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**18/SCI01/040**

**MAT 204**

1. Shear transformations: A = " 1 0 1 1 # A = " 1 1 0 1 # In general, shears are transformation in the plane with the property that there is a vector ~w such that T(~w) = ~w and T(~x) − ~x is a multiple of ~w for all ~x. Shear transformations are invertible, and are important in general because they are examples which can not be diagonalized.
2. Scaling transformations: A = " 2 0 0 2 # A = " 1/2 0 0 1/2 # One can also look at transformations which scale x differently then y and where A is a diagonal matrix. Scaling transformations can also be written as A = λI2 where I2 is the identity matrix. They are also called dilations.
3. Reflection : A" = cos(2 α) sin(2 α) sin(2 α) − cos(2 α) # A = " 1 0 0 −1 # Any reflection at a line has the form of the matrix to the left. A reflection at a line containing a unit vector ~u is T(~x) = 2(~x · ~u)~u − ~x with matrix A = " 2u 2 1 − 1 2u1u2 2u1u2 2u 2 2 − 1 # Reflections have the property that they are their own inverse. If we combine a reflection with a dilation, we get a reflection-dilation.
4. Projection : A = " 1 0 0 0 # A = " 0 0 0 1 # A projection onto a line containing unit vector " ~u is T(~x) = (~x · ~u)~u with matrix A = u1u1 u2u1 u1u2 u2u2 # . Projections are also important in statistics. Projections are not invertible except if we project onto the entire space. Projections also have the property that P 2 = P. If we do it twice, it is the same transformation. If we combine a projection with a dilation, we get a rotation dilation.
5. Rotation : A = " −1 0 0 −1 # A" = cos( α) − sin( α) sin( α) cos( α) # Any rotation has the form of the matrix to the right. Rotations are examples of orthogonal transformations. If we combine a rotation with a dilation, we get a rotation-dilation.