

## **MACHINE FOR DEVELOPMENT OF ANALYTICAL MODELS**

### **Cross-Reference to Related Applications**

**[001]** This application claims priority to U.S. Application No. 14/971,982, filed December 16, 2015, and titled "MACHINE FOR DEVELOPMENT OF ANALYTICAL MODELS MACHINE FOR DEVELOPMENT OF ANALYTICAL MODELS." This application is also related to U.S. Application No. 14/971,987, filed December 16, 2015, and titled "MACHINE FOR DEVELOPMENT AND DEPLOYMENT OF ANALYTICAL MODELS," the contents of which is hereby incorporated by reference in its entirety.

### **Technical Field**

**[002]** This disclosure relates to machines and complex system architectures for building and/or deploying analytical models.

### **Background**

**[003]** The field of data science, and more particularly, the development and implementation of analytical models, has typically required strong computer and processing system skills and familiarity with data science. These specialized skills were needed to develop, setup, and program model algorithms and to access and prepare data so that the data was effective for training the model, and so that running the model on the data would give meaningful results. These complex technical challenges have traditionally left scientists and engineers with the daunting task of building and implementing analytical models that are useful in their engineering and scientific fields. That is, analytical modeling is typically a field in which scientists and engineers have less familiarity, and which in any event is tangential to their primary goal of extracting insights from data.

**[004]** Additionally, creating accurate analytical models is often an experimental process requiring multiple iterative cycles of hypothesis testing. The iterative cycles can each take significant time to setup and/or complete (e.g., days or months). The extended creation, setup, and/or training process hinders development of additional analytical models and analytical models of higher accuracy.

## Summary

[004a] According to a first aspect of the present invention, there is provided a machine comprising: a communication interface operable to communicate with a compute engine; a memory system configured to store: a pre-defined analytical model; coefficients for the pre-defined analytical model; and pre-determined compatibility requirements; and model deployment circuitry coupled to the communication interface and the memory system, the model deployment circuitry configured to: access the pre-defined analytical model in the memory system; access the coefficients for the pre-defined analytical model from the memory system; determine a model code type of the pre-defined analytical model; verify that the pre-defined analytical model conforms to the pre-determined compatibility requirements applicable to the model code type; determine a compatible run time environment for the model code type from among multiple available run time environments; and deploy the pre-defined analytical model with the set of coefficients through the communication interface to the compatible run time environment on the compute engine.

[004b] According to a second aspect of the present invention, there is provided a method comprising: accessing, by model deployment circuitry, an pre-defined analytical model stored in a memory system; accessing, by the model deployment circuitry, coefficients for the pre-defined analytical model stored in the memory system; determining, by the model deployment circuitry, a model code type of the pre-defined analytical model; verifying, by the model deployment circuitry, that the pre-defined analytical model conforms to pre-determined compatibility requirements applicable to the model code type, the pre-determined compatibility requirements stored in the memory system; determining, by the model deployment circuitry, a compatible run time environment for the model code type from among multiple available run time environments; and deploying, by the model deployment circuitry, the pre-defined analytical model with the set of coefficients through a communication interface to the compatible run time environment on a compute engine.

[004c] According to a third aspect of the present invention, there is provided a machine comprising: a communication interface operable to communicate with a compute engine; a memory system configured to store: a first pre-defined analytical

model; first coefficients for the first pre-defined analytical model; a second pre-defined analytical model; second coefficients for the second pre-defined analytical model; and pre-determined compatibility requirements; and model deployment circuitry coupled to the communication interface and the memory system, the model deployment circuitry configured to: access the first pre-defined analytical model and the first coefficients from the memory system; determine a first model code type of the first pre-defined analytical model; determine a first compatible run time environment for the first model code type from among multiple available run time environments; access the second pre-defined analytical model and the second coefficients from the memory system; determine a second model code type of the second pre-defined analytical model, the second model code type being different from the first model code type; determine a second compatible run time environment for the second model code type from among the multiple available run time environments, the second compatible run time environment being different from the first compatible run time environment; deploy the first pre-defined analytical model with the first coefficients through the communication interface to the first compatible run time environment on the compute engine; and deploy the second pre-defined analytical model with the second coefficients through the communication interface to the second compatible run time environment on the compute engine.

## Claims

### What is claimed is:

1. A machine comprising:

a communication interface operable to communicate with a compute engine;

a memory system configured to store:

a pre-defined analytical model;

coefficients for the pre-defined analytical model; and

pre-determined compatibility requirements; and

model deployment circuitry coupled to the communication interface and the memory system, the model deployment circuitry configured to:

access the pre-defined analytical model in the memory system;

access the coefficients for the pre-defined analytical model from the memory system;

determine a model code type of the pre-defined analytical model;

verify that the pre-defined analytical model conforms to the pre-determined compatibility requirements applicable to the model code type;

determine a compatible run time environment for the model code type from among multiple available run time environments; and

deploy the pre-defined analytical model with the set of coefficients through the communication interface to the compatible run time environment on the compute engine.

