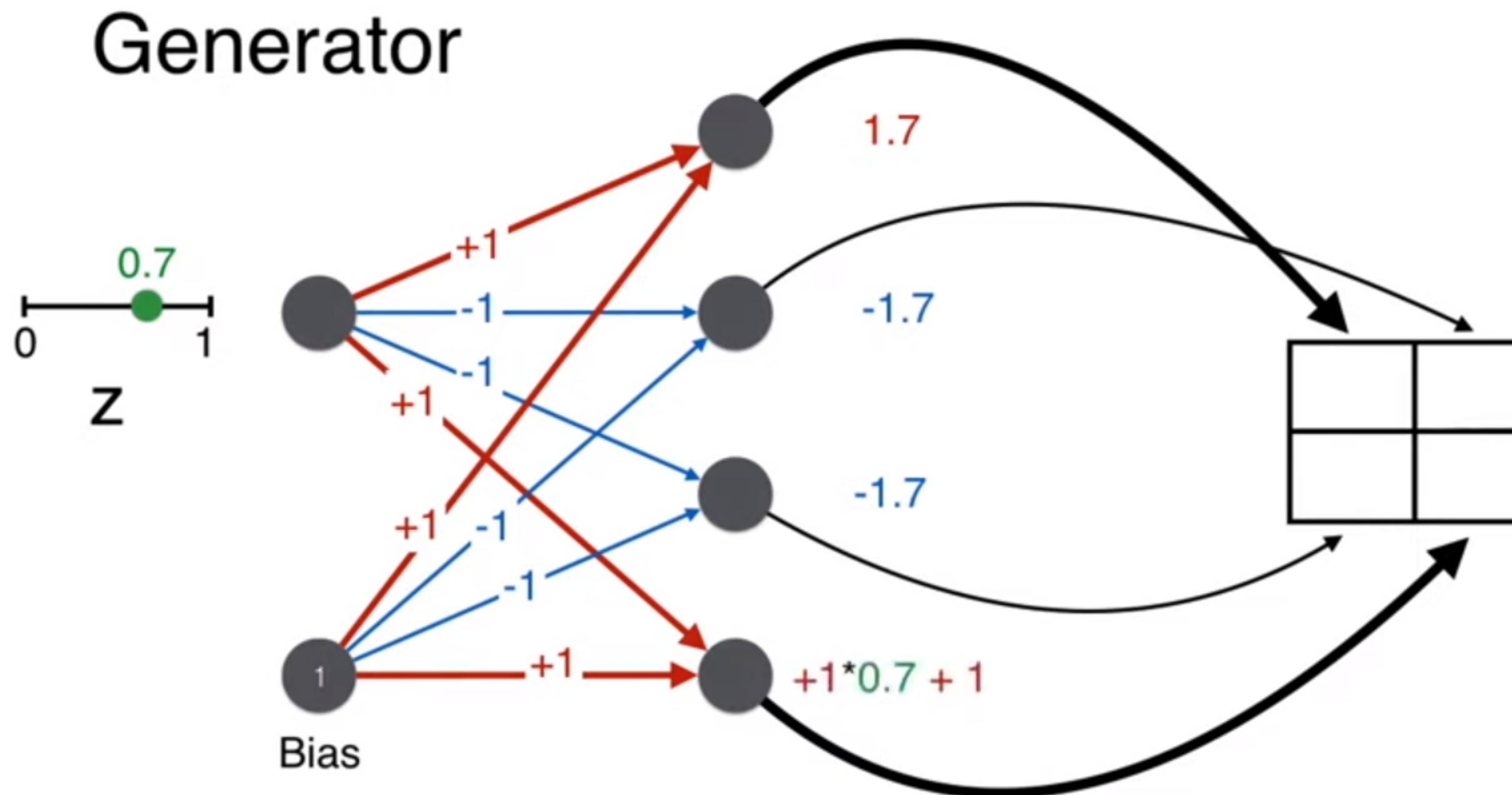
Discriminator



Construire un générateur

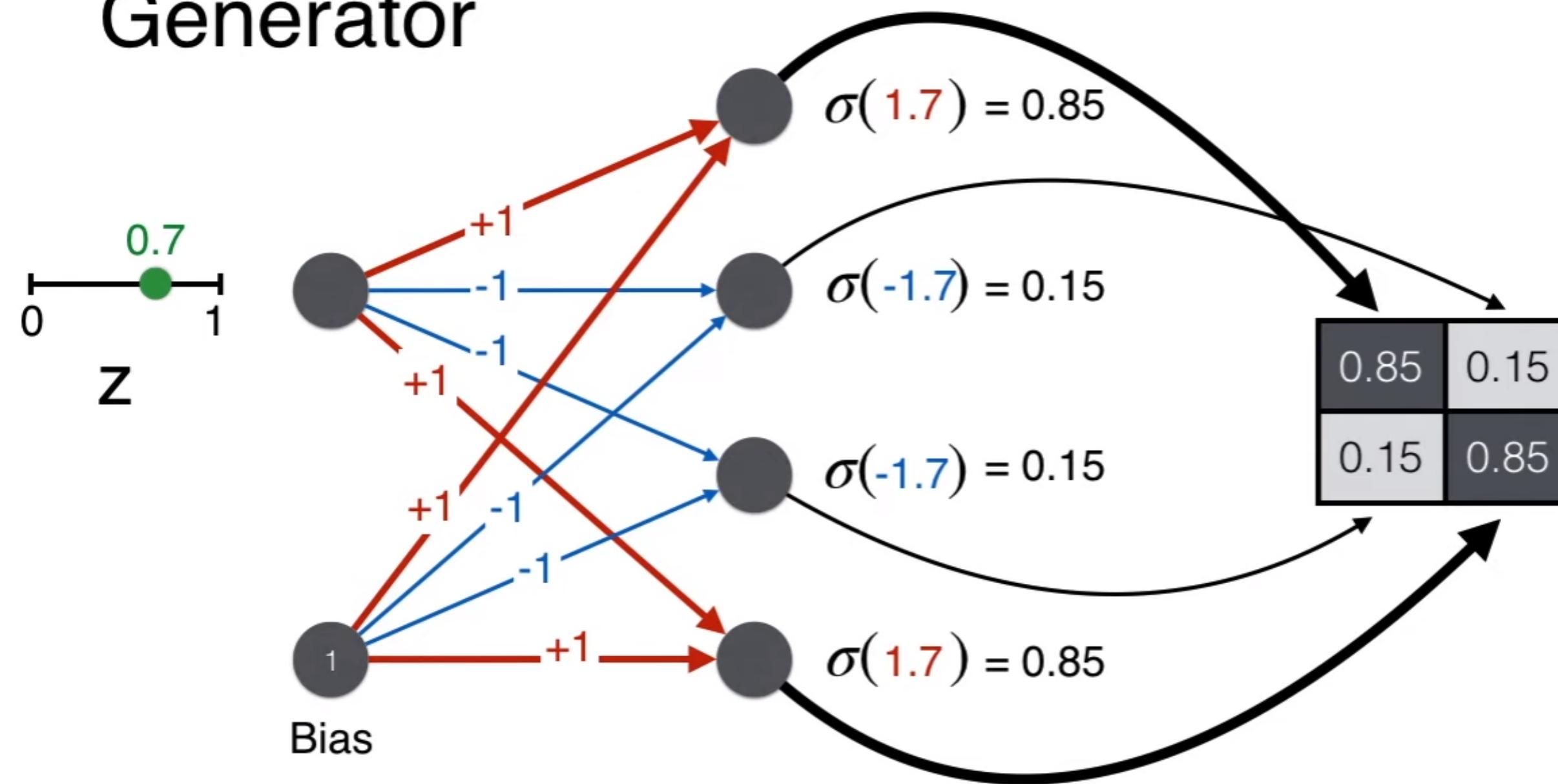


