

CLAIMS

1. A system, comprising:

a spatial convolutional neural network configured to process sequencing images of clusters, and produce spatially convolved features;

filtering logic configured to select, from the spatially convolved features, a subset of spatially convolved features that contain centers of the clusters;

compression logic configured to compress the subset of spatially convolved features into a set of compressed features, wherein the subset of spatially convolved features has M channels, and the set of compressed features has N channels, and wherein $M > N$;

contextualization logic configured to access state information for compressed features in the set of compressed features, and to append the state information with the compressed features to generate a set of stateful compressed features;

a temporal convolutional neural network configured to process the set of stateful compressed features, and produce temporally convolved stateful features; and

base calling logic configured to generate base calls for the clusters based on the temporally convolved stateful features.

2. The system of claim 1, wherein the ~~per-channel states are~~ state information comprises intensity variation correction coefficients generated on a cluster-by-cluster basis by a linear model in response to independently processing the sequencing images of clusters.

3. The system of claim 2, wherein the intensity variation correction coefficients ~~include~~ comprise one or more of:

an amplification coefficient that compensates for scale variation between intensity profiles of the clusters;

channel-specific offset coefficients that compensate for shift variation between the intensity profiles of the clusters along a plurality of channels; or

a common offset coefficient that compensates for the shift variation.

~~4. The system of claim 2 or 3, wherein the intensity variation correction coefficients include channel-specific offset coefficients that compensate for shift variation between the intensity profiles of the clusters along a plurality of channels.~~

~~5. The system of any of claims 2-4, wherein the intensity variation correction coefficients include a common offset coefficient that compensates for the shift variation.~~

46. The system of claim 3 ~~any of claims 2-5~~, wherein the intensity variation correction coefficients are generated on the cluster-by-cluster basis based on combining analysis of current intensity statistics determined at a current sequencing cycle of a sequencing run with analysis of historic intensity statistics determined at one or more previous sequencing cycles of the sequencing run that precede the current sequencing cycle.

57. The system of ~~any of claims 4-6~~ claim 4, wherein the intensity profiles of the clusters are characterized by channel-specific intensity values for channels in the plurality of channels.

68. The system of claim 5 ~~any of claims 1-7~~, wherein the state information comprises per-channel states that are characterized by channel-specific state values for ~~the channels~~ each channel.

79. The system of ~~any of claims 1-8~~ claim 6, wherein the state information comprises per-channel states that are encoded with per-cluster, channel-specific bits on a bit-by-bit basis.

~~10. (Original) The system of claim 9, wherein channel-specific state values for a subset of the channels are encoded with the per-cluster, channel-specific bits on the bit-by-bit basis.~~

~~11. (Original) The system of claim 9 or 10, wherein the channel-specific state values are averaged across the channels to generate pan-channel state values, wherein the pan-channel state values are encoded with the per-cluster, channel-specific bits on the bit-by-bit basis.~~

812. The system of claim 7 ~~any of claims 9-11~~, wherein:
the per-channel states are concatenated with the per-cluster, channel-specific bits on the bit-by-bit basis; or
the per-channel states are summed with the per-cluster, channel-specific bits on the bit-by-bit basis.

~~13. (Original) The system of any of claims 9-12, wherein the per-channel states are summed with the per-cluster, channel-specific bits on the bit-by-bit basis.~~

914. The system of ~~any of claims 1-13~~ claim 8, wherein the per-channel states are based on compressed values of per-cluster, channel-specific bits produced by a spatial processing logic at the current sequencing cycle and at the one or more previous sequencing cycles.

1015. The system of claim ~~14~~ 9, wherein the per-channel states ~~are~~ comprise at least one of: averages of the compressed values, moving averages of the compressed values, maximums of the compressed values, minimums of the compressed values, or exponentially weighted averages of the compressed values.

~~16. (Original) The system of claim 14, wherein the per-channel states are maximum ones of the compressed values.~~

~~17. (Original) The system of claim 14, wherein the per-channel states are minimum ones of the compressed values.~~

~~18. (Original) The system of claim 14, wherein the per-channel states are exponentially weighted averages of the compressed values.~~

1119. The system of claim 1018, wherein:

the per-channel states comprise the exponentially weighted averages; and
the exponentially weighted averages are determined based on weighting recent sequencing
cycles more than earlier sequencing cycles.

~~20. — (Original) The system of claim 14 or 15, wherein the per-channel states are moving
averages of the compressed values.~~

~~1221.~~ The system of claim ~~20~~10, wherein:
the per-channel states comprise the moving averages; and
the moving averages use rolling subsets of compressed values from the one or more
previous sequencing cycles.

