Bayesian Classification in Computer Vision

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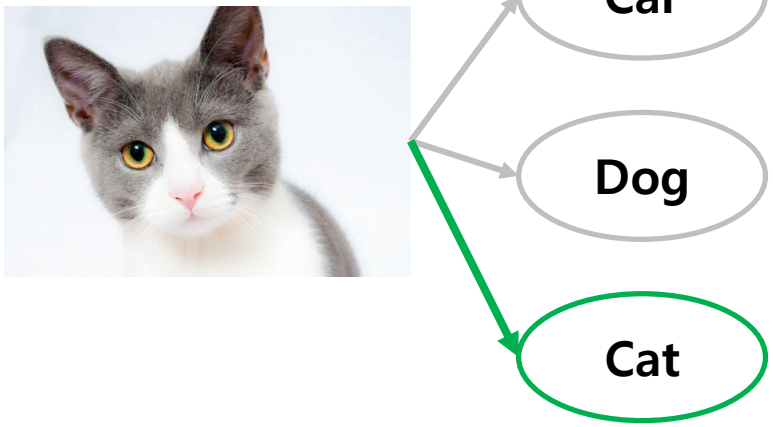
Contents

Bayesian Classification

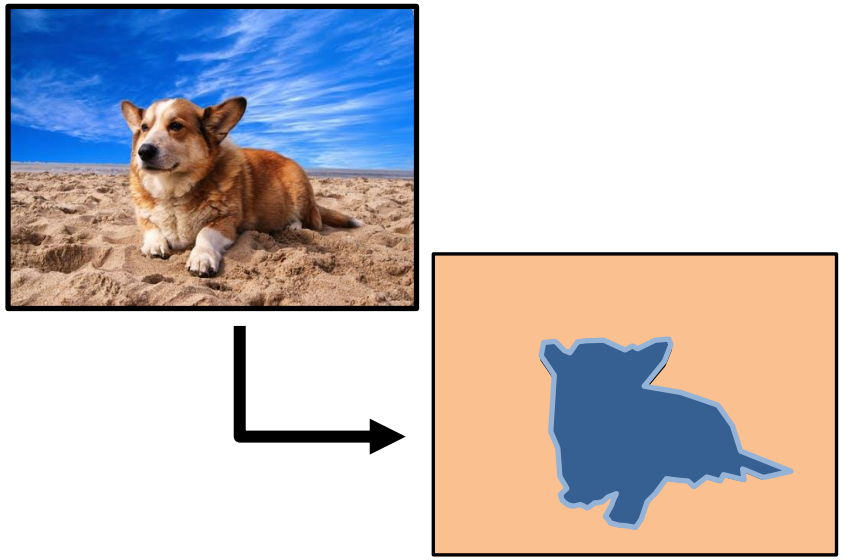
- **Classification Problem**

  - For given data, classify it into the specific class.

    ex) Object Classification, Image Segmentation, Spam Filtering, etc.



[Object Classification]



