WHAT IS CLAIMED IS:

1. A method of operating a homomorphic ciphertext, the method comprising:

receiving a non-polynomial operation command with respect to a homomorphic ciphertext;

computing a second approximate polynomial function corresponding to the non-polynomial operation;

performing an operation of the homomorphic ciphertext using the computed polynomial function; and

outputting the operated homomorphic ciphertext,

wherein the computing the second approximate polynomial function comprises:

determining a first approximate polynomial to have a first range having a preset accuracy with the non-polynomial operation within the first range; and

determining the second approximate polynomial that has a value corresponding to a computation value of the first approximate polynomial in the first range within the first range, and has a value corresponding to a computation value of the first approximate polynomial in an end of the first range within the second range other than the first range.

2. The method of claim 1, wherein

the determining the second approximate polynomial comprises determining a number of iterations and a basic function based on the first range and the second range and iteratively composing the basic function and a scaling basic function corresponding to the basic function by the determined number of iterations to compute a second approximate polynomial.

3. The method of claim 1, wherein

the non-polynomial operation includes a logistic function,

the second range used for the logistic function is computed by Equation below:

$$C_{\alpha,d,t}=\sqrt{(\alpha^2(d+1)^2+0.6\alpha(d+1))t},$$

wherein $C_{\alpha,d,t}$ refers to an upper end value of a second range, α refers to a learning rate, d refers to a number of attributes of data, and t refers to a number of learning of logistic regression analysis.

4. The method of claim 1, wherein

the non-polynomial operation uses at least one function among the logistic function, a hypertangent function, an erf function, an arctangent function, a Gaussian function, or a ReLU-n function.

5. An operation device comprising:

a memory configured to store at least one instruction; and

a processor configured to execute the at least one instruction,

wherein the processor, by executing the at least one instruction, based on receiving a non-polynomial operation command with respect to a homomorphic ciphertext, determine a first approximate polynomial to have a first range having a preset accuracy with the non-polynomial operation within the first range, determine a second approximate polynomial that has a value corresponding to a computation value of the first approximate polynomial in the first range within the first range, and has a value corresponding to a computation value of the first approximate polynomial in an end of the first range within the second range other than the first range, , and performs an operation of the homomorphic ciphertext using the determined second polynomial function.

6. The operation device of claim 5, wherein

the processor determines a number of iterations and a basic function based on the first range and the second range and iteratively composes the basic function and a scaling basic function corresponding to the basic function by the determined number of iterations to compute a second approximate polynomial.

7. The operation device of claim 5, wherein

the non-polynomial operation includes a logistic function,

the second range used for the logistic function is computed by Equation below:

$$C_{\alpha,d,t}=\sqrt{(\alpha^2(d+1)^2+0.6\alpha(d+1))t},$$

wherein $C_{\alpha,d,t}$ refers to an upper end value of a second range, α refers to a learning rate, d refers to a number of attributes of data, and t refers to a number of learning of logistic regression analysis.

8. The operation device of claim 5, wherein

the non-polynomial operation uses at least one function among the logistic function, a hypertangent function, an erf function, an arctangent function, a Gaussian function, or a ReLU-n function.