CLAIMS

Claim 1. An artificial intelligence-based system for base calling, the system comprising:

a neural network-based base caller including parallel convolutional neural network pipelines respectively trained to process at least right flanking, center, and left flanking inputs of images depicting clusters and their surrounding backgrounds, and produce at least right flanking, center, and left flanking outputs for the clusters in a current sequencing cycle;

wherein the right flanking input comprises current image data for the current sequencing cycle of a sequencing run, supplemented with previous image data for one or more previous sequencing cycles preceding the current sequencing cycle, and wherein the right flanking output comprises a right flanking base call prediction for the current sequencing cycle and base call predictions for the previous sequencing cycles;

wherein the center input comprises the current image data, supplemented with the previous image data and successive image data for one or more successive sequencing cycles succeeding the current sequencing cycle, and wherein the center output comprises a center base call prediction for the current sequencing cycle and base call predictions for the previous sequencing cycles and the successive sequencing cycles;

wherein the left flanking input comprises the current image data, supplemented with the successive image data, and wherein the left flanking output comprises a left flanking base call prediction for the current sequencing cycle and base call predictions for the successive sequencing cycles;

wherein training of the trained parallel convolutional neural network pipelines comprises providing a training dataset of the right flanking, center, and left flanking inputs of images depicting clusters and their surrounding backgrounds together with ground truth base calls of clusters in the current sequencing cycle and applying backpropagation-based gradient updates; and

a base call generator coupled to the neural network-based base caller and configured to generate a base call for the clusters in the current sequencing cycle based on the right flanking, center, and left flanking base call predictions for the current sequencing cycle.

Claim 2. The artificial intelligence-based system of claim 1, wherein the current image data for the current sequencing cycle depicts intensity emissions of analytes and their surrounding background captured at the current sequencing cycle.

Claim 3. The artificial intelligence-based system of claims 1 or 2, wherein the right flanking, center, and left flanking base call predictions for the current sequencing cycle identify likelihoods of a base incorporated in one or more analytes at the current sequencing cycle being A, C, T, and G.

Claim 4. The artificial intelligence-based system of claim 3, wherein the base call generator is further configured to comprise an averager that

base-wise sums the likelihoods across the right flanking, center, and left flanking base call predictions applicable to clusters in the current sequencing cycle;

determines base-wise averages based on the base-wise sums; and

generates the base call for the current sequencing cycle based on a highest one of the base-wise averages.

Claim 5. The artificial intelligence-based system of claim 3 or claim 4, wherein the base call generator is further configured to comprise a consensor that

determines a preliminary base call for each of the right flanking, center, and left flanking base call predictions applicable to clusters in the current sequencing cycle based on a highest one of the likelihoods, thereby producing a sequence of preliminary base calls; and

generates the base call applicable to the clusters for the current sequencing cycle based on a most common base call in the sequence of preliminary base calls.

Claim 6. The artificial intelligence-based system of any of claims 3-5, wherein the base call generator is further configured to comprise a weighted consensor that

determines a preliminary base call for each of the right flanking, center, and left flanking base call predictions for the current sequencing cycle based on a highest one of the likelihoods, thereby producing a sequence of preliminary base calls;

applies base-wise weights to respective ones of the preliminary base calls in the sequence of preliminary base calls and produces a sequence of weighted preliminary base calls; and

generates the base call for the current sequencing cycle based on a most weighted base call in the sequence of weighted preliminary base calls.

Claim 7. The artificial intelligence-based system of any of claims 3-6, wherein the likelihoods are exponentially normalized scores produced by a softmax layer.

Claim 8. The artificial intelligence-based system of any of claims 1-7, further configured to comprise a trainer that, during training,

computes errors between base calls generated by the base call generator for the current sequencing cycle, the previous sequencing cycles, and the successive sequencing cycles based on the right flanking, center, and left flanking outputs of the neural network-based base caller and ground truth base calls;

determines gradients for the current sequencing cycle, the previous sequencing cycles, and the successive sequencing cycles based on the errors; and

updates parameters of the neural network-based base caller by backpropagating the gradients.

Claim 9. The artificial intelligence-based system of any of claims 1-8, wherein the right flanking base call prediction for the current sequencing cycle accounts for a prephasing effect between the current sequencing cycle and the previous sequencing cycles.

Claim 10. The artificial intelligence-based system of claim 9, wherein the center base call prediction for the current sequencing cycle accounts for the prephasing effect between the current sequencing cycle and the previous sequencing cycles and a phasing effect between the current sequencing cycle and the successive sequencing cycles.

