

**Supplementary Figure 1**. Distribution of length of peptides in IEDB and MHCBN datasets, respectively.



**Supplementary Figure 2**. Results of choosing learning rate and the parameter of the dropout layer. A. Results of choosing learning rate. The learning rate is take from $10^{-6}$ to 1 to train model, respectively. Result shows smaller learning rates increase the training time and lager learning rates decrease the training time, and may lead unstable convergence process. Therefore, we set learning rate as $10^{-4}$. B. Results of choosing the parameter of the dropout layer. The value takes from 0.1 to 1 with step 0.1 and training epochs set 20,000. Considering the problem of data unbalance, we need to choose Sensitivity, F1, AUC as main evaluation criterion, and these three criteria achieved the best value when drop-out equals 0.8. Therefore, drop-out value was set 0.8.

**Supplementary Table1.** Results of the BVLSTM-MHC model on the test dataset.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Alleles | Length | ACC | AUC | F1 | MCC | Specificity | Sensitivity | Precision | AUPR | # Postive examples | #Negative examples |
| Patr-A0401 | Overall | 0.879 | 0.804 | 0.533 | 0.510 | 0.979 | 0.400 | 0.800 | 0.588 | 10 | 48 |
| Patr-A0401 | 9 | 0.931 | 0.840 | 0.667 | 0.680 | 1.000 | 0.500 | 1.000 | 0.655 | 4 | 25 |
| Patr-A0401 | 10 | 0.815 | 0.770 | 0.444 | 0.378 | 0.952 | 0.333 | 0.667 | 0.606 | 6 | 21 |
| Patr-B2401 | Overall | 0.763 | 0.835 | 0.533 | 0.377 | 0.822 | 0.571 | 0.500 | 0.627 | 14 | 45 |
| Patr-B2401 | 9 | 0.730 | 0.863 | 0.583 | 0.383 | 0.800 | 0.583 | 0.583 | 0.754 | 12 | 25 |
| Patr-B2401 | 10 | 0.818 | 0.775 | 0.333 | 0.261 | 0.850 | 0.500 | 0.250 | 0.591 | 2 | 20 |
| HLA-A0101 | Overall | 0.894 | 0.901 | 0.552 | 0.494 | 0.950 | 0.513 | 0.598 | 0.595 | 119 | 818 |
| HLA-A0101 | 8 | 0.923 | 0.917 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 0.500 | 1 | 12 |
| HLA-A0101 | 9 | 0.906 | 0.919 | 0.575 | 0.523 | 0.955 | 0.539 | 0.615 | 0.612 | 89 | 663 |
| HLA-A0101 | 10 | 0.828 | 0.826 | 0.500 | 0.398 | 0.911 | 0.464 | 0.542 | 0.572 | 28 | 123 |
| HLA-A0101 | 11 | 0.938 | 0.933 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 0.500 | 1 | 15 |
| HLA-A0201 | Overall | 0.873 | 0.938 | 0.831 | 0.729 | 0.899 | 0.829 | 0.832 | 0.894 | 943 | 1563 |
| HLA-A0201 | 8 | 0.810 | 0.935 | 0.500 | 0.411 | 0.833 | 0.667 | 0.400 | 0.786 | 6 | 36 |
| HLA-A0201 | 9 | 0.886 | 0.945 | 0.843 | 0.753 | 0.914 | 0.836 | 0.849 | 0.904 | 685 | 1190 |
| HLA-A0201 | 10 | 0.830 | 0.912 | 0.809 | 0.656 | 0.845 | 0.812 | 0.806 | 0.875 | 245 | 309 |
| HLA-A0201 | 11 | 0.926 | 0.952 | 0.857 | 0.824 | 0.905 | 1.000 | 0.750 | 0.800 | 6 | 21 |
| HLA-A0201 | 15 | 0.800 | 1.000 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 1.000 | 1 | 4 |
| HLA-A0202 | Overall | 0.835 | 0.930 | 0.809 | 0.664 | 0.838 | 0.830 | 0.790 | 0.913 | 358 | 488 |
| HLA-A0202 | 8 | 0.931 | 0.980 | 0.750 | 0.710 | 0.960 | 0.750 | 0.750 | 0.888 | 4 | 25 |
| HLA-A0202 | 9 | 0.848 | 0.942 | 0.834 | 0.696 | 0.829 | 0.872 | 0.799 | 0.932 | 219 | 280 |
| HLA-A0202 | 10 | 0.807 | 0.906 | 0.783 | 0.609 | 0.826 | 0.783 | 0.783 | 0.891 | 129 | 161 |
| HLA-A0202 | 11 | 0.737 | 0.872 | 0.444 | 0.327 | 0.923 | 0.333 | 0.667 | 0.774 | 6 | 13 |
| HLA-A0203 | Overall | 0.882 | 0.950 | 0.845 | 0.750 | 0.911 | 0.835 | 0.856 | 0.921 | 504 | 802 |
| HLA-A0203 | 8 | 0.912 | 0.945 | 0.727 | 0.679 | 0.931 | 0.800 | 0.667 | 0.877 | 5 | 29 |
| HLA-A0203 | 9 | 0.894 | 0.956 | 0.853 | 0.770 | 0.916 | 0.855 | 0.850 | 0.923 | 325 | 581 |
| HLA-A0203 | 10 | 0.851 | 0.933 | 0.845 | 0.705 | 0.893 | 0.810 | 0.883 | 0.930 | 168 | 168 |
| HLA-A0203 | 11 | 0.810 | 0.889 | 0.600 | 0.499 | 0.933 | 0.500 | 0.750 | 0.806 | 6 | 15 |
