Lab Nov 19th

Bhattacharya Coefficient

- a similarity metric!

Bhattacharya Coefficient

- a similarity metric!
- compares probability distribution functions

Bhattacharya Coefficient

- a similarity metric!
- compares probability distribution functions

$$\rho = \sqrt{\sum_{i=1}^{n} \left(\hat{p}_i(y) \cdot q_i \right)^2}$$

Bhattacharya Coefficient

- a similarity metric!
- compares probability distribution functions
- p hat is sample proportion of image (i.e., image region)

$$\rho = \sqrt{\sum_{i=1}^{n} \left(\hat{p}_i(y) \cdot q_i \right)^2}$$

Bhattacharya Coefficient

- a similarity metric!
- compares probability distribution functions
- p hat is sample proportion of image (i.e., image region)

$$\rho = \sqrt{\sum_{i=1}^{n} \left(\hat{p}_i(y) \cdot q_i\right)^2}$$

- qi is template PDF

PDFs

- sum of probability distribution functions(PDF)?

$$\rho = \sqrt{\sum_{i=1}^{n} \left(\hat{p}_i(y) \cdot q_i \right)^2}$$

PDFs

- sum ofr probability distribution functions(PDF)?
- PDFs sum to 1. (probability!)

$$\rho = \sqrt{\sum_{i=1}^{n} \left(\hat{p}_i(y) \cdot q_i \right)^2}$$

PDFs

- sum ofr probability distribution functions(PDF)?
- PDFs sum to 1. (probability!)
- what if the PDFs are very similar?

  The same?

$$\rho = \sqrt{\sum_{i=1}^{n} \left(\hat{p}_i(y) \cdot q_i \right)^2}$$

PDFs

- sum of probability distribution functions(PDF)?
- PDFs sum to 1. (probability!)
- what if the PDFs are very similar?

  The same? – larger value

$$\rho = \sqrt{\sum_{i=1}^{n} \left(\hat{p}_i(y) \cdot q_i \right)^2}$$

PDFs

- sum of probability distribution functions(PDF)?
- PDFs sum to 1. (probability!)
- what if the PDFs are very similar?

  The same? – larger value

$$\rho = \sqrt{\sum_{i=1}^{n} \left(\hat{p}_i(y) \cdot q_i \right)^2}$$

- PDFs very different?
  - Smaller value

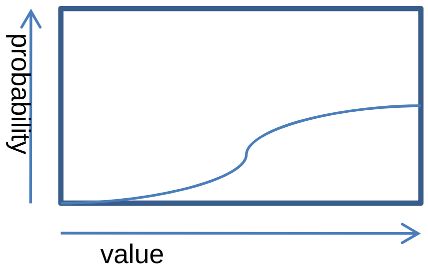
PDFs

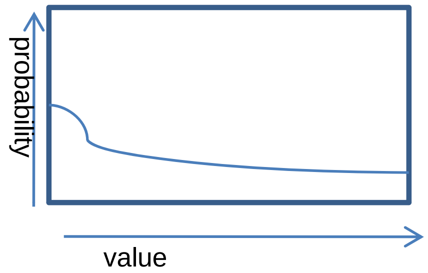
- sum of probability distribution functions(PDF)?
- PDFs sum to 1. (probability!)
- what if the PDFs are very similar?

  The same? – larger value

$$\rho = \sqrt{\sum_{i=1}^{n} \left(\hat{p}_i(y) \cdot q_i\right)^2}$$

- PDFs very different?
  - Smaller value





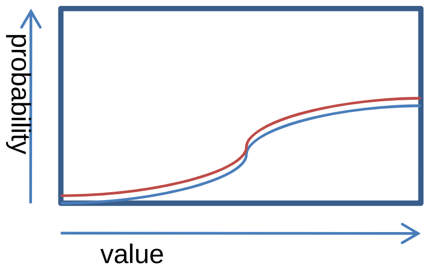
PDFs

- sum of probability distribution functions(PDF)?
- PDFs sum to 1. (probability!)
- what if the PDFs are very similar?

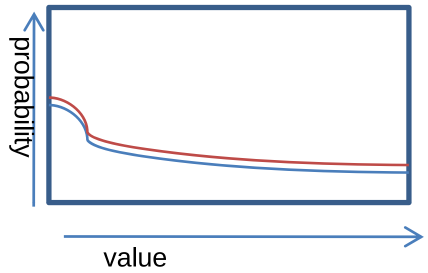
  The same? – larger value

$$\rho = \sqrt{\sum_{i=1}^{n} \left(\hat{p}_i(y) \cdot q_i\right)^2}$$

- PDFs very different?
  - Smaller value



Self overlap:
large regions get
large multipliers



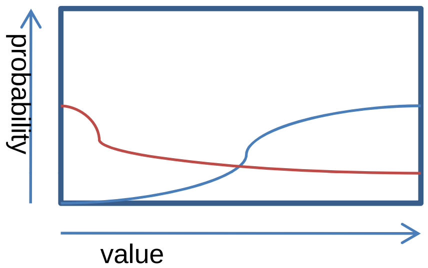
PDFs

- sum of probability distribution functions(PDF)?
- PDFs sum to 1. (probability!)
- what if the PDFs are very similar?