Claim 11. The artificial intelligence-based system of claim 10, wherein the left flanking base call prediction for the current sequencing cycle accounts for the phasing effect between the current sequencing cycle and the successive sequencing cycles.

Claim 12. An artificial intelligence-based system for base calling, the system comprising:

a host processor;

memory accessible by the host processor storing image data depicting clusters and their surrounding backgrounds for sequencing cycles of a sequencing run, wherein current image

data for a current sequencing cycle of the sequencing run depicts intensity emissions of analytes and their surrounding background captured at the current sequencing cycle; and

a configurable processor having access to the memory, the configurable processor including:

a plurality of execution clusters, the execution clusters in the plurality of execution clusters configured to execute a neural network; and

data flow logic having access to the memory and to the execution clusters in the plurality of execution clusters, configured to

provide the current image data, previous image data for one or more previous sequencing cycles preceding the current sequencing cycle, and successive image data for one or more successive sequencing cycles succeeding the current sequencing cycle to available execution clusters in the plurality of execution clusters, and

cause the execution clusters

to apply different groupings of the current image data, the previous image data, and the successive image data, the groupings comprising windows of cycles with the current sequencing cycle appearing in different positions in the windows, to parallel convolutional neural network pipelines in the neural network that have been trained using a training dataset of the windows of cycles with the current sequencing cycle appearing in different positions in the windows together with ground truth base calls of clusters in the current sequencing cycle and applying backpropagation-based gradient updates,

to produce from the groupings first, second, and third base call predictions applicable to the clusters for the current sequencing cycle, and

to feed the first, second, and third base call predictions for the current sequencing cycle to the memory for use in generation of a base call applicable to the cluster for the current sequencing cycle based on the first, second, and third base call predictions.

Claim 13. The artificial intelligence-based system of claim 12, wherein the different groupings include a first grouping comprising the current image data and the previous image data, a second grouping comprising the current image data, the previous image data, and the successive image data, and a third grouping comprising the current image data and the successive image data.

Claim 14. The artificial intelligence-based system of claim 13, wherein the execution clusters apply the first grouping to the neural network to produce the first base call prediction, the second grouping to the neural network to produce the second base call prediction, and the third grouping to the neural network to produce the third base call prediction.

Claim 15. The artificial intelligence-based system of any of claims 12-14, wherein the first, second, and third base call predictions for the current sequencing cycle identify likelihoods of a base incorporated in one or more of the analytes at the current sequencing cycle being A, C, T, and G.

Claim 16. The artificial intelligence-based system of claim 15, wherein the data flow logic is further configured to generate the base call for the current sequencing cycle by

base-wise summing the likelihoods across the first, second, and third base call predictions for the current sequencing cycle;

determining base-wise averages based on the base-wise summing; and

generating the base call for the current sequencing cycle based on a highest one of the base-wise averages.

Claim 17. An artificial intelligence-based method of base calling, the method including:

accessing current image data depicting clusters and their surrounding backgrounds for a current sequencing cycle of a sequencing run, previous image data for one or more previous sequencing cycles preceding the current sequencing cycle, and successive image data for one or more successive sequencing cycles succeeding the current sequencing cycle;

processing different groupings of the current image data, the previous image data, and the successive image data through a neural network-based base caller including trained parallel convolutional neural network pipelines respectively, the groupings comprising of windows of cycles with the current sequencing cycle appearing in different positions in the windows, and producing a plurality of base call predictions applicable to the clusters for the current sequencing cycle;

wherein training of the trained parallel convolutional neural network pipelines comprises providing a training dataset of right flanking, center, and left flanking inputs of images depicting clusters and their surrounding backgrounds together with ground truth base calls of

clusters in the current sequencing cycle and applying backpropagation-based gradient updates, wherein the right flanking, center, and left flanking inputs correspond to successive, current, and previous inputs; and

generating base calls applicable to clusters for the current sequencing cycle based on the plurality of base call predictions for the clusters.

Claim 18. An artificial intelligence-based method of base calling, the method including:

generating respective provisional base calls for images of clusters and their surrounding backgrounds in a particular sequencing cycle in response to executing respective iterations of a base caller;

wherein the respective iterations process respective input sets for respective windows of sequencing cycles with the particular sequencing cycle appearing in different positions in the respective windows; and

wherein the respective windows of sequencing cycles have the particular sequencing cycle as at least one overlapping cycle, and one or more non-overlapping cycles; and

generating a final base call for the particular sequencing cycle based on the respective provisional base calls.