

# Démystifier l'optimisation de l'encodage par l'IA

Luc Trudeau



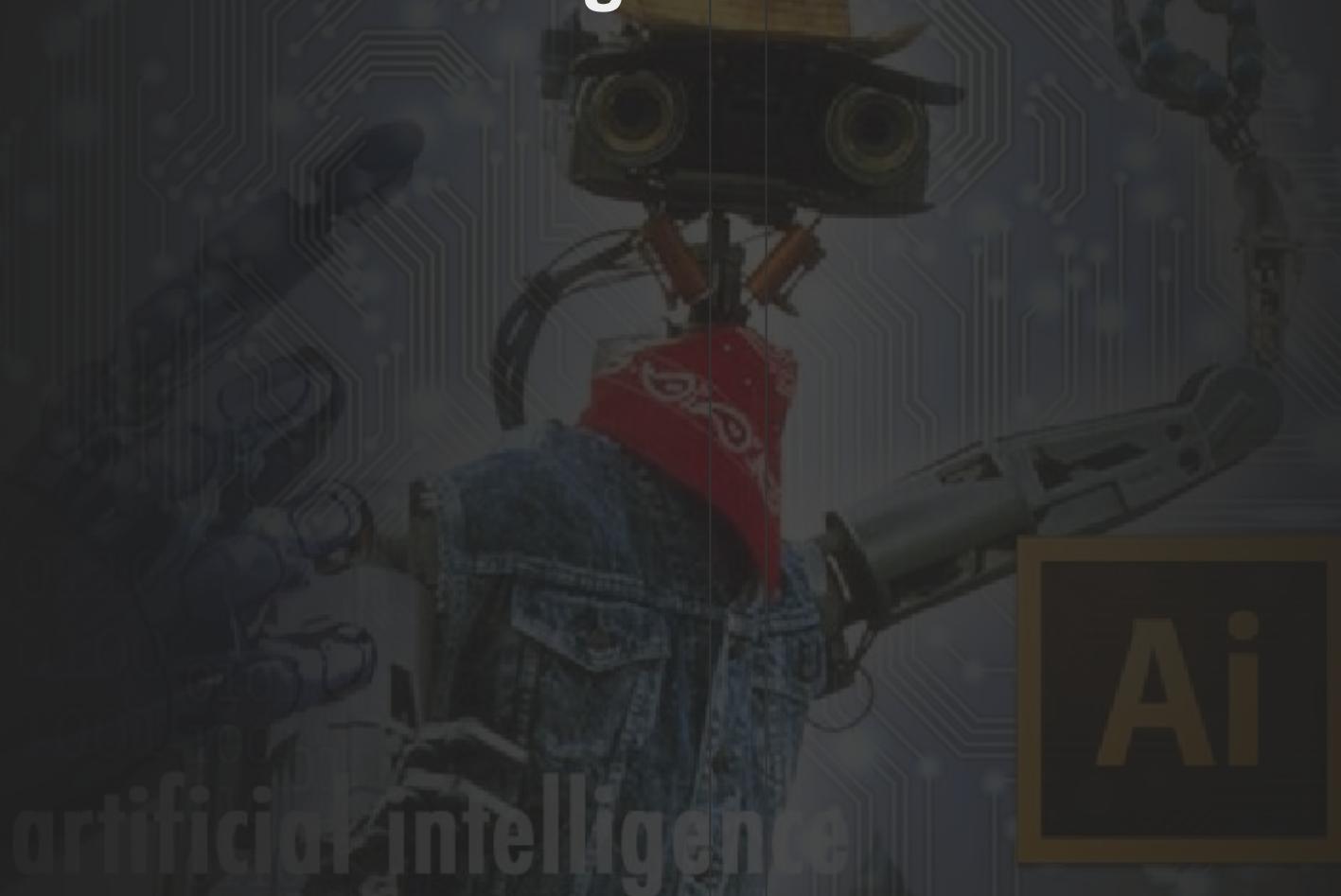
SINCE 1916



Cette présentation de [Luc Trudeau](#) est mis à disposition selon les termes de la [licence Creative Commons Attribution 4.0 International](#).



# IA et l'encodage video un “far west”

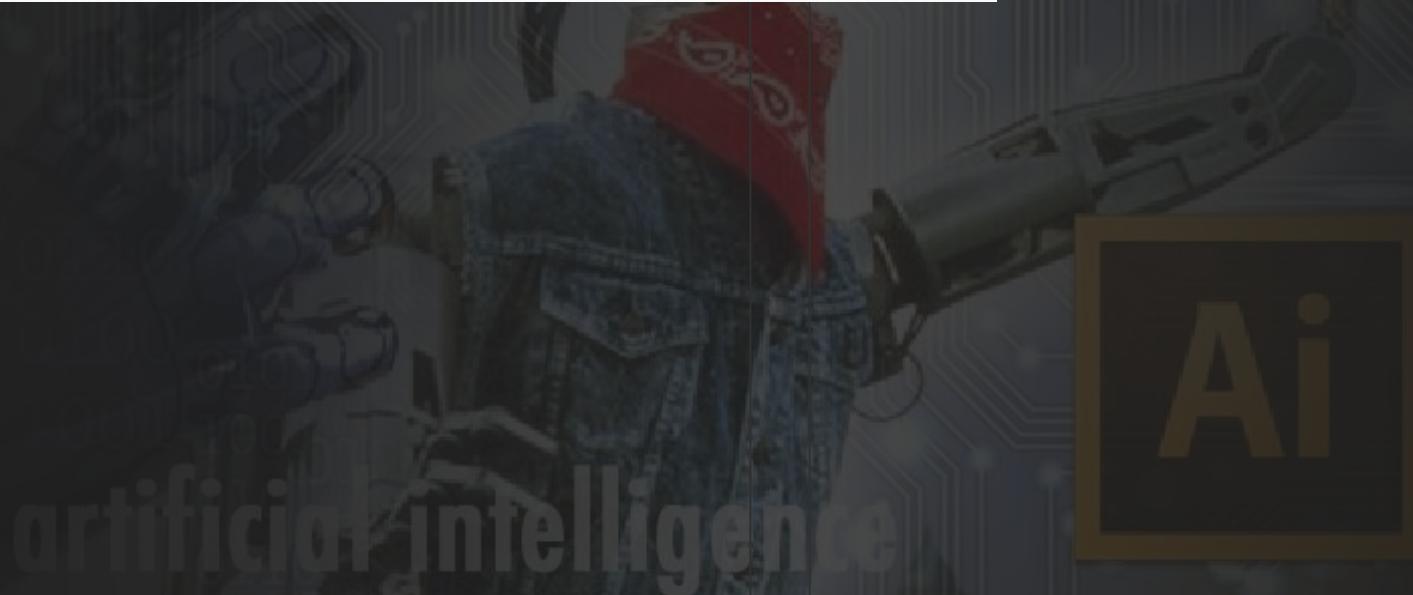


# IA et l'encodage video un “far west”

DATA DIET

## Netflix's new AI tweaks each scene individually to make video look good even on slow internet

By Joon Ian Wong • February 28, 2017



# IA et l'encodage video un “far west”

DATA DIET

## Netflix's new AI tweaks each scene individually to make video look good even on slow internet

By Joon Ian Wong • February 28, 2017

Will AI Power the Next Leap in Video Compression?

MARCH 12, 2017 | IN ARTIFICIAL INTELLIGENCE, CODEC, DIGITAL CONTENT, DIGITAL IMAGING, DIGITAL TECH CONSULTING, HEVC, INTERNET VIDEO, OTT, STREAMING VIDEO, TV SPECTRUM, VIDEO COMPRESSION | BY GREG SCOBLE

# IA et l'encodage video un “far west”

DATA DIET

## Netflix's new AI tweaks each scene individually to make video look good even on slow internet

By Joon Ian Wong • February 28, 2017

Artificial Intelligence / Machine learning

## Deep learning will help keep video from clogging up the internet

Compressing videos into smaller files has always been hard, but machine-learning techniques offer some tricks to make it easier.

by Emerging Technology from the arXiv

Nov 27, 2018

## Will AI Power the Next Leap in Video Compression?

MARCH 12, 2017 | IN ARTIFICIAL INTELLIGENCE, CODEC, DIGITAL CONTENT, DIGITAL IMAGING, DIGITAL TECH CONSULTING, HEVC, INTERNET VIDEO, OTT, STREAMING VIDEO, TV SPECTRUM, VIDEO COMPRESSION | BY GREG SCOBLE

# IA et l'encodage video un “far west”

DATA DIET

## Netflix's new AI tweaks each scene individually to make video look good even on slow internet

September 26, 2018  
By Jason Thibeault  
Future in Focus

Can AI Make the Streaming Video Experience Even Better Than TV?



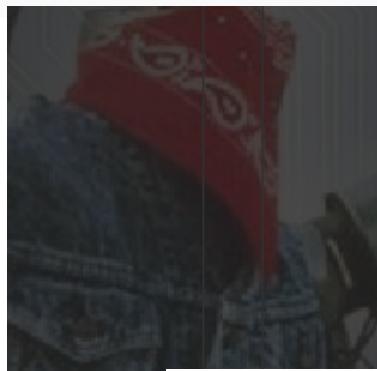
Artificial Intelligence / Machine learning

## Deep learning will help keep video from clogging up the internet

Compressing videos into smaller files has always been hard, but machine-learning techniques offer some tricks to make it easier.

by Emerging Technology from the arXiv

Nov 27, 2018



Will AI Power the Next Leap in Video Compression?

MARCH 12, 2017 | IN ARTIFICIAL INTELLIGENCE, CODEC, DIGITAL CONTENT, DIGITAL IMAGING, DIGITAL TECH CONSULTING, HEVC, INTERNET VIDEO, OTT, STREAMING VIDEO, TV SPECTRUM, VIDEO COMPRESSION | BY GREG SCOBLE

# IA et l'encodage vidéo un “far west”

DATA DIET

## Netflix's new AI tweaks each scene individually to make video look good even on slow internet

September 26, 2018  
By Jason Thibeault  
Future in Focus

Can AI Make the Streaming Video Experience Even Better Than TV?



March 27, 2018  
By Troy Dreier Senior Editor  
Online Video News

Bitmovin Intros AI-Powered Video Encoding That Learns Over Time

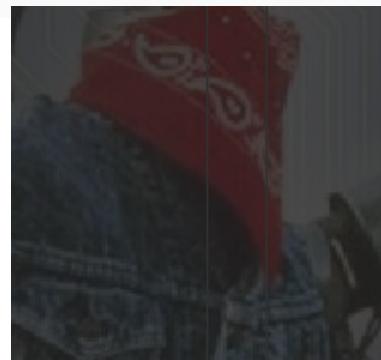
Artificial Intelligence / Machine learning

## Deep learning will help keep video from clogging up the internet

Compressing videos into smaller files has always been hard, but machine-learning techniques offer some tricks to make it easier.

by Emerging Technology from the arXiv

Nov 27, 2018



Will AI Power the Next Leap in Video Compression?

MARCH 12, 2017 | IN ARTIFICIAL INTELLIGENCE, CODEC, DIGITAL CONTENT, DIGITAL IMAGING, DIGITAL ECH CONSULTING, HEVC, INTERNET VIDEO, OTT, STREAMING VIDEO, TV SPECTRUM, VIDEO OMPRESSION | BY GREG SCOBLE

# IA et l'encodage vidéo un “far west”

DATA DIET

## Netflix's new AI tweaks each scene individually to make video look good even on slow internet

September 26, 2018  
By Jason Thibeault  
Future In Focus

Can AI Make the Streaming Video Experience Even Better Than TV?



March 27, 2018  
By Troy Dreier Senior Editor  
Online Video News

Bitmovin Intros AI-Powered Video Encoding That Learns Over Time

Artificial Intelligence / Machine learning

## Deep learning will help keep video from clogging up the internet

How AI and Machine Learning Are Changing the Face of Video Compression

April 3, 2019

Written by Jean-Louis Diascorn



Nov 27, 2018

Will AI Power the Next Leap in Video Compression?

MARCH 12, 2017 | IN ARTIFICIAL INTELLIGENCE, CODEC, DIGITAL CONTENT, DIGITAL IMAGING, DIGITAL ECH CONSULTING, HEVC, INTERNET VIDEO, OTT, STREAMING VIDEO, TV SPECTRUM, VIDEO OMPRESSION | BY GREG SCOBLE

been hard, but make it easier.

# IA et l'encodage vidéo un “far west”

## Objectifs

DATA DIET

Artificial Intelligence / Machine learning

Netflix's new AI tweaks each scene individually to make video look good even on slow internet

Mieux comprendre

Deep learning will help keep video from clogging up the internet

September 26, 2018  
By Jason Thibeault  
Future In Focus

Can AI Make the Streaming Video Experience Even Better Than TV?

Point de vue critique

How AI and Machine Learning Are Changing the Face of Video Compression

Written by Jean-Louis Diascorn

been hard, but make it easier.



March 27, 2018  
By Troy Dreier Senior Editor  
Online Video News

Bitmovin Intros AI-Powered Video Encoding That Learns Over Time



Will AI Power the Next Leap in Video Compression?

MARCH 12, 2017 | IN ARTIFICIAL INTELLIGENCE, CODEC, DIGITAL CONTENT, DIGITAL IMAGING, DIGITAL ECH CONSULTING, HEVC, INTERNET VIDEO, OTT, STREAMING VIDEO, TV SPECTRUM, VIDEO OMPRESSION | BY GREG SCOBLETE

Nov 27, 2018

Luc Trudeau ([@trudluc](https://twitter.com/trudluc), [in Luc Trudeau](https://www.linkedin.com/in/Luc-Trudeau))

# Chercheur en compression vidéo

Coauteur du format AV1

Auteur de [brevets et d'articles scientifiques](#)

Chercheur pour [Two Orioles](#)

Coconcepteur du décodeur [dav1d](#)

[Chasseur de prime en compression vidéo](#)



LUC TRUDEAU  
CONSULTING

[trud.ca](http://trud.ca)

Survol

L'OTT

L'encodage micro-optimisé

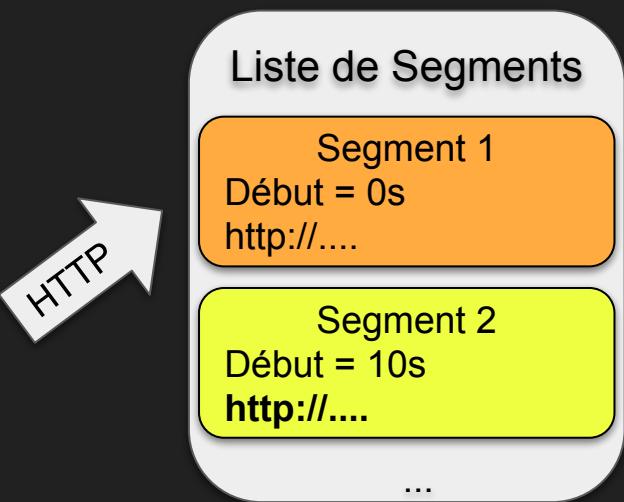
L'optimisateur dynamique

L'enveloppe convexe déterminée par l'IA

OTT  
(Over The Top)

*N'adaptez pas le web à  
la vidéo, adaptez la  
vidéo au web*

# Imitation d'une diffusion via de courts téléchargements (1 seconde à 3 minutes)



# Plusieurs encodages d'un même segment

1080p HD

720p HD

480p

360p

240p

144p

# Plusieurs encodages d'un même segment

960x540 2000 kb/s



768x432 1100 kb/s



768x432 730 kb/s



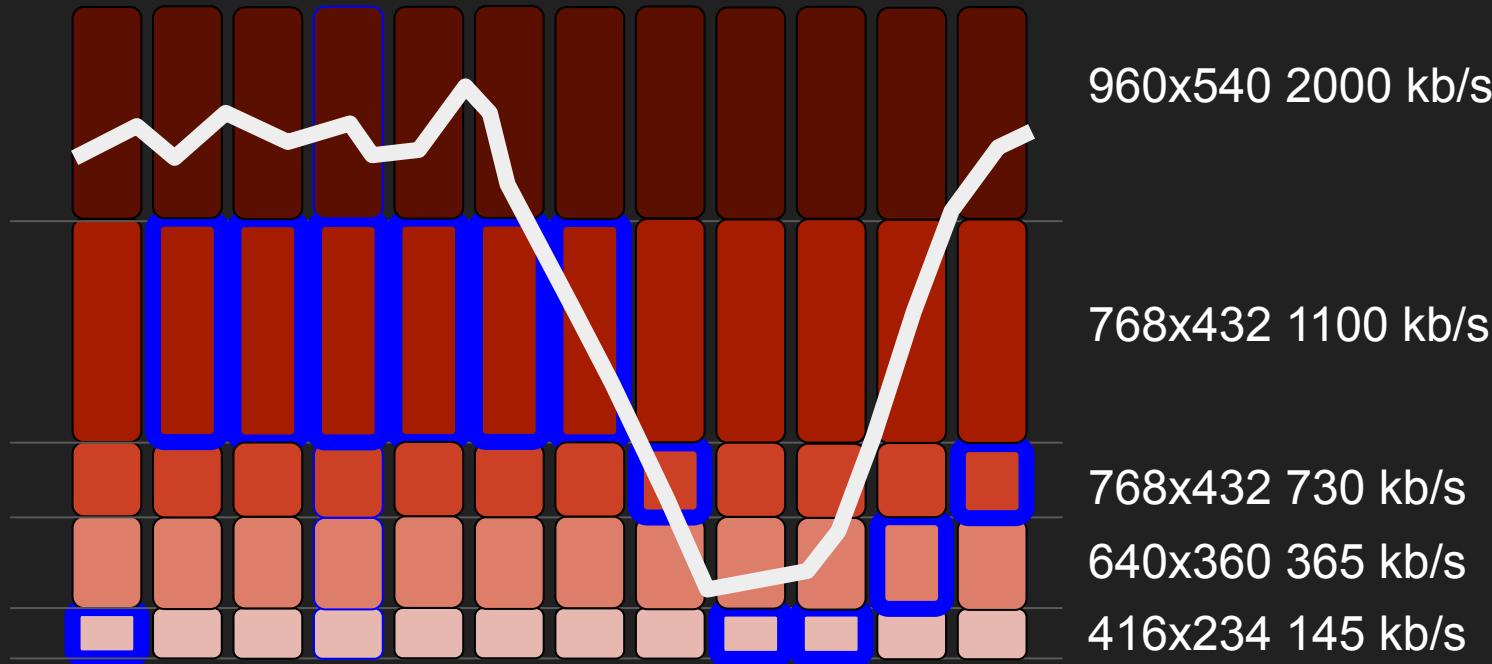
640x360 365 kb/s



416x234 145 kb/s



# Adaptation dynamique aux conditions du réseau



Sondage de mux.com (50 diffuseurs en ligne)

*“Comment choisissez-vous votre échelle de débits?”*

A vertical bar chart illustrating the distribution of video bitrates chosen by 50 online broadcasters. The y-axis lists the bitrates: 1080p HD, 720p HD, 480p, 360p, 240p, and 144p. The x-axis is a dark grey bar representing the cumulative percentage, starting at 0% on the left and ending at 100% on the right. The distribution is heavily skewed towards lower bitrates, with the highest concentration between 144p and 360p.

| Bitrate  | Percentage |
|----------|------------|
| 1080p HD | ~1%        |
| 720p HD  | ~5%        |
| 480p     | ~10%       |
| 360p     | ~25%       |
| 240p     | ~30%       |
| 144p     | ~30%       |

## *“Comment choisissez-vous votre échelle de débits?”*

Top 3 réponses:

- Échelle de débits?
- Un consultant, il y a 5 ans.
- Les recommandations d'Apple.

