

Offline 3 report

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1805052

Model-1

```
# learning rate
lr = [0.005, 0.0025, 0.001, 0.00075]
for lrate in lr:
    model = FNN(
        loss=CategoricalCrossEntropyLoss(),
        optimizer=SGD(learning_rate=lrate),
        learning_rate=lrate,
        layers=[
            Flatten(),
            DenseLayer(input_size, 1024, ReLU()),
            DropoutLayer(dropout_rate=0.3),
            DenseLayer(1024, 256, ReLU()),
            DropoutLayer(dropout_rate=0.2),
            DenseLayer(256, 64, ReLU()),
            DropoutLayer(dropout_rate=0.1),
            DenseLayer(64, output_size, Softmax()),
        ]
    )
```

Epoch: 45

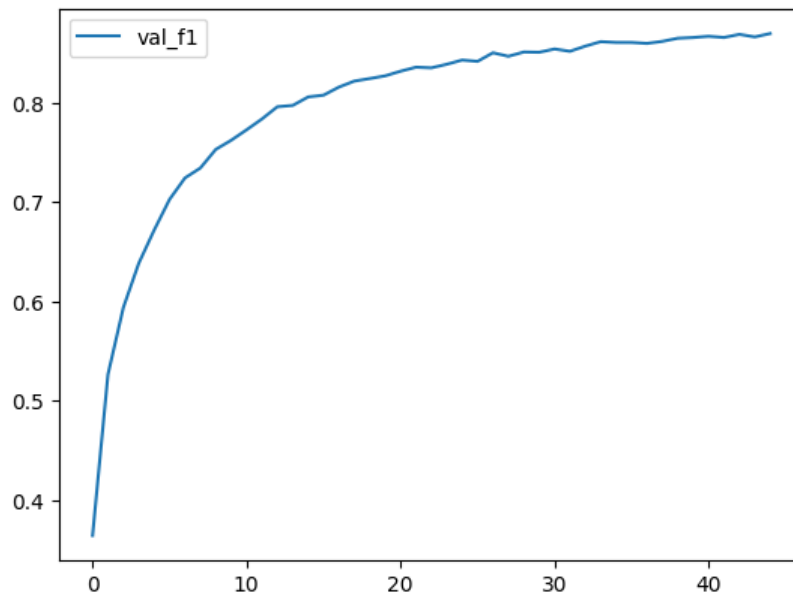
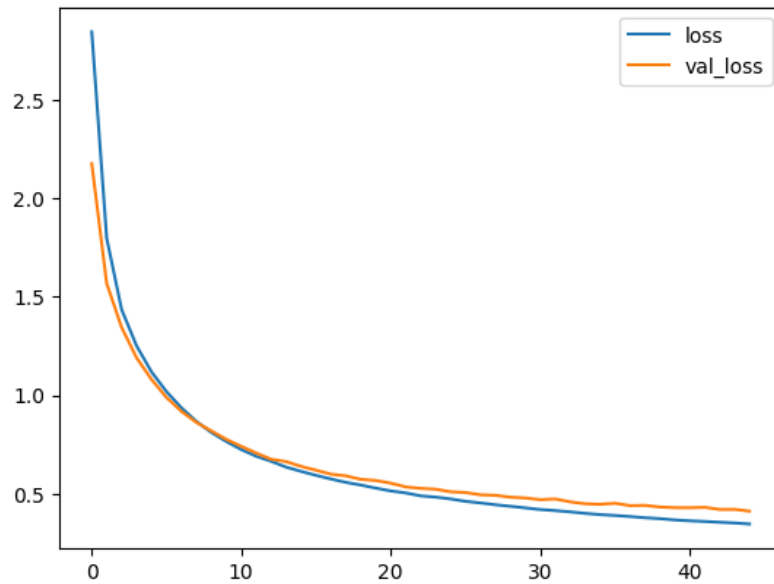
Batch-size: 64

