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United States Patent	12387618
Kind Code	B2
Date of Patent	August 12, 2025
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Information processing apparatus, storage medium and information processing method

Abstract

An information processing apparatus includes a processor that executes a program stored in a storage and generates scoring criterion information. The scoring criterion information is referenced in a scoring process of an answer figure to a problem that requires drawing of a figure in a Cartesian coordinate system. The Cartesian coordinate system is a coordinate plane or a coordinate space. In response to a reference figure being drawn in the Cartesian coordinate system based on a user operation, the scoring criterion information including information on a scoring criterion determined based on the reference figure is generated. The Cartesian coordinate system is displayed on a display.

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Appl. No.:	**17/748447**
Filed:	**May 19, 2022**

Prior Publication Data

Document Identifier	Publication Date
US 20220375360 A1	Nov. 24, 2022

Foreign Application Priority Data

JP	2021-086126	May. 21, 2021

Publication Classification

Int. Cl.:   **G09B7/02** (20060101); **G06T11/20** (20060101)

U.S. Cl.:

CPC   **G09B7/02** (20130101); **G06T11/203** (20130101); **G06T11/206** (20130101);

Field of Classification Search

CPC: G09B (5/00); G09B (5/08); G09B (7/00); G09B (7/02)

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

(1) This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2021-086126 filed May 21, 2021, the entire content of which is incorporated herein by reference.

BACKGROUND

Technical Field

(2) The present disclosure relates to an information processing apparatus, a storage medium and an information processing method.

Description of Related Art

(3) As disclosed in JP 2006-251203 A, in recent years, use of CBT (Computer Based Testing), in which questions (problems) are answered on computers, has been increasing for tests at school, various qualifying examinations and so forth. In CBT, answers are obtained in the form of electronic data. Hence, use of an automatic scoring technique with computers can improve scoring precision and reduce burdens of scorers (markers).

(4) Regarding problems that require drawing of figures, such as graphs, on coordinate planes, a restriction has been imposed on the degree of freedom of drawing in answering, thereby realizing automatic scoring with simple scoring criteria. For example, in an answering method of selecting two points on a coordinate plane, thereby automatically drawing a straight line that connects the two points, a snap technique that limits selectable points to integer coordinates is used. This enables automatic scoring with a simple scoring criterion according to which an answer is connect if coordinates of the answer and coordinates of a correct answer (model answer) exactly match.

(5) However, the imposition of the restriction on the degree of freedom in answering cannot always measure examinees' understandings of problems effectively.

(6) Meanwhile, in order to increase the degree of freedom in answering, a scoring criterion(s) representing a correct answer range, in which answers are determined to be correct, needs to be set in advance so that answer figures approximate to a model answer are determined to be correct. If, in setting such a scoring criterion(s), a conventional method of specifying a range on a coordinate plane by a user specifying numerical values is used, an error is likely to occur, and also it is troublesome.

SUMMARY

(7) According to an aspect of the present disclosure, there is provided an information processing apparatus including: a processor that executes a program stored in a storage, and generates scoring criterion information that is referenced in a scoring process of an answer figure to a problem that requires drawing of a figure in a Cartesian coordinate system that is a coordinate plane or a coordinate space, wherein in response to a reference figure being drawn in the Cartesian coordinate system based on a user operation, the Cartesian coordinate system being displayed on a display, the scoring criterion information including information on a scoring criterion determined based on the reference figure is generated.

(8) According to another aspect of the present disclosure, there is provided a non-transitory computer-readable storage medium storing a program that causes a processor of an information processing apparatus to generate scoring criterion information that is referenced in a scoring process of an answer figure to a problem that requires drawing of a figure in a Cartesian coordinate system that is a coordinate plane or a coordinate space, wherein in response to a reference figure being drawn in the Cartesian coordinate system based on a user operation, the Cartesian coordinate system being displayed on a display, the scoring criterion information including information on a scoring criterion determined based on the reference figure is generated.

(9) According to another aspect of the present disclosure, there is provided an information processing method that is performed by a computer, including: generating scoring criterion information that is referenced in a scoring process of an answer figure to a problem that requires

drawing of a figure in a Cartesian coordinate system that is a coordinate plane or a coordinate space, wherein in response to a reference figure being drawn in the Cartesian coordinate system based on a user operation, the Cartesian coordinate system being displayed on a display, the scoring criterion information including information on a scoring criterion determined based on the reference figure is generated.

Description

BRIEF DESCRIPTION OF DRAWINGS
(1) The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments, and together with the general description given above and the detailed description of the embodiments given below, serve to explain the principles of the present disclosure, wherein:
(2) FIG. **1** shows a schematic configuration diagram of a scoring system;
(3) FIG. **2** is a block diagram showing a functional configuration of a scoring server;
(4) FIG. **3** is a block diagram showing a functional configuration of a client terminal;
(5) FIG. **4** is a block diagram showing a functional configuration of a client server;
(6) FIG. **5** is a sequence diagram to explain a scoring criterion generation process;
(7) FIG. **6** shows an example of a scoring criterion setting screen;
(8) FIG. **7** shows examples of contents of scoring criterion data;
(9) FIG. **8** is a sequence diagram to explain a scoring process;
(10) FIG. **9** shows a reference figure setting screen according to a first example;
(11) FIG. **10** shows an example of the scoring criterion setting screen reflecting the contents of the reference figure setting screen shown in FIG. **9**;
(12) FIG. **11** shows another example of the scoring criterion setting screen reflecting the contents of the reference figure setting screen shown in FIG. **9**;
(13) FIG. **12** shows the reference figure setting screen according to a second example;
(14) FIG. **13** is an illustration to explain a determination region setting method;
(15) FIG. **14** is an illustration to explain the determination region setting method;
(16) FIG. **15** shows an example of the scoring criterion setting screen reflecting the contents of the reference figure setting screen shown in FIG. **14**;
(17) FIG. **16** shows the reference figure setting screen according to a third example;
(18) FIG. **17** shows an example of the scoring criterion setting screen reflecting the contents of the reference figure setting screen shown in FIG. **16**;
(19) FIG. **18** shows the reference figure setting screen according to a fourth example;
(20) FIG. **19** shows an example of the scoring criterion setting screen reflecting the contents of the reference figure setting screen shown in FIG. **18**;
(21) FIG. **20** shows an example of the reference figure setting screen according to a fifth example;
(22) FIG. **21** shows another example of the reference figure setting screen according to the fifth example; and
(23) FIG. **22** shows another example of the reference figure setting screen according to the fifth example.
DETAILED DESCRIPTION
(24) Hereinafter, one or more embodiments of the present disclosure will be described with reference to the drawings.
(25) <Configuration of Scoring System>
(26) FIG. **1** is a schematic configuration diagram of a scoring system **1** according to an embodiment(s).
(27) The scoring system **1** includes a scoring server **10** (information processing apparatus), a client

terminal **20** and a client server **30**. The scoring server **10**, the client terminal **20** and the client server **30** are connected to one another via a communication network N to perform information communications. The communication network N is, for example, the Internet, but not limited thereto and may be another network, such as a LAN (Local Area Network).

(28) The scoring system **1** is a computer system that provides automatic scoring services in CBT. The scoring system **1** of this embodiment can perform automatic scoring of answers to problems (questions) that each require drawing of a figure(s) in a Cartesian coordinate system that is a coordinate plane. The scoring system **1** may also be able to perform automatic scoring of answers to problems in other formats (e.g., problem that requires selection of a correct answer from multiple choices, problem that requires input of a numerical value as an answer, etc.). In response to a request from the client terminal **20**, the scoring server **10** of the scoring system generates scoring criterion data **332** (scoring criterion information) (shown in FIG. **4**) including information on a scoring criterion(s) for a problem and sends it to the client server **30** (scoring criterion generation process). Further, in response to a call for an automatic scoring API from the client server **30**, the scoring server **10** determines a score of an answer figure to a problem and sends scoring result data **335** including information on a scoring result to the client server **30** (scoring process). In the scoring process, the scoring server **10** references the scoring criterion included in the scoring criterion data **332**. Details of these processes will be described later.

