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Eigenvalue problems and Schrödinger equation

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Abstract

1 Theory

2 Mathematichal intermezzo

To find the eigenvalues we will use the Jacobis method witch key concept is using unitary transformations of matrices to transform them in to diagonalized matrices. If we consider a basis vector $\mathbf{v}_i$;

$$\mathbf{v}_i = \begin{bmatrix} v_{i1} \\ \dots \\ \dots \\ v_{in} \end{bmatrix}$$

and assume it is orthogonal, that is

$$\mathbf{v}_j^T \mathbf{v}_i = \delta_{ij}$$

If we use unitary transformation on $\mathbf{v}_i$ we see that the dot product and orthogonality is preserved.

$$\mathbf{w}_i = \mathbf{U}\mathbf{v}_i$$

$$\mathbf{w}_j^T \mathbf{w}_i = (\mathbf{U}\mathbf{v}_j)^T \mathbf{U}\mathbf{v}_i$$

$$= \mathbf{v}_j^T (\mathbf{U}^T \mathbf{U}) \mathbf{v}_i = \mathbf{v}_j^T \mathbf{I} \mathbf{v}_i$$

$$\mathbf{w}_j^T \mathbf{w}_i = \mathbf{v}_j^T \mathbf{v}_i = \delta_{ij}$$

Where $\mathbf{U}$ is a unitary matrix, and $(\mathbf{U}^T\mathbf{U}) = \mathbf{I}$