Construire le réseau génératif

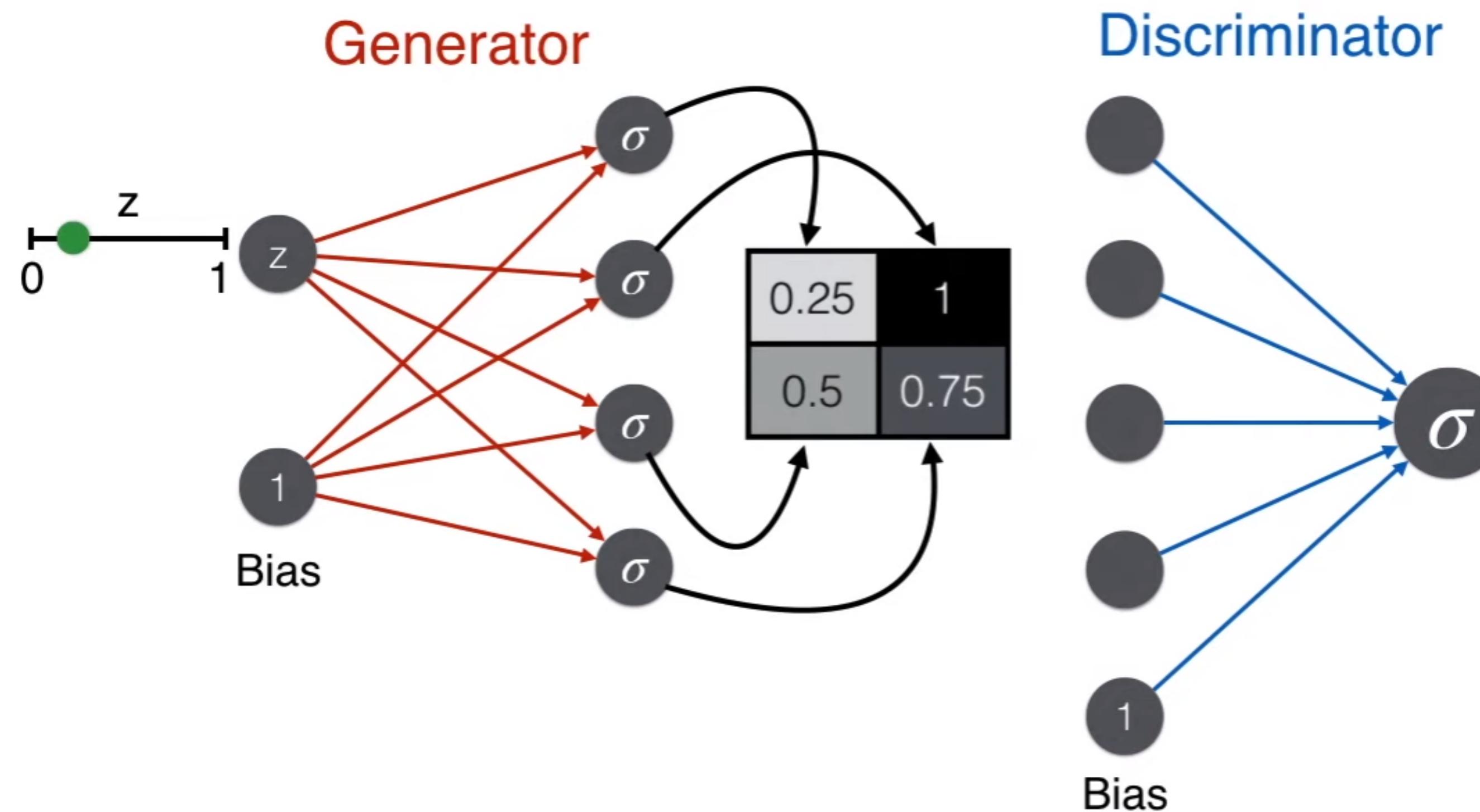


Construction d'une image