2. The machine according to claim 1, wherein the model deployment circuitry is configured to deploy the pre-defined analytical model by submitting a command-line argument, via the communication interface, to an application program interface (API) of the compatible run time environment.

3. The machine according to claim 1 or claim 2, wherein the model deployment circuitry is configured to receive, via the communication interface, an application program interface (API) instruction to verify or deploy the pre-defined analytical model, or both.

4. The machine according to claim 3, wherein the model deployment circuitry is further configured to convert the API instruction into a command-line argument for an API of

the compatible run time environment.

5. The machine according to any one of the preceding claims, wherein the model deployment circuitry is further configured to provide a status of the pre-defined analytical model via the communication interface.

6. The machine according to any one of the preceding claims, wherein the model deployment circuitry is further configured to verify that the pre-defined analytical model in combination with the coefficients conform to the pre-determined compatibility requirements applicable to the model code type by determining that the code bundle includes all necessary dependencies required for the model code type.

7. The machine according to claim 6, wherein the model deployment circuitry is further configured to determine that the dependencies within the code bundle do not conflict.

8. The machine according to any one of the preceding claims, wherein the model deployment circuitry is further configured to:

- receive an execution schedule, via the communication interface; and
- schedule an execution of the pre-defined analytical model by the compatible run time environment according to the execution schedule.

9. The machine according to any one of the preceding claims, wherein the model deployment circuitry is further configured to:

- compare a first error rate of the pre-defined analytical model deployed on compatible run time environment with a second error rate of a second pre-defined analytical model;

- determine that the second error rate is lower than the first error rate; and
- undeploy the first pre-defined analytical model and deploy the second pre-defined analytical model on a run time environment in response to determining that the second error rate is lower than the first error rate.

10. The machine according to any one of the preceding claims, wherein the model deployment circuitry is further configured to:

- monitor an output log file updated by the compatible run time environment of the compute engine for results of execution of the pre-defined analytical model.

11. A method comprising:

- accessing, by model deployment circuitry, an pre-defined analytical model stored in a memory system;

- accessing, by the model deployment circuitry, coefficients for the pre-defined analytical model stored in the memory system;

- determining, by the model deployment circuitry, a model code type of the pre-defined analytical model;

- verifying, by the model deployment circuitry, that the pre-defined analytical model conforms to pre-determined compatibility requirements applicable to the model code type, the pre-determined compatibility requirements stored in the memory system;

- determining, by the model deployment circuitry, a compatible run time environment for the model code type from among multiple available run time environments; and

- deploying, by the model deployment circuitry, the pre-defined analytical model with the set of coefficients through a communication interface to the compatible run time environment on a compute engine.

12. The method according to claim 11, further comprising receiving, via the communication interface, the pre-defined analytical model from a client device.

13. The method according to either claim 11 or claim 12, further comprising receiving, via the communication interface, an application program interface (API) instruction to verify or deploy the pre-defined analytical model, or both.

14. The method according to claim 13, further comprising converting, by the model deployment circuitry, the API instruction into a command-line argument for an API of the compatible run time environment.

15. The method according to any one of claims 11 to 14, further comprising providing, by the model deployment circuitry, a status of the pre-defined analytical model via the communication interface.

16. The method according to any one of claims 11 to 15, further wherein verifying that the pre-defined analytical model in combination with the coefficients conform to the pre-determined compatibility requirements applicable to the model code type further comprises determining, by the model deployment circuitry, that the pre-defined analytical model includes all necessary dependencies required for the model code type.

17. The method according to claim 16, further comprising determining, by the model deployment circuitry, that the dependencies within the pre-defined analytical model do not conflict.

18. The method according to any one of claims 11 to 17, further comprising:

- receiving an execution schedule via the communication interface from a client device; and

- scheduling, by the model deployment circuitry, an execution of the pre-defined analytical model by the compatible run time environment according to the execution schedule.

19. The machine according to claim 10 further comprising:

- comparing, by the model deployment circuitry, a first error rate of the pre-defined analytical model deployed on the compatible run time environment with a second error rate of a second pre-defined analytical model;

- determining, by the model deployment circuitry, that the second error rate is lower than the first error rate; and

- undeploying the first pre-defined analytical model and deploying the second pre-defined analytical model on a run time environment in response to determining that the second error rate is lower than the first error rate.

20. A machine comprising:

- a communication interface operable to communicate with a compute engine;

- a memory system configured to store:

- a first pre-defined analytical model;

- first coefficients for the first pre-defined analytical model;

- a second pre-defined analytical model;

- second coefficients for the second pre-defined analytical model; and