CLAIMS

1. A method for fabricating an analogue quantum system comprising an array of quantum dots, the method comprising:

identifying one or more measurement methods to obtain a solution for a computational problem;

generating a Hamiltonian based on the computational problem in respect of which the solution is sought using the one or more identified measurement methods;

identifying analogue quantum system fabrication parameters for the analogue quantum system based on the one or more identified measurement methods and the Hamiltonian; and

fabricating the analogue quantum system based on the identified analogue quantum system fabrication parameters.

2. The method of claim 1, wherein the one or more measurement methods is selected from a list comprising at least one of:

measuring ground state energy of the array of quantum dots of the analogue quantum system;

measuring electron transmission probability between source and drain leads of the analogue quantum system;

measuring a voltage and/or capacitance across the array of quantum dots of the analogue quantum system using a four-point probe measurement; or

measuring electron occupation in one or more quantum dots of the array of quantum dots of the analogue quantum system.

3. The method of claim 2, wherein measuring ground state energy of the array of quantum dots comprises identifying an energy gap between adjacent measured conduction peaks.

4. The method of claim 2, wherein measuring the electron transmission probability

comprises identifying a height of measured conduction peaks.

5. The method of any one of claims 1 to 4, wherein the system fabrication parameters include at least one of:

number of control gates of the analogue quantum system;

number of source leads of the analogue quantum system;

number of drain leads of the analogue quantum system;

number of charge sensors of the analogue quantum system;

dimensionality of the analogue quantum system;

number and/or geometry of the quantum dots in the array of quantum dots of the analogue quantum system;

separation between adjacent quantum dots in the array of quantum dots of the analogue quantum system;

temperature of the analogue quantum system; or

detuning of the analogue quantum system.

6. The method of any one of claims 1-5, wherein:

the array of quantum dots comprise a first quantum dot array and a second quantum dot array;

the computational problem is simulating a battery; and

the selected measurement method is measuring a voltage and/or capacitance between the first quantum dot array and the second quantum dot array using a four-point probe measurement.

7. The method of any one of claims 1-5, wherein:

the array of quantum dots comprise a first quantum dot array and a second quantum dot array;

the computational problem is simulating at least one interface; and

the selected measurement method is measuring a voltage and/or capacitance between the at least one interface between the first quantum dot array and the second quantum dot array using a four-point probe measurement; and

fabricating the analogue quantum system based on the identified system fabrication parameters.

8. The method of any one of claims 1-7, wherein fabricating the analogue quantum system comprises:

preparing a bulk layer of a semiconductor substrate;

exposing a clean crystal surface of the semiconductor layer to dopant molecules to produce the array of quantum dots on the exposed surface;

annealing the arrayed surface to incorporate the array of quantum dots into the semiconductor layer; and

forming one or more control gates, source and drain leads.

9. The method of claim 8, wherein the one or more control gates are formed in a same plane as the array of quantum dots.

10. The method of claim 8, further comprising depositing a dielectric material above the annealed second semiconductor layer, wherein the one or more control gates are formed above the dielectric material, and wherein the one or more control gates vary the electrochemical potentials of one or more quantum dots of the array of quantum dots and/or tunnel couplings between two or more of the quantum dots of the array of quantum dots.

11. The method of claim 8, further comprising forming one or more charge sensors in the analogue quantum system to sense the charge of one or more of the quantum dots of the array of quantum dots or to measure electron occupation in one or more of the quantum dots of the array of quantum dots.

12. The method of any one of claims 1-5, further comprising solving the computational problem, wherein solving the computational problem comprises:

providing the analogue quantum system comprising:

the array of quantum dots simulating a Fermi-Hubbard model,

a plurality of control gates to vary the Hubbard Hamiltonian parameters, and

one or more source and drain leads to measure the current through the array of quantum dots;

applying a selected measurement method to measure one or more properties of the analogue quantum system; and

interpreting the measured one or more properties of the analogue quantum system to determine a solution to the computational problem.

13. The method of claim 12, wherein the computational problem is a simulation problem or an optimization problem.

14. The method of claim 12, wherein:

the computational problem is simulating a battery,

the analogue quantum system comprises at least two arrays of quantum dots simulating the Fermi-Hubbard model,

applying the selected measurement method comprises measuring a voltage and/or capacitance, using a four-point probe measurement, between the first quantum dot array and the second quantum dot array; and

interpreting the measured one or more properties comprises interpreting the measured voltage and/or capacitance of the analogue quantum system.

15. The method of claim 12, wherein:

the computational problem is simulating at least one interface,

the analogue quantum system comprises:

at least two arrays of quantum dots simulating the Fermi-Hubbard model,

an interface defined between the at least two arrays of quantum dots;

applying the selected measurement method comprises applying a four-point probe measurement to measure a voltage and/or capacitance across the interface; and

interpreting the measured one or more properties comprises interpreting the measured voltage and/or capacitance of the analogue quantum system to determine a solution to simulating the at least one interface.

16. The method of any one of claims 12-15, wherein the plurality of control gates vary the electrochemical potentials of the quantum dots and/or tunnel couplings between the quantum dots.

17. The method of any one of claims 12-16, wherein the analogue quantum system includes at least one charge sensor to measure the electron occupation in one or more quantum dots of the array.

18. The method of any one of claims 12-17, wherein the array of quantum dots are donor-doped silicon quantum dots.

19. The method of any one of claims 12-18, wherein the array of quantum dots is fabricated using scanning tunneling microscopy.