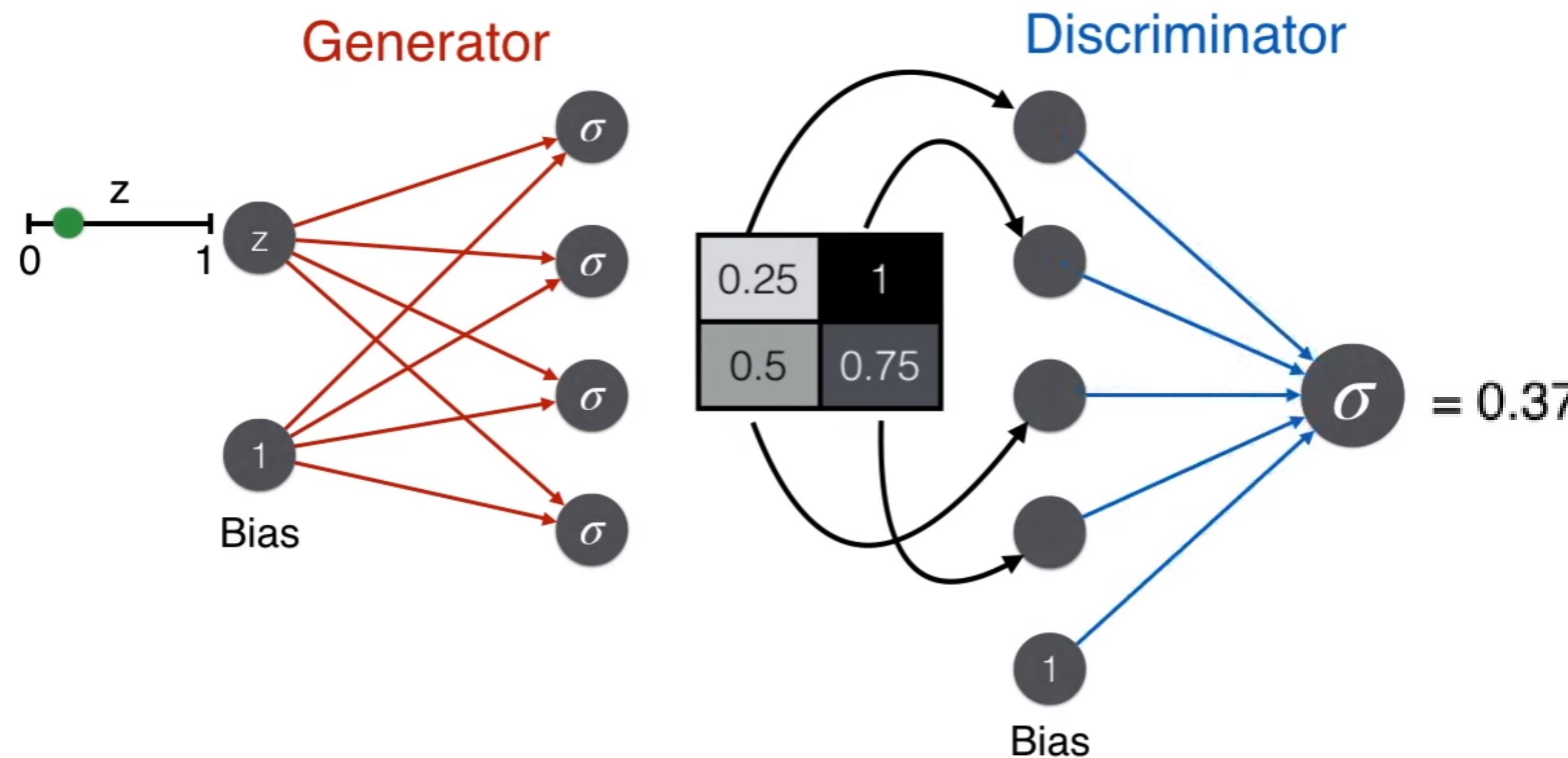
Generator



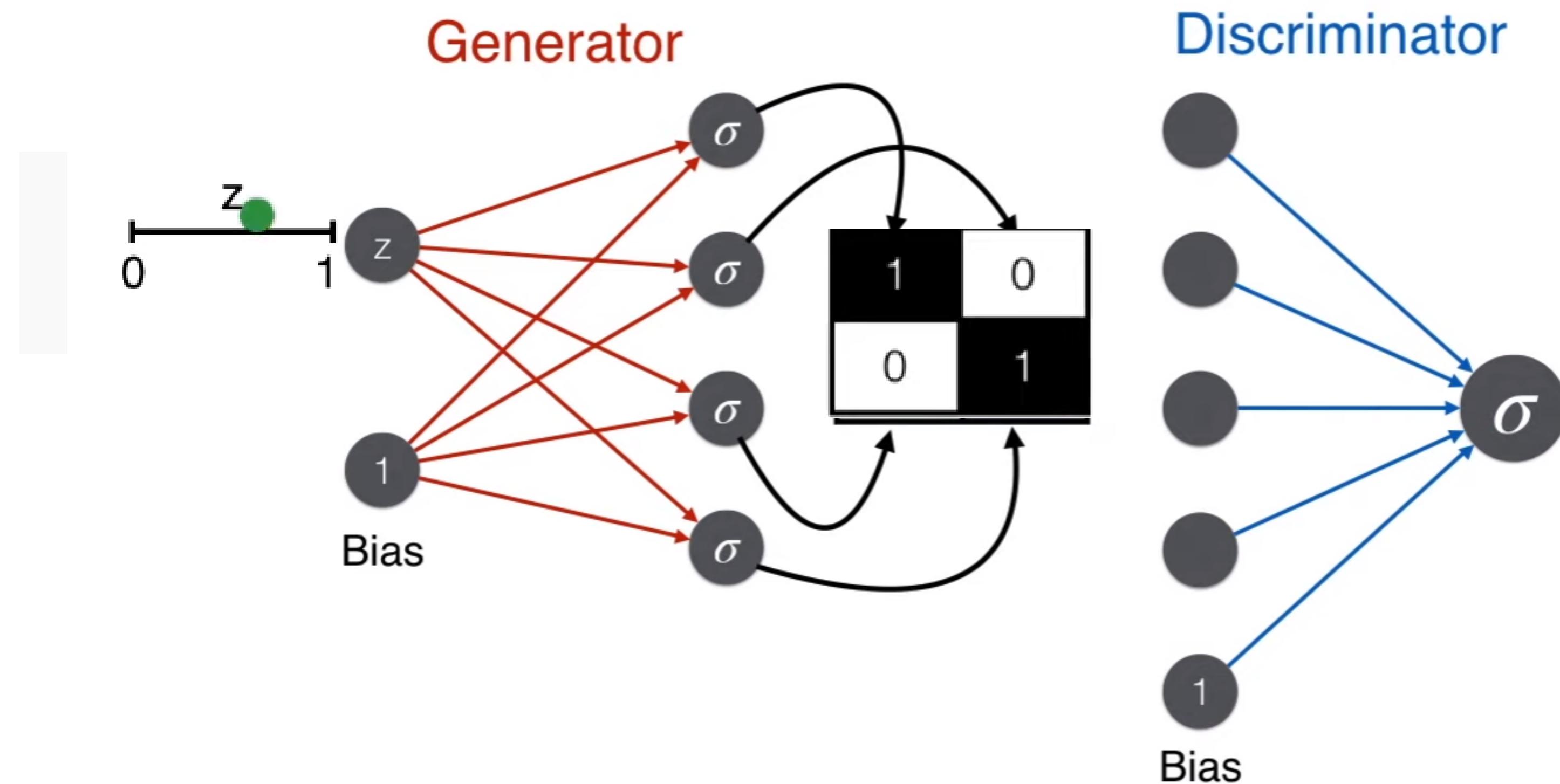
Cas échéant



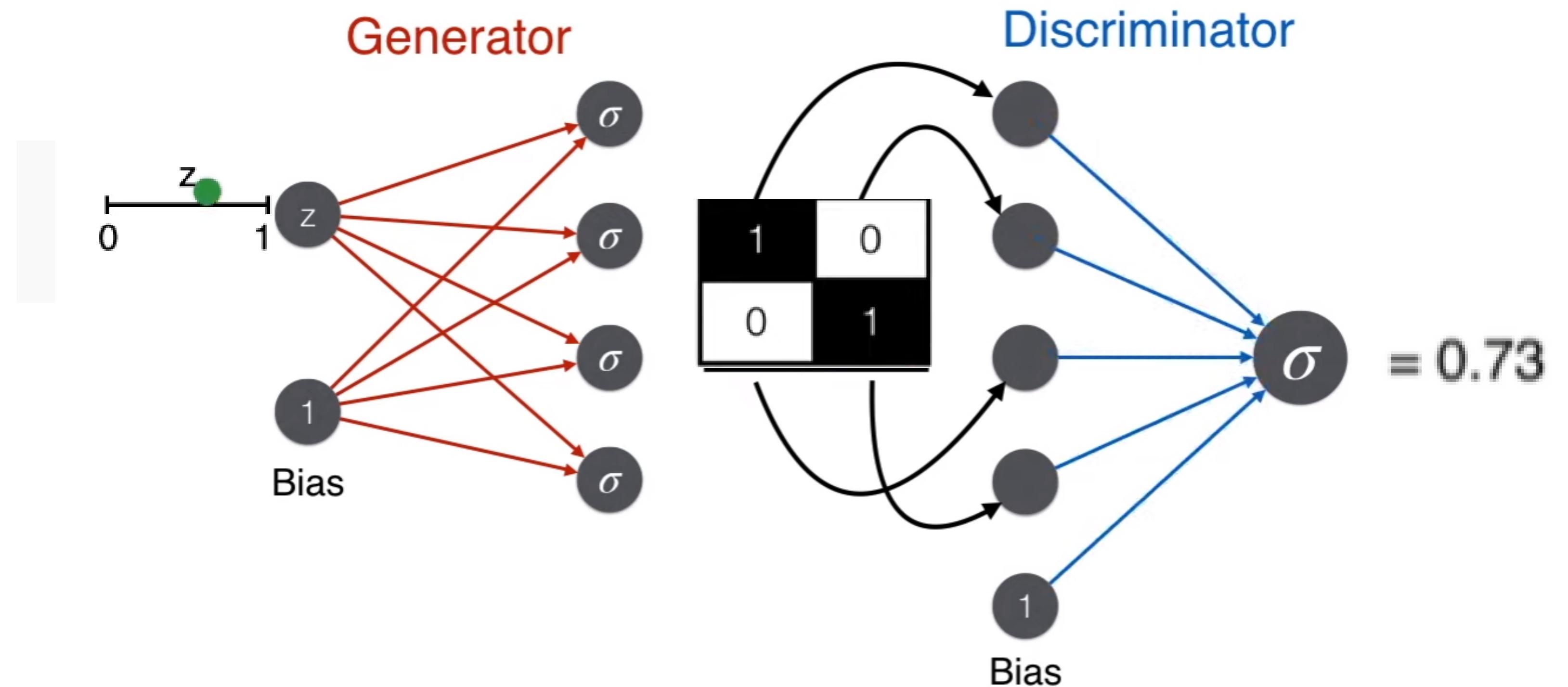
