Vector Dot Product Calculator

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REPORT SUBMITTED TO THE FACULTY OF COMPUTING, KARACHI INSTITUTE OF ECONOMICS AND TECHNOLOGY, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF SCIENCE IN COMPUTER SCIENCE

FALL 2024

1. Description

The provided Python program is a comprehensive and interactive tool designed to compute the dot product of two numerical vectors while ensuring user engagement and clarity in understanding the underlying calculations. The program begins by prompting the user to specify the size of the vectors, ensuring that the input is a valid positive integer through robust error handling. Following this, it collects the elements of the two vectors, **u** and **v**, with detailed prompts for each entry. The program validates every input, ensuring that only numeric values are accepted, and provides appropriate feedback in case of invalid entries, preventing runtime errors and enhancing user experience.

Once the vectors are fully defined, the program calculates the dot product by iterating through the elements of the vectors, performing element-wise multiplications, and summing the resulting products. Each step of the calculation is meticulously displayed, including the individual multiplications and the intermediate products, offering a clear visualization of how the final result is derived. The summation process is also presented step by step, further aiding users in understanding the computation.

Finally, the program outputs the dot product along with all intermediate calculations in a well-structured and formatted manner, making it ideal for both practical use and educational purposes. By offering detailed insights into the computation process, this tool serves as a valuable resource for students and educators alike, particularly in the context of learning vector operations in linear algebra. Additionally, its intuitive interface and robust error-handling mechanisms make it accessible to users with varying levels of programming expertise. This program not only simplifies the process of calculating the dot product but also fosters a deeper understanding of the mathematical principles involved, making it a versatile and reliable computational tool.

2. Code

```
def dot_product():
    # Get the size of the vectors
    while True:
        try:
            n = int(input("Enter the number of elements for vectors u and v: "))
            if n <= 0:
                print("Please enter a positive integer.")
                continue
            break
        except ValueError:
            print("Invalid input. Please enter a positive integer.")

    # Initialize the vectors
    u = []
    v = []

    print("\nEnter values for vector u:")
    for i in range(n):
        while True:
            try:
                value = float(input(f"u[{i+1}]: "))
                u.append(value)
                break
            except ValueError:
                print("Invalid input. Please enter a number.")

    print("\nEnter values for vector v:")
    for i in range(n):
        while True:
            try:
                value = float(input(f"v[{i+1}]: "))
                v.append(value)
                break
            except ValueError:
                print("Invalid input. Please enter a number.")

    # Calculate dot product and show detailed calculation
    dot_product_result = 0
```

```
    calculations = []
    products = []

    for i in range(n):
        product = u[i] * v[i]
        products.append(product)
        dot_product_result += product

calculations.append(f"u[{i+1}] * v[{i+1}] = {u[i]} * {v[i]} = {product}")

    # Display the calculations
    print("\nCalculations:")
    for calc in calculations:
        print(calc)

    # Display the addition of products
    print("\nAddition of products:")
    addition_steps = " + ".join([str(prod) for prod in products])
    print(f"{addition_steps} = {dot_product_result}")

    # Display the final result
    print(f"\nThe dot product of vectors u and v is: {dot_product_result}")

# Run the function
dot_product()
```