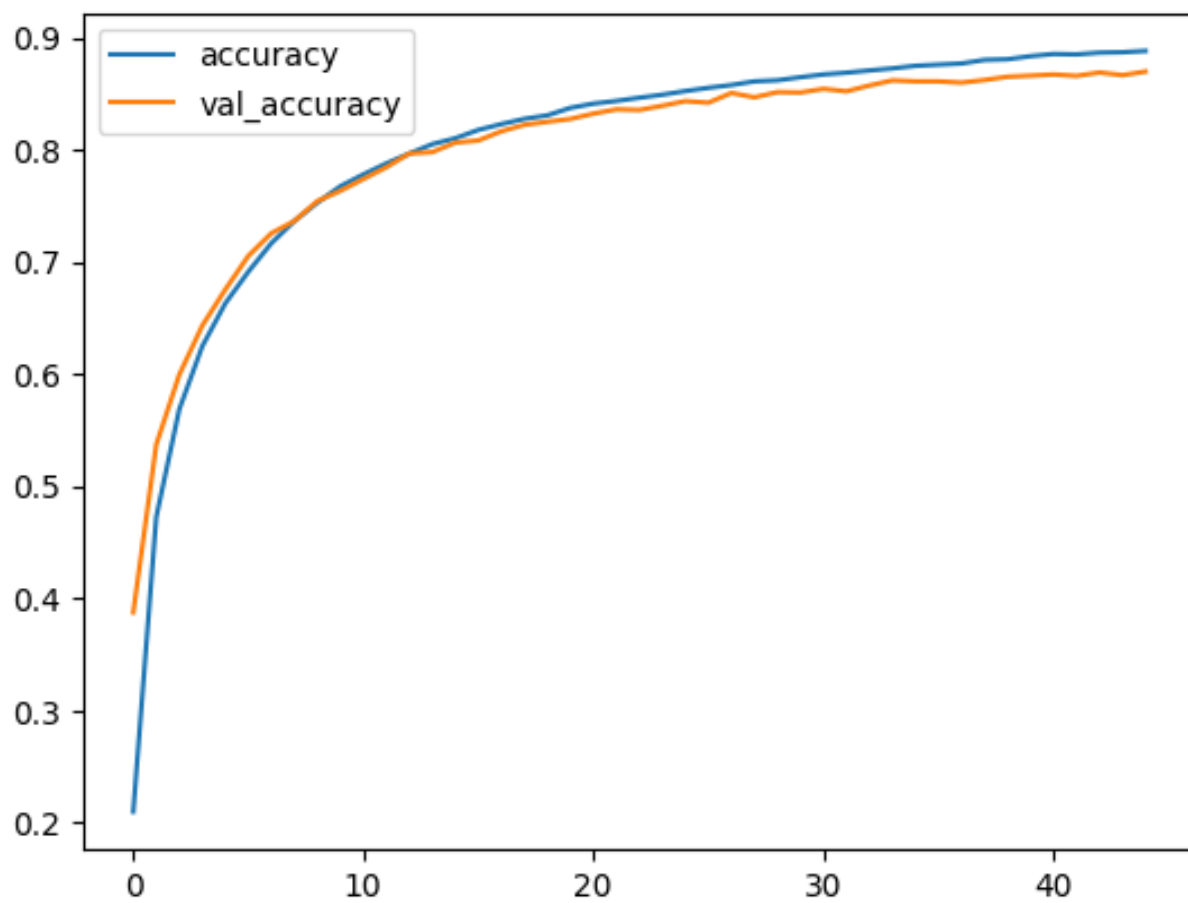
Input size: 768

Output size: 26

Learning rate 0.005

Test accuracy: 0.8701 Test loss: 0.4098 Test f1: 0.8700





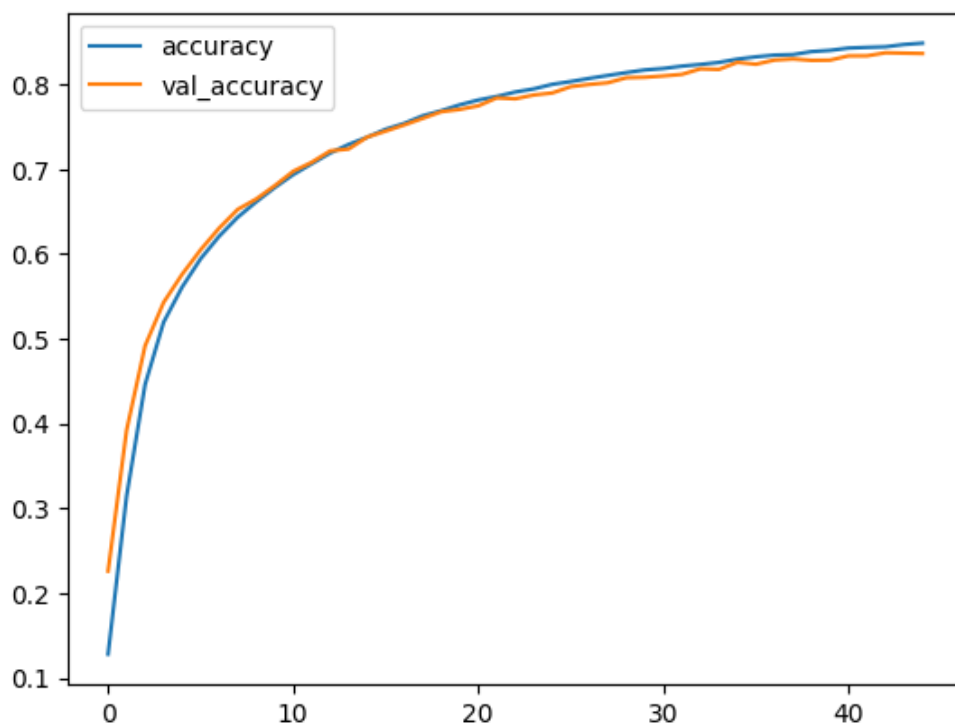
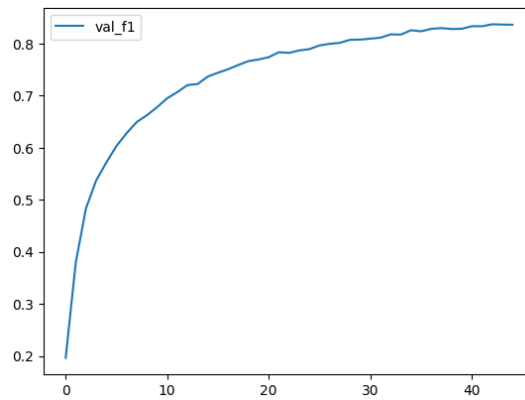
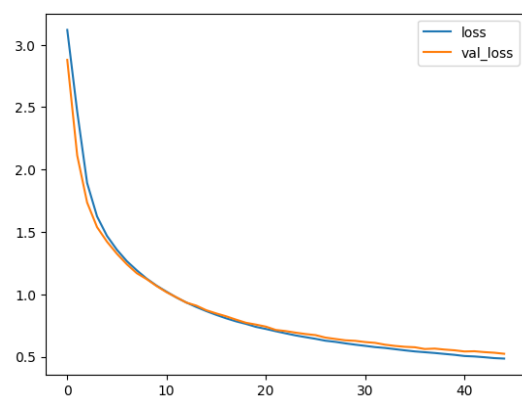
Actual	0	678	6	4	8	4	2	9	10	0	1	1	0	2	7	11	4	25	10	0	3	3	0	2	3	1	6
	1	-9	715	1	7	4	1	13	19	0	3	1	2	1	6	3	0	3	2	1	1	0	0	0	1	0	7
	2	-4	2	733	1	29	2	4	0	1	0	2	4	0	0	6	1	2	3	0	0	2	0	1	1	1	1
	3	-15	13	1	686	0	0	3	1	1	7	1	1	2	8	39	4	3	2	0	0	6	0	2	1	3	1
	4	-8	2	31	1	720	4	4	0	0	1	1	1	0	0	3	3	3	6	1	4	1	0	1	1	0	4
	5	-2	0	0	1	2	707	3	0	2	3	0	3	0	0	0	38	2	7	3	23	0	0	0	1	1	2
	6	-24	15	5	3	5	6	577	0	1	9	0	0	0	1	2	2	125	1	16	1	2	0	1	0	4	0
	7	-10	18	0	7	0	1	0	682	1	0	19	11	10	22	0	1	0	2	0	1	4	0	6	3	2	0
	8	-0	0	3	1	1	1	1	0	576	15	0	175	0	0	0	0	1	3	3	2	1	1	1	3	0	12
	9	-0	2	0	16	1	2	5	0	29	697	0	4	0	0	1	1	1	0	9	21	1	2	0	0	4	4
	10	-3	5	1	0	2	3	0	22	0	1	704	7	2	4	0	0	1	10	0	6	3	1	4	16	2	3
	11	-0	0	6	0	0	3	0	8	186	0	5	574	0	0	1	1	2	3	0	0	2	0	0	0	5	4