(29) <Configuration of Scoring Server>

(30) FIG. **2** is a block diagram showing a functional configuration of the scoring server **10**. The scoring server **10** includes a CPU (Central Processing Unit) **11**, a RAM (Random Access Memory) **12**, a storage **13**, an operation unit **14**, a display **15**, a communication unit **16** and a bus **17**. The components of the scoring server **10** are connected to one another via the bus **17**.

(31) The CPU **11** is a processor that controls operation of the components of the scoring server **10**. The CPU **11** reads a scoring criterion generation program **131**, a scoring program **132** or the like among various programs stored in the storage **13**, loads the read program to a work area of the RAM **12**, and performs a process among various processes in accordance with the loaded program. For example, the CPU **11** executes the scoring criterion generation program **131** to provide the client terminal **20** with a UI (User Interface) for generating scoring criteria, and also generate scoring criterion data **332** based on user operations at the client terminal **20** and send it to the client server **30**. Further, when the automatic scoring API is called in response to a call from the client server **30**, the CPU **11** executes the scoring program **132** to determine a score of an answer, generate scoring result data **335** and send it to the client server **30**. The scoring server **10** may have two or more processors (e.g., two or more CPUs), and these processors may perform processes that the CPU **11** of this embodiment performs. In this case, the processors may be involved in each process, or may independently perform different processes in parallel.

(32) The RAM **12** provides the CPU **11** with a memory space for working, and stores temporary data. The RAM **12** may include a nonvolatile memory.

(33) The storage **13** is a non-transitory computer-readable storage medium that stores programs, data and so forth readable by the CPU **11** as a computer, and is configured by an HDD (Hard Disk Drive), an SSD (Solid State Drive) or the like. The storage **13** stores programs that are executed by the CPU **11**, such as the scoring criterion generation program **131** and the scoring program **132**, data that is referenced in execution of the programs, and so forth. The programs are stored in the storage **13** in the form of computer-readable program codes.

(34) The operation unit **14** includes a pointing device, such as a mouse, and a keyboard, and receives user's point inputs, key inputs and so forth, and outputs information on these operations to the CPU **11**.

(35) The display **15** includes a display device, such as a liquid crystal display, and displays various kinds of information on the display device in accordance with display control signals from the CPU **11**.

(36) The communication unit **16** includes a router and a network card. Via the communication unit **16**, the CPU **11** sends and receives data to and from the client terminal **20** and the client server **30** on the communication network N by communication connection therewith.

(37) <Configuration of Client Terminal>

(38) FIG. **3** is a block diagram showing a functional configuration of the client terminal **20**.

(39) The client terminal **20** is a computer device that is used by a user who uses services of the scoring system **1** (e.g., teacher who manages student answers and scoring results thereof). The client terminal **20** is, for example, a laptop PC (Personal Computer), a desktop PC, a tablet terminal, a smartphone or the like. The client terminal **20** requests, on a browser **231**, the scoring server **10** and the client server **30** to perform various processes in accordance with input operations made by the user, and displays, on a display **25**, process results sent from the scoring server **10** and so forth.

(40) The client terminal **20** includes a CPU **21**, a RAM **22**, a storage **23**, an operation unit **24**, a display **25**, a communication unit **26** and a bus **27**. The components of the client terminal **20** are connected to one another via the bus **27**.

(41) The CPU **21** is a processor that controls operation of the components of the client terminal **20**. The CPU **21** reads a program, such as the browser **231**, among various programs stored in the storage **23**, loads the read program to a work area of the RAM **22**, and performs a process among various processes in accordance with the loaded program.

(42) The RAM **22** provides the CPU **21** with a memory space for working, and stores temporary data. The RAM **22** may include a nonvolatile memory.

(43) The storage **23** is a non-transitory computer-readable storage medium that stores programs, data and so forth readable by the CPU **21** as a computer, and is configured by an HDD, an SSD or the like. The storage **23** stores programs that are executed by the CPU **21**, such as the browser **231**, data that is referenced in execution of the programs, and so forth. The programs are stored in the storage **23** in the form of computer-readable program codes. The browser **231** is a program to display, on the display **25**, execution results of various programs sent from the scoring server **10** and the client server **30**, information on web pages on the Internet, and so forth.

(44) The operation unit **24**, the display **25** and the communication unit **26** are respectively the same as the operation unit **14**, the display **15** and the communication unit **16** of the scoring server **10** in configuration, and hence their descriptions will be omitted.

(45) <Configuration of Client Server>

(46) FIG. **4** is a block diagram showing a functional configuration of the client server **30**.

(47) The client server **30** is a computer device that stores data (e.g., scoring criterion data for each problem, answer data, scoring result data, etc.) managed by the user who uses services of the scoring system **1**, and also stores and executes an automatic scoring script(s) generated by the user.

(48) The client server **30** includes a CPU **31**, a RAM **32**, a storage **33**, an operation unit **34**, a display **35**, a communication unit **36** and a bus **37**. The components of the client server **30** are connected to one another via the bus **37**.

(49) The CPU **31** is a processor that controls operation of the components of the client server **30**. The CPU **31** reads a program, such as an automatic scoring script **331**, among various programs stored in the storage **33**, loads the read program to a work area of the RAM **32**, and performs a process among various processes in accordance with the loaded program. For example, the CPU **31** executes the automatic scoring script **331** to call the automatic scoring API of the scoring server **10** with individual data for scoring **334** as arguments, thereby causing the scoring server **10** to generate scoring result data **335**, and obtains the scoring result data **335**. In this specification, programs include scripts that are executable without being compiled.

(50) The RAM **32** provides the CPU **31** with a memory space for working, and stores temporary data. The RAM **32** may include a nonvolatile memory.

(51) The storage **33** is a non-transitory computer-readable storage medium that stores programs,

data and so forth readable by the CPU **31** as a computer, and is configured by an HDD, an SSD or the like. The storage **33** stores programs that are executed by the CPU **31**, such as the automatic scoring script **331**, data that is referenced in execution of the programs, and so forth. The programs are stored in the storage **33** in the form of computer-readable program codes. The automatic scoring script **331** is usually created by the user of the scoring system **1** for a purpose, but a pre-created one may be used.

(52) Examples of the data stored in the storage **33** include scoring criterion data **332**, answer data **333** (answer information), individual data for scoring **334** and scoring result data **335**.

(53) The scoring criterion data **332** is referenced in the scoring process of an answer figure to a problem that requires drawing of a figure in a Cartesian coordinate system that is a coordinate plane. The scoring criterion data **332** includes information on a scoring criterion(s) that is used in the scoring process. The scoring criterion data **332** is generated by the scoring server **10** in response to a request from the client terminal **20**, and sent to the client server **30** and stored in the storage **33**. The scoring criterion data **332** is a file in a format referenceable as arguments in execution of the automatic scoring API of the scoring server **10**, a file in json format in this embodiment.

(54) The answer data **333** is data of an answer figure generated by an answerer who tackles a problem, such as a student, with a not-shown terminal device for answering. If there are two or more answerers, the answer data **333** is generated by/for each answerer. Data items included in the answer data **333** are predetermined for each problem.

(55) The individual data for scoring **334** is data made of the answer data **333** of an answerer (individual) inserted into the scoring criterion data **332**. Hence, the individual data for scoring **334** includes the scoring criterion information and the answer information generated by one answerer. If there are two or more answerers, the individual data for scoring **334** is generated for each answerer. The individual data for scoring **334** is a file in the same format as the scoring criterion data **332**, the json format in this embodiment.

(56) The scoring result data **335** includes information on a scoring result of an answer. The scoring result data **335** is generated by the scoring server **10** with the automatic scoring API called with the individual data for scoring **334** as arguments, and sent to the client server **30**.

