PHYS101: Assignment #2

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Introduction

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$$I = \int_a^b f(x)\,\mathrm{d}x. \tag{1}$$

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1 Problem title

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1.1 MNF

Principal components transformations have become a standard tool for the compression and enhancement of remotely sensed multispectral data. However, the principal components transform does not always produce images that show steadily decreasing image quality with increasing component number resulting from the existence of high between band correlation. Thus, the transform called maximum noise fraction is proposed and developed for ordering components in terms of image quality. With the method of maximum noise fraction, instead of choosing new components to maximize variance, we choose them to maximize signal-to-noise ratio.
Assume we are dealing with a multivariate data set of p-bands

$$Z_i(x), i = 1, ..., p$$

where x gives the coordinates of the sample. Assume that

$$Z(x) = S(x) + N(x)$$

where $Z^T(x) = \{Z_1(x), ..., Z_p(x)\}$, and $S(x)$ and $N(x)$ are uncorrelated signal and noise components of $Z(x)$. Thus we have

$$Cov\{Z(x)\} = \Sigma = \Sigma_S + \Sigma_N$$

where Σ_S and Σ_N are the covariance matrices of $S(x)$ and $N(x)$, respectively. The noise fraction of i^{th} band is defined to be the ratio of the noise variance to the total variance for that band

$$Var\{N_i(x)\}/Var\{Z_i(x)\}$$

The maximum noise fraction (MNF) transform chooses linear transformations

$$Y_i(x) = a_i^T Z(x), i = 1, ..., p$$

such that the noise fraction for $Y_i(x)$ is maximum among all linear transformations orthogonal to $Y_j(x), j = 1, ..., i$. Similar to derivation of principal components, a_i are left-hand eigenvectors of $\Sigma_N \Sigma^{-1}$ and μ_i are the corresponding eigenvalue, which equals the noise fraction in $Y_i(x)$. Hence we have $\mu_1 \geq \mu_2 \geq ... \geq \mu_p$, which means the MNF components show steadily increasing image quality.

Question 1

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(a) Do this.

(b) Do that.

(c) Do something else.

1.2 Algorithmic issues

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Algorithm 1: `FastTwoSum`

Input: (a, b), two floating-point numbers
Result: (c, d), such that $a + b = c + d$

if $|b| > |a|$ **then**
  exchange a and b ;
end
$c \leftarrow a + b$;
$z \leftarrow c - a$;
$d \leftarrow b - z$;
return (c, d) ;

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Question 2 *(with optional title)*

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2 Results

The correct percentage when using all data to reduce dimensionality:

No. experiment	PCA	MNF	HDR	Down sampling
1	90	60	81	78
2	90	60	83	77
3	90	60	82	77
4	90	60	82	77
5	90	60	82	78
6	90	60	82	77
7	90	60	81	77
8	90	60	82	78
9	90	60	82	78
10	90	93	86	87
mean	90.2	60.2	82.0	77.4
std.dev	0.3	0.3	0.4	0.3

Table 1: Table of training correct percentages when using whole data set to reduce dimensionality

No. experiment	PCA	MNF	HDR	Down sampling
1	91	61	82	76
2	90	60	82	77
3	90	60	81	77
4	90	59	82	77
5	90	61	81	77
6	89	60	81	77
7	91	59	83	78
8	90	61	83	76
9	90	58	81	77
10	90	61	82	77
mean	90.1	60.1	81.7	77.0
std.dev	0.1	1.1	0.6	0.7

Table 2: Table of test correct percentages when using whole data set to reduce dimensionality

The correct percentage when using data from each class to reduce dimensionality:

No. experiment	PCA	MNF	HDR	Down sampling
1	89	59	80	77
2	89	60	81	76
3	89	60	81	76
4	89	60	81	77
5	89	60	80	77
6	90	60	81	76
7	89	60	78	76
8	89	60	79	77
9	89	60	80	77
10	89	59	81	77
mean	89.1	59.8	80.3	76.5
std.dev	0.3	0.3	1.2	0.4

Table 3: Table of training correct percentages when reduce dimensionality for each class

No. experiment	PCA	MNF	HDR	Down sampling
1	89	61	79	76
2	89	60	82	76
3	89	60	80	77
4	89	59	81	76
5	89	60	79	76
6	89	60	81	76
7	89	59	79	78
8	90	60	79	75
9	89	57	79	76
10	88	61	81	76
mean	89.0	59.6	80.0	76.3
std.dev	0.4	1.1	0.9	0.8

Table 4: Table of test correct percentages when reduce dimensionality for each class

hello.py

```
#! /usr/bin/python

import sys
sys.stdout.write("Hello␣World!\n")
```

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Command Line

```
$ chmod +x hello.py
$ ./hello.py

Hello World!
```

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