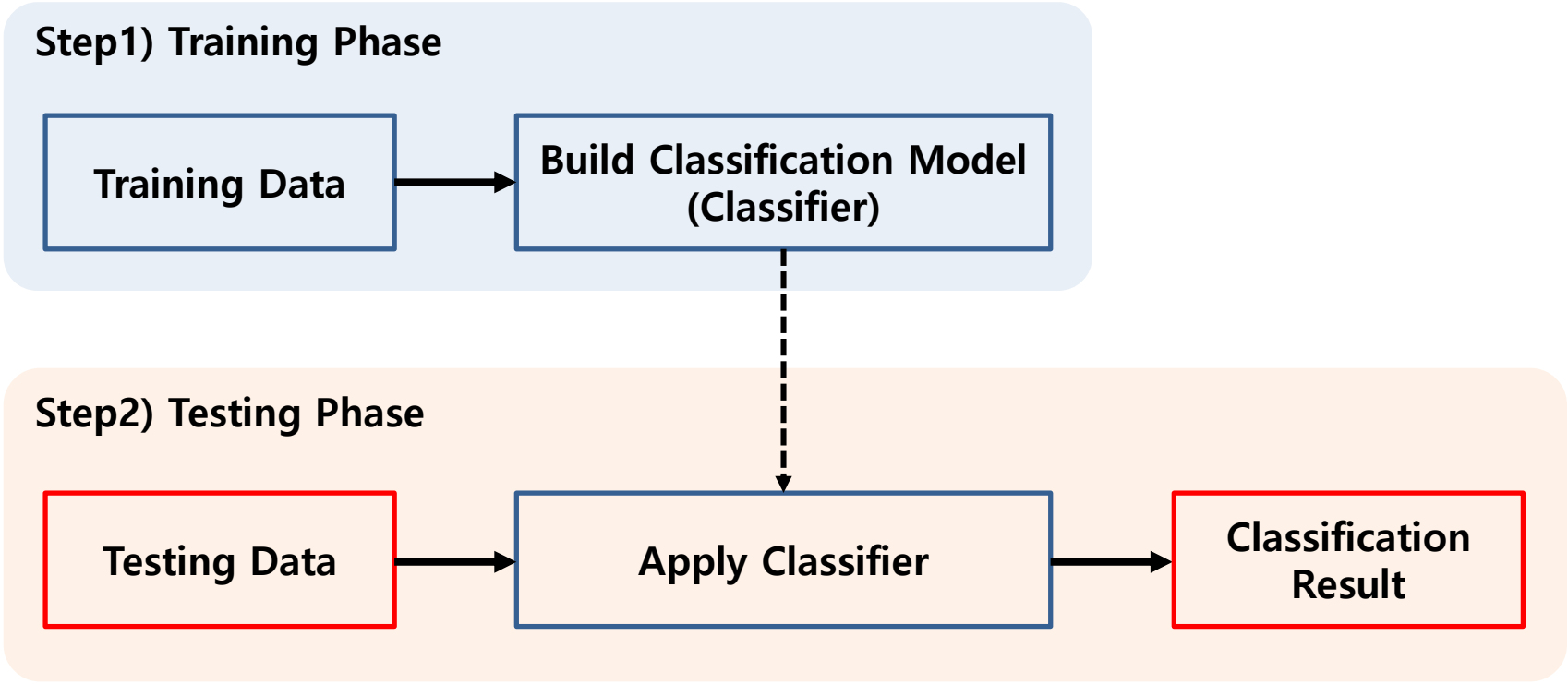
[Image Segmentation]

Bayesian Classification

Classification Problem

- For given data, classify it into the specific class.

  ex) Object Classification, Image Segmentation, Spam Filtering, etc.



Bayesian Classification

Classification Problem

- For given data($\mathbf{X}$), classify it into the specific class($\mathbf{C}$).

  → Can be described as **Probability Model**.

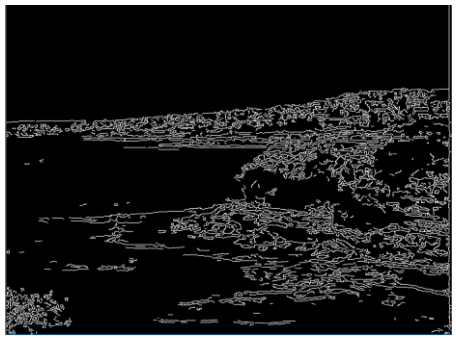
$$p(\mathbf{C}|\mathbf{X})$$

- As real data is **too complicate** to explain what it is, extract some **FEATURES** from the data which can describe the data well.

  ex) In CV: Color, Brightness, Edges, …

[Color]

[Brightness]



[Edge]

Bayesian Classification

Classification Problem

- For given data($\mathbf{X}$), classify it into the specific class($\mathbf{C}$).

  → Can be described as **Probability Model**.

$$p(\mathbf{C}|\mathbf{X})$$

- As real data is **too complicate** to explain what it is, extract some **FEATURES** from the data which can describe the data well.

- Features can be anything($:= \infty$): **Hard** to predict
- Classes are countable: **Easier** to predict than **Features**

  → Utilize **Bayesian Rule**

$$p(\mathbf{C}|\boldsymbol{X}) = \frac{\overbrace{p(\mathbf{C})}^{\text{prior}}\overbrace{\mathbf{p}(\mathbf{X}|\mathbf{C})}^{\text{Likelihood}}}{\underbrace{\mathbf{p}(\mathbf{X})}_{\text{Evidence}}}$$