1080p HD

720p HD

480p

360p

240p

144p

Échelle de débits constante (*pas une bonne idée*)

ROI (\$)

0\$

Vues

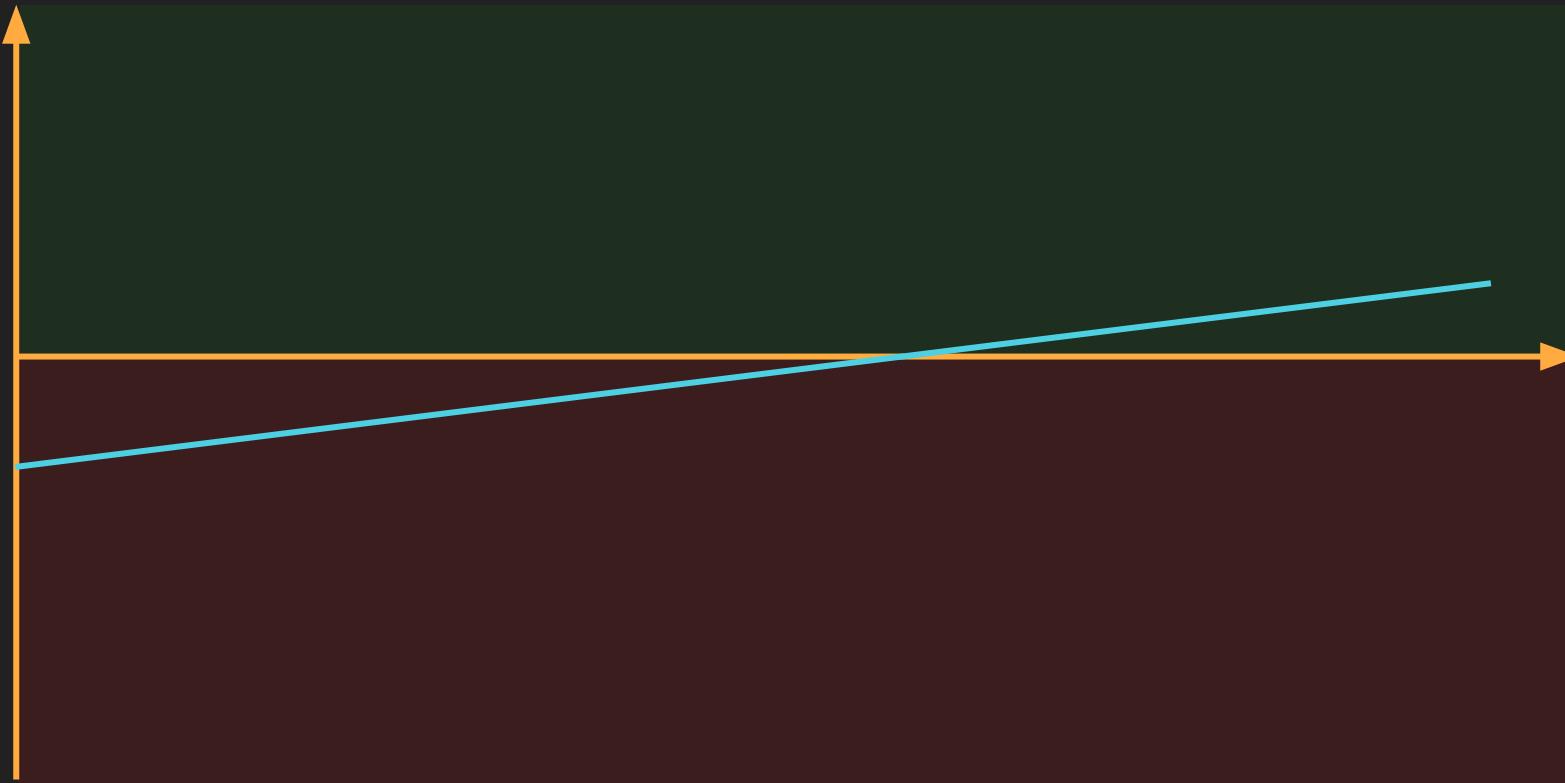


Échelle de débits constante (*pas une bonne idée*)

ROI (\$)

0\$

Vues



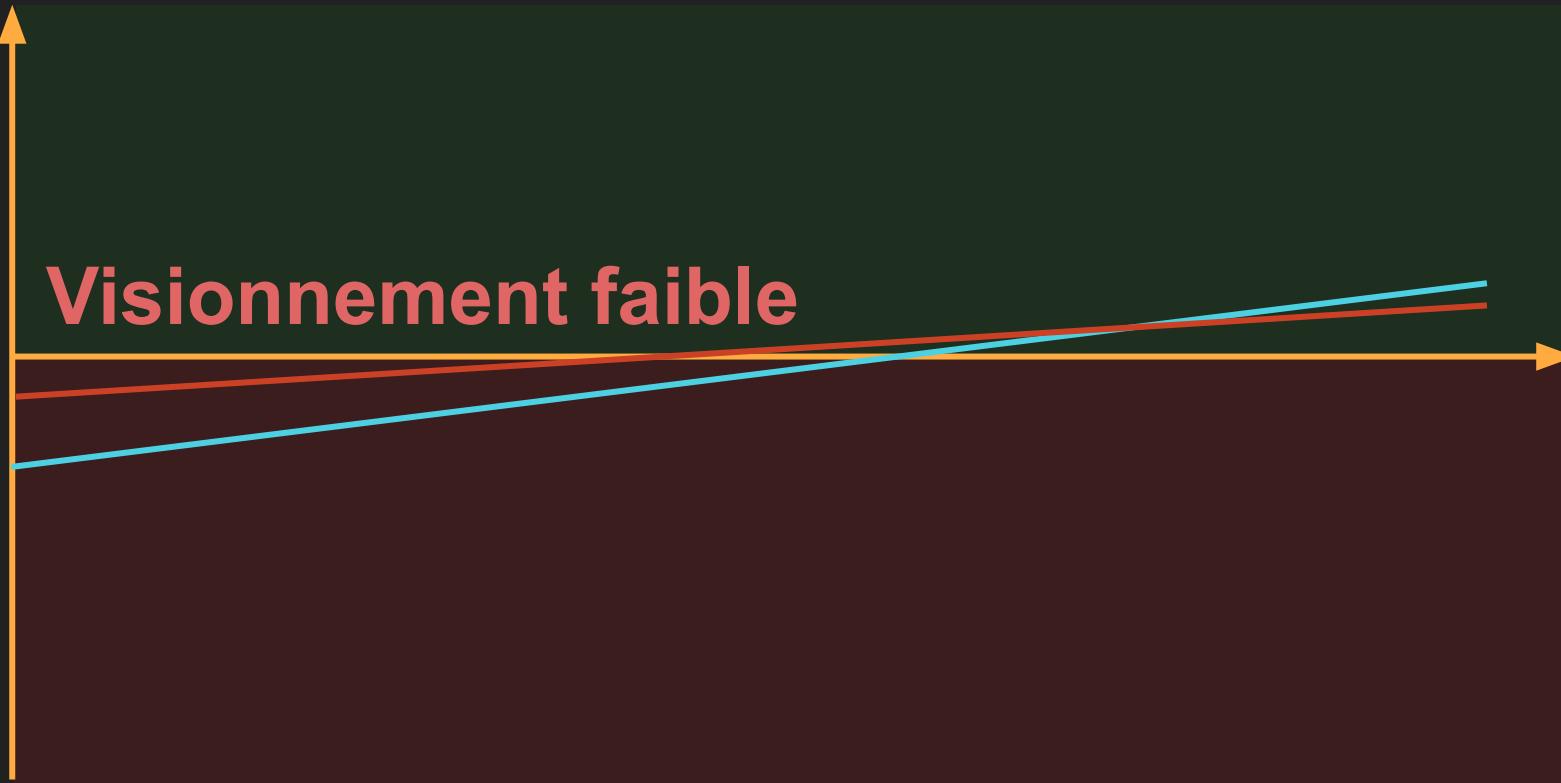
## Échelle de débits constante (*pas une bonne idée*)

ROI (\$)

0\$

**Visionnement faible**

Vues



Échelle de débits constante (*pas une bonne idée*)

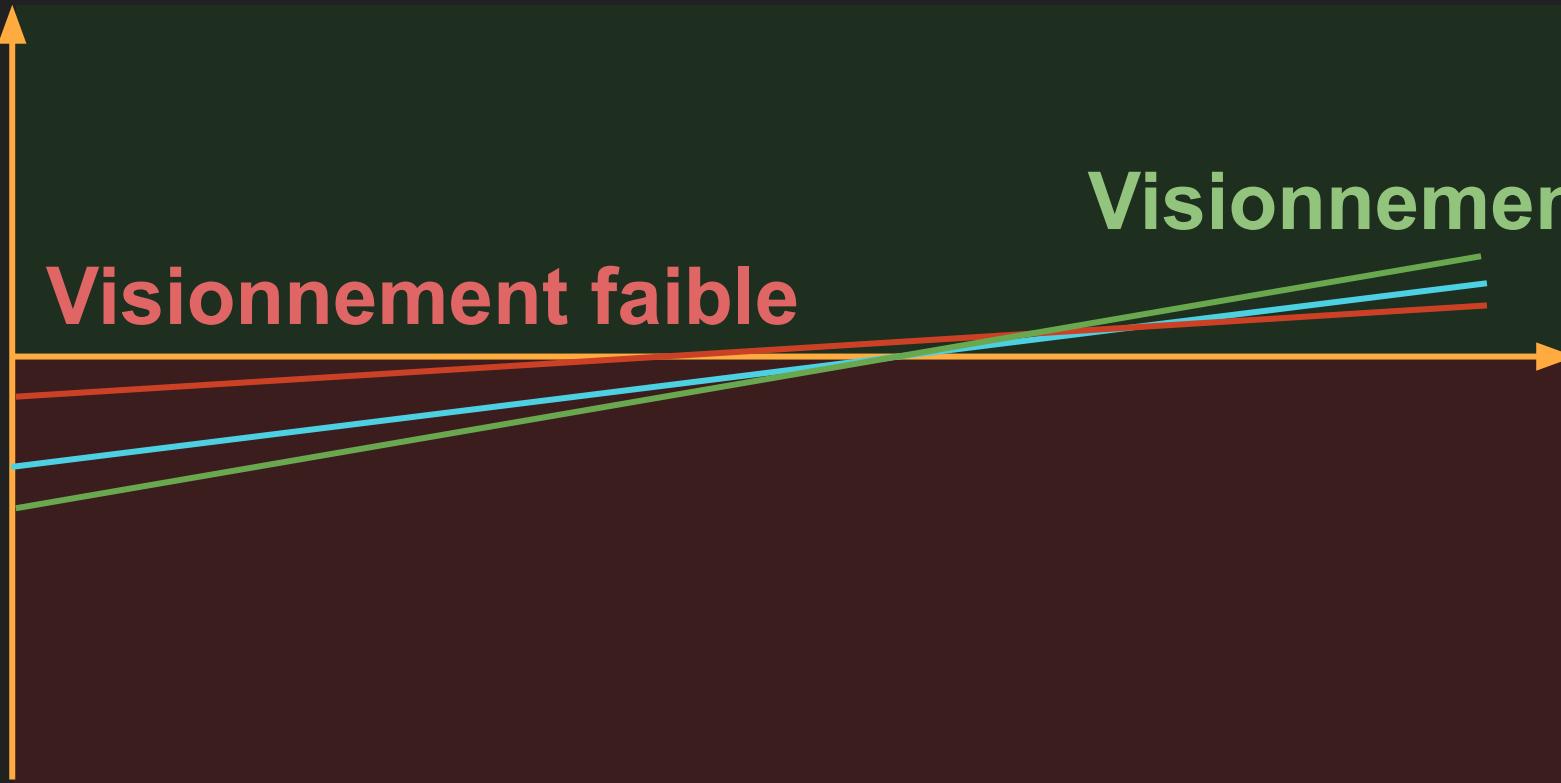
ROI (\$)

0\$

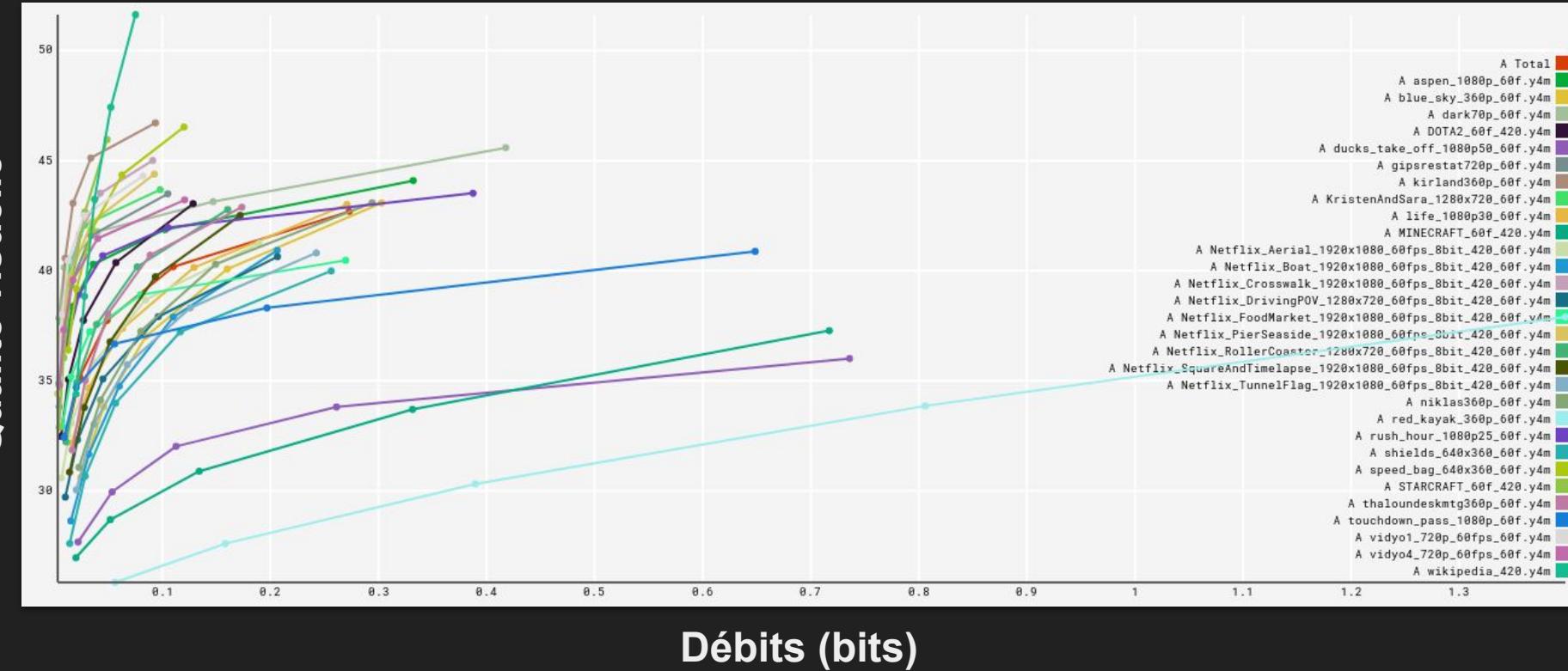
**Visionnement faible**

**Visionnement fort**

Vues



# Pas de solutions “one size fits all”



# L'encodage micro-optimisé

# Encodage optimisé par scène / par prise de vue (shot)



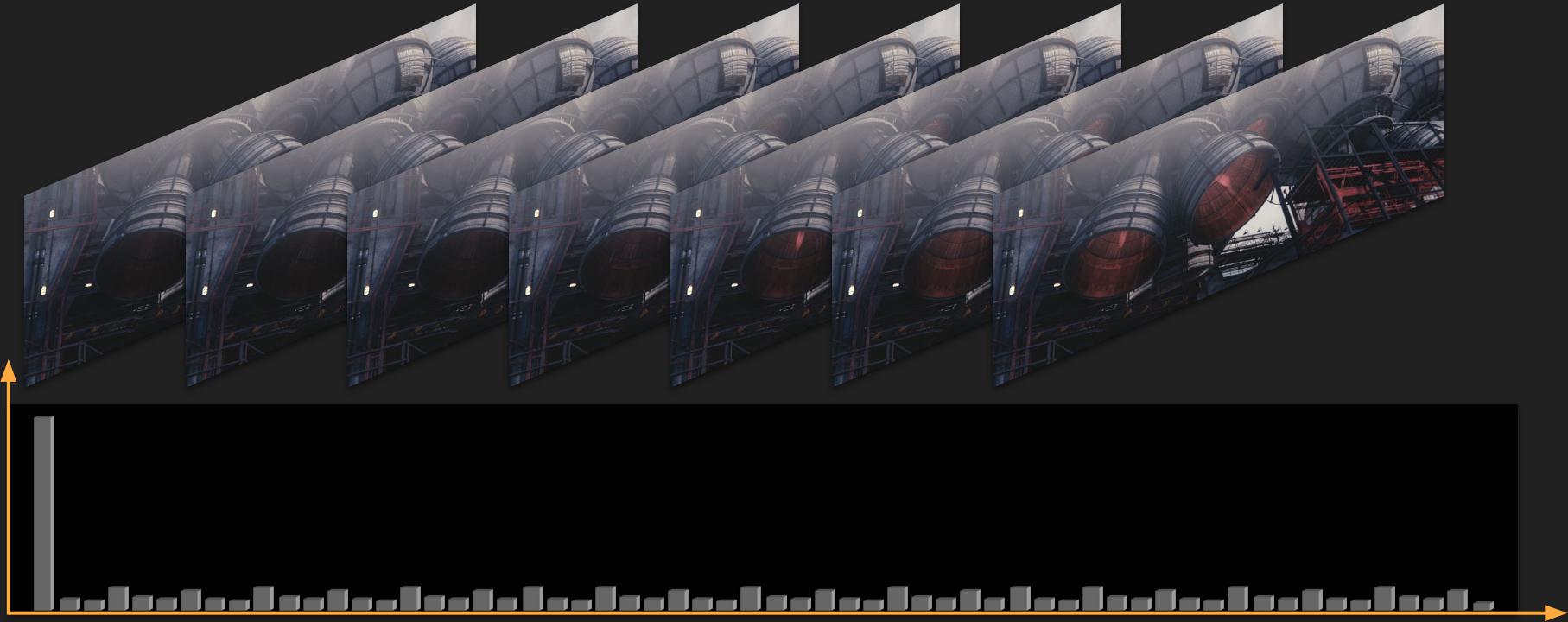
Les segments d'une séquence peuvent varier  
considérablement