13. A non-transitory computer-readable storage medium comprising instructions that,
when executed by at least one processor, cause a computing device to:
process, using a spatial convolutional neural network, sequencing images of clusters to
produce spatially convolved features;
select, from the spatially convolved features, a subset of spatially convolved features that
contain centers of the clusters;
compress the subset of spatially convolved features into a set of compressed features,
wherein the subset of spatially convolved features has M channels, and the set of compressed
features has N channels, and wherein $M > N$;
access state information for compressed features in the set of compressed features,;

append the state information with the compressed features to generate a set of stateful compressed features;

process, using a temporal convolutional neural network, the set of stateful compressed features to produce temporally convolved stateful features; and

generate base calls for the clusters based on the temporally convolved stateful features.

14. The non-transitory computer-readable storage medium of claim 13, wherein:
the state information comprises per-channel states that are characterized by channel-specific state values for each channel; and

the per-channel states are based on compressed values of per-cluster, channel-specific bits produced at a current sequencing cycle and at one or more previous sequencing cycles.

~~1522.~~ The non-transitory computer-readable storage medium ~~system of any of claims 14-24~~ of claim 14, wherein the per-channel states ~~include~~ comprise active state values and inactive state values.

~~1623.~~ The non-transitory computer-readable storage medium ~~system~~ of claim ~~22~~ 15, wherein the active state values and the inactive state values are determined based on at least one of:

~~channel-specific;~~

a preceding base call;

global maximums and global minimums of the compressed values; or

exponentially weighted averages of the compressed values.

~~24. (Original) The system of claim 22 or 23, wherein the active state values and the inactive state values are determined from a preceding base call.~~

~~25. (Original) The system of any of claims 22-24, wherein the active state values and the inactive state values are determined based on global maximums and global minimums of the compressed values.~~

~~26. (Original) The system of any of claims 22-25, wherein the active state values and inactive state values are determined based on exponentially weighted averages of the compressed values.~~

17. A computer-implemented method, comprising:
processing, using a spatial convolutional neural network, sequencing images of clusters to produce spatially convolved features;
selecting, from the spatially convolved features, a subset of spatially convolved features that contain centers of the clusters;
compressing the subset of spatially convolved features into a set of compressed features, wherein the subset of spatially convolved features has M channels, and the set of compressed features has N channels, and wherein $M > N$;
accessing state information for compressed features in the set of compressed features,;
appending the state information with the compressed features to generate a set of stateful compressed features;

processing, using a temporal convolutional neural network, the set of stateful compressed features to produce temporally convolved stateful features; and
generating base calls for the clusters based on the temporally convolved stateful features.

~~27~~18. The computer-implemented method ~~system of any of claims 1-26 of claim 17,~~ wherein an input to the spatial convolutional neural network includes a sliding window of sequencing images for a current sequencing cycle, one or more previous sequencing cycles, and one or more next sequencing cycles.

1928. The computer-implemented method ~~system~~ of claim 18~~27~~, wherein feature sets are extracted from channel-specific pixels of sequencing images in the sliding window of sequencing images for the current sequencing cycle, the one or more previous sequencing cycles, and the one or more next ~~flanking~~ sequencing cycles, wherein per-cluster, central feature sets are culled from the feature sets for the current sequencing cycle, the one or more previous sequencing cycles, and the one or more next sequencing cycles.

2029. The computer-implemented method ~~system~~ of claim 1928, wherein channel-specific bit sets are compressed from the per-cluster, central feature sets for the current sequencing cycle, the one or more previous sequencing cycles, and the one or more next sequencing cycles.

~~30. —(Original) A system, comprising:~~
~~spatial processing logic configured to process an input in which intensity profiles of clusters are dispersed across channel-specific pixels of sequencing images, and produce a spatially~~

compact output in which the intensity profiles of the clusters are aggregated into features extracted from the channel-specific pixels;

cluster focusing logic configured to cull those per-cluster, central features from the features that characterize peak intensities detected at centers of the clusters;

compression logic configured to distill the per-cluster, central features into per-cluster, channel-specific bits, wherein the per-cluster, central features have M feature channels, wherein the per-cluster, channel-specific bits have N bit channels, and wherein $M > N$;

state generation logic configured to generate per-channel states for the per-cluster, channel-specific bits;

temporal processing logic configured to process the per-cluster, channel-specific bits and the per-channel states, and produce a temporally compact output; and

base calling logic configured to produce base calls based on the temporally compact output.