Bayesian Classification

- **Bayesian Classifier**

$$p(\mathrm{C}|X) = \frac{p(\mathrm{C})\,\mathrm{p}(\mathrm{X}|\mathrm{C})}{\mathrm{p}(\mathrm{X})}$$

prior — Likelihood — Evidence

- **Prior** ($p(\mathrm{C})$): Probability that the class will show up

(Can be obtained from **training** data)

- **Likelihood** ($p(\mathrm{X}|\mathrm{C})$): Probability that the features **X** will show up given class **C**

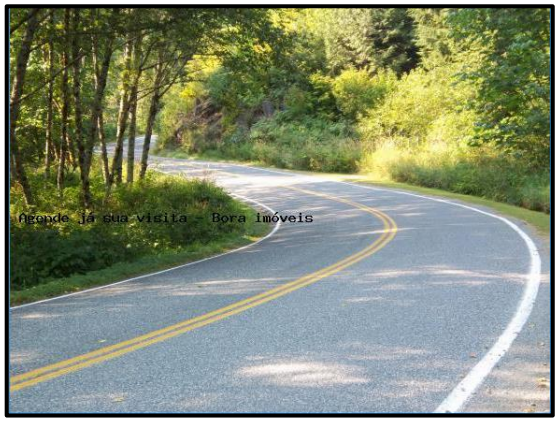
(Can be obtained from **training** data)

- **Evidence** ($p(\mathrm{X})$): Probability that the features will show up

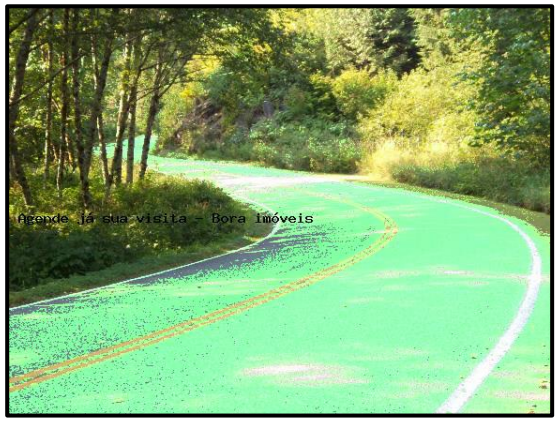
(we **don't** need to care about it- **why?**)

Bayesian Classifier for Image Segmentation

- **Goal: Classify the pixels into ROAD or NON-ROAD region**



[Input Image]



[Segmentation Result]

- Problem Definition

- For each pixel,

1) if $p(C_{Road}|\mathrm{X}) > p(C_{Non-Road}|\mathrm{X})$, the pixel belongs to **ROAD**

2) if $p(C_{Road}|\mathrm{X}) \leq p(C_{Non-Road}|\mathrm{X})$, the pixel belongs to **NON-ROAD**

$$\boldsymbol{p(\mathrm{C}_{Road}|\mathrm{X}) > p(\mathrm{C}_{Non-Road}|\mathrm{X}) \Rightarrow \frac{p(\mathrm{C}_{Road})\mathrm{p}(\mathrm{X}|\mathrm{C}_{Road})}{\mathrm{p}(\mathrm{X})} > \frac{p(\mathrm{C}_{Non-Road})p(\mathrm{X}|\mathrm{C}_{Non-Road})}{p(\mathrm{X})}}$$

