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~~n~~ 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 approximate polynomial function is a second approximate polynomial function which is obtained by extending a first approximate polynomial function to have a second range wider than the first range having a preset accuracy with the non-polynomial operation within a first range.~~

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 computing the approximate polynomial function comprises:~~

~~determining the first approximate polynomial; and~~

~~computing 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.~~

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2~~3~~. The method of claim ~~2~~1, wherein

the determining~~computing~~ 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.

34. 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.

45. 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.

56. 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, ~~computes an approximate polynomial function corresponding to the non-polynomial operation~~, and performs an operation of the homomorphic ciphertext using the determined second~~computed~~ polynomial function.~~,~~

~~wherein the approximate polynomial function is a second approximate polynomial function which is obtained by extending a first approximate polynomial function to have a second range wider than the first range having a preset accuracy with the non polynomial~~

~~operation within a first range.~~

~~7. The operation device of claim 6, wherein~~

~~the processor determines the first approximate polynomial, and computes 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.~~

6~~8~~. The operation device of claim ~~7~~5~~6~~, 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~~9~~. The operation device of claim 5~~6~~, 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~~10~~. The operation device of claim 5~~6~~, 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.