# Encodage optimisé par scène / par prise de vue (shot)

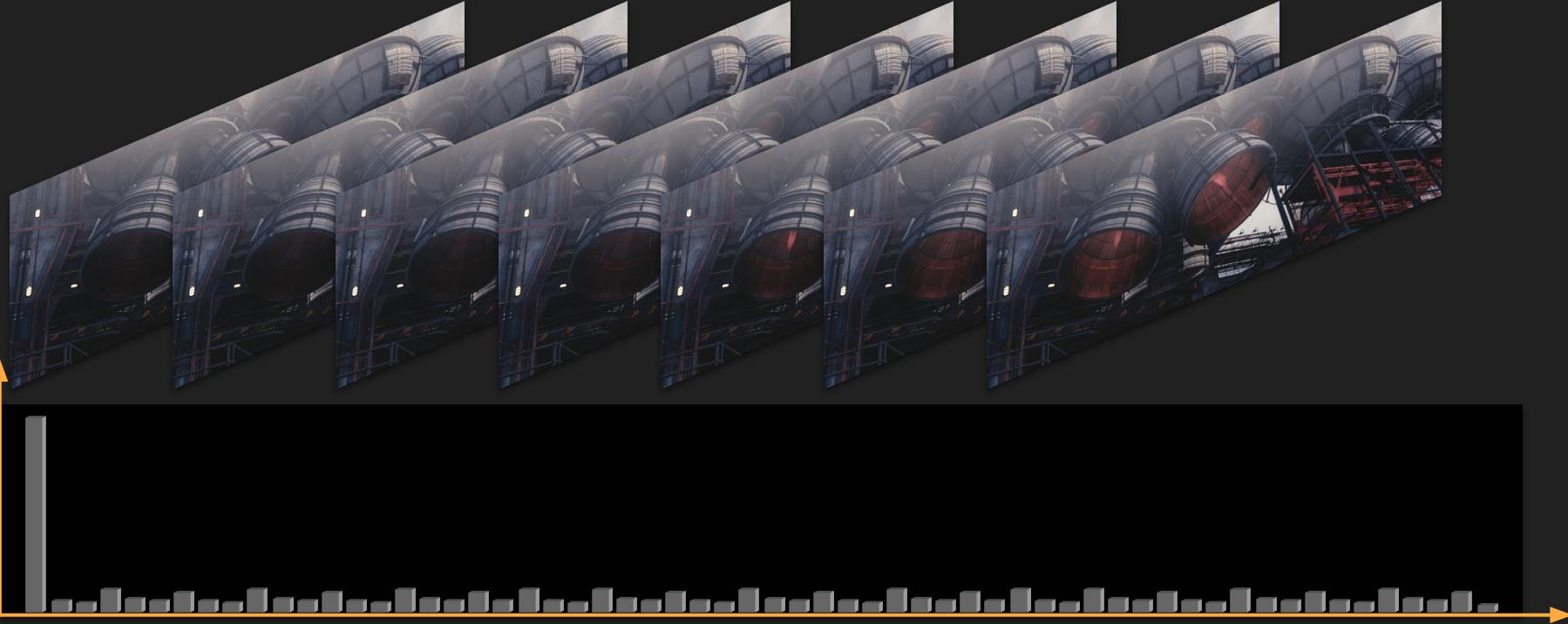


Chaque segment est encodé avec des  
paramètres différents

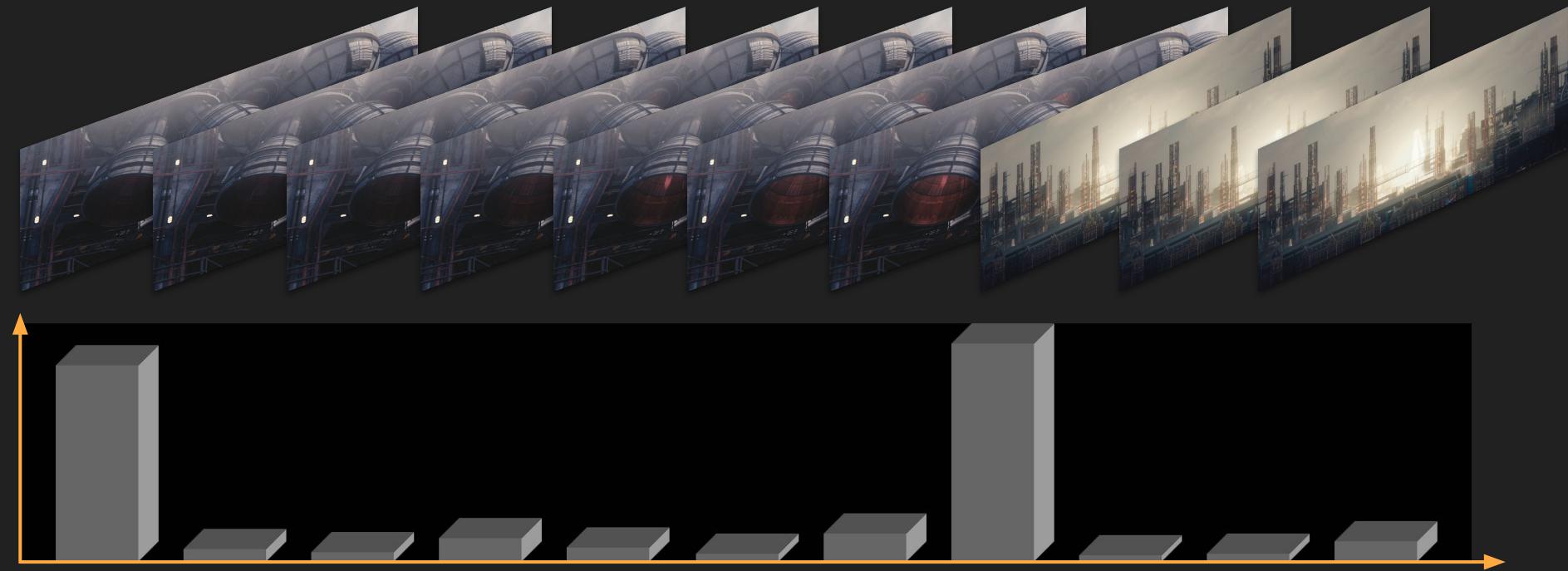
Les segments sont trop courts pour utiliser un algorithme de contrôle du débit



Alors, on encode à qualité constante  
(ou presque)