(57) The operation unit **34**, the display **35** and the communication unit **36** are respectively the same as the operation unit **14**, the display **15** and the communication unit **16** of the scoring server **10** in configuration, and hence their descriptions will be omitted.

(58) <Operation of Scoring System>

(59) Next, operation of the scoring system **1** will be described, focusing on operation to generate a scoring criterion(s) and operation to determine a score of an answer using the scoring criterion. Although the main agents of these operations are the CPU **11** of the scoring server **10**, the CPU **21** of the client terminal **20** and the CPU **31** of the client server **30**, hereinafter the scoring server **10**, the client terminal **20** and the client server **30** may be referred to as the main agents for the sake of convenience.

(60) FIG. **5** is a sequence diagram to explain the scoring criterion generation process.

(61) FIG. **5** shows flow of signals that are sent and received between the scoring server **10**, the client terminal **20** and the client server **30** in the scoring criterion generation process.

(62) First, a user who uses a function of automatic scoring provided by the scoring system **1** starts the browser **231** at the client terminal **20**, and accesses a predetermined URL. The client terminal **20** then requests the scoring server **10** to send display data for displaying a scoring criterion setting screen **251** (Step S**101**). In response to the request, the scoring server **10** executes the scoring criterion generation program **131**, and sends the display data for displaying the scoring criterion setting screen **251** to the client terminal **20** to cause the client terminal **20** to display the scoring criterion setting screen **251** on the display **25** (Step S**102**).

(63) FIG. **6** shows an example of the scoring criterion setting screen **251**.

(64) On the scoring criterion setting screen **251**, reference/correct answer information **41**, reference

geometry information **42**, answer figure information **43**, scoring variable information **44**, scoring logic information **45**, a question ID **461**, a subsidiary question ID **462**, a save button **47**, a reference figure drawing button **48** and so forth are displayed. Hereinafter, a point having "a" as x-coordinate and "b" as y-coordinate on an x-y coordinate plane that is used for answering a problem is referred to as a point (a, b).

(65) The reference/correct answer information **41** is information on a correct figure set by the user as a model answer to a problem. In FIG. **6**, a straight line L**0** having Point 0 (5, 10) and Point 1 (−5, −10) as two endpoints is set as a correct figure. The setting "Bind by index" means that scoring is carried out by taking the answering order of multiple answer elements provided after this setting into account. In the example shown in FIG. **6**, a point selected first in answering by an answerer is treated as Point 0, and a point selected second in answering by the answerer is treated as Point 1. If the part "index" in the "Bind by index" is changed from a drop-down list to be "Bind by any", scoring is carried out without taking the answering order into account. In this case, the two points selected first and second are treated as "Point 0, Point 1" and "Point 1, Point 0", and both combinations are subjected to scoring. The one having a higher score is adopted as a scoring result.

(66) The reference geometry information **42** is information on geometries that are referenced in the scoring process. In FIG. **6**, as a reference geometry, "graphBounds" representing a coordinate plane that is used for answering is set. The "graphBounds" in this embodiment is a rectangular region (square region, to be more specific) having a length in x-direction of 20 and a length in y-direction of 20 with a point (−10, −10) as the lower left end. In FIG. **6**, only one reference geometry, the "graphBounds", is set, but two or more reference geometries may be set.

(67) The answer figure information **43** is data on an answerer's answer figure. At the stage where scoring criteria are set, dummy answer figure information **43** is input for providing parts into which an answerer's answer data is to be inserted. In this embodiment, coordinate data of the two endpoints P**0** (Point 0), P**1** (Point 1) of the straight line L**0** as an answer figure is input to correspond to the reference/correct answer information **41**.

(68) The scoring variable information **44** is information on scoring variables to construct scoring logic in the scoring logic information **45**. In this embodiment, to the scoring variable "correct", a value of the automatic scoring function "equalsAll" is assigned. The automatic scoring function "equalsAll" is a function to return "true (1)" if data of the reference/correct answer information **41** (in this embodiment, coordinates of Point 0 and Point 1) and data of the answer figure information **43** (same as the above, i.e., coordinates of Point 0 and Point 1) exactly match, and returns "false (0)" if they do not exactly match. In FIG. **6**, one scoring variable is used, but two or more scoring variables may be set.

(69) The scoring logic information **45** is information on the scoring logic using the scoring variable(s) in the scoring variable information **44**. In FIG. **6**, the logical formula "score=correct" determines a score. In the example shown in FIG. **6**, the data of the reference/correct answer information **41** and the data of the answer figure information **43** do not exactly match, so that the scoring variable "correct" is "false (0)", and the score is "0".

(70) The question ID **461** is a unique code assigned to a question (problem). The question ID **461** can call the scoring criterion data **332** for the problem. The subsidiary question ID **462** is a unique code assigned to a subsidiary question (subsidiary problem) included in a problem. If a problem includes two or more subsidiary problems, the scoring criterion data **332** for the problem includes information on two or more sets of scoring criteria for the respective subsidiary problems. In this case, scoring can be carried out, for example, by a method of adding up scores of subsidiary problems of a problem to be the total score of the problem or a method of determining that a problem is correctly answered if all subsidiary problems of the problem are correctly answered.

(71) The save button **47** is a button for generating scoring criterion data **332** with the contents of the scoring criterion setting screen **251** at the time.

(72) The reference figure drawing button **48** is a button that is selected to draw, on a graph viewer,

reference figures that are used for setting scoring criteria. A method for setting scoring criteria using reference figures will be described later.

(73) When the save button **47** is selected, the client terminal **20** sends a request to the scoring server **10** to generate scoring criterion data **332** (Step S**103** in FIG. **5**). The scoring server **10** that has received the request performs a process in accordance with the scoring criterion generation program **131**, generates scoring criterion data **332** in the json format and sends it to the client server **30** (Step S**104**). When the scoring criterion data **332** is stored in the storage **33** of the client server **30** in Step S**104**, the scoring criterion generation process ends.

(74) FIG. **7** shows examples of contents of scoring criterion data **332**.

(75) As an example, FIG. **7** shows the scoring criterion data **332** reflecting the contents of the scoring criterion setting screen **251** shown in FIG. **6**. The scoring criterion data **332** includes a subsidiary question ID, scoring logic, a correct answer (contents of the reference/correct answer information **41**), an answerer's answer (contents of the answer figure information **43**) and an answerer ID to identify an answerer. The scoring criterion data **332** shown in FIG. **7** is merely an example and hence is not limited to the format shown therein.

(76) Next, the scoring process for automatically determining a score of an answer figure using generated scoring criterion data **332** will be described.

(77) FIG. **8** is a sequence diagram to explain the scoring process.

(78) The scoring process is started by a predetermined user operation at the client terminal **20** in a state in which scoring criterion data **332** and answer data **333** are stored in the storage **33** of the client server **30**.

(79) When the scoring process is started, the client terminal **20** requests the client server **30** to start the automatic scoring script **331** (Step S**201**).

(80) In response to the request, the client server **30** executes the automatic scoring script **331**. The client server **30** first inserts one answer data **333** into the scoring criterion data **332** to generate individual data for scoring **334**, and stores it in the storage **33** (Step S**202**). In Step S**202**, the client server **30** generates the individual data for scoring **334** by replacing the "Answerer's Answer" in the scoring criterion data **332** shown in FIG. **7** with the contents of the actual answer of an answerer. In this manner, the client server **30** generates the individual data for scoring **334** that includes the information on the scoring criterion included in the scoring criterion data **332** and the answer data **333** of an answerer.

(81) Next, the client server **30** calls the automatic scoring API of the scoring server **10** with the individual data for scoring **334** generated in Step S**202** as arguments (Step S**203**). In response to the call for the automatic scoring API, the scoring server **10** executes the scoring program **132**, generates scoring result data **335** and sends it to the client server **30** (Step S**204**). In this embodiment, the scoring server **10** determines a score of the answer data **333** included in the received individual data for scoring **334**, referencing the scoring criterion of the scoring criterion data **332** included in the individual data for scoring **334**. In the case shown in FIG. **6** and FIG. **7**, the scoring server **10** first compares the coordinates in the reference/correct answer information **41** with the coordinates in the answer figure information **43** corresponding to the answer data **333**, and obtains a value of the scoring variable "correct". The scoring server **10** then calculates a score in accordance with the scoring logic "score=correct", and generates scoring result data **335** including information on the score.