Cas échéant



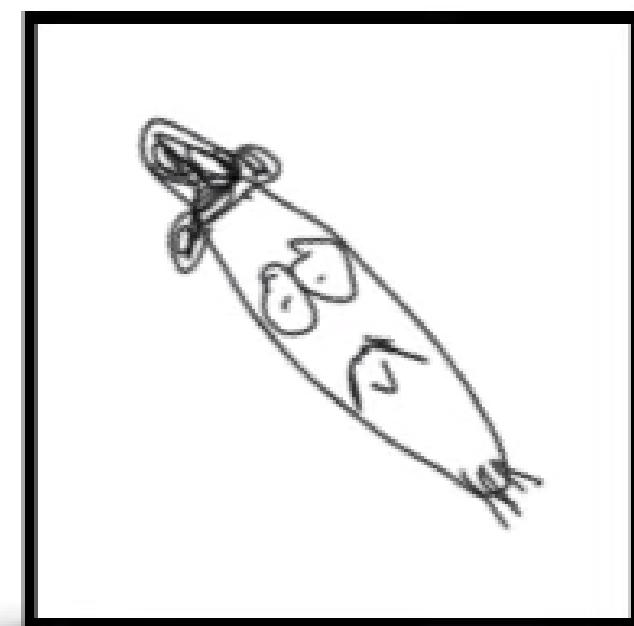
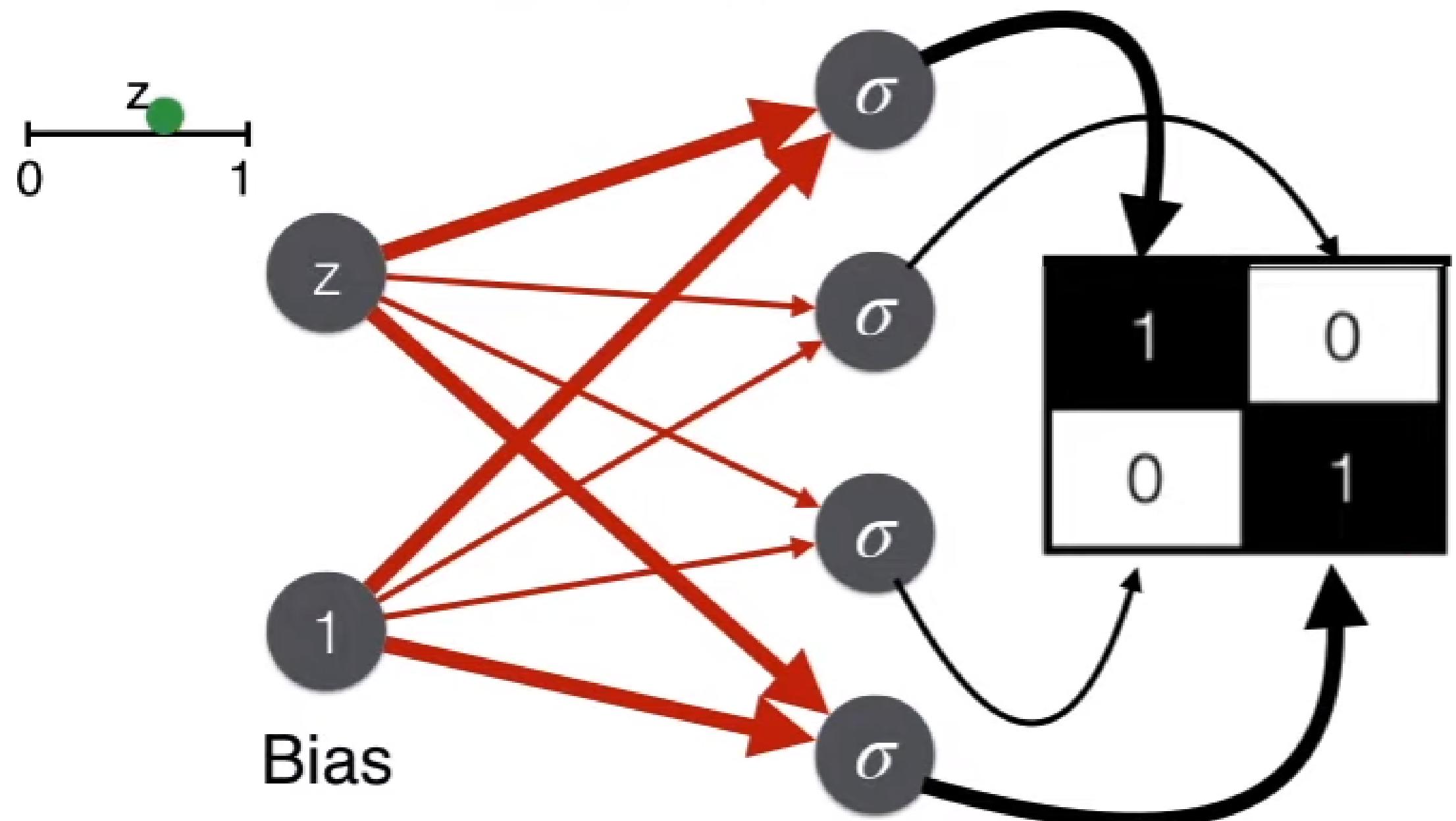
Cas réussite



