

algorithmic technique to determine that the relevant sample has amplified, involves determining whether the associated amplification curve has crossed a threshold value that is either fixed or is calculated based on the characteristics of the amplification curve. If the threshold is crossed, the curve is determined to be amplified; if the threshold is not crossed, the curve is determined to not be amplified.

SUMMARY

[0003] Automated determination of amplification is important to for increasing throughput of sample analysis, which in turn can both advance scientific research and improve provision of time-sensitive, clinically important information. Existing methods of automatically determining amplification have relied on combinations of techniques and parameters to improve accuracy. However, better accuracy is needed. Embodiments of the invention implement deep learning methods using artificial neural networks to provide improved automated predictions regarding whether a particular sample comprises a target molecule.

[0003a] An aspect of the invention provides a computer program product comprising executable code stored in a non-transitory computer readable medium. The executable code are executable on one or more computer processors to implement an artificial neural network for use in processing output of a quantitative polymerase chain reaction (qPCR) instrument, the qPCR instrument being configured to generate amplification data from one or more qPCR assays conducted using the qPCR instrument. The artificial neural

network comprises an input layer configured to receive input data obtained from amplification data corresponding to fluorescence values measured after each cycle of a plurality of thermal cycles of the qPCR instrument; a plurality of hidden layers comprising one or more convolutional layers; and an output layer. The artificial neural network is configured to use input data corresponding to a particular biological sample processed by the qPCR instrument to determine an amplification classification selected from a plurality of possible amplification classifications of the biological sample.

[0003b] Another aspect of the invention provides a method of training an artificial neural network to process output of a quantitative polymerase chain reaction (qPCR) instrument. The qPCR instrument being configured to generate amplification data from one or more qPCR assays conducted using the qPCR instrument, the artificial neural network being processed to use the amplification data to classify, using a plurality of classifications, an amplification result corresponding to the amplification data. The method comprises providing to the artificial neural network training amplification data obtained from conducting qPCR on training samples; determining a class weight for each of the plurality of classifications wherein the class weight corresponds to a portion of training sample belonging to each classification of the plurality of classifications; using the class weight to obtain a class-weighted error determination corresponding to a classification determination made by the artificial neural network for a particular training sample; and using the class-weighted error determination to adjust parameter values of the artificial neural network to reduce error.

[0003c] Another aspect of the invention provides a computer program product comprising executable code stored in a non-transitory computer readable medium. The executable code is executable on one or more computer processors to process output of a quantitative polymerase chain reaction (qPCR) instrument using an artificial neural network, the qPCR instrument being configured to generate amplification data from one or more qPCR assays conducted using the qPCR instrument. The executable code is executable on the one or more computer processors to pre-process amplification data to obtain pre-processed data to provide as input data to an input layer of the artificial neural network. The pre-processing comprises determining if the amplification data corresponds to a number of cycles of the qPCR instrument that is different than a size of a corresponding dimension of an input layer of the artificial neural network; and if the number of cycles is different than the size, then fitting the pre-processed data to the size.

[0003d] Another aspect of the invention provides a quantitative polymerase chain reaction (qPCR) system comprising a qPCR instrument configured to process biological samples and generate amplification data corresponding the samples; and one or more computers configured to receive the amplification data and to receive, store, and execute the executable instruction code of the computer program product as described.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIG. 1 illustrates a system in accordance with an embodiment of the present invention.