| HLA-A0205 | Overall | 0.941 | 0.971 | 0.952 | 0.883 | 0.857 | 1.000 | 0.909 | 0.981 | 10 | 7 |
| HLA-A0205 | 9 | 0.857 | 0.917 | 0.889 | 0.730 | 0.667 | 1.000 | 0.800 | 0.950 | 4 | 3 |
| HLA-A0205 | 10 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 6 | 1 |
| HLA-A0206 | Overall | 0.833 | 0.902 | 0.782 | 0.647 | 0.868 | 0.778 | 0.785 | 0.869 | 428 | 688 |
| HLA-A0206 | 9 | 0.835 | 0.902 | 0.792 | 0.655 | 0.873 | 0.778 | 0.807 | 0.883 | 306 | 450 |
| HLA-A0206 | 10 | 0.833 | 0.908 | 0.786 | 0.650 | 0.859 | 0.793 | 0.780 | 0.872 | 116 | 184 |
| HLA-A0206 | 11 | 0.778 | 0.831 | 0.500 | 0.388 | 0.923 | 0.400 | 0.667 | 0.573 | 5 | 13 |
| HLA-A0206 | 14 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1 | 2 |
| HLA-A0207 | Overall | 0.833 | 0.831 | 0.727 | 0.614 | 0.846 | 0.800 | 0.667 | 0.545 | 5 | 13 |
| HLA-A0207 | 9 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 2 | 7 |
| HLA-A0207 | 10 | 0.667 | 0.611 | 0.571 | 0.316 | 0.667 | 0.667 | 0.500 | 0.444 | 3 | 6 |
| HLA-A0211 | Overall | 0.921 | 0.949 | 0.881 | 0.822 | 0.951 | 0.863 | 0.900 | 0.934 | 73 | 142 |
| HLA-A0211 | 9 | 0.921 | 0.948 | 0.879 | 0.821 | 0.951 | 0.861 | 0.899 | 0.932 | 72 | 142 |
| HLA-A0212 | Overall | 0.915 | 0.937 | 0.828 | 0.772 | 0.954 | 0.800 | 0.857 | 0.912 | 60 | 174 |
| HLA-A0212 | 9 | 0.914 | 0.936 | 0.825 | 0.769 | 0.954 | 0.797 | 0.855 | 0.910 | 59 | 174 |
| HLA-A0216 | Overall | 0.957 | 0.997 | 0.875 | 0.852 | 0.962 | 0.933 | 0.824 | 0.985 | 30 | 156 |
| HLA-A0216 | 9 | 0.957 | 0.996 | 0.871 | 0.848 | 0.962 | 0.931 | 0.818 | 0.984 | 29 | 156 |
| HLA-A0219 | Overall | 0.918 | 0.977 | 0.824 | 0.773 | 0.930 | 0.875 | 0.778 | 0.939 | 56 | 200 |
| HLA-A0219 | 9 | 0.918 | 0.977 | 0.824 | 0.773 | 0.930 | 0.875 | 0.778 | 0.939 | 56 | 200 |
| HLA-A0250 | Overall | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 19 | 8 |
| HLA-A0250 | 9 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 19 | 8 |
| HLA-A0301 | Overall | 0.851 | 0.918 | 0.734 | 0.634 | 0.924 | 0.681 | 0.795 | 0.824 | 455 | 1052 |
| HLA-A0301 | 8 | 0.800 | 0.556 | NA | -0.111 | 0.889 | 0.000 | 0.000 | 0.200 | 1 | 9 |
| HLA-A0301 | 9 | 0.861 | 0.924 | 0.715 | 0.626 | 0.929 | 0.668 | 0.770 | 0.803 | 295 | 832 |
| HLA-A0301 | 10 | 0.818 | 0.904 | 0.779 | 0.633 | 0.901 | 0.716 | 0.854 | 0.879 | 155 | 191 |
| HLA-A0301 | 11 | 0.857 | 0.939 | 0.667 | 0.576 | 0.909 | 0.667 | 0.667 | 0.806 | 3 | 11 |
| HLA-A0301 | 15 | 0.750 | 0.000 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 0.250 | 1 | 3 |
| HLA-A1101 | Overall | 0.873 | 0.939 | 0.806 | 0.712 | 0.911 | 0.798 | 0.815 | 0.888 | 420 | 850 |
| HLA-A1101 | 8 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 3 | 10 |
| HLA-A1101 | 9 | 0.883 | 0.945 | 0.798 | 0.716 | 0.924 | 0.785 | 0.810 | 0.875 | 261 | 629 |
| HLA-A1101 | 10 | 0.843 | 0.922 | 0.820 | 0.680 | 0.859 | 0.822 | 0.817 | 0.911 | 152 | 198 |
| HLA-A1101 | 11 | 0.800 | 0.750 | 0.667 | 0.612 | 1.000 | 0.500 | 1.000 | 0.768 | 4 | 6 |
| HLA-A2301 | Overall | 0.868 | 0.920 | 0.699 | 0.615 | 0.924 | 0.675 | 0.725 | 0.765 | 117 | 397 |
| HLA-A2301 | 8 | 0.889 | 1.000 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 1.000 | 1 | 8 |
| HLA-A2301 | 9 | 0.870 | 0.914 | 0.699 | 0.616 | 0.921 | 0.690 | 0.707 | 0.753 | 84 | 302 |
| HLA-A2301 | 10 | 0.842 | 0.928 | 0.724 | 0.621 | 0.928 | 0.656 | 0.808 | 0.861 | 32 | 69 |
| HLA-A2402 | Overall | 0.871 | 0.883 | 0.672 | 0.594 | 0.933 | 0.636 | 0.712 | 0.742 | 132 | 504 |
| HLA-A2402 | 8 | 0.824 | 0.938 | 0.400 | 0.451 | 0.813 | 1.000 | 0.250 | 0.500 | 1 | 16 |
| HLA-A2402 | 9 | 0.878 | 0.880 | 0.667 | 0.596 | 0.943 | 0.617 | 0.725 | 0.738 | 94 | 383 |
| HLA-A2402 | 10 | 0.842 | 0.900 | 0.725 | 0.615 | 0.905 | 0.694 | 0.758 | 0.805 | 36 | 84 |
| HLA-A2402 | 11 | 0.900 | 0.316 | NA | -0.053 | 0.947 | 0.000 | 0.000 | 0.071 | 1 | 19 |