Un changement de scène à l'intérieur d'un segment va créer une seconde trame i



# Encodage optimisé par scène / par prise de vue (shot)

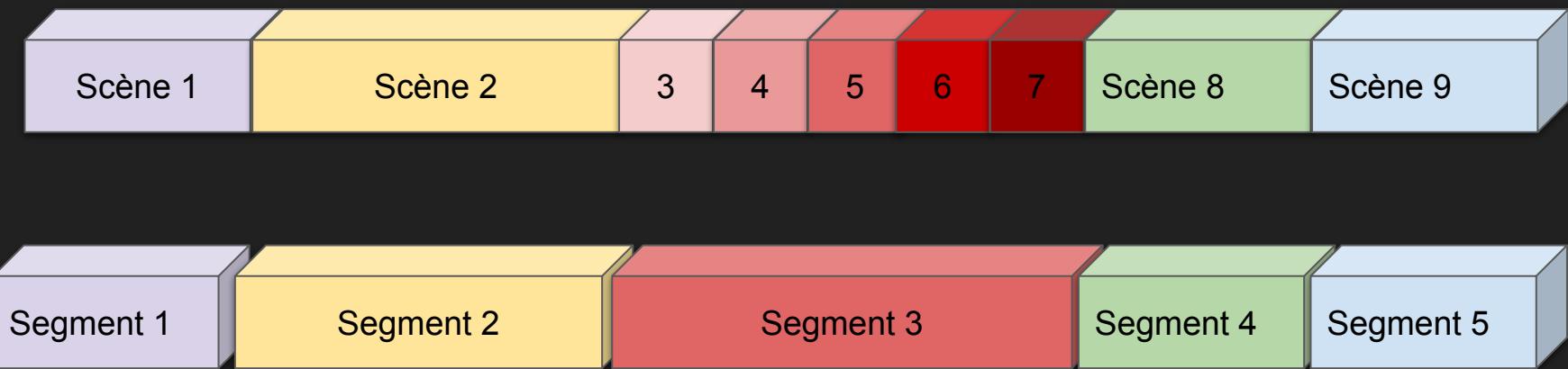


**Segment 1**



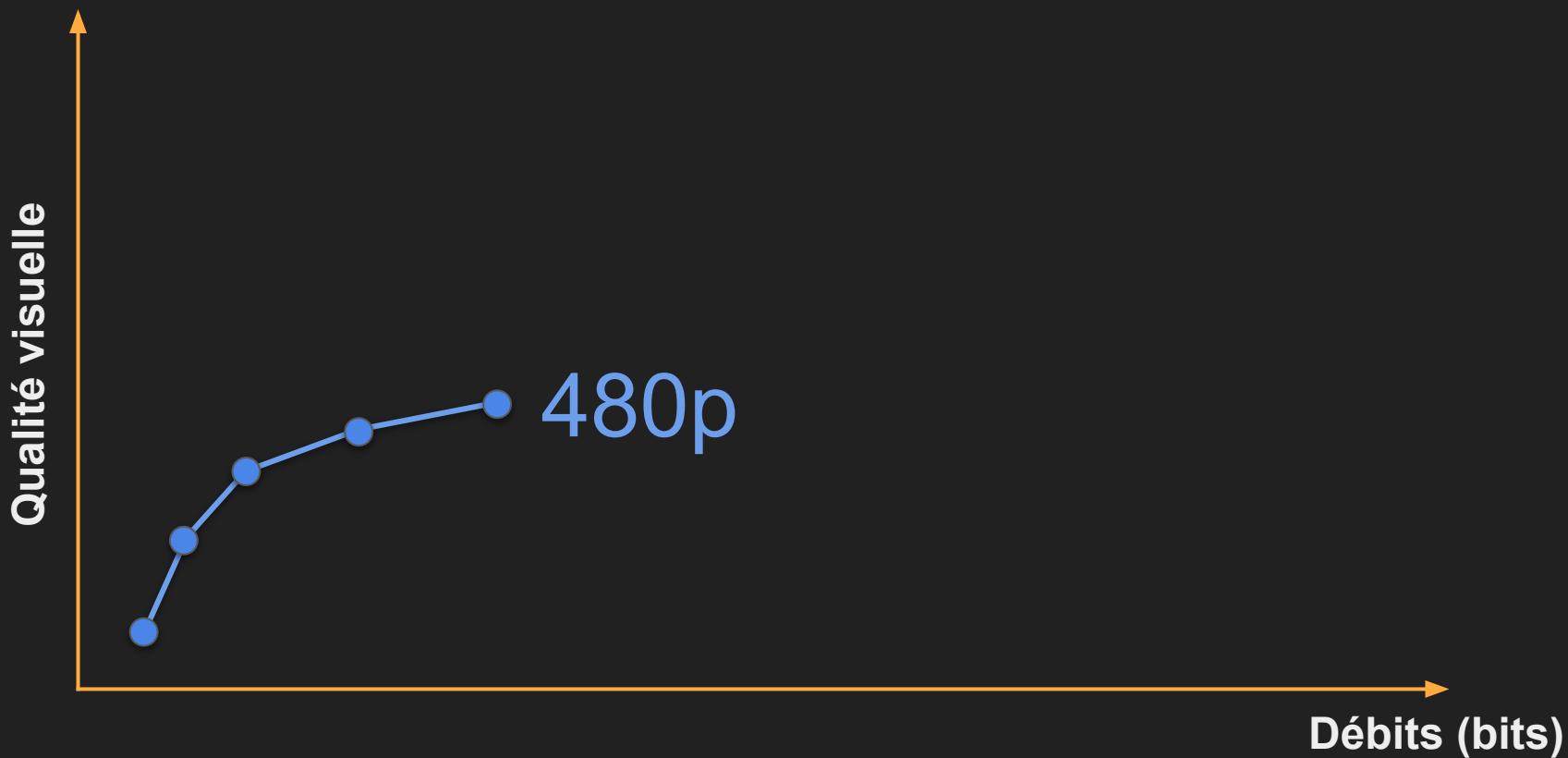
**Segment 2**

# Encodage optimisé par scène / par prise de vue (shot)

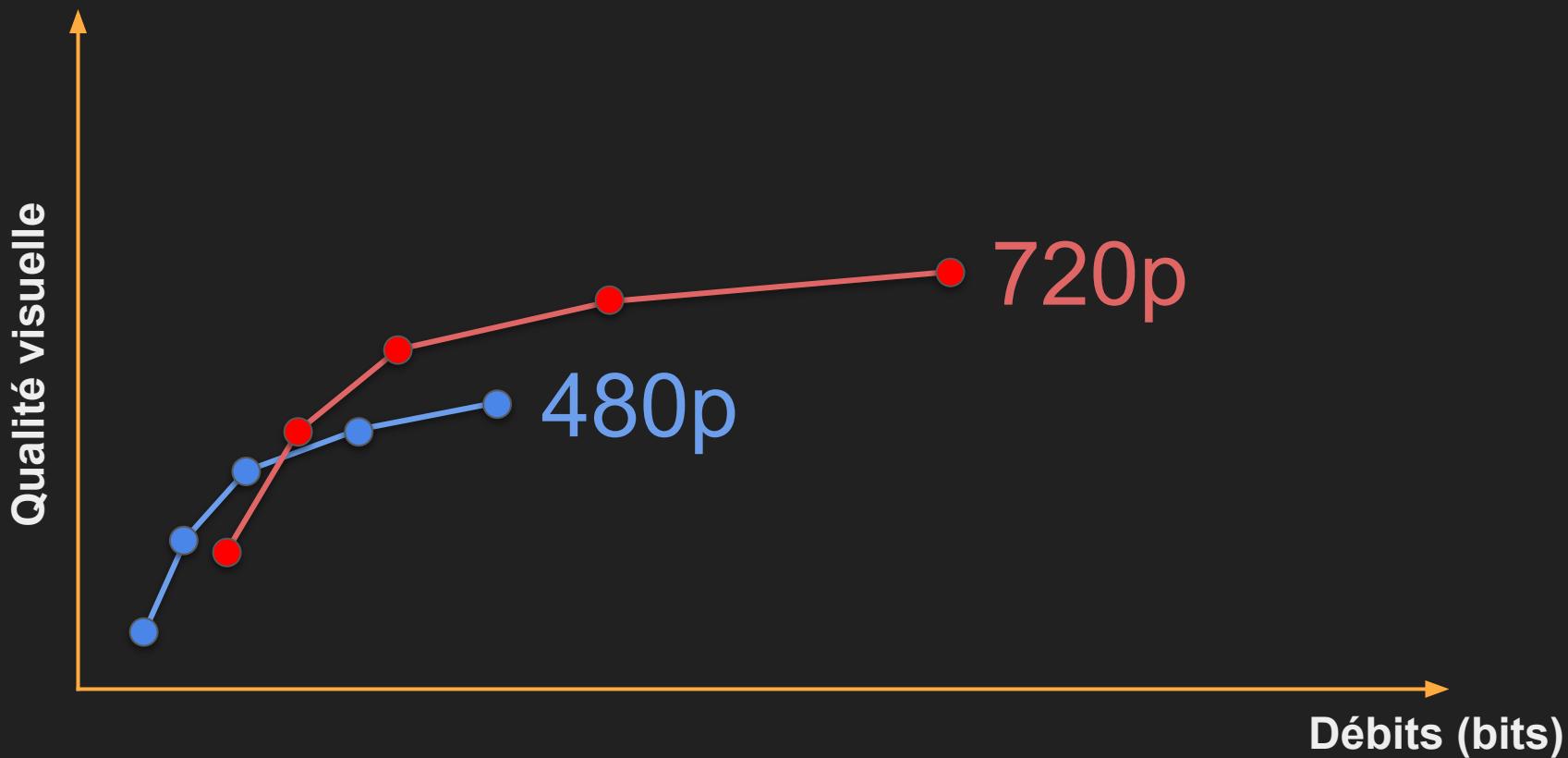


# L'optimisateur dynamique

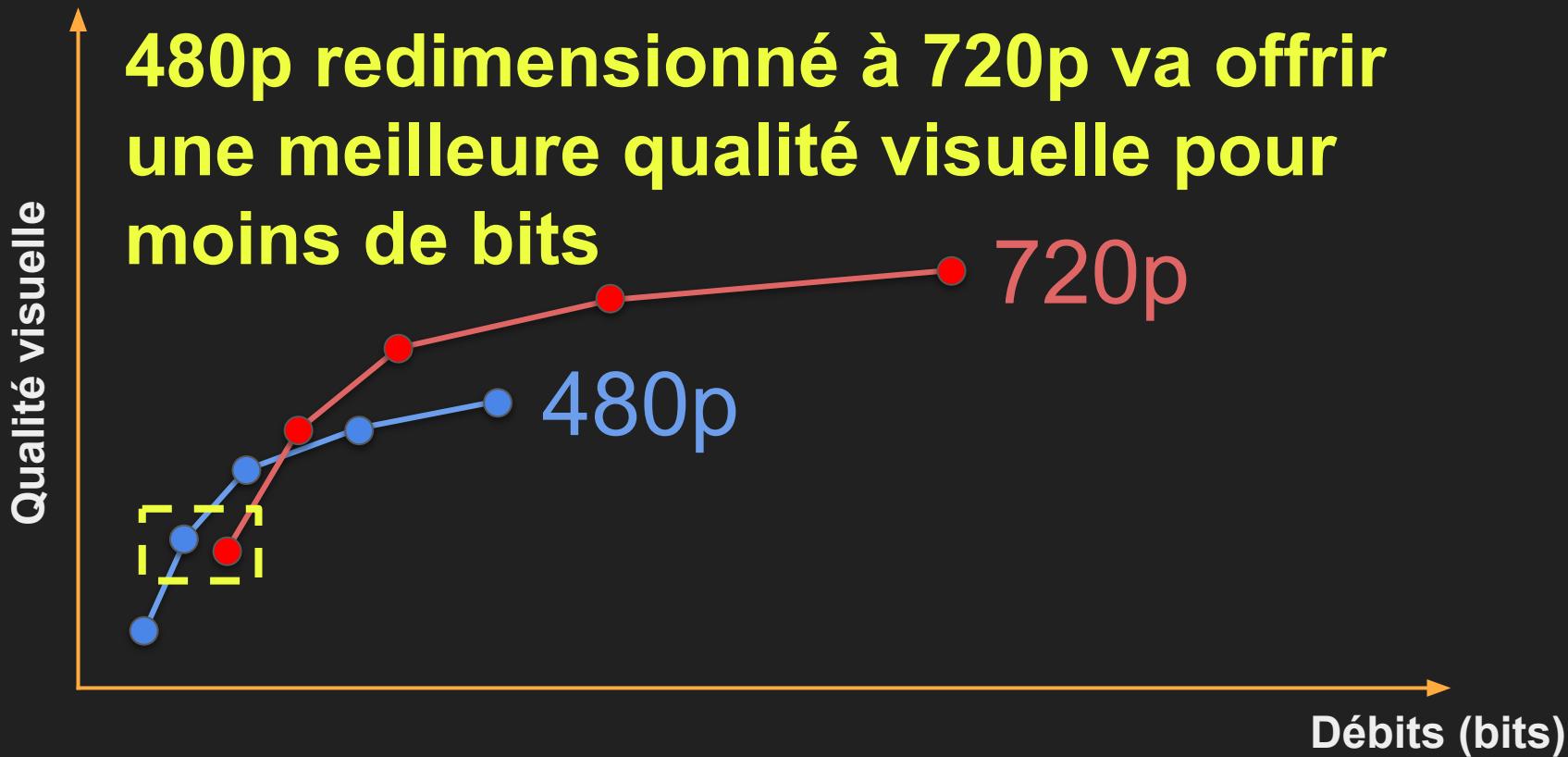
# Comment choisir les paramètres



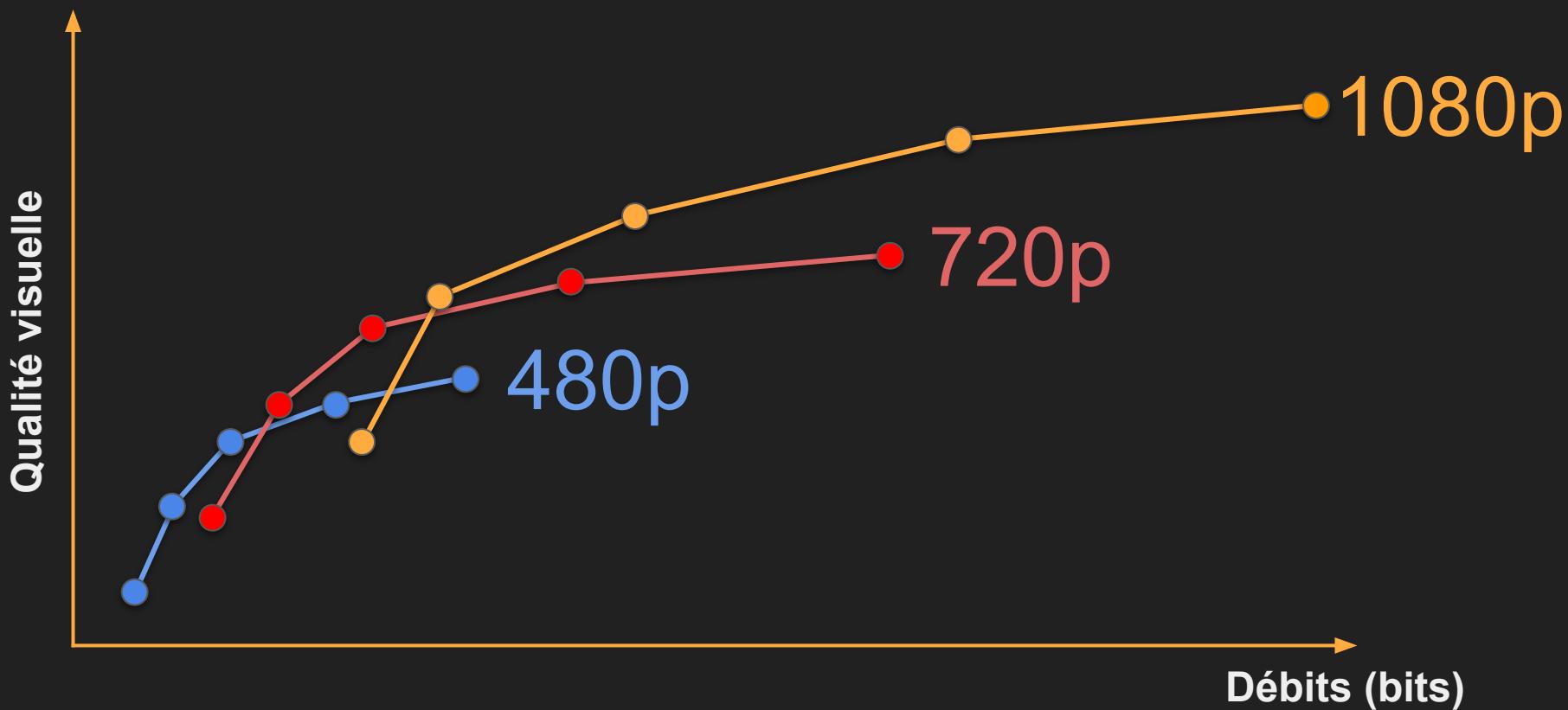
# Comment choisir les paramètres



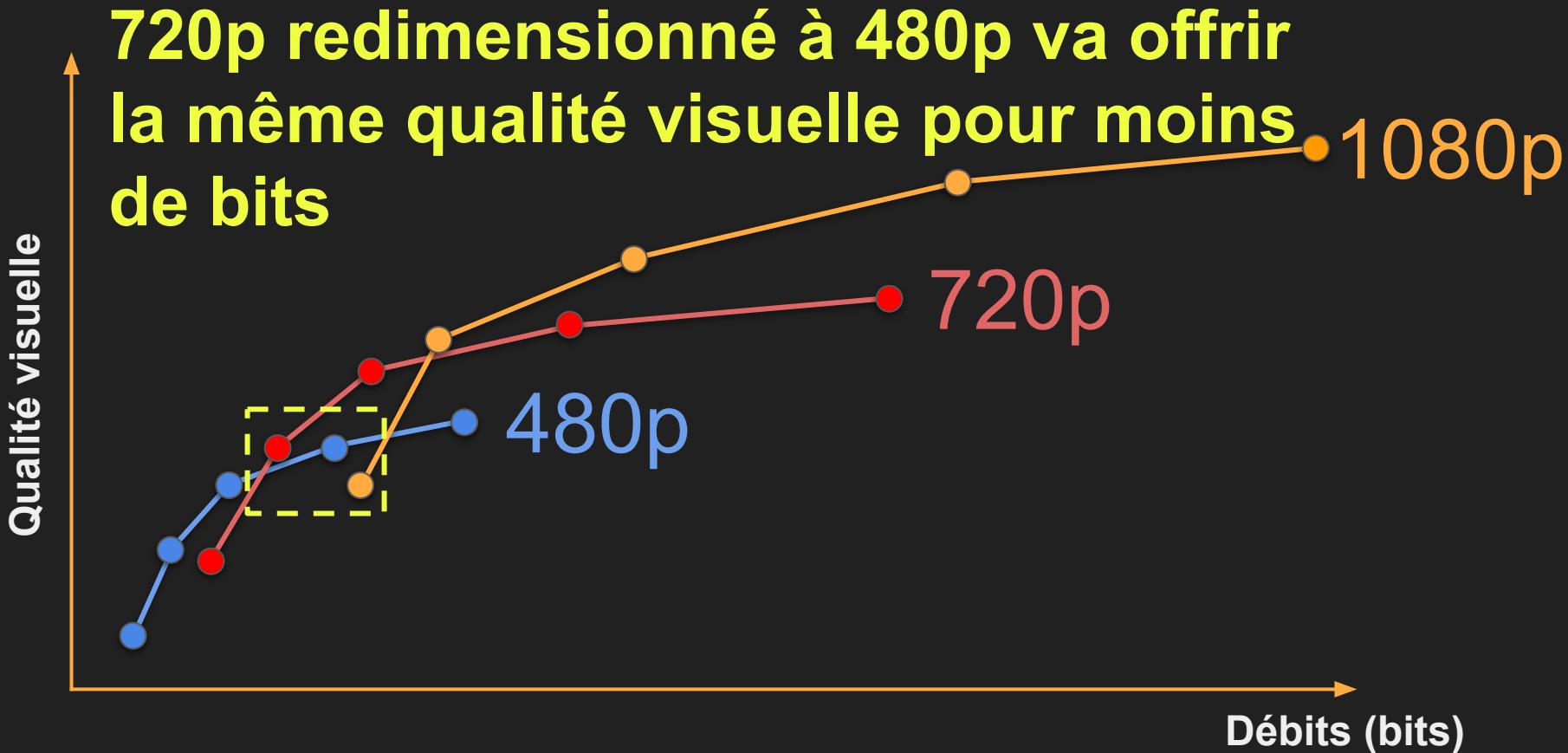
# Comment choisir les paramètres



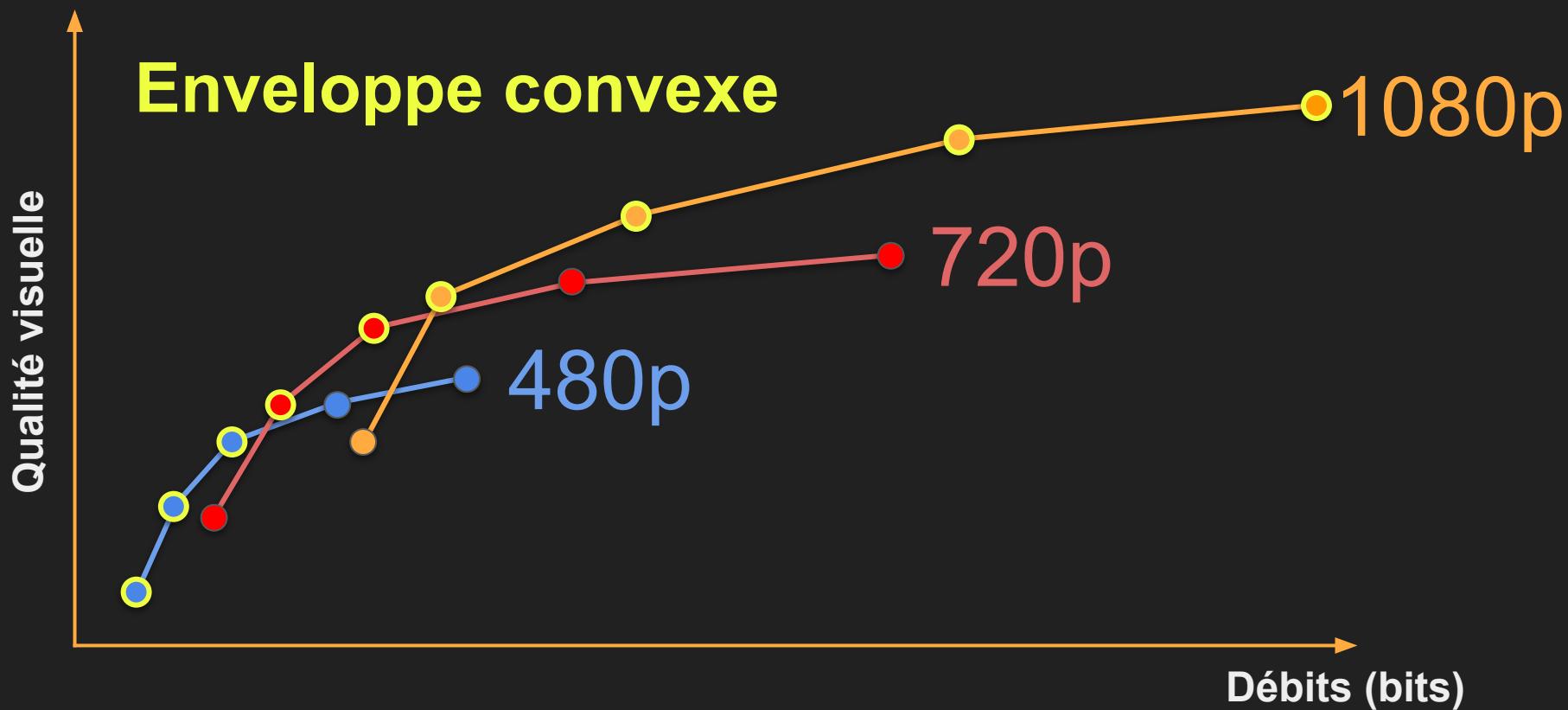
# Comment choisir les paramètres



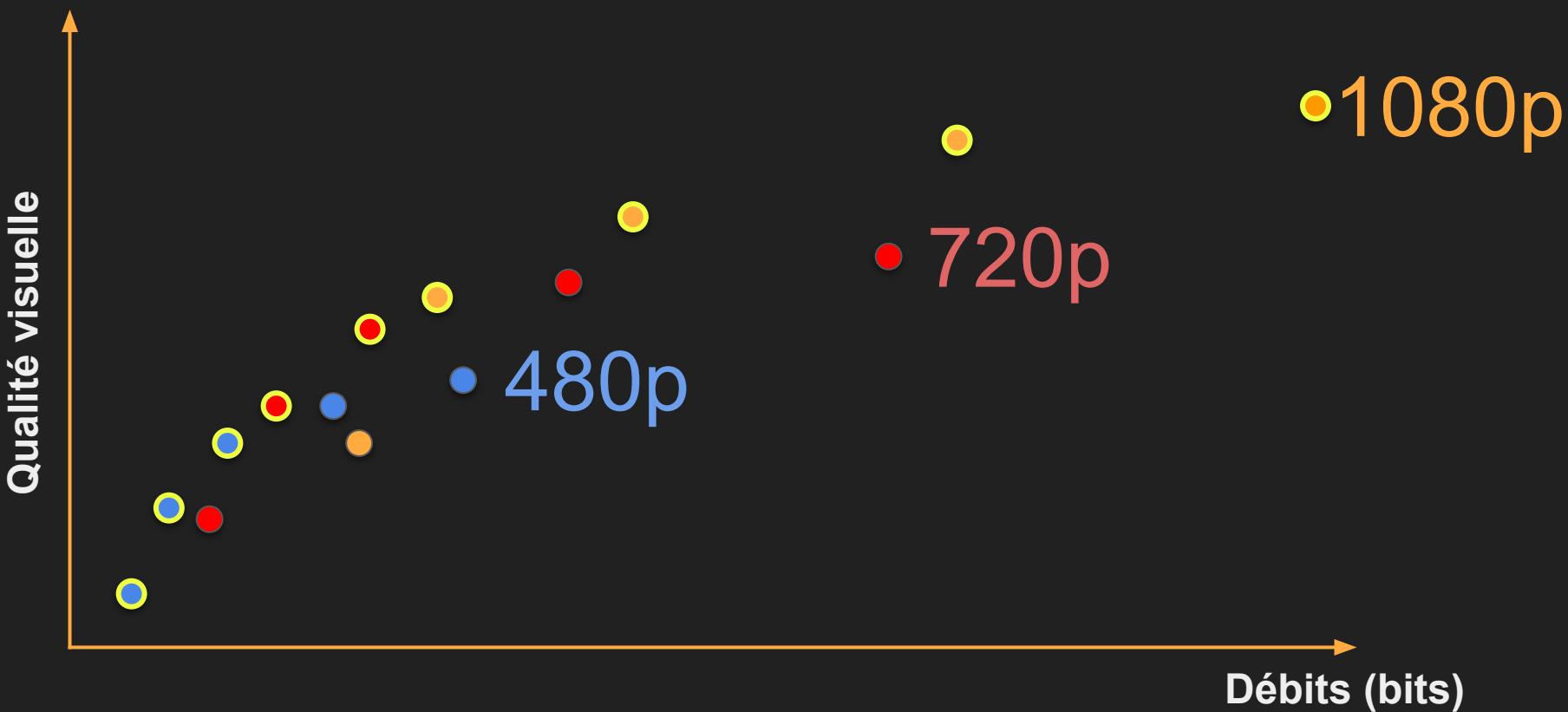
# Comment choisir les paramètres



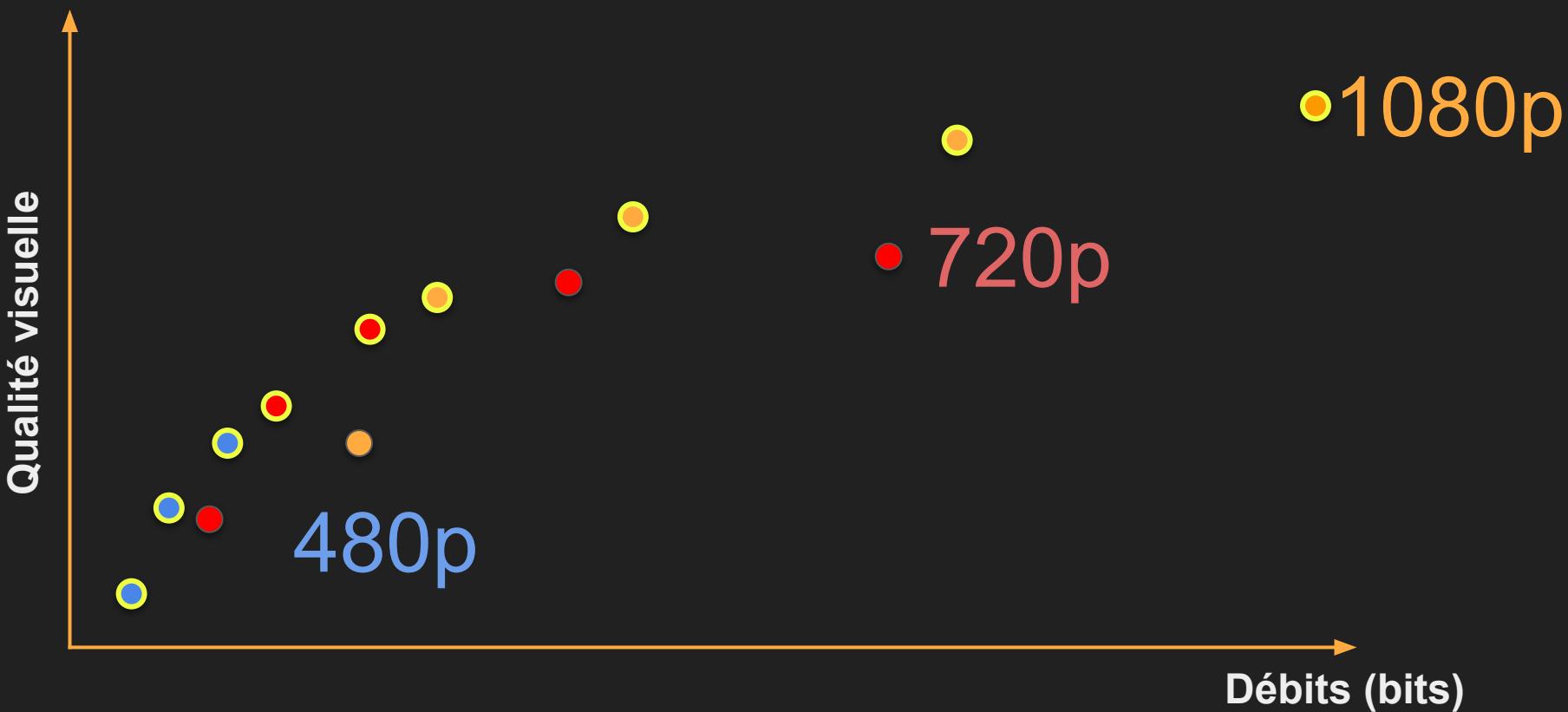
# Comment choisir les paramètres



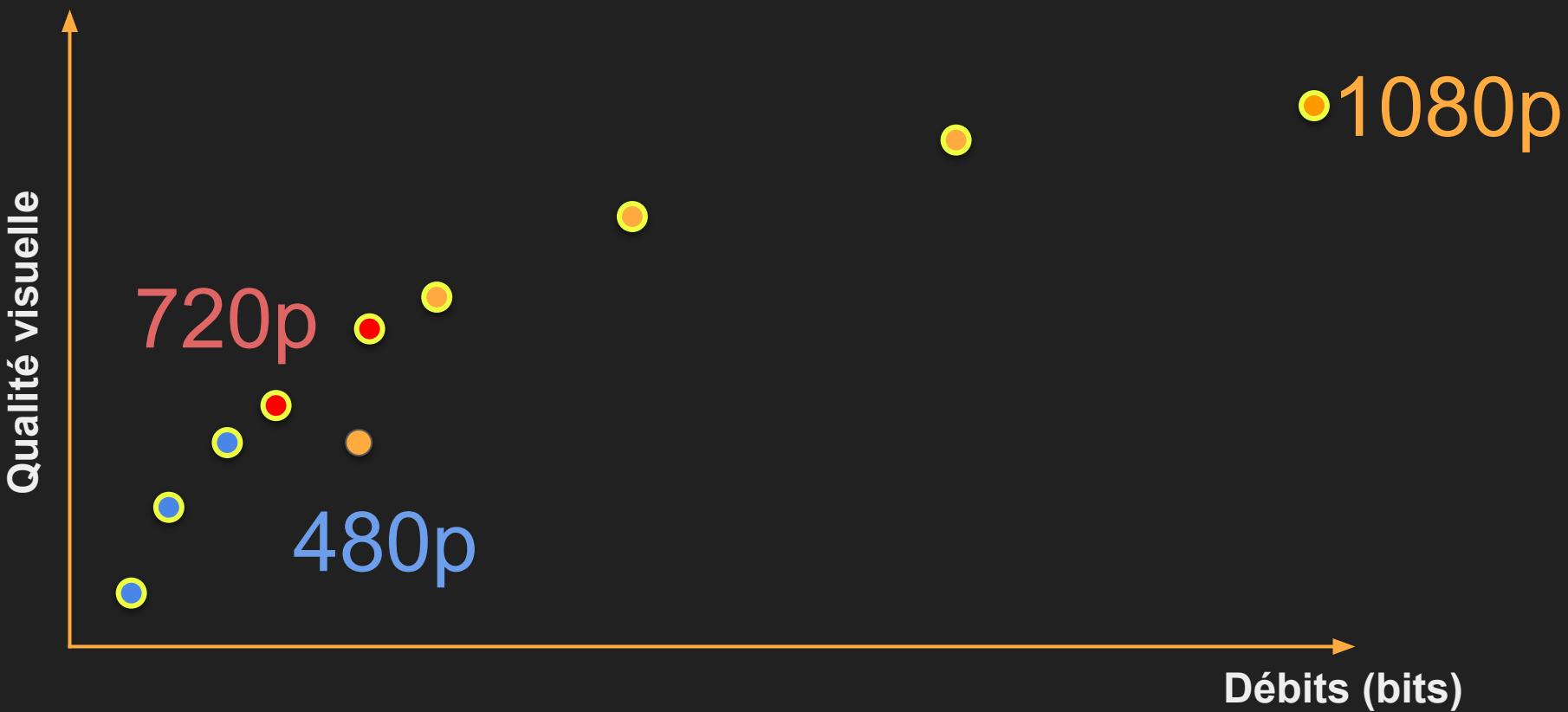
# Enveloppe convexe



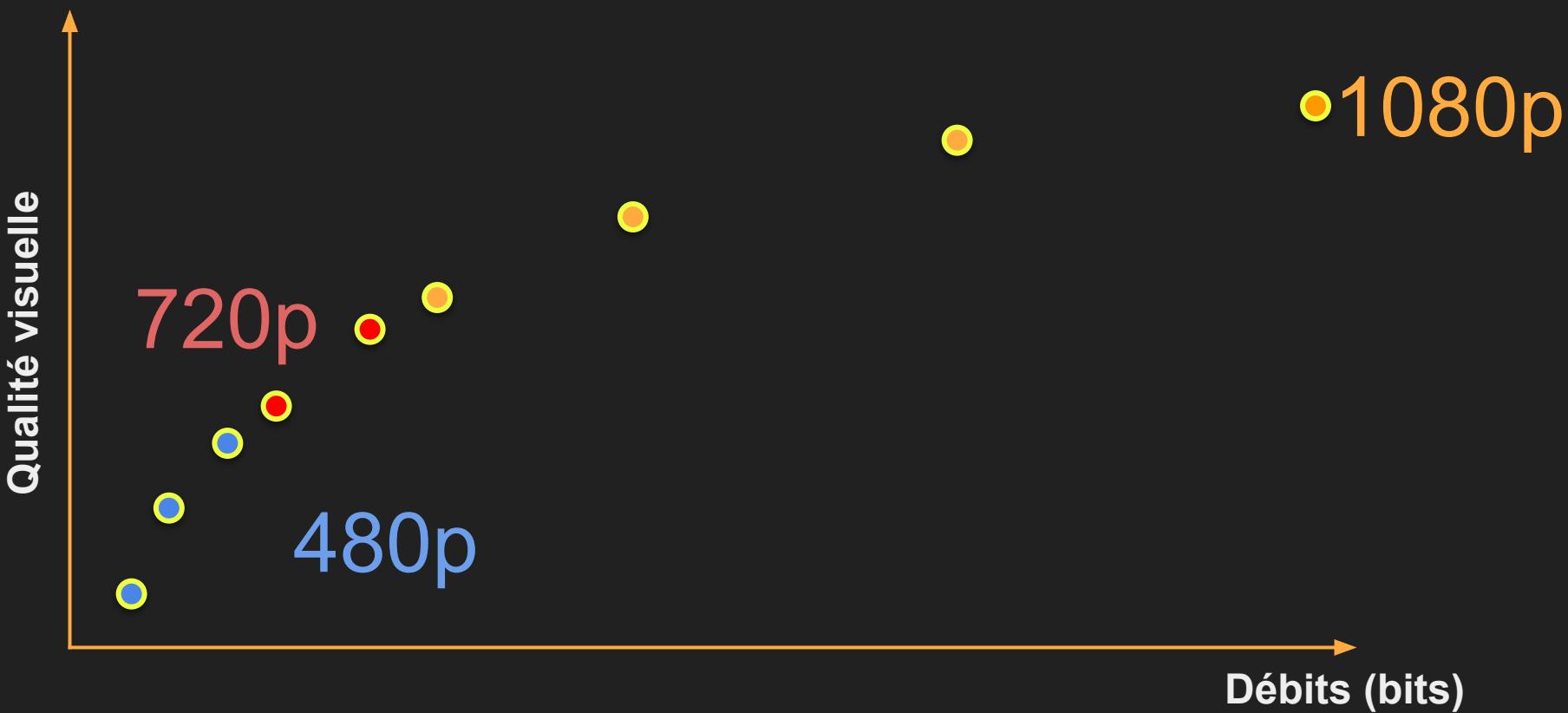
# Enveloppe convexe



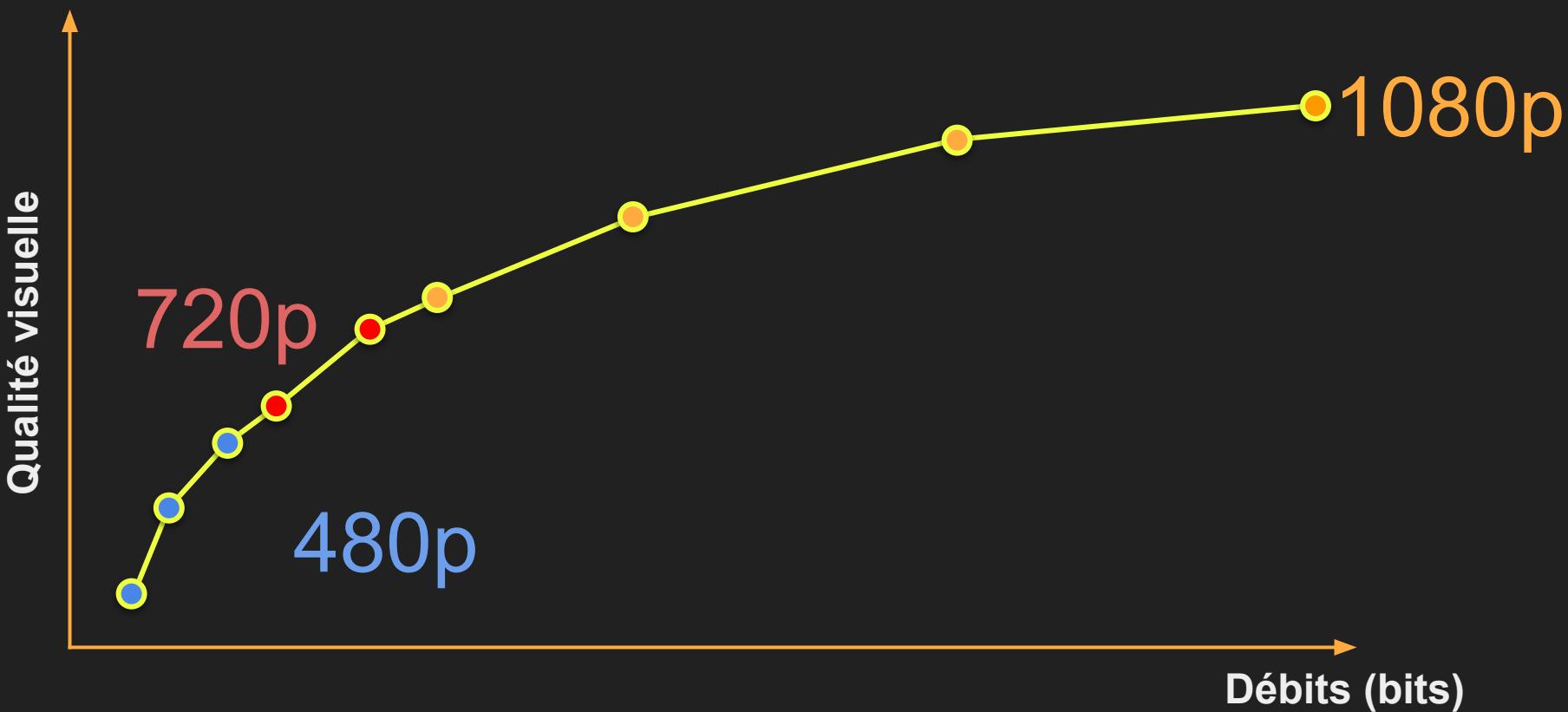
# Enveloppe convexe



# Enveloppe convexe



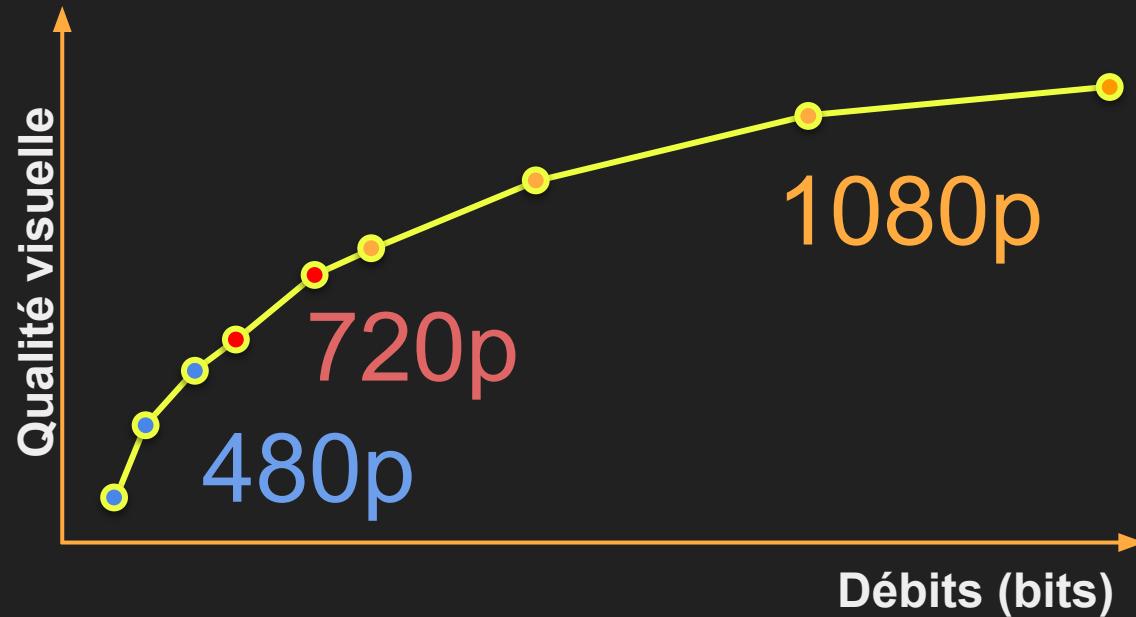
# Enveloppe convexe



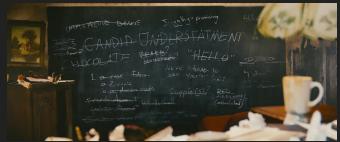
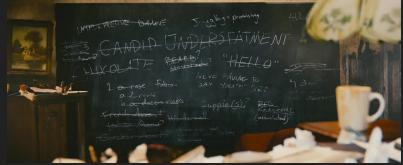