Cas réussite

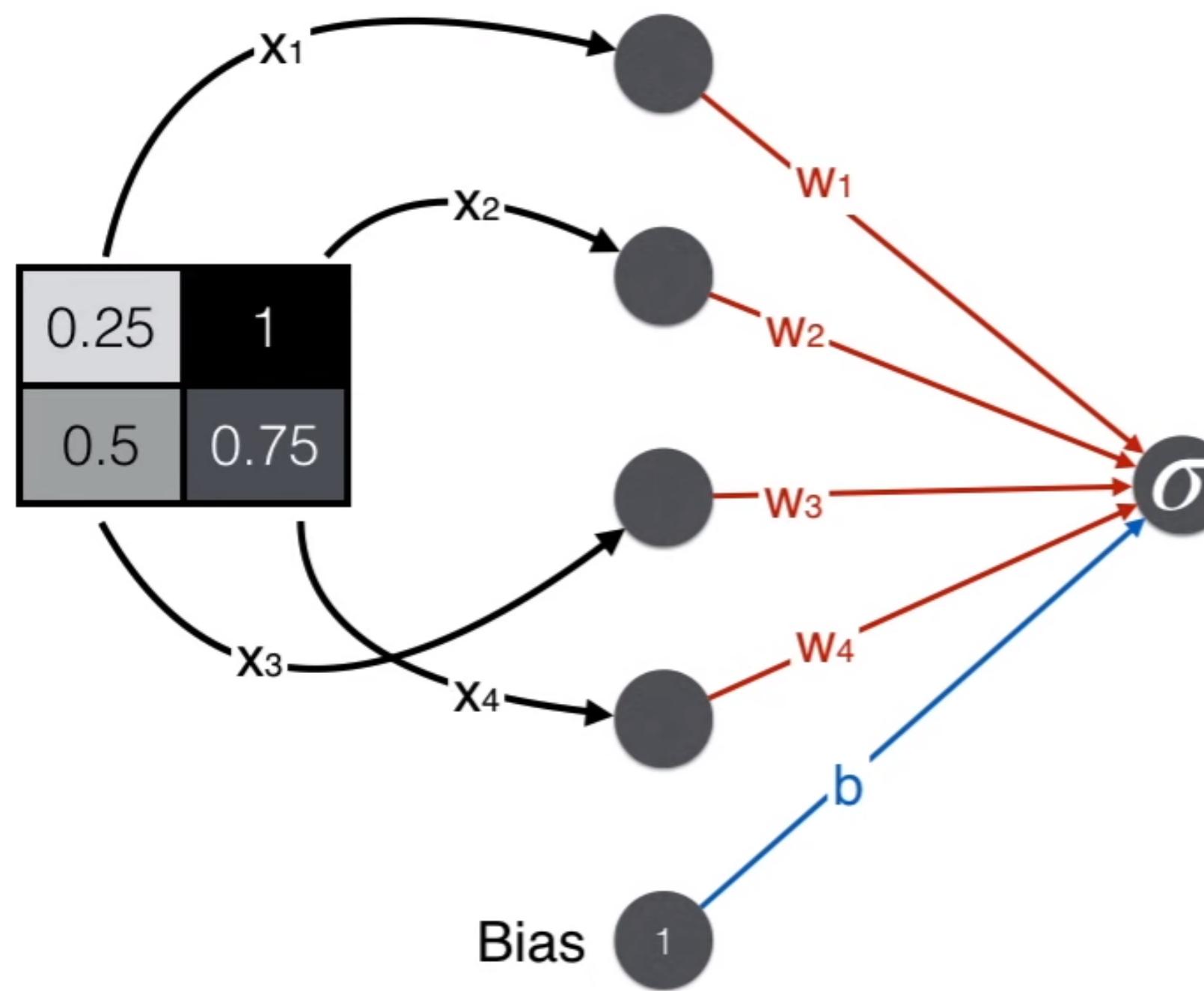


Après plusieurs itérations (epochs)