| HLA-A2403 | Overall | 0.931 | 0.974 | 0.862 | 0.816 | 0.949 | 0.875 | 0.848 | 0.918 | 64 | 197 |
| HLA-A2403 | 9 | 0.931 | 0.974 | 0.862 | 0.816 | 0.949 | 0.875 | 0.848 | 0.918 | 64 | 196 |
| HLA-A2501 | Overall | 0.924 | 0.903 | 0.417 | 0.427 | 0.988 | 0.294 | 0.714 | 0.642 | 17 | 167 |
| HLA-A2501 | 9 | 0.921 | 0.902 | 0.417 | 0.426 | 0.988 | 0.294 | 0.714 | 0.645 | 17 | 160 |
| HLA-A2601 | Overall | 0.904 | 0.899 | 0.511 | 0.478 | 0.972 | 0.413 | 0.672 | 0.645 | 109 | 789 |
| HLA-A2601 | 9 | 0.906 | 0.890 | 0.514 | 0.484 | 0.974 | 0.411 | 0.685 | 0.630 | 90 | 657 |
| HLA-A2601 | 10 | 0.871 | 0.917 | 0.500 | 0.439 | 0.952 | 0.421 | 0.615 | 0.719 | 19 | 105 |
| HLA-A2602 | Overall | 0.833 | 0.862 | 0.690 | 0.589 | 0.933 | 0.606 | 0.800 | 0.814 | 33 | 75 |
| HLA-A2602 | 9 | 0.827 | 0.859 | 0.690 | 0.583 | 0.930 | 0.606 | 0.800 | 0.816 | 33 | 71 |
| HLA-A2603 | Overall | 0.849 | 0.834 | 0.364 | 0.300 | 0.949 | 0.286 | 0.500 | 0.559 | 14 | 79 |
| HLA-A2603 | 9 | 0.841 | 0.824 | 0.364 | 0.295 | 0.946 | 0.286 | 0.500 | 0.560 | 14 | 74 |
| HLA-A2902 | Overall | 0.793 | 0.805 | 0.533 | 0.419 | 0.918 | 0.445 | 0.663 | 0.631 | 146 | 404 |
| HLA-A2902 | 9 | 0.786 | 0.778 | 0.477 | 0.364 | 0.917 | 0.390 | 0.612 | 0.570 | 105 | 315 |
| HLA-A2902 | 10 | 0.798 | 0.852 | 0.697 | 0.558 | 0.903 | 0.622 | 0.793 | 0.800 | 37 | 62 |
| HLA-A2902 | 11 | 0.824 | 0.905 | 0.400 | 0.310 | 0.929 | 0.333 | 0.500 | 0.700 | 3 | 14 |
| HLA-A2902 | 13 | 0.500 | 1.000 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 1.000 | 1 | 1 |
| HLA-A3001 | Overall | 0.836 | 0.871 | 0.683 | 0.573 | 0.889 | 0.686 | 0.681 | 0.722 | 140 | 404 |
| HLA-A3001 | 9 | 0.835 | 0.879 | 0.697 | 0.583 | 0.889 | 0.692 | 0.702 | 0.766 | 133 | 351 |
| HLA-A3001 | 10 | 0.840 | 0.791 | 0.500 | 0.411 | 0.884 | 0.571 | 0.444 | 0.371 | 7 | 43 |
| HLA-A3002 | Overall | 0.760 | 0.827 | 0.599 | 0.431 | 0.851 | 0.565 | 0.638 | 0.637 | 131 | 282 |
| HLA-A3002 | 8 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1 | 10 |
| HLA-A3002 | 9 | 0.799 | 0.832 | 0.620 | 0.486 | 0.886 | 0.579 | 0.667 | 0.658 | 76 | 193 |
| HLA-A3002 | 10 | 0.650 | 0.745 | 0.586 | 0.282 | 0.701 | 0.580 | 0.592 | 0.620 | 50 | 67 |
| HLA-A3002 | 11 | 0.636 | 0.893 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 0.804 | 4 | 7 |
| HLA-A3101 | Overall | 0.841 | 0.904 | 0.712 | 0.602 | 0.892 | 0.708 | 0.717 | 0.786 | 318 | 827 |
| HLA-A3101 | 8 | 0.833 | 0.750 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 0.643 | 2 | 10 |
| HLA-A3101 | 9 | 0.861 | 0.925 | 0.732 | 0.638 | 0.910 | 0.725 | 0.739 | 0.821 | 207 | 587 |
| HLA-A3101 | 10 | 0.789 | 0.855 | 0.688 | 0.529 | 0.837 | 0.694 | 0.682 | 0.724 | 108 | 215 |
| HLA-A3101 | 11 | 0.818 | 0.900 | NA | -0.100 | 0.900 | 0.000 | 0.000 | 0.500 | 1 | 10 |
| HLA-A3201 | Overall | 0.825 | 0.866 | 0.724 | 0.596 | 0.872 | 0.724 | 0.724 | 0.756 | 76 | 164 |
| HLA-A3201 | 9 | 0.771 | 0.826 | 0.726 | 0.530 | 0.796 | 0.736 | 0.716 | 0.763 | 72 | 103 |
| HLA-A3201 | 10 | 0.963 | 0.800 | 0.667 | 0.693 | 1.000 | 0.500 | 1.000 | 0.576 | 4 | 50 |
| HLA-A3207 | Overall | 0.895 | 0.944 | 0.941 | 0.544 | 1.000 | 0.889 | 1.000 | 0.997 | 18 | 1 |
| HLA-A3207 | 9 | 0.895 | 0.944 | 0.941 | 0.544 | 1.000 | 0.889 | 1.000 | 0.997 | 18 | 1 |
| HLA-A3301 | Overall | 0.892 | 0.918 | 0.693 | 0.627 | 0.938 | 0.679 | 0.706 | 0.753 | 131 | 601 |
| HLA-A3301 | 9 | 0.910 | 0.928 | 0.739 | 0.687 | 0.957 | 0.699 | 0.785 | 0.807 | 73 | 327 |
| HLA-A3301 | 10 | 0.868 | 0.911 | 0.650 | 0.568 | 0.913 | 0.667 | 0.633 | 0.718 | 57 | 253 |
| HLA-A3301 | 13 | 0.667 | 0.000 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 0.333 | 1 | 2 |
| HLA-A6801 | Overall | 0.808 | 0.902 | 0.782 | 0.612 | 0.809 | 0.808 | 0.757 | 0.876 | 344 | 465 |