# L'optimisateur dynamique



⋮



# L'optimiseur dynamique



⋮

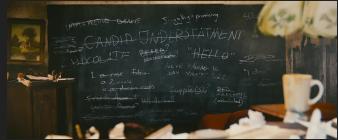
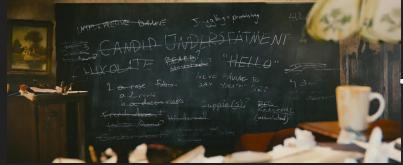
⋮

⋮

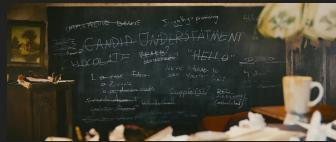
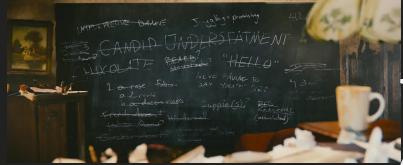
⋮



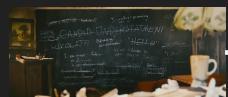
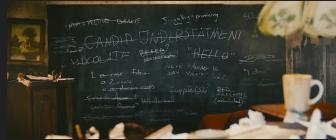
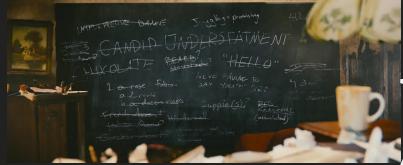
# L'optimisateur dynamique



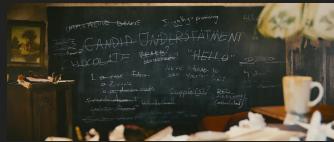
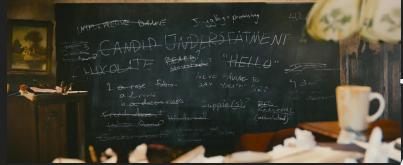
# L'optimisateur dynamique



# L'optimiseur dynamique



# L'optimiseur dynamique



⋮

⋮

⋮

⋮

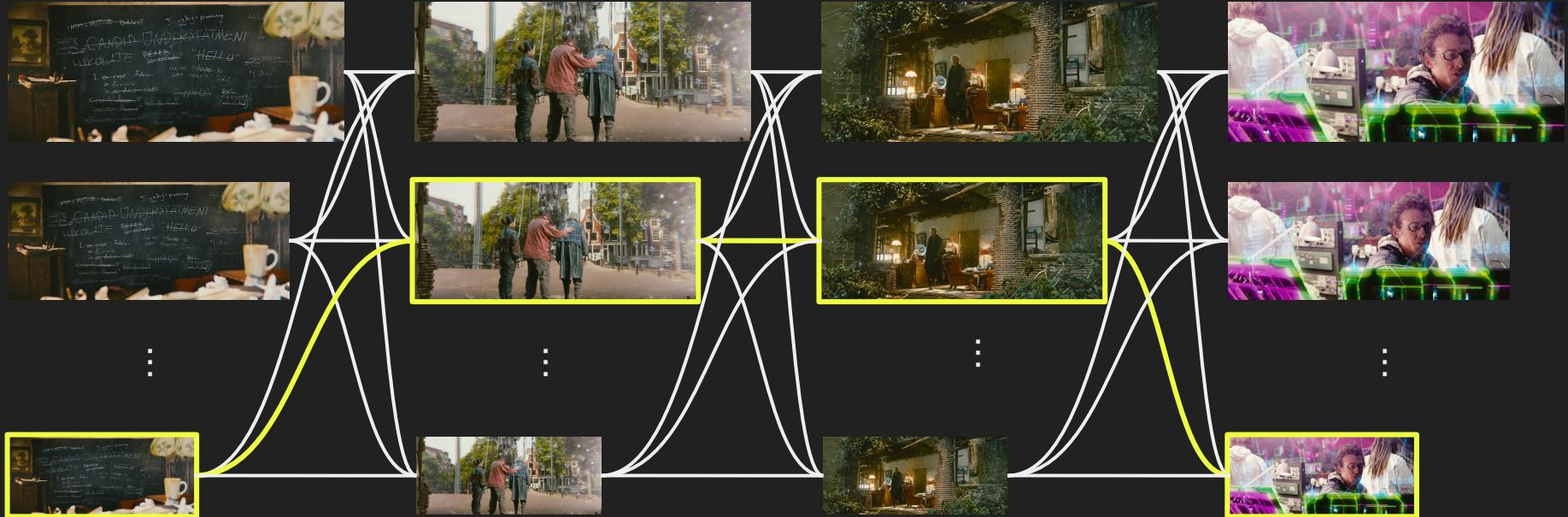


# L'optimisateur dynamique



Maximiser la qualité pour un débit de x kb/s

# L'optimisateur dynamique



**Minimiser le débit pour une qualité x**

*Si vos coûts d'encodage sont de 20 000\$  
quelles seront vos coûts d'encodage avec  
l'optimisateur dynamique?*

*Si vos coûts d'encodage sont de 20 000\$  
quelles seront vos coûts d'encodage avec  
l'optimisateur dynamique?*

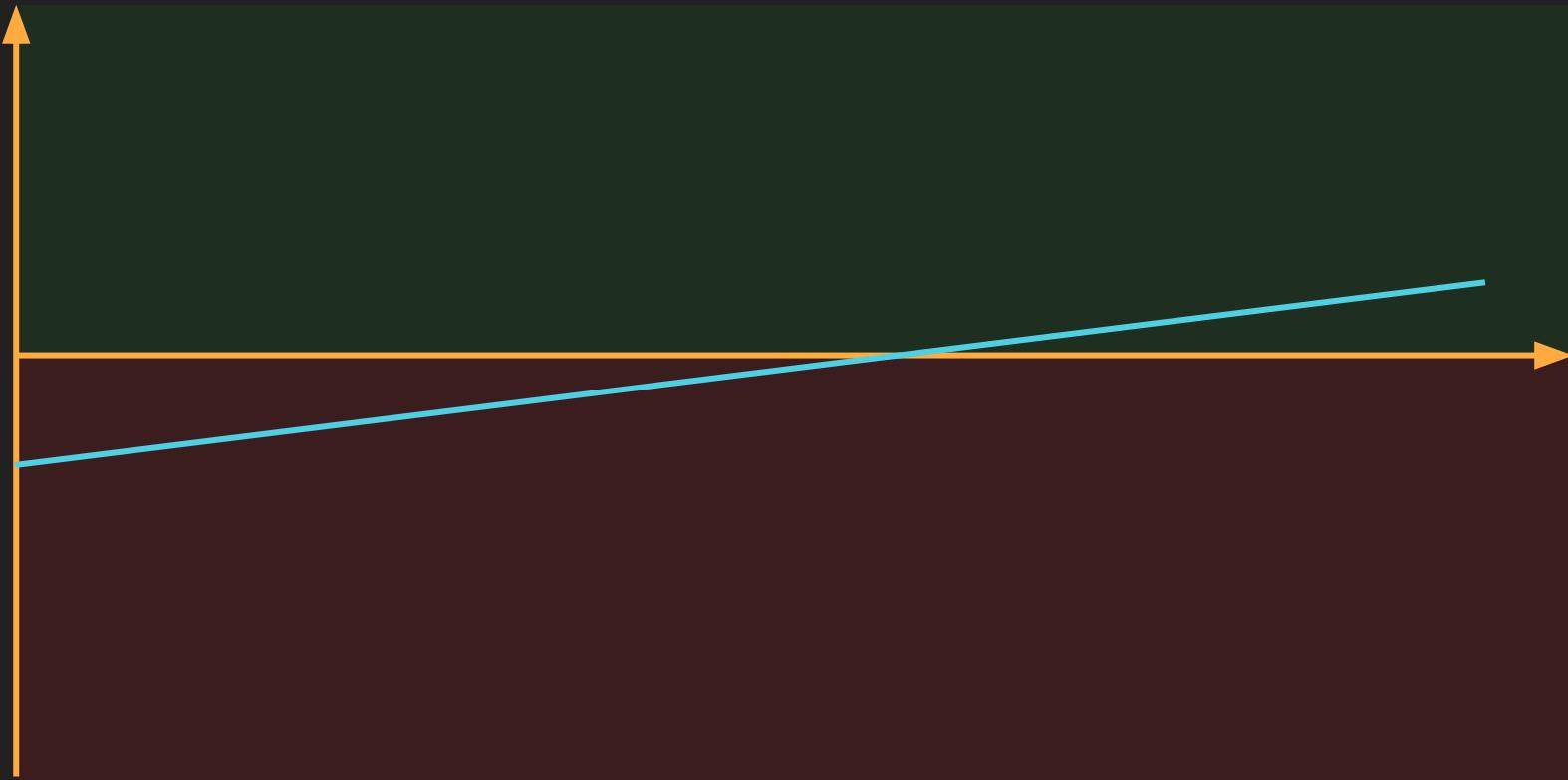
20x

## Graphe des coûts encodage vs bande passante

ROI (\$)

0\$

Vues



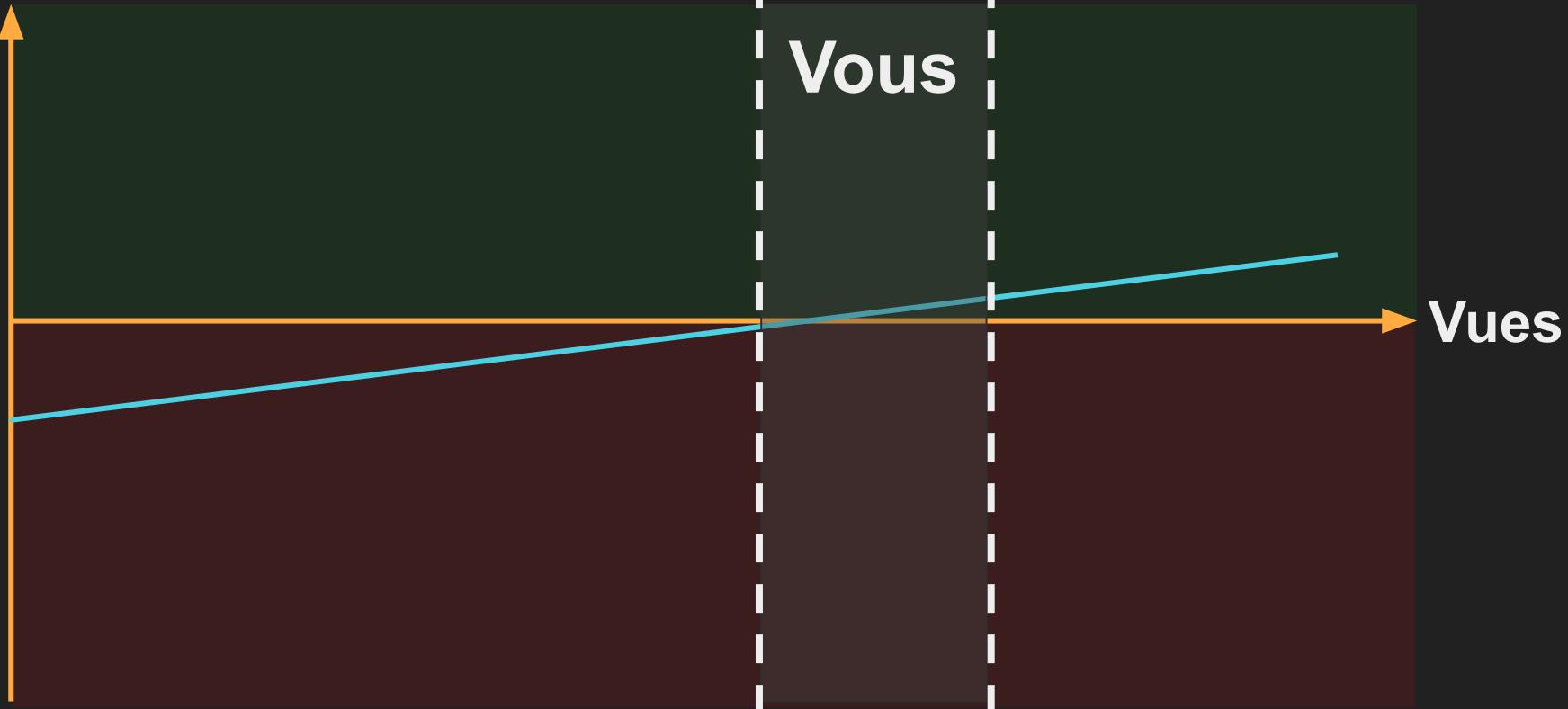
## Graphe des coûts encodage vs bande passante