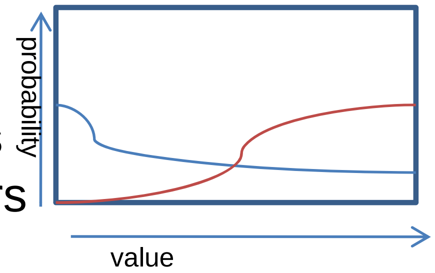
  The same? – larger value

$$\rho = \sqrt{\sum_{i=1}^{n} \left(\hat{p}_i(y) \cdot q_i\right)^2}$$

- PDFs very different?
  - Smaller value



Here, large regions
Get small multipliers



So what about images

- Bhattacharya requires a PDF.
- How can we get a PDF from an image region?
- One way... Histogram!
  - Image histogram gives total for each pixel intensity. Treat this as a probability distribution!
  - Normalize histogram to sum to 1, as a PDF

Okay, how to do it

- calculate histograms of image regions
- normalize histogram to sum to 1
- calculate Bhattacharya coefficient

Try one.

template

5	4	4
5	4	4
2	3	4

image region 1

4	3	1
4	3	1
1	2	3

Image region 2

4	5	4
4	5	4
4	2	2

Try one.

template

5	4	4
5	4	4
2	3	4

image region 1

4	3	1
4	3	1
1	2	3

Image region 2

4	5	4
4	5	4
4	2	2

Histograms:

0	1	1	5	2
1	**2**	**3**	**4**	**5**

3	1	3	2	0
1	**2**	**3**	**4**	**5**

0	2	0	5	2
1	**2**	**3**	**4**	**5**

Try one.

template

5	4	4
5	4	4
2	3	4

image region 1

4	3	1
4	3	1
1	2	3

Image region 2

4	5	4
4	5	4
4	2	2

Histograms:

0	1	1	5	2
1	**2**	**3**	**4**	**5**

3	1	3	2	0
1	**2**	**3**	**4**	**5**

0	2	0	5	2
1	**2**	**3**	**4**	**5**

Normalized: (/ total number of pixels, / 9), now they sum to 1

0	1/9	1/9	5/9	2/9
1	**2**	**3**	**4**	**5**

1/3	1/9	1/3	2/9	0
1	**2**	**3**	**4**	**5**

0	2/9	0	5/9	2/9
1	**2**	**3**	**4**	**5**

Try one.

template		
5	4	4
5	4	4
2	3	4

image region 1		
4	3	1
4	3	1
1	2	3

Image region 2		
4	5	4
4	5	4
4	2	2

Histograms:

1	**2**	**3**	**4**	**5**
0	1	1	5	2

1	**2**	**3**	**4**	**5**
3	1	3	2	0

1	**2**	**3**	**4**	**5**
0	2	0	5	2

Normalized: (/ total number of pixels, / 9), now they sum to 1

1	**2**	**3**	**4**	**5**
0	1/9	1/9	5/9	2/9

1	**2**	**3**	**4**	**5**
1/3	1/9	1/3	2/9	0

1	**2**	**3**	**4**	**5**
0	2/9	0	5/9	2/9

Bhattacharya: $\rho = \sqrt{\sum_{i=1}^{n} \left(\hat{p}_i(y) \cdot q_i\right)^2}$

Region1 = $\sqrt{(0 \cdot \frac{1}{3})^2 + (\frac{1}{9} \cdot \frac{1}{9})^2 + (\frac{1}{9} \cdot \frac{1}{3})^2 + (\frac{5}{9} \cdot \frac{2}{9})^2 + (\frac{2}{9} \cdot 0)^2} = \sqrt{0.01766} = 0.13$

Try one.

template

5	4	4
5	4	4
2	3	4

image region 1

4	3	1
4	3	1
1	2	3

Image region 2

4	5	4
4	5	4
4	2	2

Histograms:

0	1	1	5	2
1	**2**	**3**	**4**	**5**

3	1	3	2	0
1	**2**	**3**	**4**	**5**

0	2	0	5	2
1	**2**	**3**	**4**	**5**

Normalized: (/ total number of pixels, / 9), now they sum to 1

0	1/9	1/9	5/9	2/9
1	**2**	**3**	**4**	**5**

1/3	1/9	1/3	2/9	0
1	**2**	**3**	**4**	**5**

0	2/9	0	5/9	2/9
1	**2**	**3**	**4**	**5**

Bhattacharya: $\rho = \sqrt{\sum_{i=1}^{n} \left(\hat{p}_i(y) \cdot q_i\right)^2}$

Region1 = $\sqrt{(0 \cdot \frac{1}{3})^2 + (\frac{1}{9} \cdot \frac{1}{9})^2 + (\frac{1}{9} \cdot \frac{1}{3})^2 + (\frac{5}{9} \cdot \frac{2}{9})^2 + (\frac{2}{9} \cdot 0)^2} = \sqrt{0.01766} = 0.13$

Region 2 = $\sqrt{(0 \cdot 0)^2 + (\frac{1}{9} \cdot \frac{2}{9})^2 + (\frac{1}{9} \cdot 0)^2 + (\frac{5}{9} \cdot \frac{5}{9})^2 + (\frac{2}{9} \cdot \frac{2}{9})^2} = \sqrt{0.09831} = 0.31$