| HLA-A6801 | 9 | 0.789 | 0.889 | 0.768 | 0.577 | 0.779 | 0.802 | 0.737 | 0.865 | 192 | 249 |
| HLA-A6801 | 10 | 0.821 | 0.910 | 0.797 | 0.637 | 0.827 | 0.813 | 0.782 | 0.893 | 150 | 196 |
| HLA-A6801 | 11 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 2 | 8 |
| HLA-A6802 | Overall | 0.863 | 0.898 | 0.710 | 0.620 | 0.913 | 0.703 | 0.717 | 0.776 | 263 | 836 |
| HLA-A6802 | 8 | 0.935 | 0.931 | 0.500 | 0.466 | 0.966 | 0.500 | 0.500 | 0.667 | 2 | 29 |
| HLA-A6802 | 9 | 0.875 | 0.900 | 0.730 | 0.650 | 0.930 | 0.703 | 0.759 | 0.784 | 175 | 554 |
| HLA-A6802 | 10 | 0.822 | 0.886 | 0.682 | 0.560 | 0.860 | 0.718 | 0.649 | 0.780 | 85 | 236 |
| HLA-A6802 | 11 | 0.923 | 1.000 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 1.000 | 1 | 12 |
| HLA-A6901 | Overall | 0.929 | 0.895 | 0.561 | 0.526 | 0.970 | 0.511 | 0.622 | 0.599 | 45 | 465 |
| HLA-A6901 | 9 | 0.929 | 0.896 | 0.561 | 0.526 | 0.970 | 0.511 | 0.622 | 0.601 | 45 | 464 |
| HLA-B0702 | Overall | 0.870 | 0.925 | 0.775 | 0.684 | 0.913 | 0.767 | 0.783 | 0.819 | 249 | 607 |
| HLA-B0702 | 8 | 0.824 | 0.933 | NA | -0.091 | 0.933 | 0.000 | 0.000 | 0.583 | 2 | 15 |
| HLA-B0702 | 9 | 0.885 | 0.928 | 0.786 | 0.708 | 0.925 | 0.778 | 0.795 | 0.818 | 189 | 508 |
| HLA-B0702 | 10 | 0.784 | 0.876 | 0.765 | 0.565 | 0.806 | 0.759 | 0.772 | 0.848 | 58 | 67 |
| HLA-B0801 | Overall | 0.835 | 0.856 | 0.621 | 0.516 | 0.904 | 0.599 | 0.645 | 0.664 | 167 | 572 |
| HLA-B0801 | 8 | 0.875 | 1.000 | 0.667 | 0.655 | 0.857 | 1.000 | 0.500 | 1.000 | 1 | 7 |
| HLA-B0801 | 9 | 0.828 | 0.858 | 0.628 | 0.516 | 0.894 | 0.613 | 0.643 | 0.667 | 150 | 482 |
| HLA-B0801 | 10 | 0.850 | 0.778 | 0.500 | 0.437 | 0.954 | 0.400 | 0.667 | 0.624 | 15 | 65 |
| HLA-B0801 | 11 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1 | 10 |
| HLA-B0802 | Overall | 0.944 | 0.864 | 0.421 | 0.410 | 0.984 | 0.333 | 0.571 | 0.482 | 12 | 184 |
| HLA-B0802 | 9 | 0.943 | 0.862 | 0.421 | 0.409 | 0.984 | 0.333 | 0.571 | 0.482 | 12 | 182 |
| HLA-B0803 | Overall | 0.968 | 1.000 | 0.571 | 0.622 | 0.967 | 1.000 | 0.400 | 1.000 | 2 | 91 |
| HLA-B0803 | 9 | 0.978 | 1.000 | 0.667 | 0.699 | 0.977 | 1.000 | 0.500 | 1.000 | 2 | 87 |
| HLA-B1501 | Overall | 0.833 | 0.887 | 0.715 | 0.601 | 0.910 | 0.665 | 0.773 | 0.806 | 281 | 612 |
| HLA-B1501 | 9 | 0.824 | 0.875 | 0.687 | 0.569 | 0.906 | 0.635 | 0.748 | 0.777 | 252 | 576 |
| HLA-B1501 | 10 | 0.939 | 0.981 | 0.945 | 0.876 | 0.952 | 0.929 | 0.963 | 0.988 | 28 | 21 |
| HLA-B1501 | 11 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1 | 4 |
| HLA-B1503 | Overall | 0.848 | 0.922 | 0.872 | 0.688 | 0.846 | 0.850 | 0.895 | 0.944 | 80 | 52 |
| HLA-B1503 | 8 | 0.875 | 0.571 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 0.250 | 1 | 7 |
| HLA-B1503 | 9 | 0.829 | 0.897 | 0.873 | 0.611 | 0.781 | 0.849 | 0.899 | 0.947 | 73 | 32 |
| HLA-B1503 | 10 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 3 | 8 |
| HLA-B1503 | 11 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 3 | 3 |
| HLA-B1517 | Overall | 0.839 | 0.876 | 0.676 | 0.570 | 0.906 | 0.649 | 0.706 | 0.743 | 74 | 212 |
| HLA-B1517 | 9 | 0.836 | 0.870 | 0.657 | 0.550 | 0.905 | 0.629 | 0.688 | 0.719 | 70 | 211 |
| HLA-B1801 | Overall | 0.912 | 0.824 | 0.510 | 0.486 | 0.977 | 0.403 | 0.694 | 0.570 | 62 | 484 |
| HLA-B1801 | 8 | 0.875 | 0.625 | 0.667 | 0.655 | 1.000 | 0.500 | 1.000 | 0.642 | 4 | 12 |
| HLA-B1801 | 9 | 0.929 | 0.826 | 0.515 | 0.515 | 0.988 | 0.386 | 0.773 | 0.576 | 44 | 409 |
| HLA-B1801 | 10 | 0.814 | 0.890 | 0.522 | 0.407 | 0.875 | 0.545 | 0.500 | 0.661 | 11 | 48 |
| HLA-B1801 | 11 | 0.700 | 0.619 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 0.592 | 3 | 7 |
| HLA-B2705 | Overall | 0.877 | 0.894 | 0.637 | 0.563 | 0.930 | 0.622 | 0.653 | 0.663 | 127 | 603 |