ROI (\$)

0\$

Vous

Vues



# Graphe des coûts encodage vs bande passante

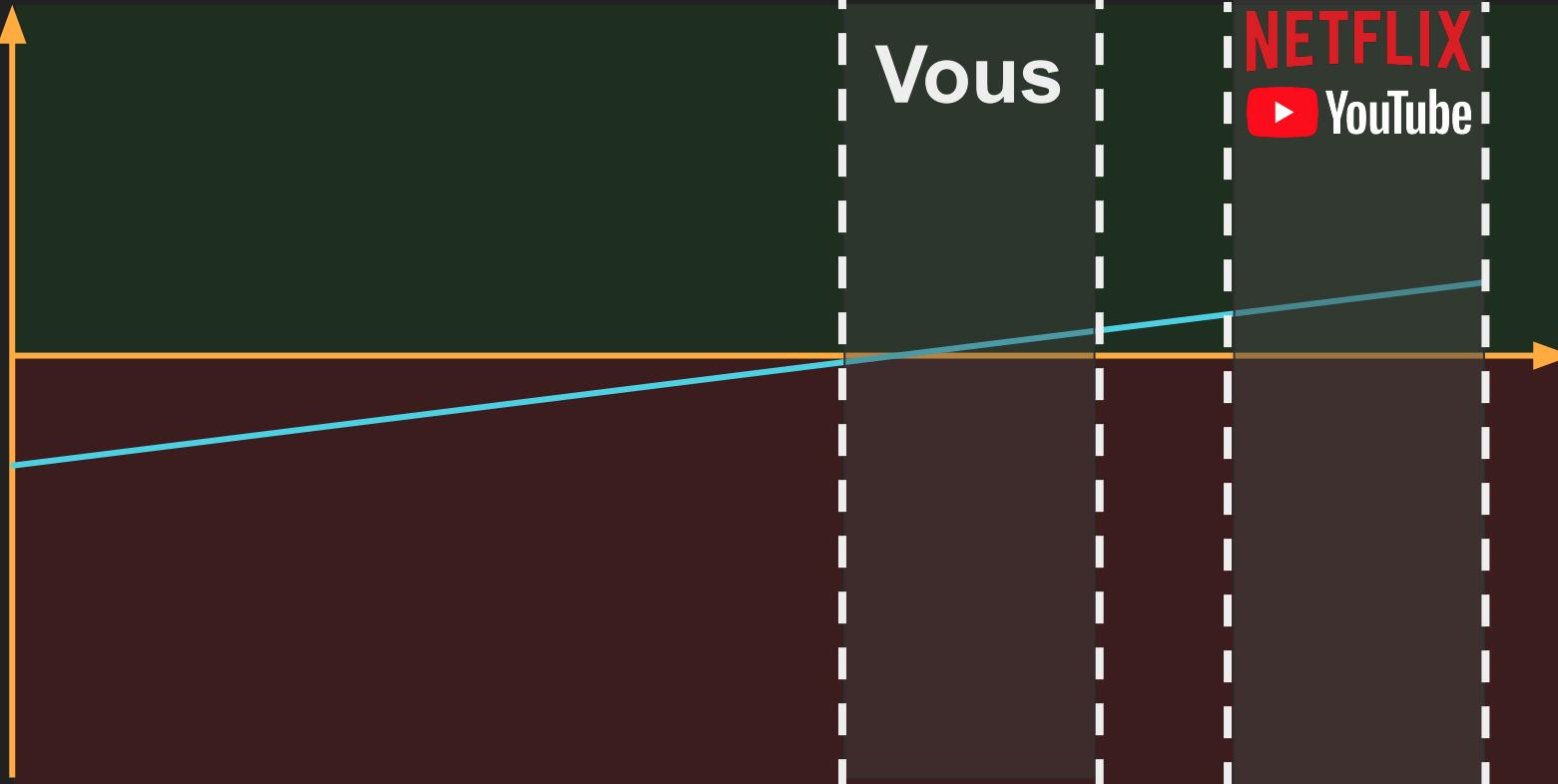
ROI (\$)

0\$

Vous

NETFLIX  
YouTube

Vues



# Graphe des coûts encodage vs bande passante

ROI (\$)

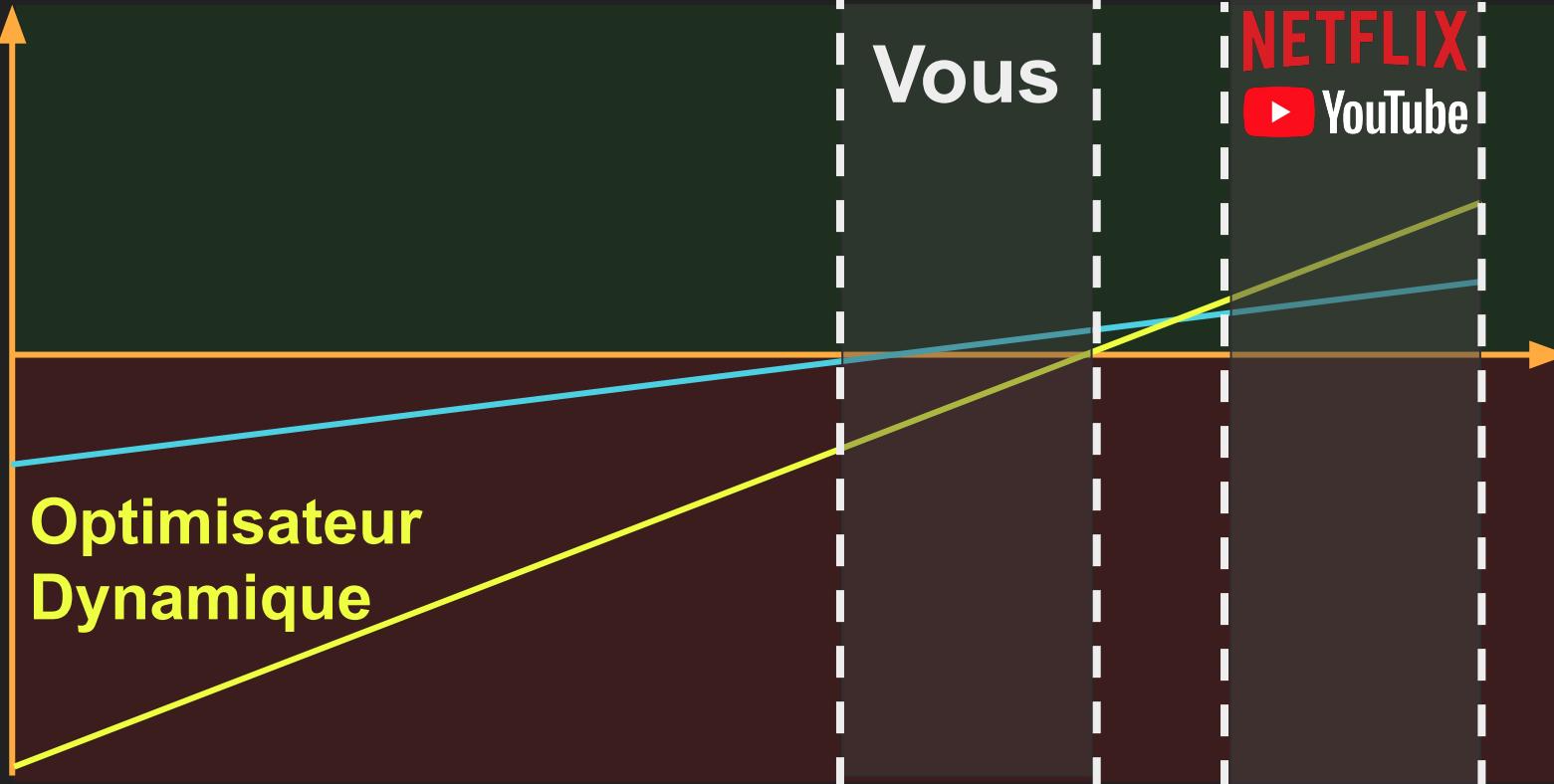
0\$

Optimisateur  
Dynamique

Vous

NETFLIX  
YouTube

Vues



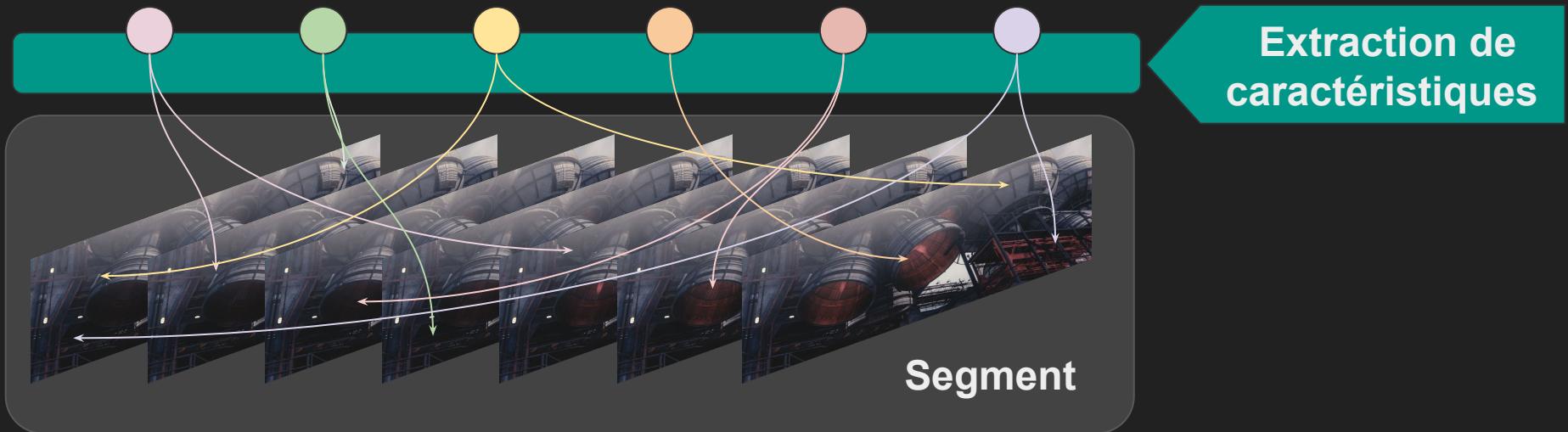
L'enveloppe convexe déterminée par l'IA

L'enveloppe convexe déterminée par l'IA

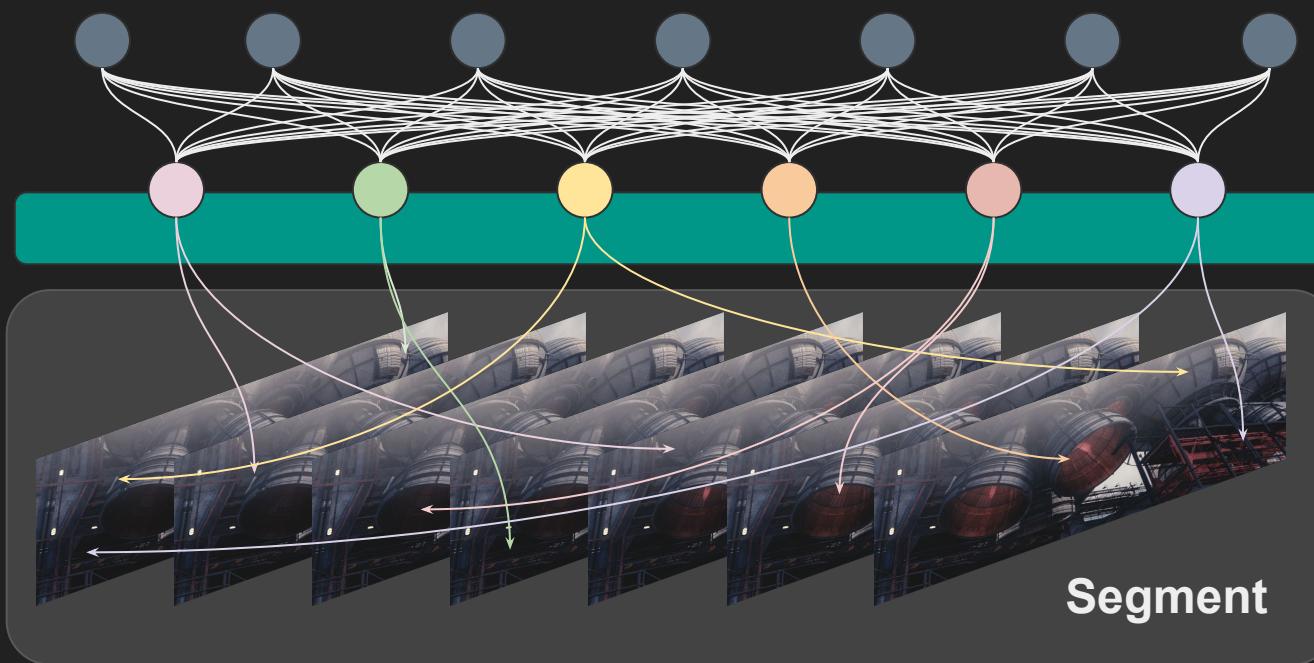


**Segment**

# L'enveloppe convexe déterminée par l'IA



# L'enveloppe convexe déterminée par l'IA

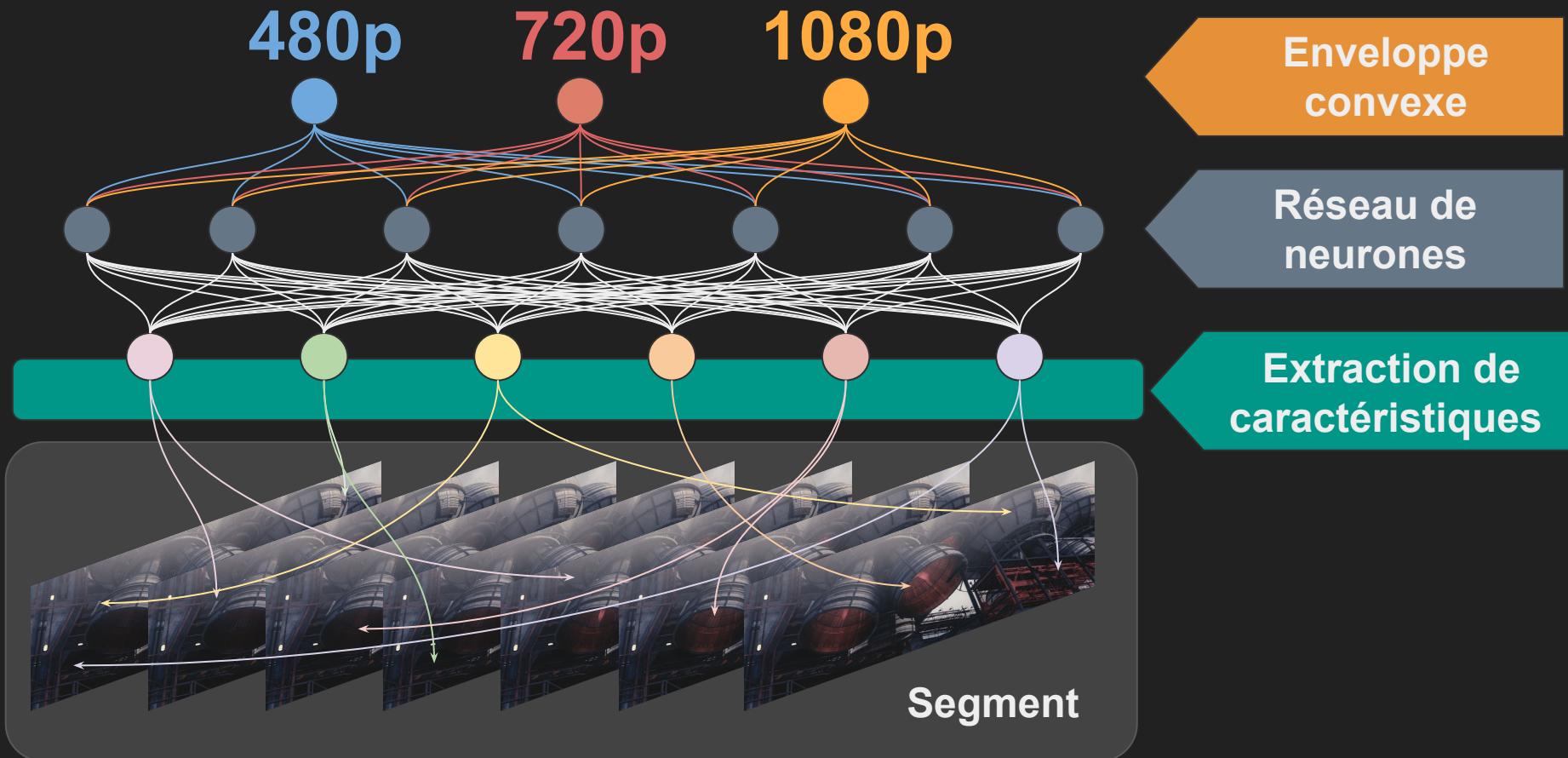


Réseau de  
neurones

Extraction de  
caractéristiques

Segment

# L'enveloppe convexe déterminée par l'IA



# Extraction de caractéristiques (simples)

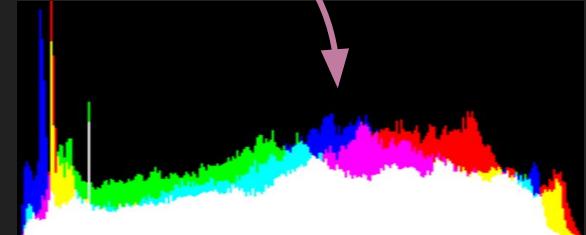
Pixels

Bordures, coins

Histogrammes de couleurs

Difference temporelles

...



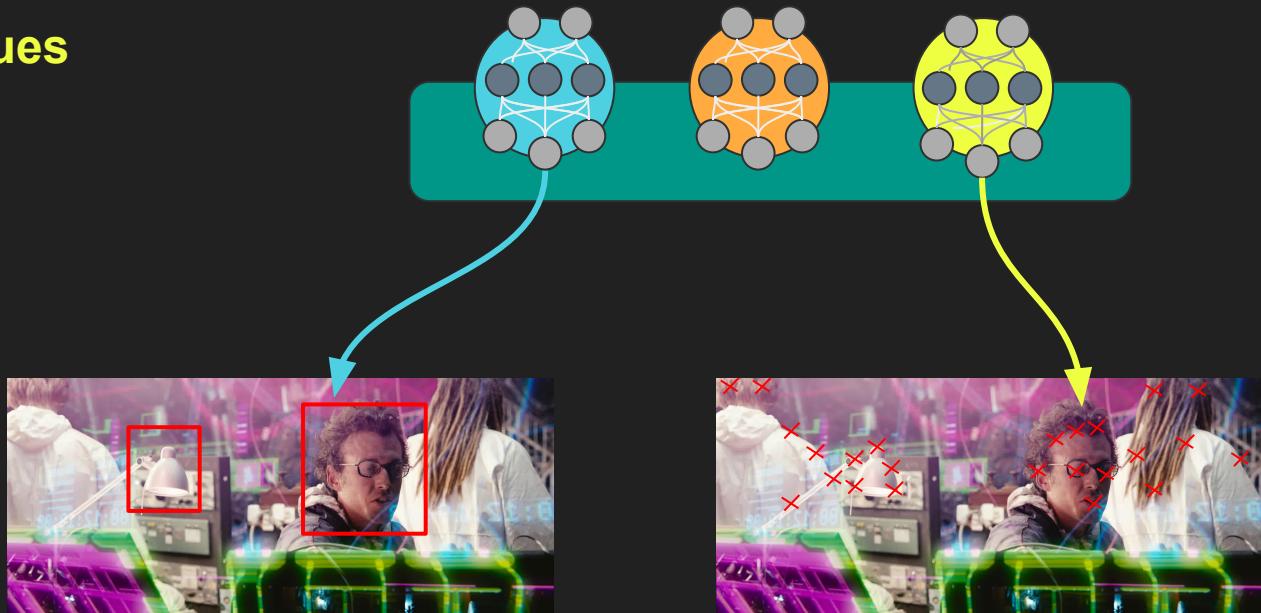
# Extraction de caractéristiques (complexes)

## Reconnaissance d'objets

Type de séquences (action, animation, ...)