(82) When receiving the scoring result data **335**, the client server **30** determines whether scoring has finished for all answerers (Step S**205**). If the client server **30** determines that there is at least one answerer for whom scoring has not finished yet (Step S**205**; "NO"), the client server **30** performs Step S**202** again with the answer data **333** of the next answerer. If the client server **30** determines that scoring has finished for all answerers (Step S**205**; "YES"), the client server **30** exits the automatic scoring script **331**. Thus, the scoring process ends.

(83) <Method for Setting Scoring Criteria Using Reference Figures>

(84) In the scoring system **1** of this embodiment, in order to set scoring criteria with the scoring criterion setting screen **251**, it is possible to display (draw) reference figures on the display **25** of the client terminal **20** and reflect information on the reference figures in the scoring criteria. Hereinafter, first to fifth examples of the method for setting scoring criteria with reference figures will be described.

First Example

(85) First, as a first example, a case will be described where determination regions are defined by reference figures, and a scoring criterion about a positional relationship between the determination regions and an answer figure is set.

(86) FIG. **9** shows a reference figure setting screen **252** according to the first example.

(87) The reference figure setting screen **252** is the graph viewer displayed on the display **25** when the reference figure drawing button **48** is selected on the scoring criterion setting screen **251**. On the reference figure setting screen **252**, a coordinate plane **51** (Cartesian coordinate system), a mode selection button **52**, a reference line **61**, reference rectangles **62**, an answer FIG. **71** and so forth are displayed. Among these, the reference line **61** and the reference rectangles **62** are examples of reference figures.

(88) The coordinate plane **51** corresponds to the "graphBounds" set in the reference geometry information **42** on the scoring criterion setting screen **251**. On this coordinate plane **51**, the reference line **61**, the reference rectangles **62** and the answer FIG. **71** are drawn, for example. The coordinate ranges (x-range, y-range) and grid spacing(s) (x grid spacing, y grid spacing) of the coordinate plane **51** can be changed by inputting numerical values in text boxes **53** provided at the right side on the reference figure setting screen **252**. This change is reflected in the contents of the "graphBounds" in the reference geometry information **42** on the scoring criterion setting screen **251**. Further, reference values can be displayed on the x axis and/or the y axis of the coordinate plane **51** in accordance with to user operations. For example, "0" representing the origin can be displayed at the intersection of the x axis and the y axis.

(89) The mode selection button **52** is a button for specifying a mode for drawing reference figures on the reference figure setting screen **252**. When the mode selection button **52** is selected, a not-shown group of icons representing multiple drawing mode choices is displayed, and the current drawing mode can be changed to another by selecting an icon from the icons. The drawing modes include a line drawing mode for drawing reference lines as reference figures, a region specifying mode for specifying regions based on reference lines, and a rectangle drawing mode for drawing reference rectangles as reference figures.

(90) In this example, the reference line **61** corresponds to the straight line L**0** (correct figure set by the user as a model answer to a problem) set in the reference/correct answer information **41** on the scoring criterion setting screen **251**. The reference line **61** can be generated by selecting the line drawing mode with the mode selection button **52**, and making an operation(s) to specify two endpoints on the coordinate plane **51** (e.g., operations of putting a mouse cursor on desired points and clicking). For specifying the endpoints, the snap technique may be employed that limits selectable points to integer coordinates. The shape of the reference line **61** may be changed by an operation(s) to change the position(s) of the endpoint(s) of the reference line **61**, and this change may be reflected in the reference/correct answer information **41** on the scoring criterion setting screen **251**. On the contrary, if the coordinate data of one or both of the two endpoints (Point 0, Point 1) in the reference/correct answer information **41** is changed, this change may be reflected in the reference line **61** on the reference figure setting screen **252**.

(91) The reference rectangles **62** are rectangles having sides parallel to the coordinate axes of the coordinate plane **51**. The reference rectangles **62** shown in FIG. **9** are squares having a length of each side of 2 with the two endpoints of the reference line **61** as their respective centers. The reference rectangles **62** represent boundaries respectively defining determination regions R**0**, R**1**. The positional relationship between these determination regions R**0**, R**1** and the answer FIG. **71**

can be set as a scoring criterion. For example, the scoring criterion can be set such that the answer FIG. **71** is determined to be correct if it is partly in each of the determination regions R**0**, R**1**. In this case, not only the answer FIG. **71** that exactly matches with the reference line **61** as a correct figure but also the answer FIG. **71** that is partly in each of the determination regions R**0**, R**1** are determined to be correct. Alternatively, the scoring criterion may be set such that the answer FIG. **71** having predetermined feature points (two endpoints P**0**, P**1**) respectively located in the determination regions R**0**, R**1** is determined to be correct.

(92) The reference rectangles **62** are drawn on the coordinate plane in accordance with user operations in a state in which the rectangle drawing mode is selected with the mode selection button **52**. The user operations are, for example, operations to specify positions of opposite vertices of the reference rectangles **62** on the coordinate plane **51**. On the basis of these user operations, the CPU **11** identifies the positions of the reference rectangles **62** on the coordinate plane **51**. The user operations may be drag operations. In this case, the CPU **11** identifies the start point and the end point of each drag operation as the positions of opposite vertices of each reference rectangle **62**. For specifying the positions of the opposite vertices of the reference rectangles **62**, the snap technique may be employed that limits selectable points to integer coordinates.

(93) The answer FIG. **71** corresponds to the straight line L**0** in the answer figure information **43** on the scoring criterion setting screen **251**. At the stage where criteria are generated, the answer FIG. **71** is a dummy.

(94) FIG. **10** shows an example of the scoring criterion setting screen **251** reflecting the contents of the reference figure setting screen **252** shown in FIG. **9**.

(95) In the reference geometry information **42** on the scoring criterion setting screen **251** shown in FIG. **10**, as reference geometries, the "graphBounds" representing a coordinate region for answering and the determination regions "R**0**", "R**1**" corresponding to the two reference rectangles **62** are defined and displayed. The coordinate data or the like representing the determination regions "R**0**", "R**1**" in the reference geometry information **42** is calculated by the CPU **11** from the contents of the determination regions R**0**, R**1** on the reference figure setting screen **252** and displayed. This eliminates the need for the user to input coordinate data of the determination regions "R**0**", "R**1**" as reference geometries and accordingly saves user time and effort.

(96) In the scoring variable information **44**, the scoring variables "satisfied_0" and "satisfied_1" are defined and displayed. To the scoring variable "satisfied_0", a value of the automatic scoring function "lineHits" with the straight line "L**0**" in the answer figure information **43** and the determination region "R**0**", which is a reference geometry, as arguments is assigned. To the scoring variable "satisfied_1", a value of the automatic scoring function "lineHits" with the straight line "L**0**" in the answer figure information **43** and the determination region "R**1**", which is a reference geometry, as arguments is assigned. The automatic scoring function "lineHits" is a function to return "true" if a straight line as an argument is partly in a determination region as an argument.

(97) In the scoring logic information **45**, the scoring logic is defined to make the "score" "1" if the scoring variables "satisfied_0" and "satisfied_1" are both "true". In the case shown in FIG. **9** and FIG. **10**, the straight line L**0** (answer FIG. **71**) in the answer figure information **43** is partly in each of the determination regions R**0**, R**1**, so that the "score" calculated is "1". Thus, the scoring criterion data **332** generated with the scoring criterion setting screen **251** shown in FIG. **10** is used in the scoring process to determine whether the answer FIG. **71** is partly in each of the determination regions R**0**, R**1**.

(98) FIG. **11** shows another example of the scoring criterion setting screen **251** reflecting the contents of the reference figure setting screen **252** shown in FIG. **9**.