| HLA-B2705 | 8 | 0.755 | 0.870 | 0.581 | 0.442 | 0.756 | 0.750 | 0.474 | 0.660 | 12 | 41 |
| HLA-B2705 | 9 | 0.903 | 0.881 | 0.624 | 0.570 | 0.953 | 0.587 | 0.667 | 0.640 | 75 | 469 |
| HLA-B2705 | 10 | 0.821 | 0.931 | 0.714 | 0.614 | 0.952 | 0.600 | 0.882 | 0.859 | 25 | 42 |
| HLA-B2705 | 11 | 0.831 | 0.921 | 0.667 | 0.556 | 0.867 | 0.714 | 0.625 | 0.734 | 14 | 45 |
| HLA-B2705 | 13 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1 | 2 |
| HLA-B3501 | Overall | 0.800 | 0.874 | 0.663 | 0.522 | 0.873 | 0.637 | 0.692 | 0.743 | 215 | 480 |
| HLA-B3501 | 8 | 0.778 | 0.875 | 0.333 | 0.236 | 0.813 | 0.500 | 0.250 | 0.450 | 2 | 16 |
| HLA-B3501 | 9 | 0.815 | 0.897 | 0.710 | 0.582 | 0.904 | 0.649 | 0.783 | 0.823 | 194 | 364 |
| HLA-B3501 | 10 | 0.700 | 0.750 | 0.400 | 0.227 | 0.741 | 0.526 | 0.323 | 0.397 | 19 | 81 |
| HLA-B3503 | Overall | 0.911 | 0.937 | 0.286 | 0.242 | 0.943 | 0.333 | 0.250 | 0.360 | 3 | 53 |
| HLA-B3503 | 9 | 0.931 | 1.000 | 0.500 | 0.556 | 1.000 | 0.333 | 1.000 | 1.000 | 3 | 26 |
| HLA-B3701 | Overall | 0.875 | 0.897 | 0.500 | 0.537 | 1.000 | 0.333 | 1.000 | 0.810 | 3 | 13 |
| HLA-B3701 | 8 | 0.500 | 1.000 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 1.000 | 1 | 1 |
| HLA-B3701 | 9 | 0.800 | 1.000 | 0.667 | 0.612 | 1.000 | 0.500 | 1.000 | 1.000 | 2 | 3 |
| HLA-B3801 | Overall | 0.845 | 0.875 | 0.694 | 0.604 | 0.942 | 0.607 | 0.810 | 0.744 | 28 | 69 |
| HLA-B3801 | 9 | 0.868 | 0.932 | 0.739 | 0.656 | 0.939 | 0.680 | 0.810 | 0.781 | 25 | 66 |
| HLA-B3801 | 10 | 0.600 | 0.333 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 0.450 | 2 | 3 |
| HLA-B3901 | Overall | 0.871 | 0.881 | 0.456 | 0.382 | 0.925 | 0.462 | 0.450 | 0.526 | 39 | 294 |
| HLA-B3901 | 9 | 0.869 | 0.879 | 0.456 | 0.381 | 0.924 | 0.462 | 0.450 | 0.527 | 39 | 288 |
| HLA-B4001 | Overall | 0.903 | 0.947 | 0.731 | 0.673 | 0.934 | 0.757 | 0.707 | 0.788 | 115 | 546 |
| HLA-B4001 | 9 | 0.929 | 0.961 | 0.771 | 0.729 | 0.960 | 0.762 | 0.780 | 0.831 | 84 | 452 |
| HLA-B4001 | 10 | 0.747 | 0.838 | 0.648 | 0.465 | 0.750 | 0.742 | 0.575 | 0.744 | 31 | 68 |
| HLA-B4002 | Overall | 0.849 | 0.927 | 0.759 | 0.651 | 0.869 | 0.800 | 0.721 | 0.807 | 55 | 130 |
| HLA-B4002 | 8 | 0.846 | 1.000 | 0.500 | 0.527 | 0.833 | 1.000 | 0.333 | 1.000 | 1 | 12 |
| HLA-B4002 | 9 | 0.831 | 0.904 | 0.727 | 0.606 | 0.871 | 0.741 | 0.714 | 0.769 | 27 | 62 |
| HLA-B4002 | 10 | 0.851 | 0.938 | 0.800 | 0.685 | 0.854 | 0.846 | 0.759 | 0.863 | 26 | 48 |
| HLA-B4002 | 11 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1 | 6 |
| HLA-B4013 | Overall | 0.800 | 1.000 | 0.875 | 0.509 | 1.000 | 0.778 | 1.000 | 1.000 | 9 | 1 |
| HLA-B4013 | 9 | 0.800 | 1.000 | 0.875 | 0.509 | 1.000 | 0.778 | 1.000 | 1.000 | 9 | 1 |
| HLA-B4201 | Overall | 0.787 | 0.817 | 0.545 | 0.532 | 1.000 | 0.375 | 1.000 | 0.745 | 16 | 31 |
| HLA-B4201 | 9 | 0.696 | 0.826 | 0.533 | 0.479 | 1.000 | 0.364 | 1.000 | 0.818 | 11 | 12 |
| HLA-B4201 | 10 | 0.846 | 0.833 | 0.500 | 0.527 | 1.000 | 0.333 | 1.000 | 0.698 | 3 | 10 |
| HLA-B4402 | Overall | 0.907 | 0.946 | 0.746 | 0.693 | 0.962 | 0.685 | 0.818 | 0.837 | 92 | 371 |
| HLA-B4402 | 8 | 0.889 | 0.969 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 0.833 | 2 | 16 |
| HLA-B4402 | 9 | 0.913 | 0.941 | 0.714 | 0.668 | 0.966 | 0.648 | 0.795 | 0.803 | 54 | 268 |
| HLA-B4402 | 10 | 0.877 | 0.941 | 0.800 | 0.713 | 0.931 | 0.765 | 0.839 | 0.901 | 34 | 72 |
| HLA-B4402 | 11 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 2 | 10 |
| HLA-B4403 | Overall | 0.837 | 0.913 | 0.747 | 0.629 | 0.899 | 0.714 | 0.783 | 0.838 | 91 | 179 |
| HLA-B4403 | 8 | 0.889 | 0.875 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 0.500 | 1 | 8 |
| HLA-B4403 | 9 | 0.836 | 0.910 | 0.739 | 0.619 | 0.880 | 0.739 | 0.739 | 0.806 | 46 | 100 |