Implémenter cas échéant Discriminant

Discriminator



Prediction
$$D(x) = \sigma(x_1 w_1 + x_2 w_2 + x_3 w_3 + x_4 w_4 + b)$$

Loss function (error) from noise
$$E = -\ln(1 - D(x))$$

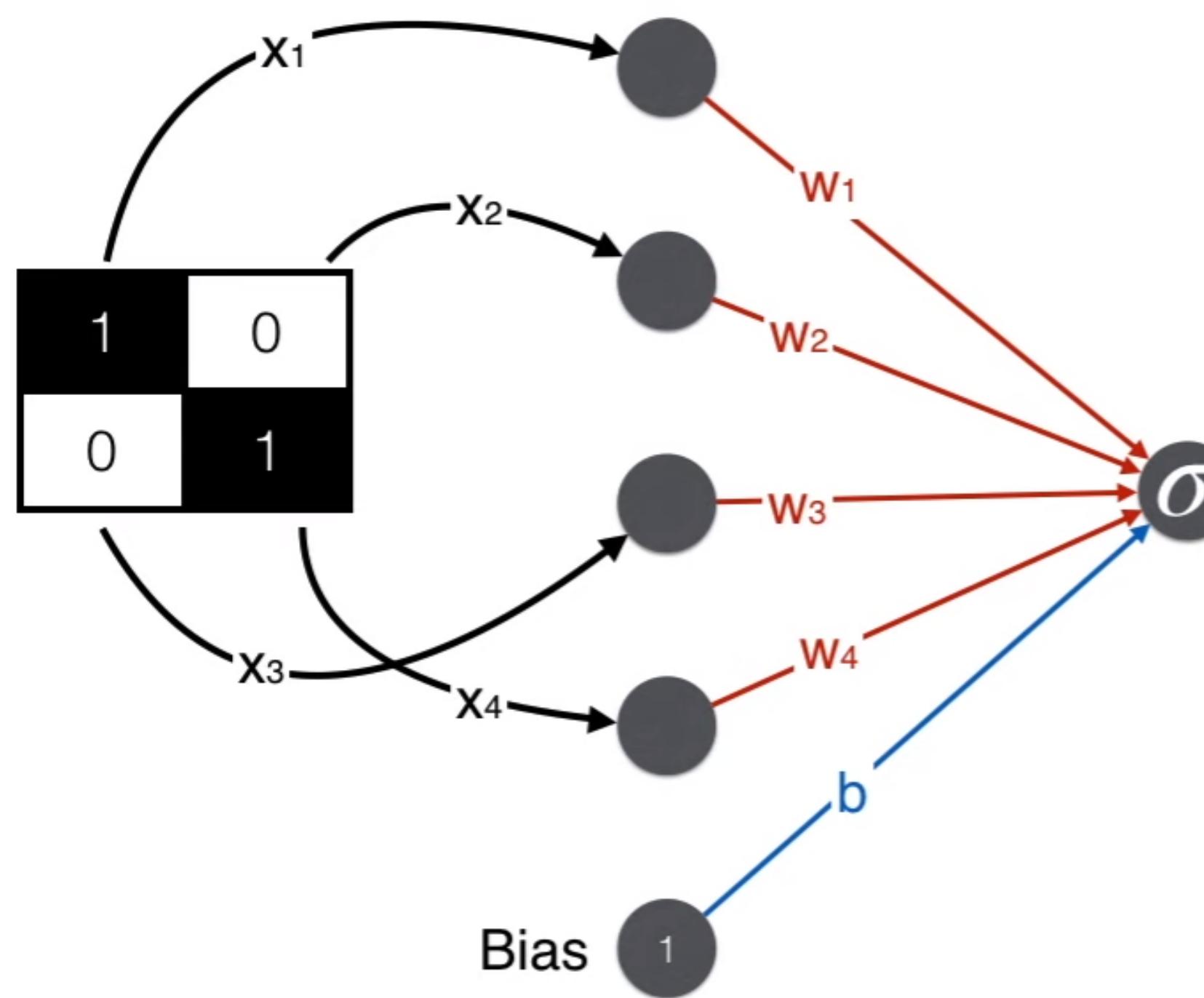
Derivatives

$$\begin{aligned}\frac{\partial E}{\partial w_i} &= \frac{\partial E}{\partial D} \cdot \frac{\partial D}{\partial w_i} \\ &= \frac{1}{1 - D(x)} \cdot \sigma(\sum_{j=1}^4 x_j w_j + b)[1 - \sigma(\sum_{j=1}^4 x_j w_j + b)]x_i \\ &= \frac{1}{1 - D(x)} \cdot D(x)[1 - D(x)]x_i \\ &= D(x)x_i\end{aligned}$$

$$\frac{\partial E}{\partial b} = \frac{\partial E}{\partial D} \cdot \frac{\partial D}{\partial b} = D(x)$$

Implémenter cas réussite Discriminant

Discriminator



Prediction
$$D(x) = \sigma(x_1 w_1 + x_2 w_2 + x_3 w_3 + x_4 w_4 + b)$$

Loss function (error) from images
$$E = -\ln(D(x))$$

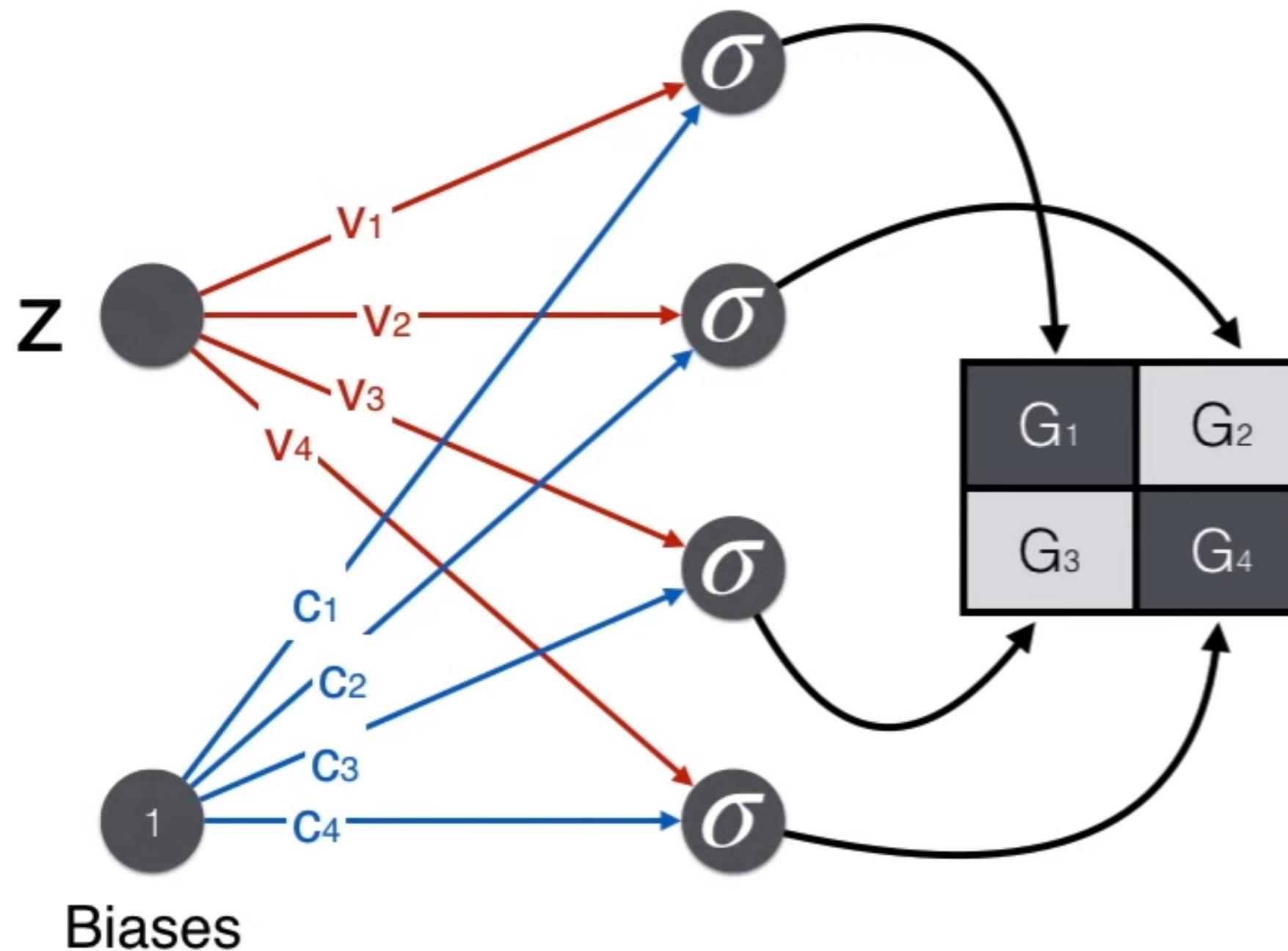
Derivatives

$$\begin{aligned}\frac{\partial E}{\partial w_i} &= \frac{\partial E}{\partial D} \cdot \frac{\partial D}{\partial w_i} \\ &= \frac{-1}{D(x)} \cdot \sigma(\sum_{j=1}^4 x_j w_j + b)[1 - \sigma(\sum_{j=1}^4 x_j w_j + b)]x_i \\ &= \frac{-1}{D(x)} \cdot D(x)[1 - D(x)]x_i \\ &= -[1 - D(x)]x_i\end{aligned}$$

$$\frac{\partial E}{\partial b} = \frac{\partial E}{\partial D} \cdot \frac{\partial D}{\partial b} = -[1 - D(x)]$$

