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Math 362 Fourier Analysis

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Class Prep 10

Section 5.2

Key Concepts - We will compute the symmetric extension of a matrix as well as the DCT II and IDCT II of a matrix. We then use the DCT II, IDCT II, and quantization matrices to perform JPEG compression on an image matrix.

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| Input Commands | Output (Plot if Applicable) |
| >> A=imread('bwsphinx.jpg');  >> MatrixSymPlot(A);  >> A=imread('bwflower.jpg');  >> MatrixSymPlot(A);  >> A=[1,2;3,4];  >> C=1/sqrt(2)\*[1,1;1,-1];  >> D=C\*A\*C' | D =  5.0000 -1.0000  -2.0000 0 |

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| Input Commands | Output (Plot if Applicable) |
| >> A1=C\*D\*C'  >> A=[1,0,1,1;1,2,-1,0;3,1,0,1;-1,-1,1,2];  >> dct4x4(A)  >> Mountain=imread('bwmtn.jpg');  >> MatrixPlot(Mountain)  >> A=Mountain(94:101,341:348);  >> MatrixPlot(A) | A1 =  1.0000 2.0000  3.0000 4.0000  D =  2.7500 0.1353 1.2500 -0.3266  0.2474 1.4269 -0.4059 -0.3232  -0.7500 -2.9070 -0.2500 1.4748  1.2505 0.6768 0.9799 1.0733 |

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| Input Commands | Output (Plot if Applicable) |
| >> A=double(A);  >> B=A-127  >> C=DCTIIC(8);  >> D=C\*B\*C' | B =  123 128 128 125 126 124 128 112  112 119 127 128 128 118 128 120  100 110 124 128 128 109 128 120  22 116 128 126 118 128 117 126  27 0 4 124 128 125 121 113  53 63 37 29 112 122 91 49  52 58 36 -10 35 60 34 4  60 37 17 34 11 12 29 35 |

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| D Matrix From Previous Entry |
| D =  688.0000 -66.7176 -38.9823 30.0662 -13.5000 -9.4139 -17.6777 -1.5138  282.7447 -2.5175 -26.7753 -50.2815 2.6463 8.9431 -4.3940 3.7871  -65.1992 107.3943 65.1786 1.9209 -6.7049 10.1678 9.2050 13.0026  -4.2236 -37.5590 -15.8074 69.1009 -2.9310 -9.3339 1.5928 5.0210  0.0000 -40.4020 -16.5002 -33.7441 30.5000 18.6133 -9.1307 -28.6563  -0.1165 44.2762 3.8744 -17.6403 -56.9811 -30.2235 11.0053 9.1333  21.5944 5.6227 6.7050 11.7260 6.0244 0.5289 -5.1786 9.3105  -27.6196 -19.0192 2.3034 19.3645 40.0352 29.4213 -2.6327 -3.8599 |

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| >> Q50matrix  >> R1=D./Q | Q =  16 11 10 16 24 40 51 61  12 12 14 19 26 58 60 55  14 13 16 24 40 57 69 56  14 17 22 29 51 87 80 62  18 22 37 56 68 109 103 77  24 35 55 64 81 104 113 92  49 64 78 87 103 121 120 101  72 92 95 98 112 100 103 99 |

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| R1 Matrix From Previous Entry |
| R1 =  43.0000 -6.0652 -3.8982 1.8791 -0.5625 -0.2353 -0.3466 -0.0248  23.5621 -0.2098 -1.9125 -2.6464 0.1018 0.1542 -0.0732 0.0689  -4.6571 8.2611 4.0737 0.0800 -0.1676 0.1784 0.1334 0.2322  -0.3017 -2.2094 -0.7185 2.3828 -0.0575 -0.1073 0.0199 0.0810  0.0000 -1.8365 -0.4460 -0.6026 0.4485 0.1708 -0.0886 -0.3722  -0.0049 1.2650 0.0704 -0.2756 -0.7035 -0.2906 0.0974 0.0993  0.4407 0.0879 0.0860 0.1348 0.0585 0.0044 -0.0432 0.0922  -0.3836 -0.2067 0.0242 0.1976 0.3575 0.2942 -0.0256 -0.0390 |

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| >> R=round(R1)  >> D1=R.\*Q  >> A1=round(C'\*D1\*C)+127 | R =  43 -6 -4 2 -1 0 0 0  24 0 -2 -3 0 0 0 0  -5 8 4 0 0 0 0 0  0 -2 -1 2 0 0 0 0  0 -2 0 -1 0 0 0 0  0 1 0 0 -1 0 0 0  0 0 0 0 0 0 0 0  0 0 0 0 0 0 0 0  D1 =  688 -66 -40 32 -24 0 0 0  288 0 -28 -57 0 0 0 0  -70 104 64 0 0 0 0 0  0 -34 -22 58 0 0 0 0  0 -44 0 -56 0 0 0 0  0 35 0 0 -81 0 0 0  0 0 0 0 0 0 0 0  0 0 0 0 0 0 0 0  A1 =  234 264 271 248 240 257 258 240  256 236 240 266 268 243 238 256  220 245 261 254 248 252 249 239  157 218 254 240 236 260 265 244  153 149 177 231 260 252 244 251  184 157 145 177 228 246 211 168  190 189 159 131 160 204 180 115  179 160 145 142 136 133 148 170 |

