

CLAIMS

What is claimed is:

- 5 1. A method of predicting performance in electronic design based on machine learning using at least one processor, the method comprising:

providing a first machine learning model configured to predict performance data for an electronic system based on a set of input design parameters for the electronic system;

- 10 providing a second machine learning model configured to generate a new set of parameter values for the set of input design parameters for the electronic system based on a desired performance data provided for the electronic system;

generating, using the second machine learning model, the new set of parameter values for the set of input design parameters for the electronic system based on the desired performance data provided for the electronic system;

- 15 evaluating the set of input design parameters having the new set of parameter values for the electronic system to obtain an evaluated performance data associated with the set of input design parameters having the new set of parameter values;

- 20 generating a new set of training data based on the set of input design parameters having the new set of parameter values and the evaluated performance data associated with the set of input design parameters having the new set of parameter values; and

training the first machine learning model based on at least the new set of training data;

- 25 wherein the first machine learning model is trained iteratively in a plurality of iterations, comprising a first iteration and one or more subsequent iterations,

wherein the first iteration comprises:

said providing the second machine learning model;

- 30 said generating the new set of parameter values for the set of input design parameters;

said evaluating the set of input design parameters having the new set of parameter values;

said generating the new set of training data; and

said training the first machine learning model based on at least the new set of training data,

wherein in each of the one or more subsequent iterations, the subsequent iteration comprises:

updating the second machine learning model based on the first machine learning model trained in the immediately previous iteration to obtain an updated second machine learning model;

generating, using the updated second machine learning model, a further new set of parameter values for the set of input design parameters for the electronic system based on the desired performance data provided for the electronic system;

evaluating the set of input design parameters having the further new set of parameter values for the electronic system to obtain a further evaluated performance data associated with the set of input design parameters having the further new set of parameter values;

generating a further new set of training data based on the set of input design parameters having the further new set of parameter values and the further evaluated performance data associated with the set of input design parameters having the further new set of parameter values; and

training the first machine learning model based on at least the further new set of training data.

2. The method according to claim 1, wherein said providing the first machine learning model comprises training the first machine learning model based on an initial set of training data for the electronic system.

3. The method according to claim 1, wherein said providing the second machine learning model comprises generating the second machine learning model based on the first machine learning model.

5 4. The method according to claim 1, wherein said evaluating the set of input design parameters having the new set of parameter values comprises evaluating the set of input design parameters having the new set of parameter values using an electronic design automation tool.

10 5. The method according to claim 1, wherein said generating the new set of training data comprises labeling the set of input design parameters having the new set of parameter values based on the evaluated performance data to obtain a new set of labeled data, the new set of training data comprising the new set of labeled data.

15 ~~6. The method according to claim 1,~~
~~wherein the first machine learning model is trained iteratively in a plurality~~
~~of iterations, comprising a first iteration and one or more subsequent iterations,~~
~~wherein the first iteration comprises:~~
~~said providing the second machine learning model;~~
20 ~~said generating the new set of parameter values for the set of input~~
~~design parameters;~~
~~said evaluating the set of input design parameters having the new set~~
~~of parameter values;~~
~~said generating the new set of training data; and~~
25 ~~said training the first machine learning model based on at least the new set~~
~~of training data,~~
~~wherein in each of the one or more subsequent iterations, the subsequent iteration~~
~~comprises:~~
~~updating the second machine learning model based on the first machine~~
30 ~~learning model trained in the immediately previous iteration to obtain an updated~~
~~second machine learning model;~~

~~generating, using the updated second machine learning model, a further new set of parameter values for the set of input design parameters for the electronic system based on the desired performance data provided for the electronic system;~~
~~evaluating the set of input design parameters having the further new set of parameter values for the electronic system to obtain a further evaluated performance data associated with the set of input design parameters having the further new set of parameter values;~~
~~generating a further new set of training data based on the set of input design parameters having the further new set of parameter values and the further evaluated performance data associated with the set of input design parameters having the further new set of parameter values; and~~
~~training the first machine learning model based on at least the further new set of training data.~~

76. The method according to claim 61, wherein the first machine learning model is trained iteratively and continues from a current iteration to a subsequent iteration of the plurality of iteration until the further new set of parameter values for the set of input design parameters obtained in the current iteration is evaluated to satisfy the desired performance data.

87. The method according to claim 1, wherein the first machine learning model is a forward machine learning model and the second machine learning model is an inverse machine learning model.

98. The method according to claim 1, wherein the performance data and the desired performance data each comprises a set of performance parameters.

109. The method according to claim 1, wherein the electronic system comprises at least one of an integrated circuit and a printed circuit board.