Caractéristiques perçues  
par le système visuel  
humain

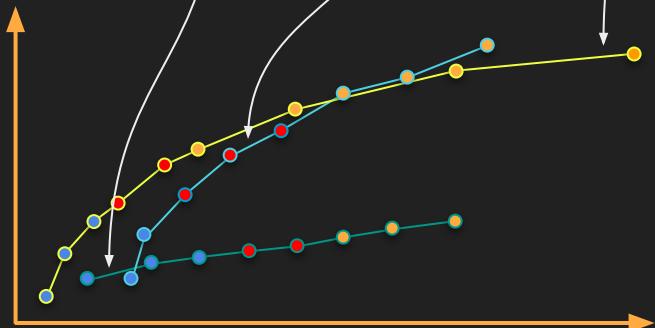
...



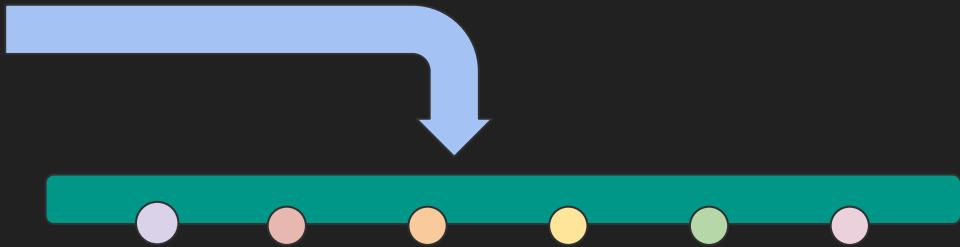
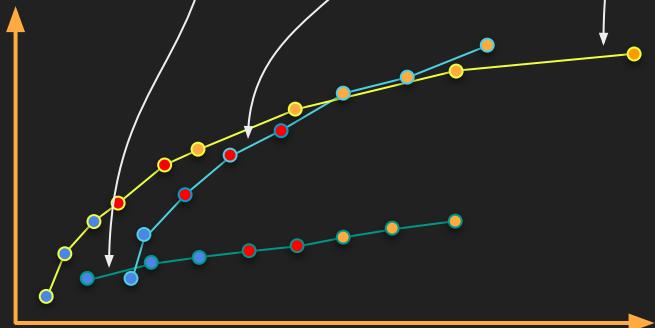
# Entraînement avec des enveloppes convexes



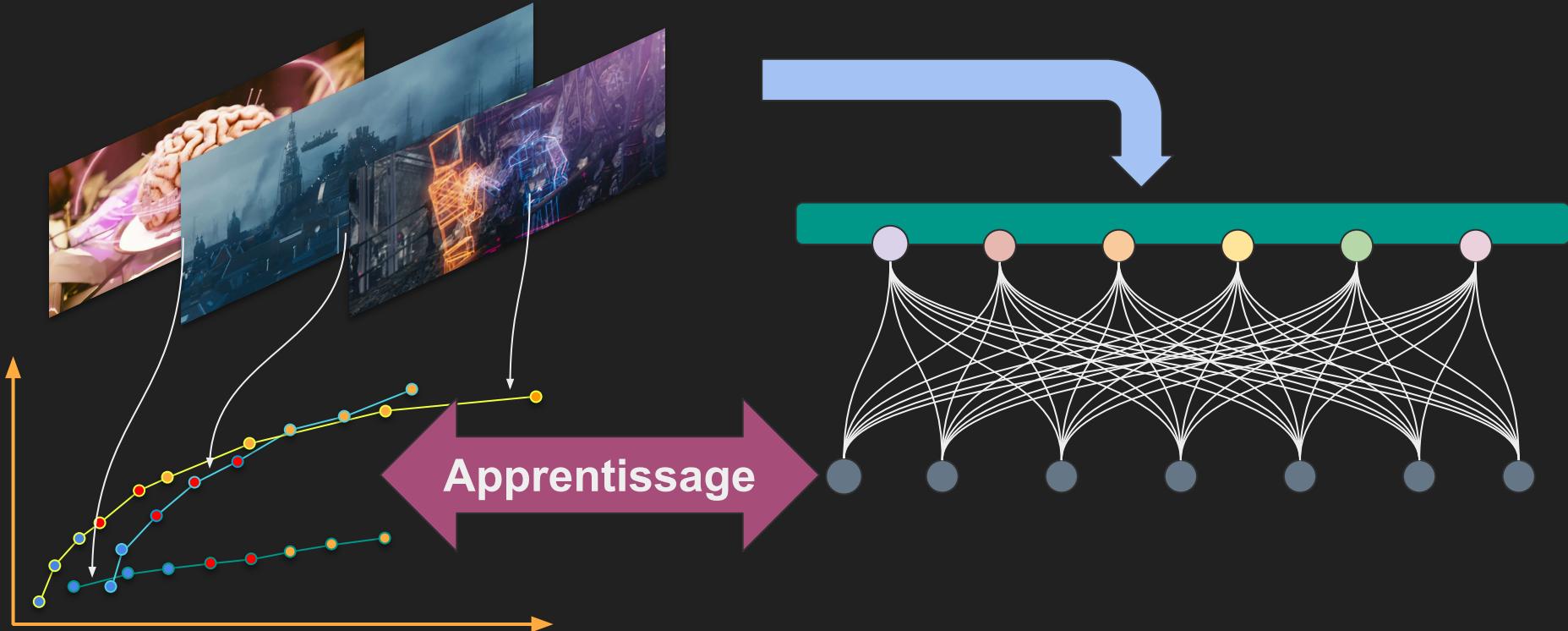
# Entraînement avec des enveloppes convexes



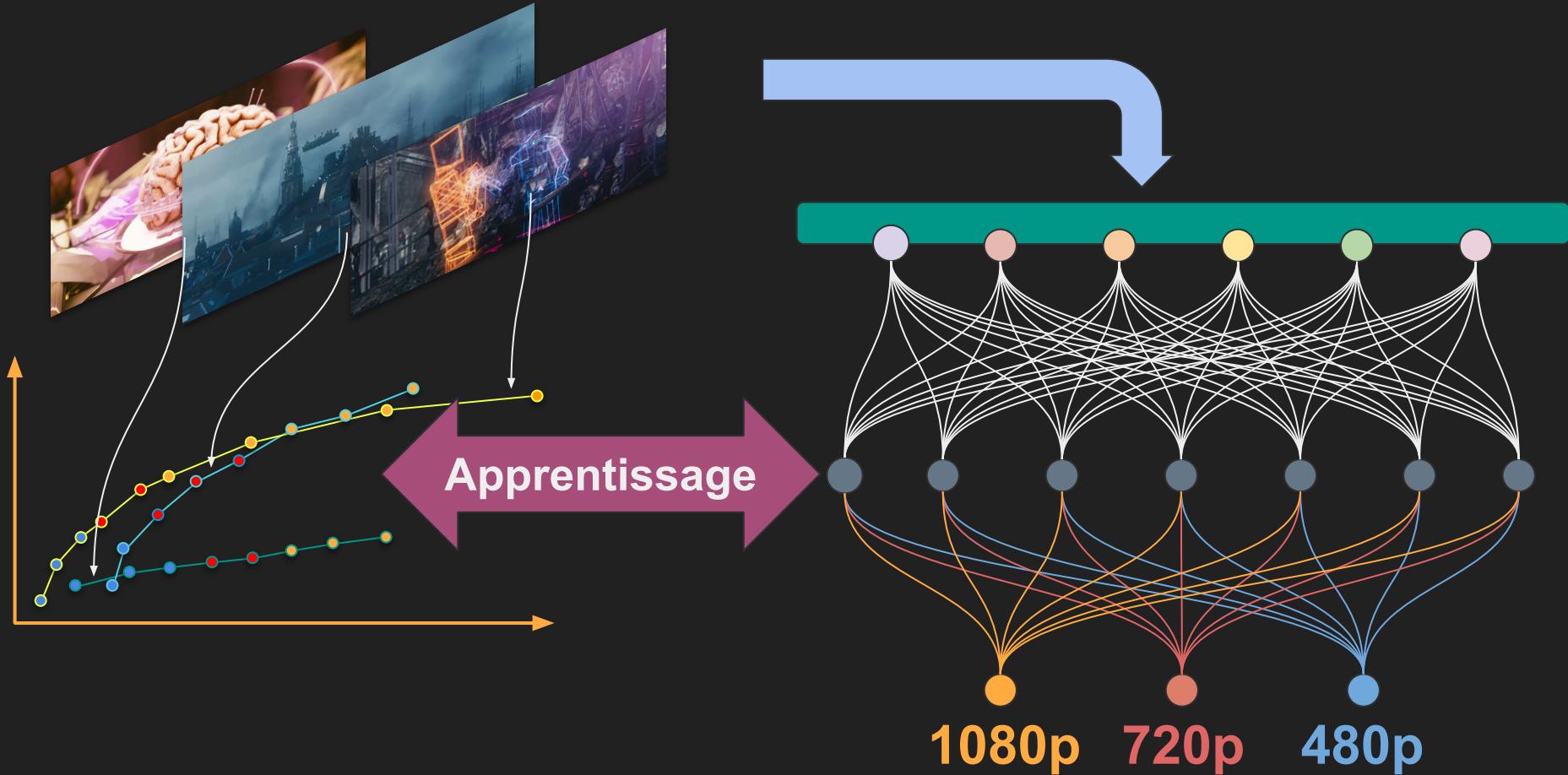
# Entraînement avec des enveloppes convexes



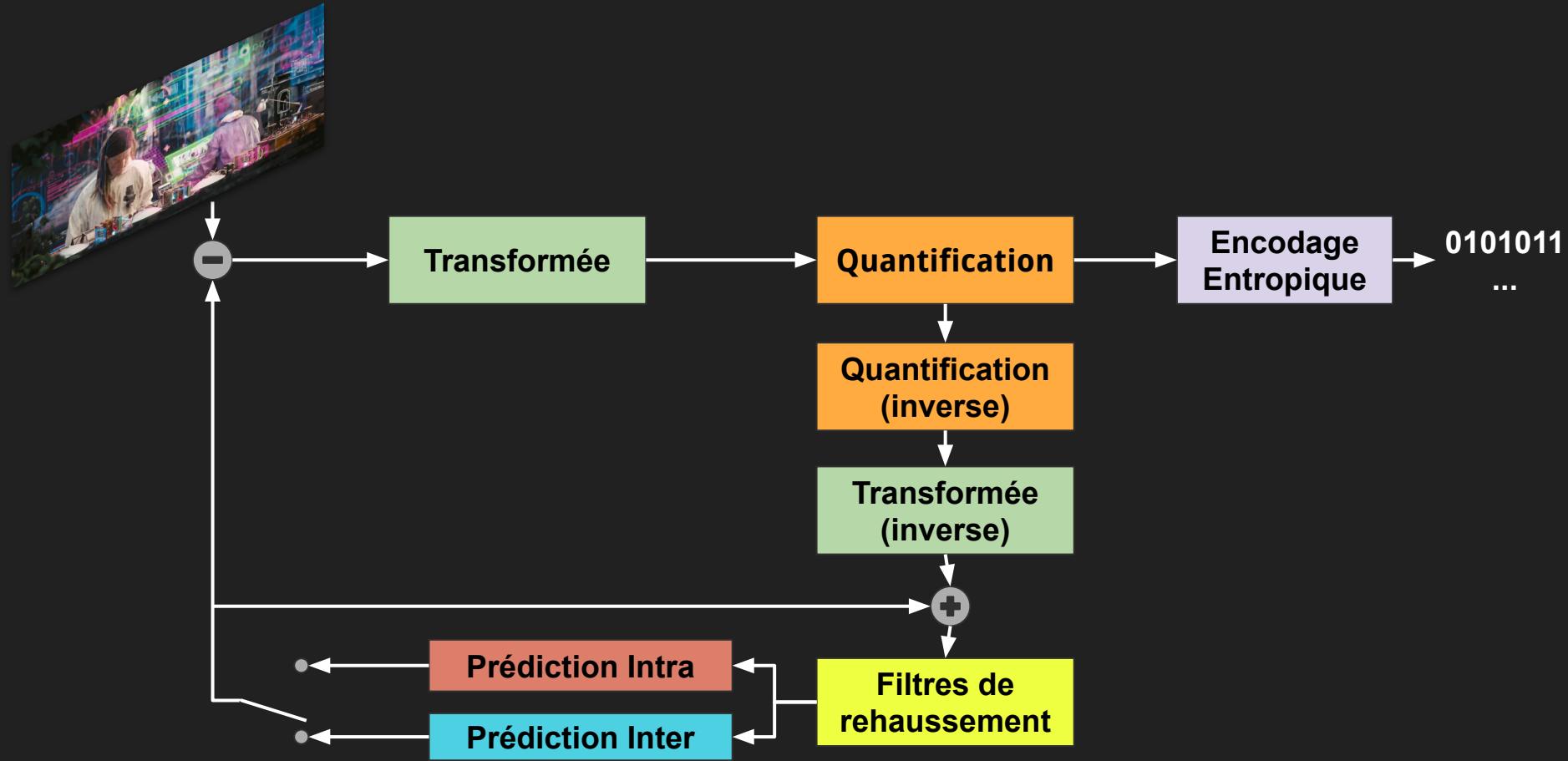
# Entraînement avec des enveloppes convexes



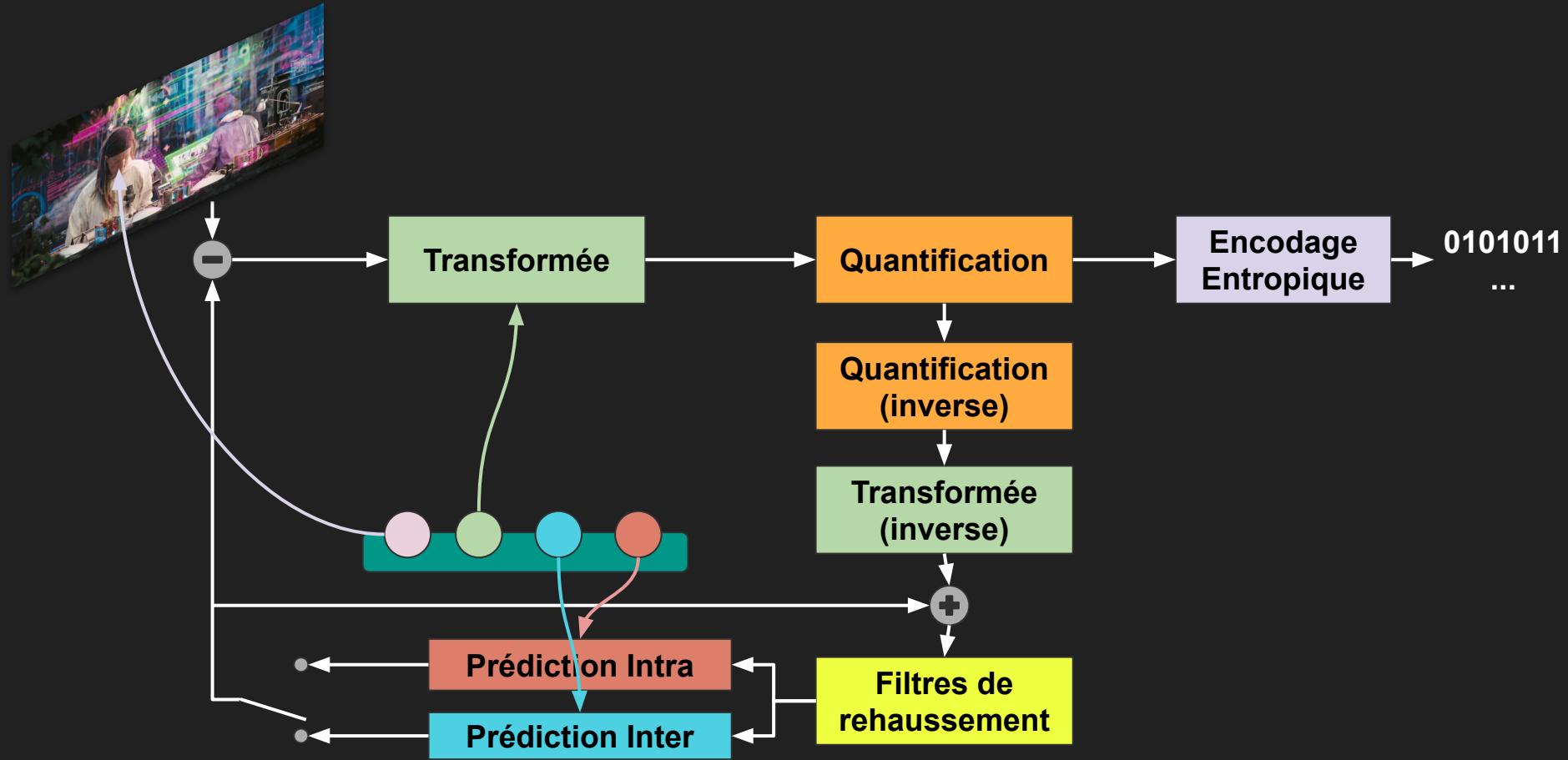
# Entraînement avec des enveloppes convexes