(99) In the scoring variable information **44** on the scoring criterion setting screen **251** shown in FIG. **11**, the scoring variables "in1", "in2" and "correct" are defined and displayed. To the scoring variable "in1", a value of the automatic scoring function "inBox" with "L**0**.points[0]" representing one endpoint P**0** of the straight line L**0** in the answer figure information **43** and the determination

region "R**0**" as arguments is assigned. To the scoring variable "in2", a value of the automatic scoring function "inBox" with "L**0**.points[1]" representing the other endpoint P**1** of the straight line L**0** in the answer figure information **43** and the determination region "R**1**" as arguments is assigned. The automatic scoring function "inBox" is a function to return "true" if a point as an argument is located in a determination region as an argument. The scoring variable "correct" is defined to be "true" if the scoring variables "in1" and "in2" are both "true".

(100) In the scoring logic information **45**, the logical formula "score=correct" determines a score. In the case shown in FIG. **9** and FIG. **11**, the endpoints P**0**, P**1** of the straight line L**0** (answer FIG. **71**) in the answer figure information **43** are respectively located in the determination regions R**0**, R**1**, so that the scoring variables "in1", "in2" and "correct" are all "true (1)", and the "score" calculated is "1". Thus, the scoring criterion data **332** generated with the scoring criterion setting screen **251** shown in FIG. **11** is used in the scoring process to determine whether predetermined feature points (two endpoints P**0**, P**1** in the first example) of the answer FIG. **71** are respectively located in the determination regions R**0**, R**1**.

(101) As shown in FIG. **10** and FIG. **11**, the definitions of the scoring variables in the scoring variable information **44** and the contents of the scoring logic in the scoring logic information **45** can be freely set by the user in accordance with a desired scoring method.

Second Example

(102) In the first example, the reference rectangles **62** as reference figures respectively define the determination regions R**0**, R**1**. Instead of this, two or more reference lines as reference figures may define a determination region (R**4**), serving as its boundary.

(103) FIG. **12** shows the reference figure setting screen **252** according to a second example.

(104) On the reference figure setting screen **252** shown in FIG. **12**, instead of the reference rectangles **62** shown in FIG. **9**, reference lines **63**, **64** are displayed. The reference lines **63**, **64** are examples of reference figures. The reference line **63** corresponds to the graph of the function $y=2x+2$, and the reference line **64** corresponds to the graph of the function $y=2x-2$. A region with the reference line **63** as its boundary and the y-coordinate being equal to or smaller than that of the reference line **63** is a determination region R**2**, and a region with the reference line **64** as its boundary and the y-coordinate being equal to larger than that of the reference line **64** is a determination region R**3**. In other words, the determination region R**2** is a region satisfying $y \leq 2x+2$, and the determination region R**3** is a region satisfying $y \geq 2x-2$. Hereinafter, the overlap area of the determination regions R**2**, R**3** is referred to as a determination region R**4**.

(105) The determination regions R**2**, R**3** shown in FIG. **12** are set by the following procedure. First, as shown in FIG. **13**, the region specifying mode is selected with the mode selection button **52**, and the reference line **63** is drawn. The reference line **63** can be drawn by a user operation(s) to specify two points on the coordinate plane **51**. From this state, a user operation (mouse over operation) is made to put a cursor **55** on one side or the other side of the reference line **63** on the display screen (reference figure setting screen **252**), so that the one side or the other side of the reference line **63** can be specified as the determination region R**2**. In FIG. **13**, the cursor **55** is put on the side having the y-coordinate smaller (x-coordinate larger) than that of the reference line **63**, so that the determination region R**2** is specified. The contents of the specified determination region R**2** are reflected in an information display section **54** provided at the right side on the reference figure setting screen **252**. If the contents input in the text boxes of the information display section **54** are changed, this change may be reflected in the reference line **63** and the determination region R**2**. When a confirmation operation, such as a click operation, is made in the state shown in FIG. **13**, the reference line **63** and the determination region R**2** are fixed and reflected in the reference geometry information **42** on the scoring criterion setting screen **251**. The user operation to specify the determination region R**2** may be an operation other than the mouse over operation.

(106) Next, as shown in FIG. **14**, the reference line **64** is drawn, and the cursor **55** is put on the side having the y-coordinate larger (x-coordinate smaller) than that of the reference line **64**, so that the

determination region R**3** is specified. When a click operation or the like is made in the state shown in FIG. **14**, the reference line **64** and the determination region R**3** are fixed. Also, the determination region R**4**, which is the overlap area of the determination regions R**2**, R**3**, is fixed.

(107) FIG. **15** shows an example of the scoring criterion setting screen **251** reflecting the contents of the reference figure setting screen **252** shown in FIG. **14**.

(108) In the reference geometry information **42** on the scoring criterion setting screen **251** shown in FIG. **15**, as reference geometries, the "graphBounds" representing a coordinate region for answering and the determination regions "R**2**", "R**3**" shown in FIG. **12** to FIG. **14** are defined and displayed. The inequalities representing the determination regions "R**2**", "R**3**" in the reference geometry information **42** are respectively calculated by the CPU **11** from the contents of the reference lines **63**, **64** and the determination regions R**2**, R**3** on the reference figure setting screen **252** and displayed. This eliminates the need for the user to input data for the CPU **11** to identify the determination regions R**2**, R**3** as reference geometries and accordingly saves user time and effort.

(109) In the scoring variable information **44**, the scoring variables "sati_pt0R**2**", "sati_pt0R**3**", "sati_pt1R**2**" and "sati_pt1R**3**" are defined and displayed. To the scoring variable "sati_pt0R**2**", a value of the automatic scoring function "satisfies" with "L**0**.pt0" representing one endpoint P**0** of the straight line L**0** in the answer figure information **43** and the determination region "R**2**" as arguments is assigned. To the scoring variable "sati_pt0R**3**", a value of the automatic scoring function "satisfies" with "L**0**.pt0" representing one endpoint P**0** of the straight line L**0** in the answer figure information **43** and the determination region "R**3**" as arguments is assigned. To the scoring variable "sati_pt1R**2**", a value of the automatic scoring function "satisfies" with "L**0**.pt1" representing the other endpoint P**1** of the straight line L**0** in the answer figure information **43** and the determination region "R**2**" as arguments is assigned. To the scoring variable "sati_pt1R**3**", a value of the automatic scoring function "satisfies" with "L**0**.pt1" representing the other endpoint P**1** of the straight line L**0** in the answer figure information **43** and the determination region "R**3**" as arguments is assigned. The automatic scoring function "satisfies" is a function to return "true" if a point as an argument is located in a determination region as an argument.

(110) In the scoring logic information **45**, the scoring logic is defined to make the "score" "1" if the scoring variables "sati_pt0R**2**", "sati_pt0R**3**", "sati_pt1R**2**" and "sati_pt1R**3**" are all "true". The scoring variables "sati_pt0R**2**" and "sati_pt1R**2**" are both "true" if the straight line L**0** (answer FIG. **71**) in the answer figure information **43** is (fully) located in the determination region R**2**, and the scoring variables "sati_pt0R**3**" and "sati_pt1R**3**" are both "true" if the straight line L**0** (answer FIG. **71**) in the answer figure information **43** is (fully) located in the determination region R**3**. That is, the scoring logic shown in FIG. **15** makes the "score" "1" if the straight line L**0** in the answer figure information **43** is (fully) located in the determination region R**4**, which is the overlap area of the determination regions R**2**, R**3**. Thus, the scoring criterion data **332** generated with the scoring criterion setting screen **251** shown in FIG. **15** is used in the scoring process to determine whether the two endpoints P**0**, P**1** of the answer FIG. **71** are located in the determination region R**4**, the boundary of which is defined by the two reference lines **63**, **64**.

Third Example

(111) Next, as a third example, a case will be described where a scoring criterion about an analogy in shape between a reference figure and an answer figure is set.