| HLA-B4403 | 10 | 0.828 | 0.916 | 0.785 | 0.646 | 0.895 | 0.738 | 0.838 | 0.906 | 42 | 57 |
| HLA-B4403 | 11 | 0.909 | 0.800 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 0.333 | 1 | 10 |
| HLA-B4403 | 13 | 0.500 | 1.000 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 1.000 | 1 | 1 |
| HLA-B4501 | Overall | 0.874 | 0.916 | 0.542 | 0.471 | 0.920 | 0.571 | 0.516 | 0.559 | 28 | 187 |
| HLA-B4501 | 8 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1 | 13 |
| HLA-B4501 | 9 | 0.882 | 0.924 | 0.480 | 0.418 | 0.948 | 0.429 | 0.545 | 0.562 | 14 | 96 |
| HLA-B4501 | 10 | 0.811 | 0.889 | 0.563 | 0.460 | 0.836 | 0.692 | 0.474 | 0.621 | 13 | 61 |
| HLA-B4601 | Overall | 0.952 | 0.901 | 0.370 | 0.360 | 0.985 | 0.294 | 0.500 | 0.370 | 17 | 337 |
| HLA-B4601 | 9 | 0.951 | 0.902 | 0.370 | 0.360 | 0.985 | 0.294 | 0.500 | 0.375 | 17 | 332 |
| HLA-B4801 | Overall | 0.903 | 0.884 | NA | -0.038 | 0.982 | 0.000 | 0.000 | 0.350 | 15 | 170 |
| HLA-B4801 | 9 | 0.903 | 0.884 | NA | -0.038 | 0.982 | 0.000 | 0.000 | 0.350 | 15 | 170 |
| HLA-B5101 | Overall | 0.902 | 0.839 | 0.440 | 0.396 | 0.963 | 0.373 | 0.537 | 0.455 | 59 | 510 |
| HLA-B5101 | 8 | 0.846 | 0.364 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 0.171 | 2 | 11 |
| HLA-B5101 | 9 | 0.897 | 0.844 | 0.430 | 0.384 | 0.962 | 0.362 | 0.531 | 0.453 | 47 | 390 |
| HLA-B5101 | 10 | 0.910 | 0.897 | 0.526 | 0.478 | 0.956 | 0.500 | 0.556 | 0.610 | 10 | 90 |
| HLA-B5301 | Overall | 0.859 | 0.904 | 0.730 | 0.634 | 0.914 | 0.707 | 0.753 | 0.751 | 82 | 222 |
| HLA-B5301 | 9 | 0.846 | 0.909 | 0.733 | 0.637 | 0.941 | 0.649 | 0.841 | 0.851 | 57 | 118 |
| HLA-B5301 | 10 | 0.854 | 0.886 | 0.737 | 0.648 | 0.859 | 0.840 | 0.656 | 0.636 | 25 | 78 |
| HLA-B5401 | Overall | 0.911 | 0.928 | 0.667 | 0.631 | 0.976 | 0.564 | 0.815 | 0.746 | 39 | 207 |
| HLA-B5401 | 9 | 0.885 | 0.906 | 0.679 | 0.620 | 0.960 | 0.594 | 0.792 | 0.760 | 32 | 125 |
| HLA-B5401 | 10 | 0.933 | 0.960 | 0.600 | 0.631 | 1.000 | 0.429 | 1.000 | 0.816 | 7 | 53 |
| HLA-B5701 | Overall | 0.912 | 0.928 | 0.695 | 0.659 | 0.977 | 0.594 | 0.838 | 0.803 | 96 | 475 |
| HLA-B5701 | 9 | 0.931 | 0.950 | 0.750 | 0.726 | 0.988 | 0.638 | 0.911 | 0.857 | 80 | 410 |
| HLA-B5701 | 10 | 0.804 | 0.738 | 0.375 | 0.259 | 0.884 | 0.375 | 0.375 | 0.498 | 8 | 43 |
| HLA-B5701 | 11 | 0.667 | 0.875 | 0.500 | 0.329 | 0.900 | 0.375 | 0.750 | 0.836 | 8 | 10 |
| HLA-B5703 | Overall | 0.571 | 1.000 | 0.667 | 0.354 | 1.000 | 0.500 | 1.000 | 1.000 | 6 | 1 |
| HLA-B5703 | 9 | 0.571 | 1.000 | 0.667 | 0.354 | 1.000 | 0.500 | 1.000 | 1.000 | 6 | 1 |
| HLA-B5801 | Overall | 0.880 | 0.920 | 0.698 | 0.624 | 0.938 | 0.662 | 0.738 | 0.784 | 136 | 512 |
| HLA-B5801 | 8 | 0.846 | 0.583 | NA | -0.083 | 0.917 | 0.000 | 0.000 | 0.167 | 1 | 12 |
| HLA-B5801 | 9 | 0.893 | 0.928 | 0.730 | 0.666 | 0.947 | 0.689 | 0.778 | 0.808 | 122 | 456 |
| HLA-B5801 | 10 | 0.690 | 0.795 | 0.435 | 0.223 | 0.774 | 0.455 | 0.417 | 0.569 | 11 | 31 |
| HLA-B5801 | 11 | 0.875 | 0.917 | 0.667 | 0.655 | 1.000 | 0.500 | 1.000 | 0.833 | 2 | 6 |
| HLA-C0501 | Overall | 0.795 | 0.805 | 0.750 | 0.580 | 0.864 | 0.706 | 0.800 | 0.831 | 17 | 22 |
| HLA-C0501 | 9 | 0.795 | 0.805 | 0.750 | 0.580 | 0.864 | 0.706 | 0.800 | 0.831 | 17 | 22 |
| HLA-C1203 | Overall | 0.800 | 0.803 | 0.885 | 0.185 | 0.500 | 0.818 | 0.964 | 0.987 | 33 | 2 |
| HLA-C1203 | 9 | 0.800 | 0.803 | 0.885 | 0.185 | 0.500 | 0.818 | 0.964 | 0.987 | 33 | 2 |
| Mamu-A01 | Overall | 0.751 | 0.811 | 0.692 | 0.483 | 0.799 | 0.681 | 0.702 | 0.776 | 204 | 294 |
| Mamu-A01 | 8 | 0.761 | 0.879 | 0.712 | 0.534 | 0.719 | 0.839 | 0.619 | 0.831 | 31 | 57 |
| Mamu-A01 | 9 | 0.741 | 0.819 | 0.732 | 0.489 | 0.805 | 0.682 | 0.789 | 0.846 | 88 | 82 |
| Mamu-A01 | 10 | 0.759 | 0.798 | 0.639 | 0.462 | 0.849 | 0.596 | 0.689 | 0.716 | 52 | 93 |