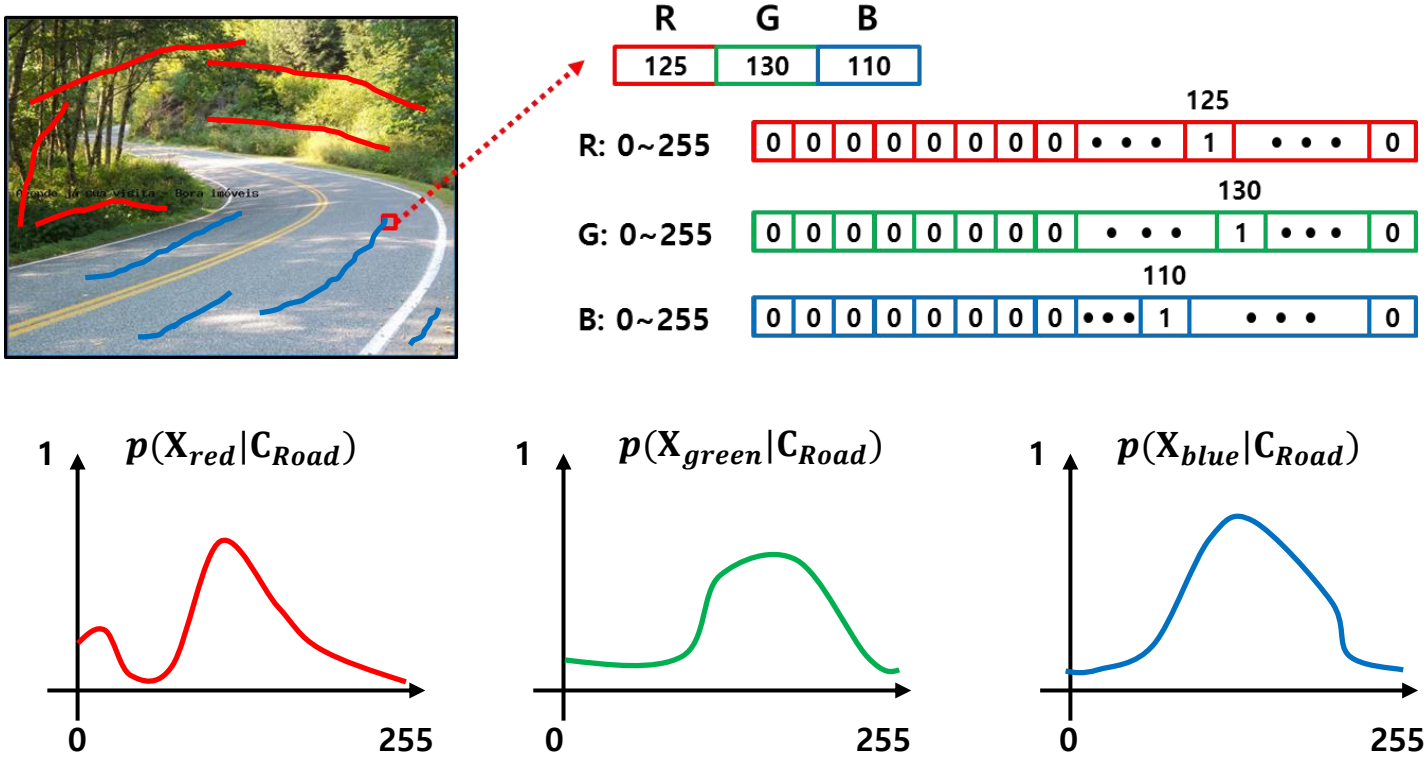
Bayesian Classifier for Image Segmentation

Road – Non-Road Region Segmentation

- Training Phase

  - Feature: Color – R,G,B (Can be anything what you want)

➡ $p(\mathbf{C}_{Road}|\mathbf{X}) \propto p(\mathbf{C}_{Road}) * p(\mathbf{X}_{red}|\mathbf{C}_{Road}) * p(\mathbf{X}_{green}|\mathbf{C}_{Road}) * p(\mathbf{X}_{blue}|\mathbf{C}_{Road})$