(112) FIG. **16** shows the reference figure setting screen **252** according to the third example. In FIG. **16**, elements other than the coordinate plane **51** are not shown. The same applies to FIG. **18**, FIG. **20**, FIG. **21** and FIG. **22**.

(113) In FIG. **16**, as a reference figure, a reference rectangle **65** having a length of each side of 6 with the origin as its center is drawn. The reference rectangle **65** represents a boundary defining a determination region R**5**. Also, a rectangular answer FIG. **75** with four points on the coordinate plane **51** connected is drawn. The answer FIG. **75** represents a boundary defining an answer region U**0**.

(114) FIG. **17** shows an example of the scoring criterion setting screen **251** reflecting the contents of the reference figure setting screen **252** shown in FIG. **16**.

(115) In the reference geometry information **42** on the scoring criterion setting screen **251** shown in FIG. **17**, as reference geometries, the "graphBounds" representing a coordinate region for answering and the determination region "R**5**" shown in FIG. **16** are defined and displayed.

(116) In the answer figure information **43**, the answer region "U**0**", the boundary of which is represented by the answer FIG. **75**, is defined.

(117) In the scoring variable information **44**, the scoring variable "same" is defined. To the scoring variable "same", a value of the automatic scoring function "sameRegion" with the answer region "U**0**" in the answer figure information **43** and the determination region "R**5**" as arguments is assigned. The automatic scoring function "sameRegion" is a function to return "true" if two regions as arguments exactly match.

(118) On the scoring criterion setting screen **251** shown in FIG. **17**, a default precision **49** is set. The default precision **49** defines an acceptable deviation amount from a correct answer (model answer). In FIG. **17**, the default precision **49** is set to "0". Hence, the value of the automatic scoring function "sameRegion" is "true" if four points of the answer FIG. **75** shown in FIG. **17** and their corresponding vertices of the reference rectangle **65** exactly match. Meanwhile, for example, if the default precision **49** is set to "1", the value of the automatic scoring function "sameRegion" is "true" if the four points of the answer FIG. **75** deviate from their corresponding vertices of the reference rectangle **65** by 1 or less. The setting of the default precision **49** may be included in the scoring criterion setting screen **251** shown in any of FIG. **6**, FIG. **10**, FIG. **11** and FIG. **15** too.

(119) In the scoring logic information **45**, the logical formula "score=correct" determines a score. In the case shown in FIG. **16** and FIG. **17**, the determination region R**5** does not match with the answer region U**0** corresponding to the answer FIG. **75**, so that the scoring variable "same" is "false (0)", and the "score" is "0". Thus, the scoring criterion data **332** generated with the scoring criterion setting screen **251** shown in FIG. **17** is used in the scoring process to make a determination as to the analogy in shape between the answer FIG. **75** and the reference rectangle **65** as a reference figure.

Fourth Example

(120) Next, as a fourth example, a case will be described where a scoring criterion about a comparison in area (square measure) between a reference figure and an answer figure is set.

(121) FIG. **18** shows the reference figure setting screen **252** according to the fourth example.

(122) In FIG. **18**, as a reference figure, a reference rectangle **66** having a length of each side of 6 with the origin as its center is drawn. The reference rectangle **66** represents a boundary defining a determination region R**6**. Also, a hexagonal answer FIG. **76** with six points on the coordinate plane **51** connected is drawn. The answer FIG. **76** represents a boundary defining an answer region U**1**.

(123) FIG. **19** shows an example of the scoring criterion setting screen **251** reflecting the contents of the reference figure setting screen **252** shown in FIG. **18**.

(124) In the reference geometry information **42** on the scoring criterion setting screen **251** shown in FIG. **19**, as reference geometries, the "graphBounds" representing a coordinate region for answering and the determination region "R**6**" shown in FIG. **18** are defined and displayed.

(125) In the answer figure information **43**, the answer region "U**1**", the boundary of which is represented by the answer FIG. **76**, is defined.

(126) In the scoring variable information **44**, the scoring variable "intersection" is defined. To the scoring variable "intersection", a value of the automatic scoring function "overlap" with the determination region "R**6**" and the answer region "U**1**" in the answer figure information **43** as arguments is assigned. The automatic scoring function "overlap" is a function to return the value of "(area of overlap of two regions as arguments)/(area of predetermined one of the two regions as arguments)".

(127) In the scoring logic information **45**, the logical formula "score=intersection>0.75" determines

a score. This makes the "score" "1" if the value of the scoring variable "intersection" is larger than 0.75. Thus, the scoring criterion data **332** generated with the scoring criterion setting screen **251** shown in FIG. **19** is used in the scoring process to make a determination as to the comparison in area between the answer FIG. **76** and the reference rectangle **66** as a reference figure.

Fifth Example

(128) Next, as a fifth example, a case will be described where scoring criteria about an analogy in shape, distance and/or the like between a reference figure(s) representing a graph(s) of a predetermined function(s) and an answer figure(s) are set.

(129) FIG. **20** shows an example of the reference figure setting screen **252** according to the fifth example.

(130) On the reference figure setting screen **252** shown in FIG. **20**, reference lines **67***a*, **67***b* representing graphs of two linear functions are drawn. The reference lines **67***a*, **67***b* are examples of reference figures. Also, answer FIGS. **77***a*, **77***b* of straight lines respectively for the reference lines **67***a*, **67***b* are drawn. On the basis of these reference figures, for example, the scoring variables (i) to (iii) below can be set, and a score can be calculated by the scoring logic of combination of these scoring variables. (i) Distance (minimum distance) between each endpoint of answer FIG. **77***a* and reference line **67***a* (ii) Distance (minimum distance) between each endpoint of answer FIG. **77***b* and reference line **67***b* (iii) Difference or distance between intersection **77***c* of answer FIGS. **77***a*, **77***b* and intersection **67***c* of reference lines **67***a*, **67***b*

(131) For example, the scoring logic can be set to add a score of "1" if the distance in (i) is 1 or less, add a score of "1" if the distance in (ii) is 1 or less, and add a score of "1" if the intersections **77***c*, **67***c* in (iii) match.

(132) FIG. **21** shows another example of the reference figure setting screen **252** according to the fifth example.

(133) On the reference figure setting screen **252** shown in FIG. **21**, two reference lines **68***a*, **68***b* representing a graph of a hyperbolic function are drawn. The reference lines **68***a*, **68***b* are examples of reference figures. Also, answer FIGS. **78***a*, **78***b* of hyperbolae respectively for the reference lines **68***a*, **68***b* are drawn. On the basis of these reference figures, for example, the scoring variables (i) to (iv) below can be set, and a score can be calculated by the scoring logic of combination of these scoring variables. (i) Value of "(area of overlap of smallest rectangles respectively enclosing answer FIG. **78***a* and reference line **68***a*)/(area of predetermined one of the two rectangles)" (ii) Value of "(area of overlap of smallest rectangles respectively enclosing answer FIG. **78***b* and reference line **68***b*)/(area of predetermined one of the two rectangles)" (iii) Analogy in shape between answer FIGS. **78***a*, **78***b* and reference lines **68***a*, **68***b* (iv) x-coordinate of asymptote **78***c* of answer FIGS. **78***a*, **78***b* For example, the scoring logic can be set to add a score of "1" if the value in (i) is 0.75 or larger, add a score of "1" if the value in (ii) is 0.75 or larger, add a score of "1" if (iii) satisfies a predetermined analogy condition, and add a score of "1" if the x-coordinate of the asymptote **78***c* matches with a predetermined value (or is within a predetermined range).

(134) FIG. **22** shows another example of the reference figure setting screen **252** according to the fifth example.