| Mamu-A01 | 11 | 0.747 | 0.758 | 0.647 | 0.451 | 0.790 | 0.667 | 0.629 | 0.648 | 33 | 62 |
| Mamu-A02 | Overall | 0.736 | 0.824 | 0.685 | 0.465 | 0.824 | 0.630 | 0.750 | 0.784 | 119 | 142 |
| Mamu-A02 | 8 | 0.750 | 0.851 | 0.571 | 0.398 | 0.848 | 0.533 | 0.615 | 0.706 | 15 | 33 |
| Mamu-A02 | 9 | 0.773 | 0.857 | 0.787 | 0.584 | 0.912 | 0.685 | 0.925 | 0.913 | 54 | 34 |
| Mamu-A02 | 10 | 0.765 | 0.854 | 0.667 | 0.491 | 0.857 | 0.615 | 0.727 | 0.801 | 26 | 42 |
| Mamu-A02 | 11 | 0.632 | 0.681 | 0.571 | 0.249 | 0.667 | 0.583 | 0.560 | 0.540 | 24 | 33 |
| Mamu-A07 | Overall | 0.850 | 0.901 | 0.764 | 0.657 | 0.914 | 0.723 | 0.810 | 0.834 | 47 | 93 |
| Mamu-A07 | 8 | 0.889 | 0.889 | 0.500 | 0.542 | 1.000 | 0.333 | 1.000 | 0.667 | 3 | 15 |
| Mamu-A07 | 9 | 0.810 | 0.860 | 0.789 | 0.619 | 0.857 | 0.757 | 0.824 | 0.847 | 37 | 42 |
| Mamu-A07 | 10 | 0.833 | 0.911 | 0.571 | 0.478 | 0.867 | 0.667 | 0.500 | 0.700 | 3 | 15 |
| Mamu-A07 | 11 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 3 | 20 |
| Mamu-A2201 | Overall | 0.796 | 0.871 | 0.709 | 0.560 | 0.804 | 0.780 | 0.650 | 0.847 | 50 | 107 |
| Mamu-A2201 | 9 | 0.842 | 0.943 | 0.822 | 0.685 | 0.814 | 0.881 | 0.771 | 0.943 | 42 | 59 |
| Mamu-A2201 | 10 | 0.717 | 0.547 | 0.211 | 0.044 | 0.800 | 0.250 | 0.182 | 0.192 | 8 | 45 |
| Mamu-B01 | Overall | 0.929 | 0.825 | 0.538 | 0.502 | 0.955 | 0.583 | 0.500 | 0.486 | 12 | 156 |
| Mamu-B01 | 8 | 0.944 | 0.886 | NA | -0.029 | 0.971 | 0.000 | 0.000 | 0.200 | 1 | 35 |
| Mamu-B01 | 9 | 0.889 | 0.850 | 0.737 | 0.682 | 0.971 | 0.636 | 0.875 | 0.802 | 11 | 34 |
| Mamu-B03 | Overall | 0.908 | 0.941 | 0.800 | 0.741 | 0.932 | 0.824 | 0.778 | 0.787 | 51 | 177 |
| Mamu-B03 | 8 | 0.944 | 0.954 | 0.824 | 0.810 | 0.936 | 1.000 | 0.700 | 0.609 | 7 | 47 |
| Mamu-B03 | 9 | 0.904 | 0.923 | 0.811 | 0.752 | 0.911 | 0.882 | 0.750 | 0.793 | 17 | 56 |
| Mamu-B03 | 10 | 0.902 | 0.976 | 0.848 | 0.777 | 0.941 | 0.824 | 0.875 | 0.953 | 17 | 34 |
| Mamu-B03 | 11 | 0.896 | 0.923 | 0.706 | 0.645 | 0.949 | 0.667 | 0.750 | 0.658 | 9 | 39 |
| Mamu-B03 | 12 | 0.500 | 0.000 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 0.500 | 1 | 1 |
| Mamu-B08 | Overall | 0.846 | 0.901 | 0.726 | 0.622 | 0.870 | 0.778 | 0.681 | 0.748 | 63 | 177 |
| Mamu-B08 | 8 | 0.780 | 0.848 | 0.621 | 0.507 | 0.769 | 0.818 | 0.500 | 0.521 | 11 | 39 |
| Mamu-B08 | 9 | 0.860 | 0.906 | 0.727 | 0.634 | 0.906 | 0.727 | 0.727 | 0.818 | 22 | 64 |
| Mamu-B08 | 10 | 0.875 | 0.955 | 0.800 | 0.710 | 0.897 | 0.824 | 0.778 | 0.912 | 17 | 39 |
| Mamu-B08 | 11 | 0.848 | 0.860 | 0.720 | 0.617 | 0.882 | 0.750 | 0.692 | 0.660 | 12 | 34 |
| Mamu-B17 | Overall | 0.781 | 0.823 | 0.561 | 0.416 | 0.842 | 0.585 | 0.539 | 0.551 | 82 | 260 |
| Mamu-B17 | 9 | 0.761 | 0.825 | 0.680 | 0.493 | 0.843 | 0.636 | 0.729 | 0.716 | 55 | 83 |
| Mamu-B17 | 10 | 0.721 | 0.786 | 0.433 | 0.275 | 0.758 | 0.565 | 0.351 | 0.410 | 23 | 99 |
| Mamu-B17 | 11 | 0.911 | 0.659 | NA | 0.000 | 1.000 | 0.000 | 0.000 | 0.229 | 4 | 41 |
| Mamu-B52 | Overall | 0.755 | 0.832 | 0.805 | 0.477 | 0.681 | 0.798 | 0.812 | 0.895 | 119 | 69 |
| Mamu-B52 | 8 | 0.685 | 0.790 | 0.767 | 0.282 | 0.529 | 0.757 | 0.778 | 0.905 | 37 | 17 |
| Mamu-B52 | 9 | 0.821 | 0.867 | 0.865 | 0.602 | 0.750 | 0.857 | 0.873 | 0.937 | 56 | 28 |
| Mamu-B52 | 10 | 0.704 | 0.806 | 0.692 | 0.414 | 0.667 | 0.750 | 0.643 | 0.756 | 12 | 15 |
| Mamu-B52 | 11 | 0.739 | 0.810 | 0.769 | 0.481 | 0.778 | 0.714 | 0.833 | 0.836 | 14 | 9 |
| Mamu-B8301 | Overall | 0.679 | 0.812 | 0.658 | 0.395 | 0.829 | 0.558 | 0.800 | 0.847 | 43 | 35 |
| Mamu-B8301 | 9 | 0.725 | 0.837 | 0.718 | 0.458 | 0.789 | 0.667 | 0.778 | 0.872 | 21 | 19 |
| Mamu-B8301 | 10 | 0.622 | 0.803 | 0.588 | 0.337 | 0.867 | 0.455 | 0.833 | 0.847 | 22 | 15 |