Implémenter class Générateur

Generator



Predictions
 $G(z) = (G_1, G_2, G_3, G_4)$

$$= (\sigma(v_1 z + c_1), \sigma(v_2 z + c_2), \sigma(v_3 z + c_3), \sigma(v_4 z + c_4))$$

$$D(G(z)) = \sigma(G_1 w_1 + G_2 w_2 + G_3 w_3 + G_4 w_4 + b)$$

Loss function (error)
 $E = -\ln(D(G(z)))$

Derivatives

$$\frac{\partial E}{\partial w_i} = \frac{\partial E}{\partial D} \cdot \frac{\partial D}{\partial G} \cdot \frac{\partial G}{\partial z}$$

$$= \frac{-1}{D(G(z))} \cdot \sigma(\sum_{j=1}^4 G_j w_i + b)[1 - \sigma(\sum_{j=1}^4 G_j w_i + b)]G(z) \cdot \sigma(w_i z + b_i)[1 - \sigma(w_i z + b_i)]z$$

$$= \frac{-1}{D(G(z))} \cdot D(G(z))[1 - D(G(z))] \cdot G_i(1 - G_i)z$$

$$= -[1 - D(G(z))] \cdot G_i(1 - G_i)z$$

$$\frac{\partial E}{\partial b} = -[1 - D(G(z))] \cdot G_i(1 - G_i)$$

Fonctions d'erreurs

Log-loss error function

$$\text{Error} = -\ln(\text{prediction})$$

Label: 1
Prediction: 0.1

Error: large $-\ln(0.1) = 2.3$

Label: 1
Prediction: 0.9

Error: small $-\ln(0.9) = 0.1$

Log-loss error function

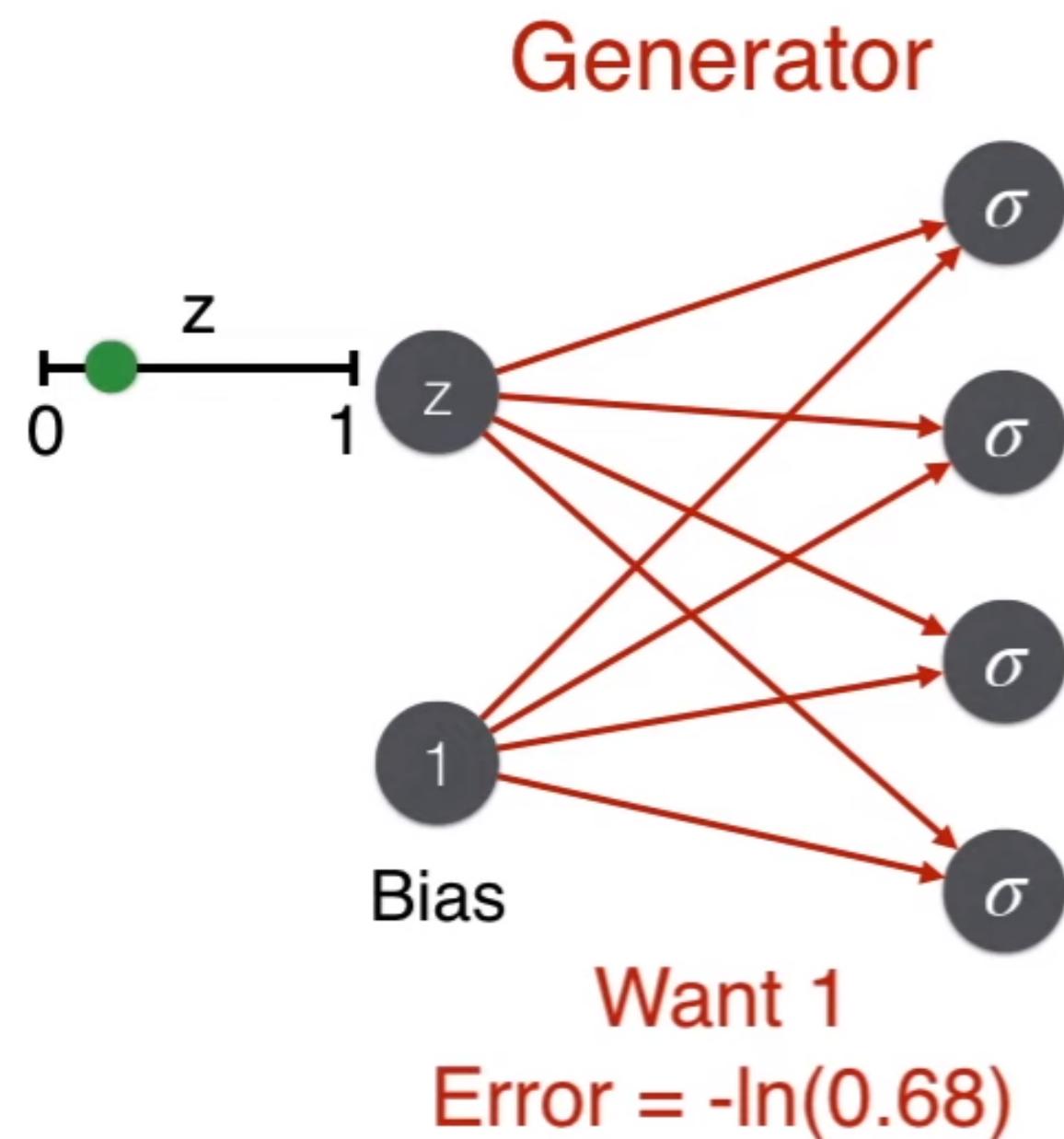
$$\text{Error} = -\ln(1 - \text{prediction})$$