(135) On the reference figure setting screen **252** shown in FIG. **22**, a reference line **69***a* representing a graph of a quadratic function and a reference rectangle **69***b* with the minimum point of the reference line **69***a* as its center are drawn. The reference rectangle **69***b* represents a boundary defining a determination region R**7**. The reference line **69***a* and the reference rectangle **69***b* are examples of reference figures. Also, an answer FIG. **79***a* of a curve for the reference line **69***a* is drawn. On the basis of these reference figures, for example, the scoring variables (i) to (iii) below can be set, and a score can be calculated by the scoring logic of combination of these scoring variables. (i) Value of "(area of overlap of smallest rectangles respectively enclosing answer FIG. **79***a* and reference line **69***a*)/(area of predetermined one of the two rectangles)" (ii) Analogy in shape between answer FIG. **79***a* and reference line **69***a* (iii) Whether minimum point as feature

point of answer FIG. **79***a* is located in determination region R**7**

(136) For example, the scoring logic can be set to add a score of "1" if the value in (i) is 0.75 or larger, add a score of "1" if (ii) satisfies a predetermined analogy condition, and add a score of "1" if the minimum point satisfies the positional relationship in (iii).

(137) If the reference line **69***a* represents a graph of a quadratic function being convex upward, the maximum point can be used as a feature point. If the reference line **69***a* represents a graph of a cubic function, the maximum point, the minimum point or the inflection point may be used as a feature point.

Advantageous Effects

(138) As described above, the scoring server **10** as the information processing apparatus according to the embodiment includes the CPU (processor) that executes the scoring criterion generation program **131** (program) stored in the storage **13**. The CPU **11** generates the scoring criterion data **332** (scoring criterion information) that is referenced in the scoring process of an answer figure to a problem that requires drawing of a figure in a Cartesian coordinate system that is the coordinate plane **51**, wherein in response to a reference figure(s) (reference line **61**, reference rectangles **62**, etc.) being drawn on the coordinate plane **51** based on a user operation(s), the coordinate plane **51** being displayed on the display **25** of the client terminal **20**, the scoring criterion data **332** including information on a scoring criterion(s) determined based on the reference figure is generated. This makes the following possible: to easily set scoring criteria in a visual and intuitive manner; to easily adjust scoring criteria by simple operations to adjust the shapes of reference figures displayed; as compared with the conventional method of setting the correct answer range by inputting numerical values only, to easily identify errors in setting scoring criteria if there are any; and to minutely and flexibly set scoring criteria by combining two or more reference figures.

(139) Further, in the first example, the reference rectangles **62** as reference figures represent boundaries respectively defining the determination regions R**0**, R**1**, and the scoring criterion data **332** is used in the scoring process to determine whether the answer FIG. **71** is partly in each of the determination regions R**0**, R**1**. Further, in the second example, the reference lines **63**, **64** as reference figures represent boundaries respectively defining the determination regions R**2**, R**3**, and the scoring criterion data **332** is used in the scoring process to determine whether the answer FIG. **71** is fully in each of the determination regions R**2**, R**3**. Each of these makes it possible to easily set the correct answer range, which is used as a scoring criterion(s), in a visual and intuitive manner.

(140) Further, in the first example, the reference rectangles **62** as reference figures represent boundaries respectively defining the determination regions R**0**, R**1**, and the scoring criterion data **332** is used in the scoring process to determine whether the endpoints P**0**, P**1** as feature points of the answer FIG. **71** are respectively located in the determination regions R**0**, R**1**. This makes it possible to easily set the correct answer range, which is used as a scoring criterion(s), in a visual and intuitive manner.

(141) Further, in the fifth example, the answer FIGS. **77***a*, **77***b*, **78***a*, **78***b*, **79***a* are each a straight line or a curve of a graph, and a feature point(s) of each answer figure is/are the endpoint(s) of the straight line or the endpoint(s), maximum point, minimum point or inflection point of the curve. This makes it possible to easily and properly set scoring criteria for a problem that requires drawing of a straight line(s) or a curve(s).

(142) Further, in the first, third and fourth examples, the reference rectangles **62**, **65**, **66** as reference figures are each a rectangle having sides parallel to the coordinate axes of the coordinate plane **51**. This makes it possible for the CPU **11** to identify the positional relationship between a reference figure(s) and an answer figure by a simple process.

(143) Further, in the first, third and fourth examples, the CPU **11** identifies a position(s) of the reference rectangle(s) **62**, **65**, **66** on the coordinate plane **51** based on the user operation to specify positions of opposite vertices of the reference rectangle(s) **62**, **65**, **66** on the coordinate plane **51**. This makes it possible to display reference figures by simple operations.

(144) Further, in the second example, two reference lines **63**, **64** as reference figures represent a boundary defining the determination region R**4**, and the scoring criterion information **332** is used in the scoring process to determine whether the answer FIG. **71** is fully in the determination region R**4**. This makes it possible to easily and flexibly set a determination region by adjusting the slope or intercept of each reference line.

(145) Further, in the second example, the CPU **11** sets the determination regions R**2**, R**3** based on the user operation to specify one side or the other side of the respective reference lines **63**, **64** on the coordinate plane **51**, and the user operation to specify the one side or the other side of the respective reference lines **63**, **64** is an operation to put a predetermined cursor, **55**, on the one side or the other side of the respective reference lines **63**, **64** on, of the display **25**, the display screen where the reference lines **63**, **64** are displayed. This makes it possible to specify determination regions by simple operations.

(146) Further, in the third and fifth examples, the scoring criterion data **332** is used in the scoring process to make a determination as to an analogy in shape between the answer figure(s) and it/their reference figure(s). This makes it possible to easily set scoring criteria about the analogy in shape in a visual and intuitive manner.

(147) Further, in the fourth example, the reference rectangle **66** as a reference figure is a figure that encloses a predetermined region on the coordinate plane **51**, and the scoring criterion data **332** is used in the scoring process to make a determination as to a comparison in area between the answer FIG. **76** and the reference rectangle **66**. This makes it possible to easily set scoring criteria about the comparison in area in a visual and intuitive manner.

(148) Further, in the fifth example, the scoring criterion data **332** is used in the scoring process to make a determination, for example, as to distance(s) between each endpoint of the respective answer FIGS. **77***a*, **77***b* as a feature point and their reference lines **67***a*, **67***b* as reference figures shown in FIG. **20**. This makes it possible to easily set scoring criteria about the distance from a reference figure (i.e., position of an answer figure) in a visual and intuitive manner.

(149) Further, the CPU **11** performs the scoring process based on the individual data for scoring **334** that includes the scoring criterion data **332** and the answer data **333** on the answer figure. This makes it possible to perform automatic scoring based on set scoring criteria.

(150) The storage **13** (non-transitory computer-readable storage medium) according to the embodiment stores the scoring criterion generation program **131** that causes the CPU **11** of the scoring server **10** to generate the scoring criterion data **332** that is referenced in the scoring process of an answer figure to a problem that requires drawing of a figure in a Cartesian coordinate system that is the coordinate plane **51**, wherein in response to a reference figure(s) (reference line **61**, reference rectangles **62**, etc.) being drawn on the coordinate plane **51** based on a user operation(s), the coordinate plane **51** being displayed on the display **25** of the client terminal **20**, the scoring criterion data **332** including information on a scoring criterion(s) determined based on the reference figure is generated. This makes it possible to easily set scoring criteria in a visual and intuitive manner.

(151) The information processing method according to the embodiment is performed by, as a computer, the CPU **11** of the scoring server **10**, and includes generating the scoring criterion data **332** that is referenced in the scoring process of an answer figure to a problem that requires drawing of a figure in a Cartesian coordinate system that is the coordinate plane **51**, wherein in response to a reference figure(s) (reference line **61**, reference rectangles **62**, etc.) being drawn on the coordinate plane **51** based on a user operation(s), the coordinate plane **51** being displayed on the display **25** of the client terminal **20**, the scoring criterion data **332** including information on a scoring criterion(s) determined based on the reference figure is generated. This makes it possible to easily set scoring criteria in a visual and intuitive manner.

(152) <Others>

(153) Those described in the above embodiment or the like are not limitations but mere examples

of the information processing apparatus, the storage medium and the information processing method of the present disclosure.