10. A system for predicting performance in electronic design based on machine learning, the system comprising:

a memory; and

at least one processor communicatively coupled to the memory and configured to:

provide a first machine learning model configured to predict performance data for an electronic system based on a set of input design parameters for the electronic system;

provide a second machine learning model configured to generate a new set of parameter values for the set of input design parameters for the electronic system based on a desired performance data provided for the electronic system;

generate, using the second machine learning model, the new set of parameter values for the set of input design parameters for the electronic system based on the desired performance data provided for the electronic system;

evaluate the set of input design parameters having the new set of parameter values for the electronic system to obtain an evaluated performance data associated with the set of input design parameters having the new set of parameter values;

generate a new set of training data based on the set of input design parameters having the new set of parameter values and the evaluated performance data associated with the set of input design parameters having the new set of parameter values; and

train the first machine learning model based on at least the new set of training data;

wherein the first machine learning model is trained iteratively in a plurality of iterations, comprising a first iteration and one or more subsequent iterations,

wherein the first iteration comprises:

said providing the second machine learning model;

said generating the new set of parameter values for the set of input design parameters;

said evaluating the set of input design parameters having the new set of parameter values;

said generating the new set of training data; and
 said training the first machine learning model based on at least the
 new set of training data,
 wherein in each of the one or more subsequent iterations, the subsequent
 iteration comprises:
 updating the second machine learning model based on the first
 machine learning model trained in the immediately previous iteration to
 obtain an updated second machine learning model;
 generating, using the updated second machine learning model, a
 further new set of parameter values for the set of input design parameters
 for the electronic system based on the desired performance data provided
 for the electronic system;
 evaluating the set of input design parameters having the further new
 set of parameter values for the electronic system to obtain a further
 evaluated performance data associated with the set of input design
 parameters having the further new set of parameter values;
 generating a further new set of training data based on the set of input
 design parameters having the further new set of parameter values and the
 further evaluated performance data associated with the set of input design
 parameters having the further new set of parameter values; and
 training the first machine learning model based on at least the further
 new set of training data.

~~12~~11. The system according to claim ~~11~~10, wherein said provide the first machine
 learning model comprises training the first machine learning model based on an
 initial set of training data for the electronic system.

~~13~~12. The system according to claim ~~11~~10, wherein said provide the second machine
 learning model comprises generating the second machine learning model based on
 the first machine learning model.

~~13~~13. The system according to claim ~~11~~10, wherein said evaluate the set of input design parameters having the new set of parameter values comprises evaluating the set of input design parameters having the new set of parameter values using an electronic design automation tool.

5

~~14~~14. The system according to claim ~~11~~10, wherein said generate the new set of training data comprises labeling the set of input design parameters having the new set of parameter values based on the evaluated performance data to obtain a new set of labeled data, the new set of training data comprising the new set of labeled data.

10

~~16~~. The system according to claim ~~11~~,

~~wherein the first machine learning model is trained iteratively in a plurality of iterations, comprising a first iteration and one or more subsequent iterations,~~

~~wherein the first iteration comprises:~~

15

~~said providing the second machine learning model;~~

~~said generating the new set of parameter values for the set of input design parameters;~~

~~said evaluating the set of input design parameters having the new set of parameter values;~~

20

~~said generating the new set of training data; and~~

~~said training the first machine learning model based on at least the new set of training data,~~

~~wherein in each of the one or more subsequent iterations, the subsequent iteration comprises:~~

25

~~updating the second machine learning model based on the first machine learning model trained in the immediately previous iteration to obtain an updated second machine learning model;~~

~~generating, using the updated second machine learning model, a further new set of parameter values for the set of input design parameters for the electronic system based on the desired performance data provided for the electronic system;~~

30

~~evaluating the set of input design parameters having the further new set of parameter values for the electronic system to obtain a further evaluated performance data associated with the set of input design parameters having the further new set of parameter values;~~
 5 ~~generating a further new set of training data based on the set of input design parameters having the further new set of parameter values and the further evaluated performance data associated with the set of input design parameters having the further new set of parameter values; and~~
 10 ~~training the first machine learning model based on at least the further new set of training data.~~

15 ~~15.~~ The system according to claim ~~46~~10, wherein the first machine learning model is trained iteratively and continues from a current iteration to a subsequent iteration of the plurality of iteration until the further new set of parameter values for the set of input design parameters obtained in the current iteration is evaluated to satisfy the desired performance data.

20 ~~16.~~ The system according to claim ~~44~~10, wherein the first machine learning model is a forward machine learning model and the second machine learning model is an inverse machine learning model.

25 ~~17.~~ The system according to claim ~~44~~10, wherein the electronic system comprises at least one of an integrated circuit and a printed circuit board.

20. ~~A computer program product, embodied in one or more non-transitory computer-readable storage mediums, comprising instructions executable by at least one processor to perform a method of predicting performance in electronic design based on machine learning, the method comprising:~~

- 5 ~~providing a first machine learning model configured to predict performance data for an electronic system based on a set of input design parameters for the electronic system;~~
- ~~providing a second machine learning model configured to generate a new set of parameter values for the set of input design parameters for the electronic system based on a desired performance data provided for the electronic system;~~
- ~~generating, using the second machine learning model, the new set of parameter values for the set of input design parameters for the electronic system based on the desired performance data provided for the electronic system;~~
- 10 ~~evaluating the set of input design parameters having the new set of parameter values for the electronic system to obtain an evaluated performance data associated with the set of input design parameters having the new set of parameter values;~~
- ~~generating a new set of training data based on the set of input design parameters having the new set of parameter values and the evaluated performance data associated with the new set of input design parameters having the new set of parameter values; and~~
- 15 ~~training the first machine learning model based on at least the new set of training data.~~