Label: 0
Prediction: 0.1

Error: small $-\ln(0.9) = 0.1$

Label: 0
Prediction: 0.9

Error: large $-\ln(0.1) = 2.3$

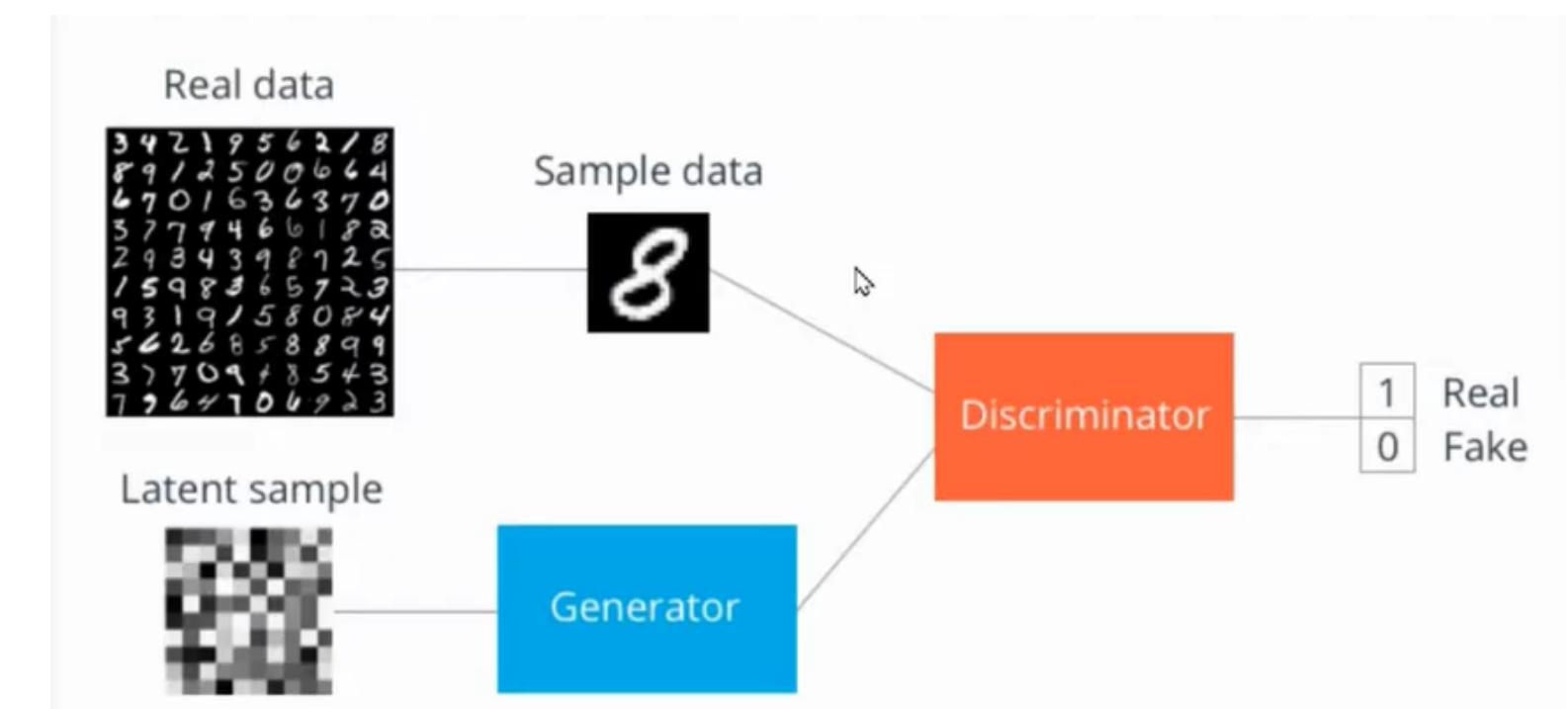


$$-\ln(D(G(z)))$$

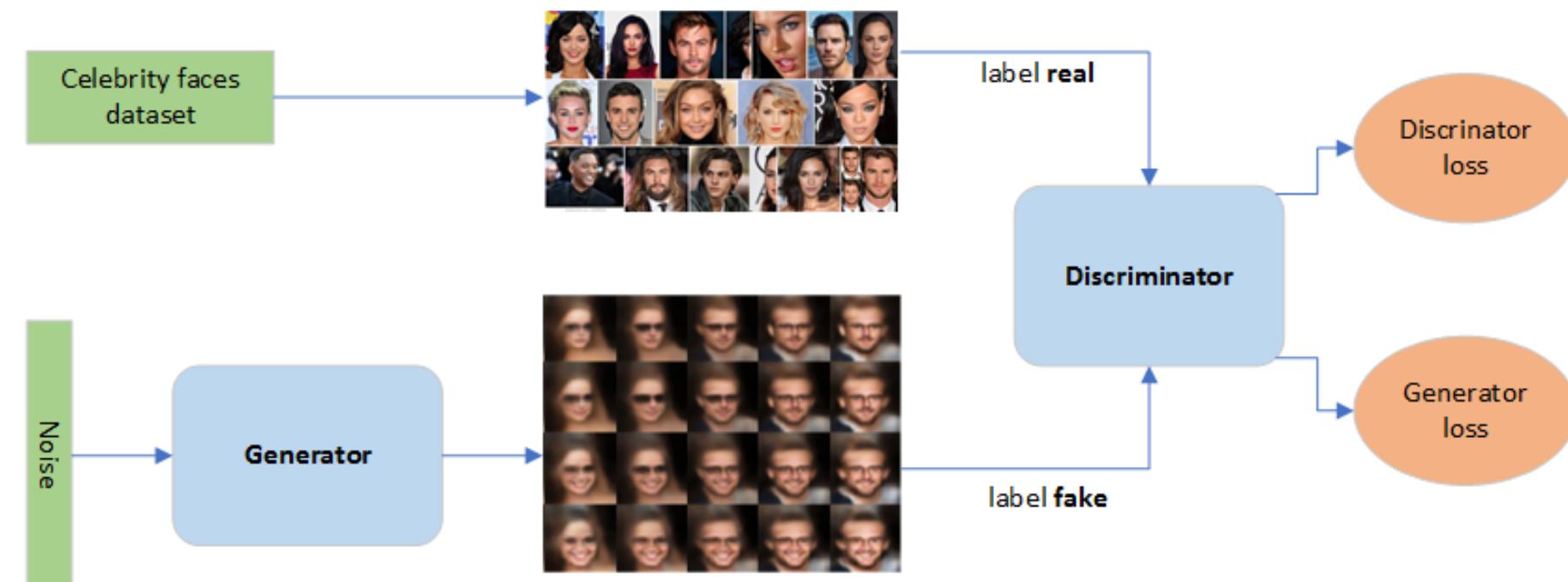


$$-\ln(1 - D(G(z)))$$

Cas d'étude avancé



Modèles sur 3 couches



Conclusion

Principe des GANs

Son fonctionnement

Différences entre
Réseau Discriminant/ Génératif

Exemple d'application

Ouverture : "data augmentation"

- élaboration de modèles + performants
- taux d'erreur minime
- modèle simplifié des modèles génératifs