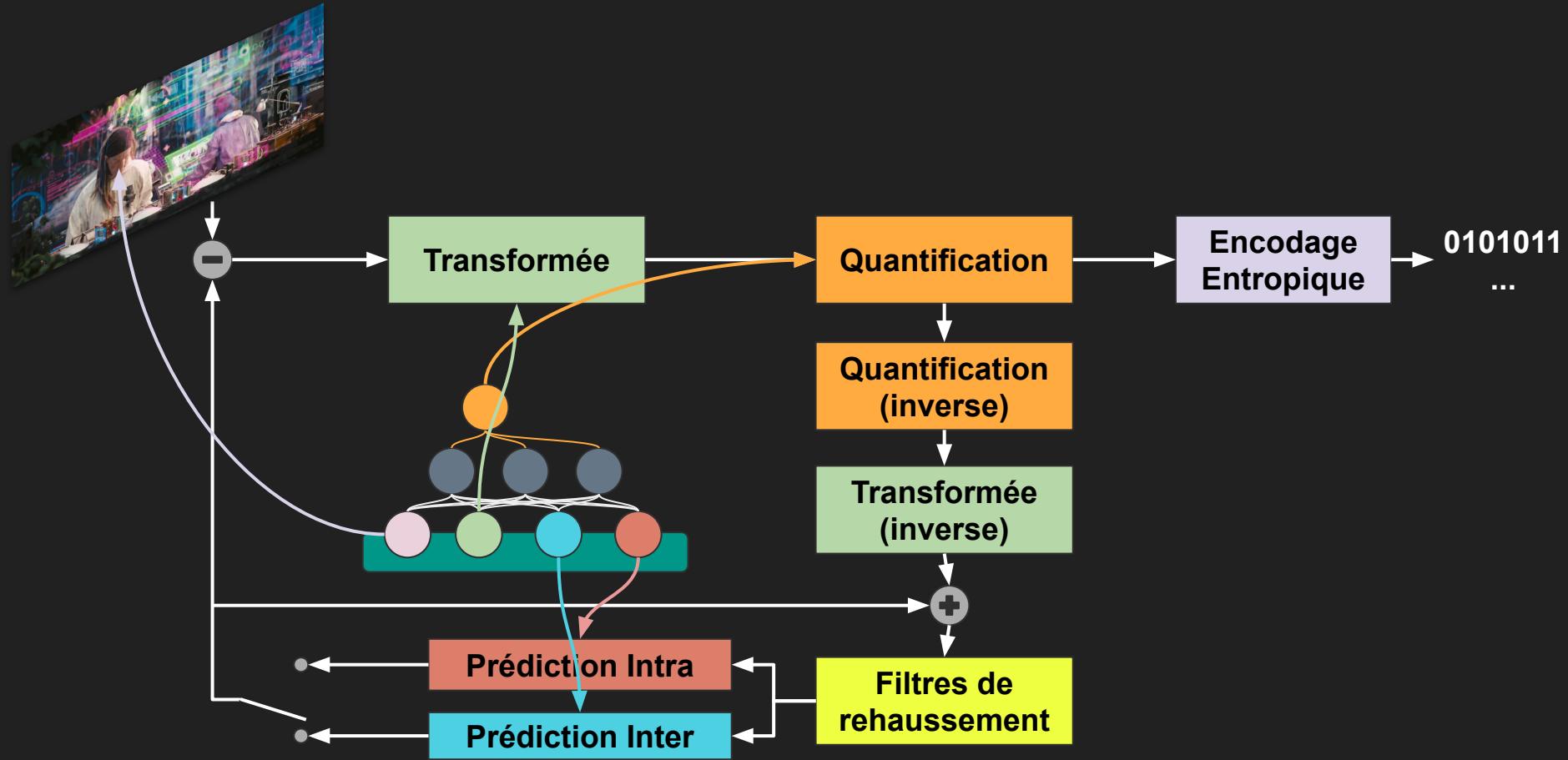
# Encodeur vidéo



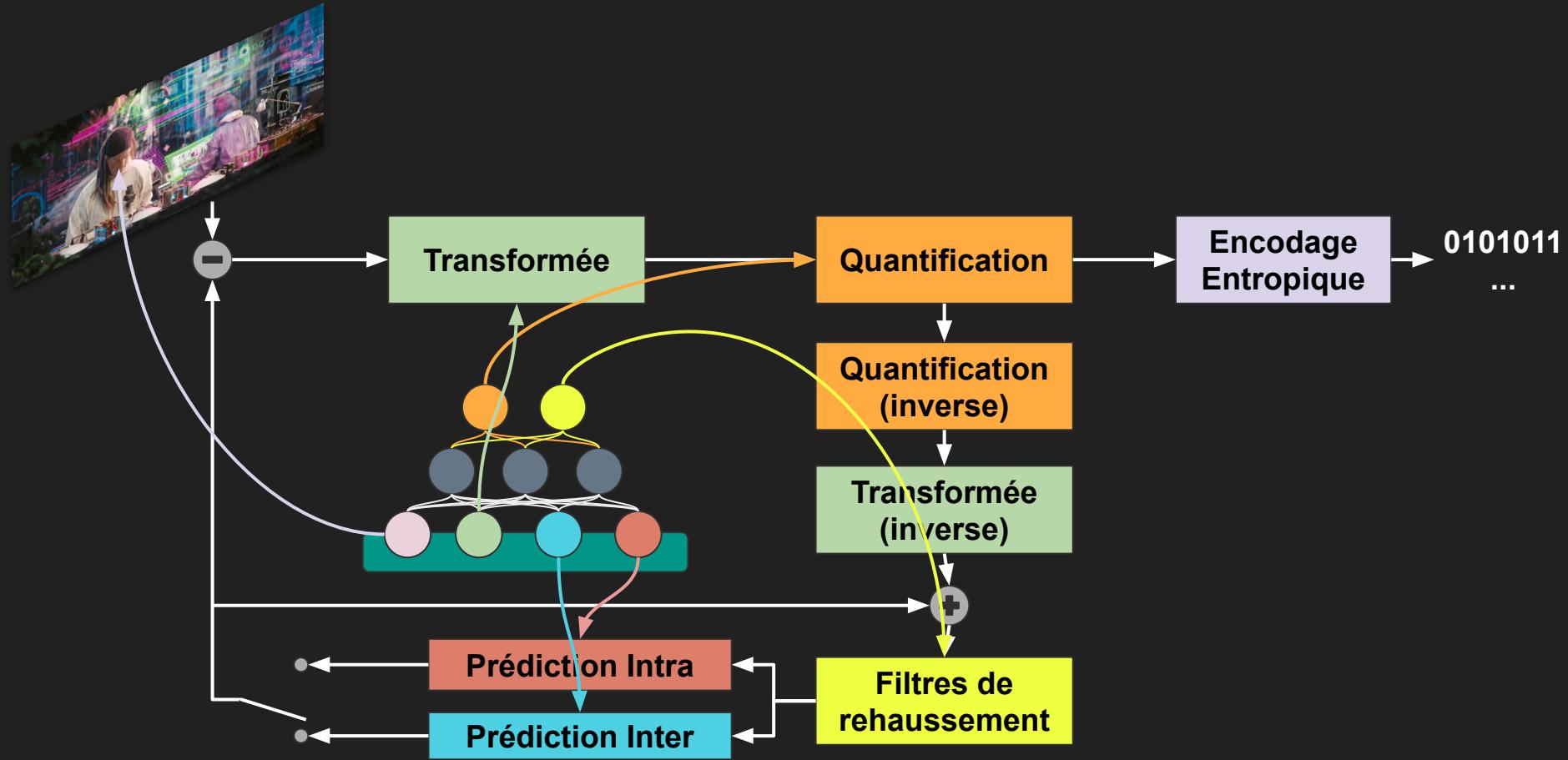
# IA intégrée à l'interne



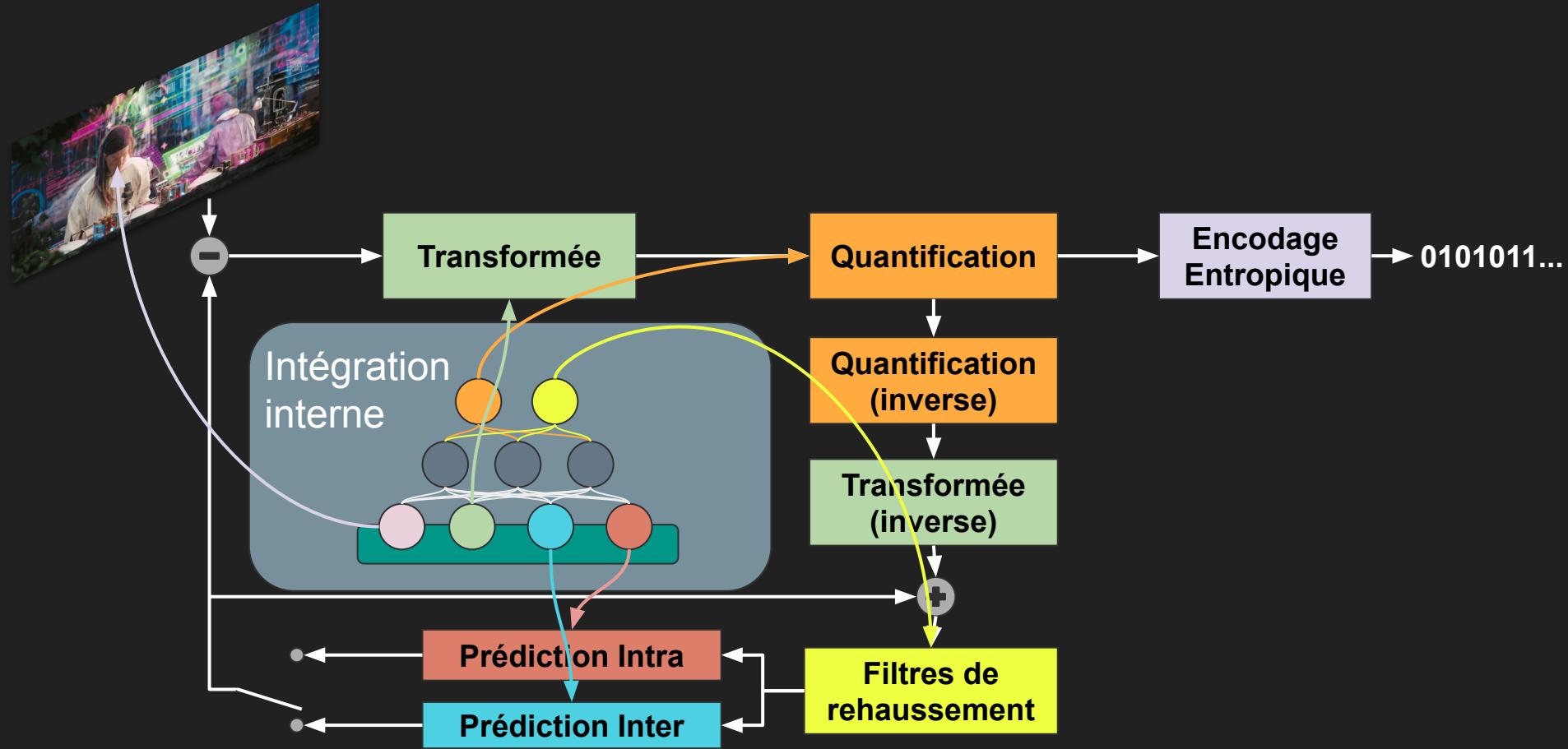
# IA intégrée à l'interne



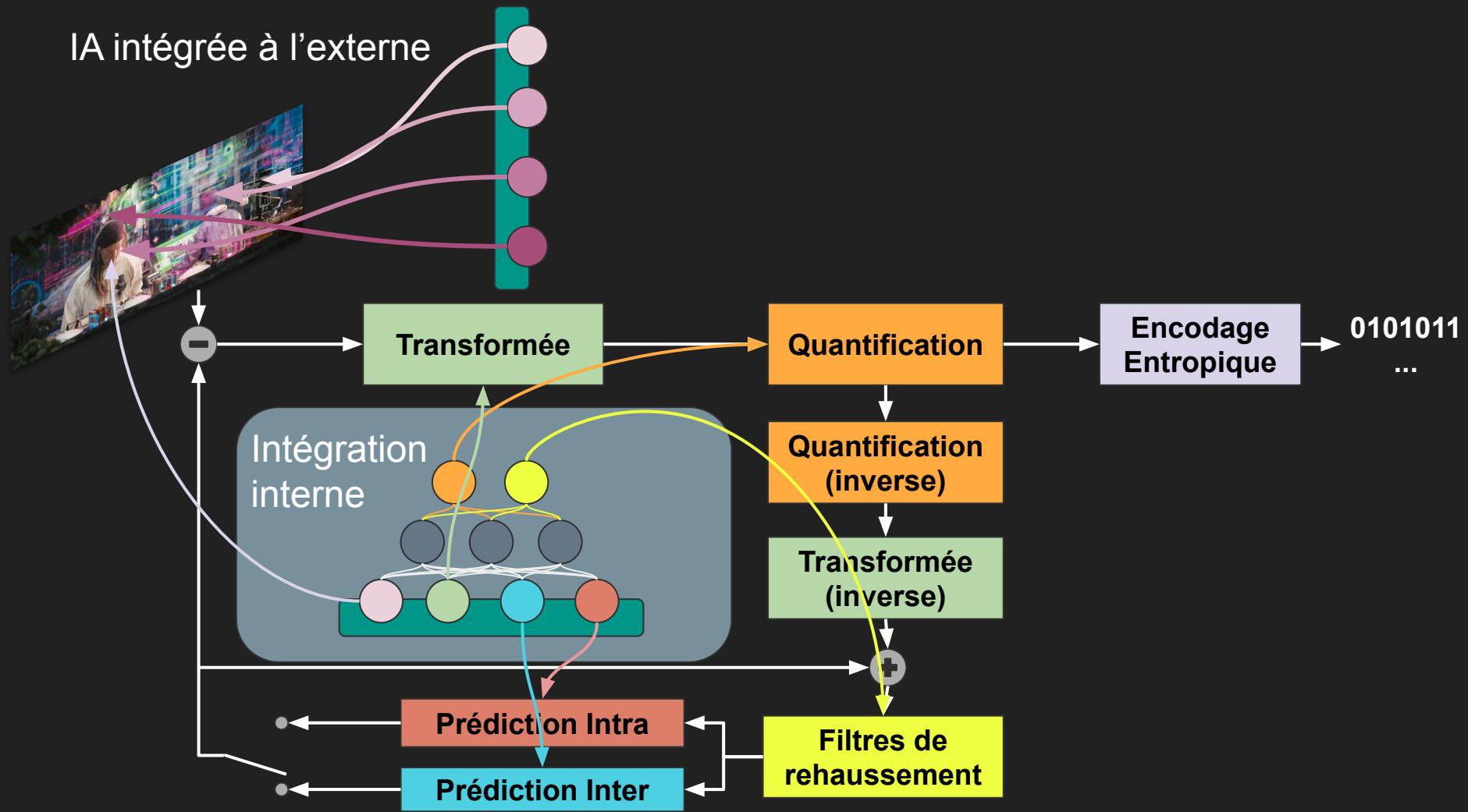
# IA intégrée à l'interne



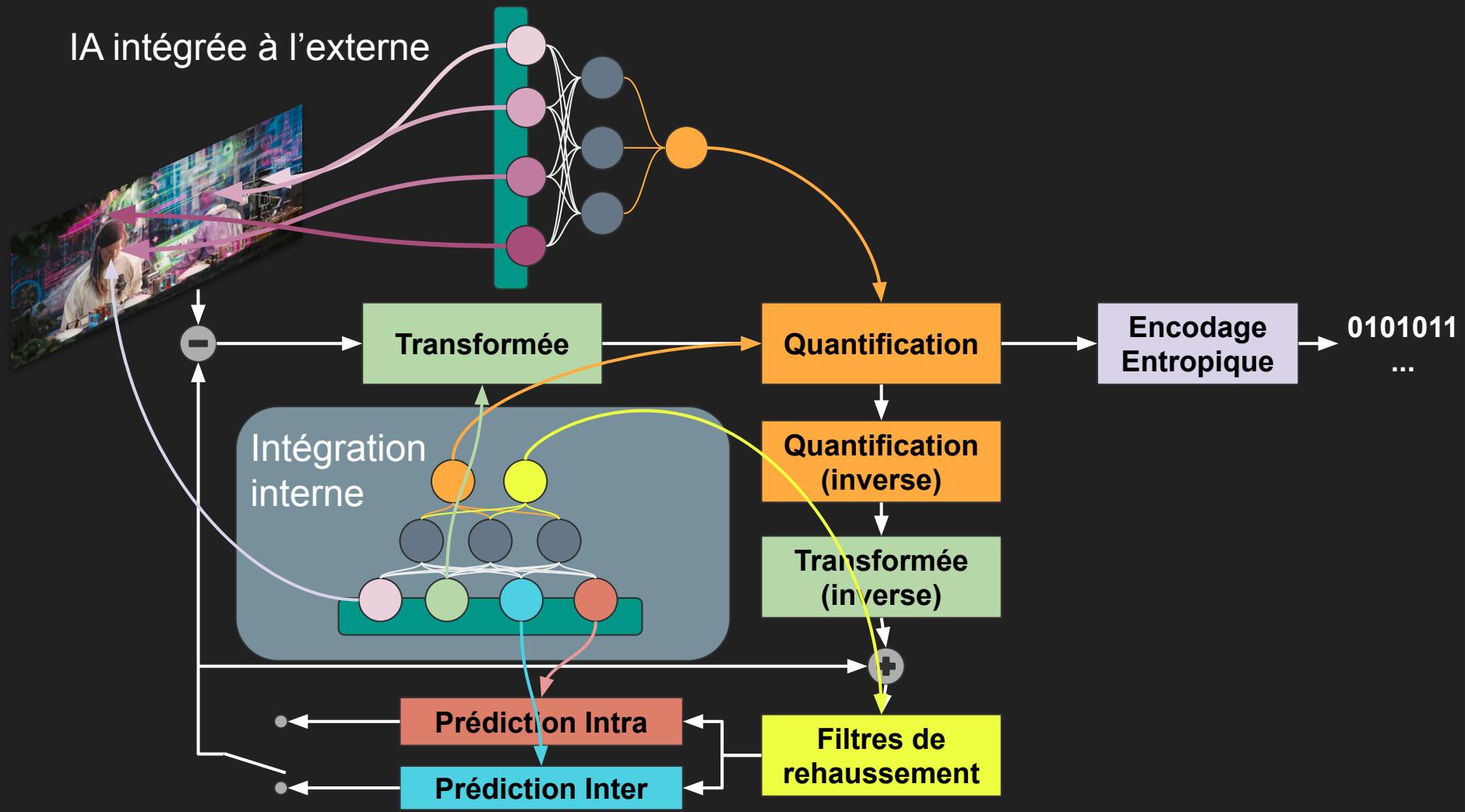
# IA intégrée à l'interne

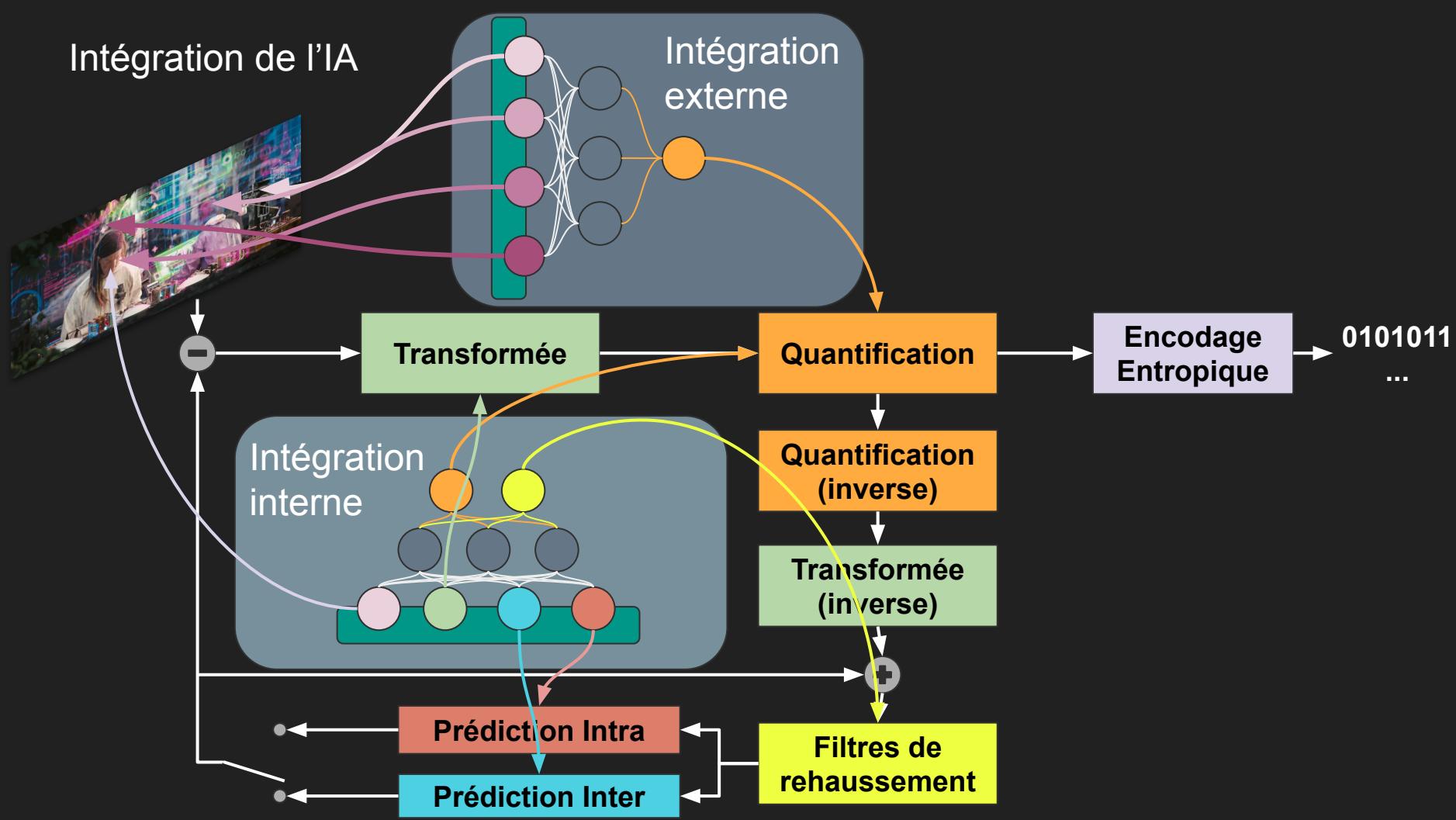


IA intégrée à l'externe



IA intégrée à l'externe





## Conclusion

ROI (\$)

0\$

Optimisateur  
Dynamique

Vous

Encodage  
guidé par l'IA

Vues