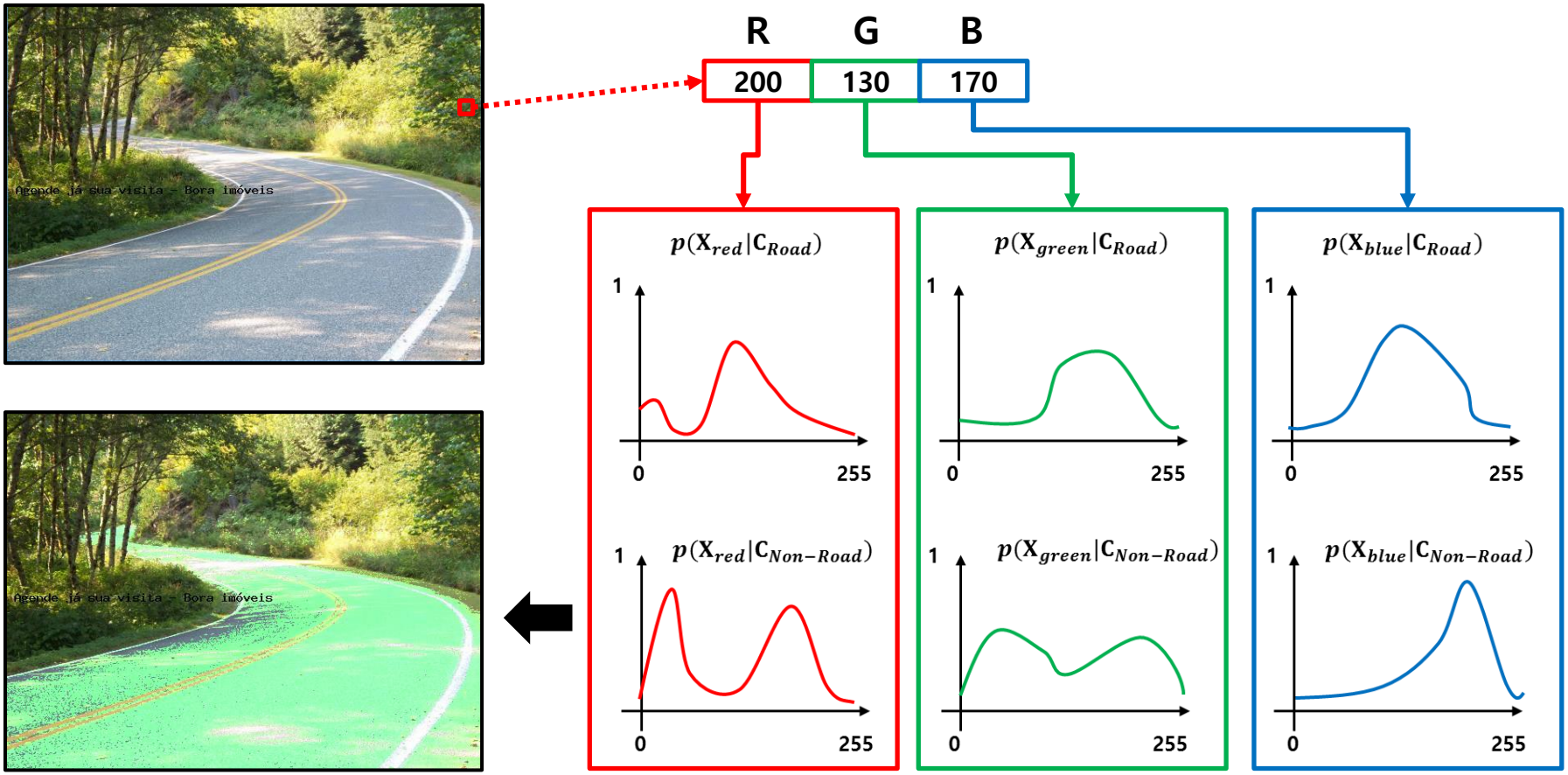


Bayesian Classifier for Image Segmentation

Road – Non-Road Region Segmentation

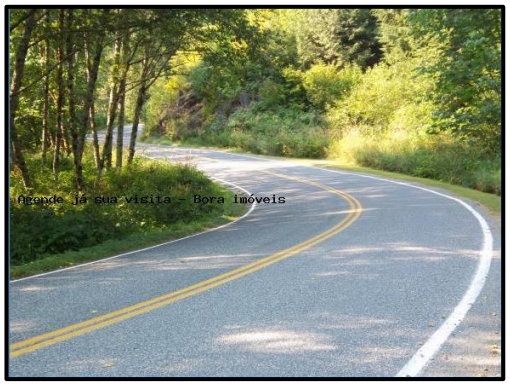
- Testing Phase

  - For all pixels, compare $p(C_{Road}|\mathrm{X})$ and $p(C_{Non-Road}|\mathrm{X})$

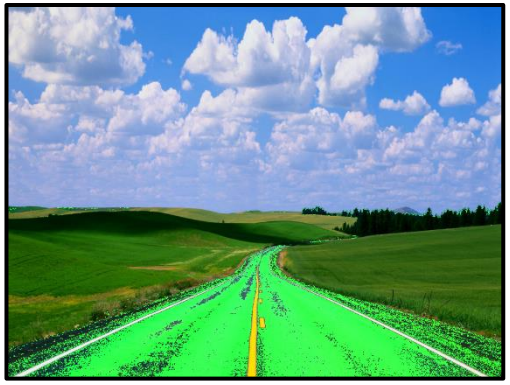


Bayesian Classifier for Image Segmentation

- **Road – Non-Road Region Segmentation**
  - Results








Questions?