(154) For example, in the above embodiment, the scoring system **1** includes the scoring server **10**, the client terminal **20** and the client server **30**, but is not limited thereto. For example, the scoring system **1** may have an information processing apparatus provided with the functions of the scoring server **10**, the client terminal **20** and the client server **30**. Alternatively, the functions of the scoring server **10**, the client terminal **20** and the client server **30** may be shared by two or more information processing apparatuses. Still alternatively, part of the functions may be performed by cloud computing. For example, a CPU (first processor) that provides a UI for generating scoring criteria and generates the scoring criterion data **332** and a CPU (second processor) that generates the scoring result data **335** may be provided in separate servers.

(155) Further, the programs and data used in the scoring criterion generation process and the scoring process (e.g., scoring criterion generation program **131**, scoring program **132**, automatic scoring script **331**, scoring criterion data **332**, answer data **333**, individual data for scoring **334** and scoring result data **335**) are not necessarily stored in the storages described in the above embodiment, but may be stored in any external file server or the like.

(156) Further, the scoring logic relevant to scoring criteria is not limited to those exemplified above as far as it somehow references the positions and/or shapes of reference figures.

(157) Further, in the above, the scoring process is performed with the individual data for scoring **334** obtained by inserting the answer data **333** into the scoring criterion data **332**, but not limited thereto. The scoring process can be performed in any manner as far as the scoring criterion information on a scoring criterion(s) and the answer information on an answer are referenced therein.

(158) Further, in the above embodiment, figures are drawn in an xy Cartesian coordinate system that is a coordinate plane, but not limited thereto. The present disclosure is also applicable to a case where figures are drawn in an xyz Cartesian coordinate system that is a coordinate space. In this case, reference figures, answer figures and correct figures may be solids in the coordinate space.

(159) Further, although in the above, the HDD or SDD of the storage **13** is used as the non-transitory computer-readable storage medium of the present disclosure, it is not limited thereto. The non-transitory computer-readable storage medium may be an information storage medium, such as a flash memory or a CD-ROM. Further, as a medium to provide data of the programs of the present disclosure via a communication line, a carrier wave can be used.

(160) It goes without saying that the specific configurations and operations of the components of the scoring system **1**, the scoring server **10**, the client terminal **20** and the client server **30** in the above embodiment or the like can be appropriately modified within a range not departing from the scope of the present disclosure.

(161) Although one or more embodiments or the like of the present disclosure have been described above, the scope of the present invention is not limited to the embodiments or the like described above but includes the scope of the present invention described in claims below and the scope of their equivalents.

Claims

1. An information processing apparatus comprising: a processor configured to: receive a first user operation to input information on a model answer to a problem; control a display to display a correct figure in a Cartesian coordinate system, based on the input information on the model answer received through the first user operation; receive a cursor operation on the Cartesian coordinate system displayed on the display including a second user operation to draw one or more reference lines; determine a reference region in the Cartesian coordinate system based on the one or more reference lines drawn via the cursor operation; control the display to display the correct

figure, the one or more reference lines and the reference region determined based on the one or more reference lines in the Cartesian coordinate system; determine coordinates of the reference region displayed on the display; and generate a scoring logic to output one of at least two outcomes in response to input of an answer figure, as an answer to the problem, received through a communication network, wherein the one of the at least two outcomes is output according to the scoring logic based on whether coordinates of at least a portion of the answer figure matches the coordinates of the reference region displayed on the display, and wherein the one of the at least two outcomes is output based on whether a minimum distance between a predetermined feature point of the answer figure and the reference region is less than or equal to a predetermined distance.

2. The information processing apparatus according to claim 1, wherein the reference lines represent a boundary defining the reference region.

3. The information processing apparatus according to claim 1, wherein the answer figure is a straight line or a curve of a graph, and wherein the at least a portion of the answer figure is: an endpoint of the straight line; or an endpoint, a maximum point, a minimum point or an inflection point of the curve.

4. The information processing apparatus according to claim 1, wherein the reference region is a rectangle having sides parallel to coordinate axes of the Cartesian coordinate system.

5. The information processing apparatus according to claim 4, wherein the processor is configured to identify a position of the reference region in the Cartesian coordinate system based on the second user operation to specify positions of opposite vertices of the reference region in the Cartesian coordinate system.

6. The information processing apparatus according to claim 1, wherein the one of the at least two outcomes is output according to the scoring logic based on whether the answer figure is fully in the reference region.

7. The information processing apparatus according to claim 6, wherein the processor is configured to: receive another cursor operation on the Cartesian coordinate system displayed on the display including a third user operation to specify a side of a first reference line of the one or more reference lines and to specify a side of the second refence line of the one or more reference lines; and determine the reference region in the Cartesian coordinate system based on the side of the first reference line and the side of the second reference line specified.

8. The information processing apparatus according to claim 1, wherein the processor is configured to make a determination as to an analogy in shape between the answer figure and the correct figure based on the one of at least two outcomes.

9. The information processing apparatus according to claim 1, wherein the scoring logic compares an area between the answer figure and an area of the reference region.

10. The information processing apparatus according to claim 1, wherein the processor is configured to perform scoring based on the scoring logic and the answer figure.

11. A non-transitory computer-readable storage medium storing a program that causes a processor of an information processing apparatus to at least perform: receive a first user operation to input information on a model answer to a problem; control a display to display a correct figure in a Cartesian coordinate system, wherein the correct figure displayed on the display based on the input information on the model answer received through the first user operation; receive a cursor operation on the Cartesian coordinate system displayed on the display including a second user operation to draw one or more reference lines; determine a reference region in the Cartesian coordinate system based on the one or more reference lines drawn via the cursor operation; control the display to display the correct figure, the one or more reference lines and the reference region determined based on the one or more reference lines in the Cartesian coordinate system; determine coordinates of the reference region displayed on the display; and generate a scoring logic to output one of at least two outcomes in response to input of an answer figure, as an answer to the problem, received through a communication network, wherein the one of the at least two outcomes is output

according to the scoring logic based on whether coordinates of at least a portion of the answer figure matches the coordinates of the reference region displayed on the display, and wherein the one of the at least two outcomes is output based on whether a minimum distance between a predetermined feature point of the answer figure and the reference region is less than or equal to a predetermined distance.

12. The non-transitory computer-readable storage medium according to claim 11, wherein the reference lines represent a boundary defining the reference region.

13. The non-transitory computer-readable storage medium according to claim 11, wherein the answer figure is a straight line or a curve of a graph, and wherein the at least a portion of the answer figure is: an endpoint of the straight line; or an endpoint, a maximum point, a minimum point or an inflection point of the curve.

14. An information processing method that is performed by a computer, comprising: receiving a first user operation to input information on a model answer to a problem; controlling a display to display a correct figure in a Cartesian coordinate system, wherein the correct figure displayed on the display based on the input information on the model answer received through the first user operation; receiving a cursor operation on the Cartesian coordinate system displayed on the display including a second user operation to draw one or more reference lines; determining a reference region in the Cartesian coordinate system based on the one or more reference lines drawn via the cursor operation; controlling the display to display the correct figure, the one or more reference lines and the reference region determined based on the one or more reference lines in the Cartesian coordinate system; determining coordinates of the reference region displayed on the display; and generating a scoring logic to output one of at least two outcomes in response to input of an answer figure, as an answer to the problem, received through a communication network, wherein the one of the at least two outcomes is output according to the scoring logic based on whether coordinates of at least a portion of the answer figure matches the coordinates of the reference region displayed on the display, and wherein the one of the at least two outcomes is output based on whether a minimum distance between a predetermined feature point of the answer figure and the reference region is less than or equal to a predetermined distance.

15. The information processing method according to claim 14, wherein the reference lines represent a boundary defining the reference region.

16. The information processing method according to claim 14, wherein the answer figure is a straight line or a curve of a graph, and wherein the at least a portion of the answer figure is: an endpoint of the straight line; or an endpoint, a maximum point, a minimum point or an inflection point of the curve.