| H-2-Db | Overall | 0.850 | 0.883 | 0.560 | 0.481 | 0.940 | 0.483 | 0.667 | 0.685 | 145 | 586 |
| H-2-Db | 8 | 0.959 | 0.530 | NA | -0.021 | 0.977 | 0.000 | 0.000 | 0.026 | 4 | 216 |
| H-2-Db | 9 | 0.765 | 0.862 | 0.609 | 0.474 | 0.917 | 0.500 | 0.778 | 0.792 | 126 | 218 |
| H-2-Db | 10 | 0.864 | 0.816 | 0.400 | 0.324 | 0.915 | 0.429 | 0.375 | 0.269 | 14 | 118 |
| H-2-Db | 11 | 0.933 | 1.000 | 0.500 | 0.557 | 0.931 | 1.000 | 0.333 | 1.000 | 1 | 29 |
| H-2-Kb | Overall | 0.774 | 0.840 | 0.688 | 0.511 | 0.822 | 0.689 | 0.687 | 0.769 | 293 | 518 |
| H-2-Kb | 8 | 0.740 | 0.811 | 0.744 | 0.481 | 0.749 | 0.732 | 0.757 | 0.821 | 183 | 171 |
| H-2-Kb | 9 | 0.787 | 0.827 | 0.640 | 0.489 | 0.840 | 0.656 | 0.624 | 0.718 | 96 | 237 |
| H-2-Kb | 10 | 0.837 | 0.852 | 0.348 | 0.259 | 0.890 | 0.400 | 0.308 | 0.441 | 10 | 82 |
| H-2-Kb | 11 | 0.839 | 0.815 | 0.286 | 0.199 | 0.926 | 0.250 | 0.333 | 0.478 | 4 | 27 |
| H-2-Kd | Overall | 0.744 | 0.816 | 0.619 | 0.434 | 0.769 | 0.686 | 0.565 | 0.632 | 51 | 117 |
| H-2-Kd | 8 | 0.800 | 0.885 | 0.571 | 0.555 | 0.769 | 1.000 | 0.400 | 0.500 | 2 | 13 |
| H-2-Kd | 9 | 0.690 | 0.789 | 0.629 | 0.371 | 0.692 | 0.688 | 0.579 | 0.679 | 32 | 52 |
| H-2-Kd | 10 | 0.739 | 0.756 | 0.455 | 0.287 | 0.806 | 0.500 | 0.417 | 0.513 | 10 | 36 |
| H-2-Kd | 11 | 0.913 | 0.955 | 0.857 | 0.795 | 0.938 | 0.857 | 0.857 | 0.928 | 7 | 16 |

**Supplementary Table2.** Performance of BVLSTM-MHC along with ten existent MHC class I predictors on independent MHCBN dataset for different length pf peptide.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Length | Methods | ACC | AUC | F1 | MCC | Specificity | Sensitivity | Precision | AUPR | # Postive examples | # Negative examples |
| 9mer | ANN [44]  | 0.880 | 0.937 | 0.606 | 0.535 | 0.934 | 0.588 | 0.625 | 0.733 | 17 | 91 |
| comblibsidney2008 [71]  | 0.742 | 0.114 | NA | 0.000 | **1.000** | 0.000 | 0.000 | 0.159 | 16 | 46 |
| NetMHCcons [42]  | 0.880 | 0.938 | 0.581 | 0.514 | 0.945 | 0.529 | 0.643 | 0.739 | 17 | 91 |
| NetMHCpan [63]  | 0.861 | 0.941 | 0.545 | 0.464 | 0.923 | 0.529 | 0.563 | 0.717 | 17 | 91 |
| NetMHCpan EL [43]  | 0.815 | 0.873 | 0.474 | 0.366 | 0.868 | 0.529 | 0.429 | 0.601 | 17 | 91 |
| PickPocket [27]  | 0.870 | 0.886 | 0.667 | 0.607 | 0.879 | 0.824 | 0.560 | 0.615 | 17 | 91 |
| SMM [72]  | 0.898 | 0.944 | 0.667 | 0.607 | 0.945 | 0.647 | 0.688 | 0.801 | 17 | 91 |
| SMMPMBEC [25]  | 0.898 | 0.940 | 0.667 | 0.607 | 0.945 | 0.647 | 0.688 | 0.800 | 17 | 91 |
| BVLSTM-MHC | **0.963** | **0.958** | **0.875** | **0.863** | **1.000** | 0.778 | **1.000** | **0.909** | 21 | 128 |
| CNN-NF [46]  | 0.872 | 0.881 | 0.667 | 0.598 | 0.890 | 0.778 | 0.583 | 0.619 | 21 | 128 |
| MHCflurry [45] | 0.789 | 0.859 | 0.566 | 0.488 | 0.780 | **0.833** | 0.429 | 0.512 | 21 | 125 |
| non 9mer | ANN [44]  | 0.879 | 0.905 | 0.765 | 0.706 | 0.978 | 0.650 | 0.929 | 0.861 | 20 | 51 |
| NetMHCcons [42]  | 0.924 | 0.901 | 0.872 | 0.819 | 0.957 | 0.850 | 0.895 | 0.913 | 20 | 51 |
| NetMHCpan [63]  | 0.833 | 0.868 | 0.645 | 0.590 | 0.978 | 0.500 | 0.909 | 0.816 | 20 | 51 |
| NetMHCpan EL [43]  | 0.803 | 0.827 | 0.552 | 0.507 | 0.978 | 0.400 | 0.889 | 0.753 | 20 | 51 |
| PickPocket [27]  | 0.864 | 0.836 | 0.710 | 0.678 | **1.000** | 0.550 | **1.000** | 0.806 | 20 | 51 |
| SMM [72]  | **0.982** | 0.954 | **0.947** | **0.939** | **1.000** | **0.900** | **1.000** | 0.932 | 10 | 46 |
| SMMPMBEC [25]  | 0.946 | **0.991** | 0.842 | 0.812 | 0.978 | 0.800 | 0.889 | 0.965 | 10 | 46 |
| BVLSTM-MHC | 0.970 | 0.961 | **0.947** | 0.929 | **1.000** | **0.900** | **1.000** | **0.966** | 21 | 51 |
| CNN-NF [46]  | 0.828 | 0.793 | 0.615 | 0.508 | 0.870 | 0.667 | 0.571 | 0.703 | 13 | 46 |
| MHCflurry [45] | 0.727 | 0.726 | 0.400 | 0.273 | 0.913 | 0.300 | 0.600 | 0.570 | 20 | 51 |