Analytical Geometry and Linear Algebra II, Lab 5

Projection

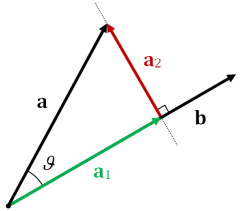
Application (Least Squares)

INNOPOLIS UNIVERSITY

Projection

Definition

The *vector projection* of a vector **a** on (or onto) a nonzero vector **b**, sometimes denoted $\text{proj}_{\mathbf{b}}\,\mathbf{a}$ is the orthogonal projection of **a** onto a straight line parallel to **b**.



Projection of **a** on **b** ($\mathbf{a}_1$), and rejection of **a** from **b** ($\mathbf{a}_2$)

Where it can be used:

- Maps
- Blueprints
- Fitting algorithms (Least squares)
- Reduce matrix dimention
- RL fitness functions

Projection 2D case from school

Proofing 2d case formula (we project “b” on “a1”)

$$e = b - ax \tag{1}$$

$$a_1 \cdot (b - a_1 x) = 0 \tag{2}$$

$$a_1^T (b - a_1 x) = 0 \tag{3}$$

$$a_1^T b = a_1^T a_1 x \tag{4}$$

$$\frac{a_1^T b}{a_1^T a_1} = x \text{ – classic formula from school} \tag{5}$$

Reference material

- Lecture 15 and 16
- *"Linear Algebra and Applications", pdf pages 181–204*
  Projections onto lines and Least squares
- The Least-Squares Problem
  Video from Matrix Algebra for Engineers course
- Matrix online calculator(russian)

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– Oleg Bulichev

o.bulichev@innopolis.ru

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Room 105 (Underground robotics lab)