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| Input Commands | Output (Plot if Applicable) |
| >> MatrixPlot(A)  >> MatrixPlot(A1)  >> Mountain=imread('bwmtn.jpg');  >> A=Mountain(94:101,341:348);  >> jpg8x8plot(A) | B =  123 128 128 125 126 124 128 112  112 119 127 128 128 118 128 120  100 110 124 128 128 109 128 120  22 116 128 126 118 128 117 126  27 0 4 124 128 125 121 113  53 63 37 29 112 122 91 49  52 58 36 -10 35 60 34 4  60 37 17 34 11 12 29 35 |

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| D Matrix From Previous Entry |
| D =  688.1814 -66.7244 -38.9842 30.0705 -13.5036 -9.4110 -17.6764 -1.5085  282.7734 -2.5204 -26.7722 -50.2770 2.6495 8.9409 -4.3923 3.7866  -65.1999 107.3819 65.1656 1.9197 -6.7048 10.1642 9.1997 12.9928  -4.2244 -37.5584 -15.8056 69.0996 -2.9279 -9.3257 1.5926 5.0235  -0.0000 -40.4094 -16.5010 -33.7485 30.5080 18.6135 -9.1302 -28.6568  -0.1235 44.2715 3.8739 -17.6309 -56.9874 -30.2253 11.0040 9.1304  21.5980 5.6179 6.7003 11.7241 6.0249 0.5291 -5.1782 9.3083  -27.6445 -19.0191 2.3049 19.3660 40.0407 29.4219 -2.6324 -3.8594 |

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|  | R =  43 -6 -4 2 -1 0 0 0  24 0 -2 -3 0 0 0 0  -5 8 4 0 0 0 0 0  0 -2 -1 2 0 0 0 0  0 -2 0 -1 0 0 0 0  0 1 0 0 -1 0 0 0  0 0 0 0 0 0 0 0  0 0 0 0 0 0 0 0  D1 =  688 -66 -40 32 -24 0 0 0  288 0 -28 -57 0 0 0 0  -70 104 64 0 0 0 0 0  0 -34 -22 58 0 0 0 0  0 -44 0 -56 0 0 0 0  0 35 0 0 -81 0 0 0  0 0 0 0 0 0 0 0  0 0 0 0 0 0 0 0  A1 =  234 264 271 248 240 257 258 240  256 237 240 266 268 243 238 257  220 245 261 254 248 252 249 239  157 218 254 240 236 260 265 244  153 149 177 231 260 252 244 251  184 157 145 177 228 246 211 168  190 189 159 131 160 204 180 115  179 160 145 142 136 133 148 170  Compression\_Ratio =  'The compression ratio is 63 to 18, or 3.500000 to 1.'  Percent\_Reduction =  71.4286 |

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| Input Command | Output (Plot if Applicable) |
| >> A=imread('bwmtn.jpg');  >> jpgplot(A)  >> A=imread('bwflower.jpg');  >> jpgplot(A)  >> A=imread('bwsphinx.jpg');  >> jpgplot(A) | Compression\_Ratio =  'The compression ratio is 420344 to 150607, or 2.790999 to 1.'  Percent\_Reduction =  64.1705    Compression\_Ratio =  'The compression ratio is 296050 to 42025, or 7.044616 to 1.'  Percent\_Reduction =  85.8048    Compression\_Ratio =  'The compression ratio is 128252 to 33954, or 3.777228 to 1.'  Percent\_Reduction =  73.5256 |

Section 6.1

Key Concepts - In this section we investigate the even-odd extension on of a function on We use to develop the CT IV of , which gives another cosine transform of , different than the CT II. In addition to all of the Fourier sine coefficients zeroing out, half of the Fourier cosine coefficients are also eliminated. Typically it will be the case that and its periodic extension is continuous.

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| Input Commands | Output (Plot if Applicable) |
| >> ExpTimeFreqCIV(16) |  |

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| Input Commands | Output (Plot if Applicable) |
| >> LinearTimeFreqCIV(2,-1,16)  >> CIVwindowPlot(0,1) |  |

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| Input Commands | Output (Plot if Applicable) |
| >> ExpCIVwindow(16) |  |

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| Input Commands | Output (Plot if Applicable) |
| >> LinearCIVwindow(2,-1,16) |  |