	12	-5	0	0	1	0	0	0	5	0	0	2	0	756	15	1	2	0	0	0	2	2	0	7	1	0	1
	13	-20	0	0	9	0	0	0	14	0	0	11	1	21	682	1	4	0	5	0	1	7	3	17	3	1	0
	14	-9	0	5	15	2	0	1	0	0	0	0	0	0	3	752	2	5	0	1	0	4	0	1	0	0	0
	15	-1	0	0	6	1	15	2	0	0	0	0	0	0	3	0	749	7	8	0	5	0	1	0	0	1	1
	16	-34	3	2	3	9	8	106	0	4	0	0	0	0	2	4	8	599	1	3	2	3	0	0	0	9	0
	17	-12	2	4	0	8	9	0	1	2	0	19	1	2	5	1	10	1	688	1	12	0	10	1	5	4	2
	18	-6	0	0	1	1	1	17	1	2	13	0	0	0	1	0	0	2	0	753	1	0	0	0	0	1	0
	19	-0	4	3	1	5	10	0	1	2	7	3	3	0	0	1	0	2	13	1	725	0	0	0	2	14	3
	20	-2	0	1	3	0	0	4	4	0	1	0	2	2	1	4	0	2	0	1	0	724	36	11	0	2	0
	21	-0	0	0	3	0	0	0	0	0	1	2	1	1	1	0	1	0	8	1	0	25	728	6	4	18	0
	22	-4	1	0	1	0	0	0	3	0	1	1	0	3	12	0	0	1	0	0	1	10	5	756	1	0	0
	23	-5	0	0	1	0	1	0	2	3	1	21	2	0	1	0	0	2	5	0	2	3	7	1	725	14	4
	24	-0	1	0	1	0	0	12	2	0	10	2	3	1	0	0	2	3	4	2	9	2	19	2	13	712	0
	25	-5	6	1	4	7	0	4	1	9	0	0	3	0	0	0	0	4	2	0	2	0	0	0	3	0	749
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
	Predicted																										

Learning rate 0.0025

Test accuracy:0.8367

Test loss: 0.5253

Test f1: 0.8364



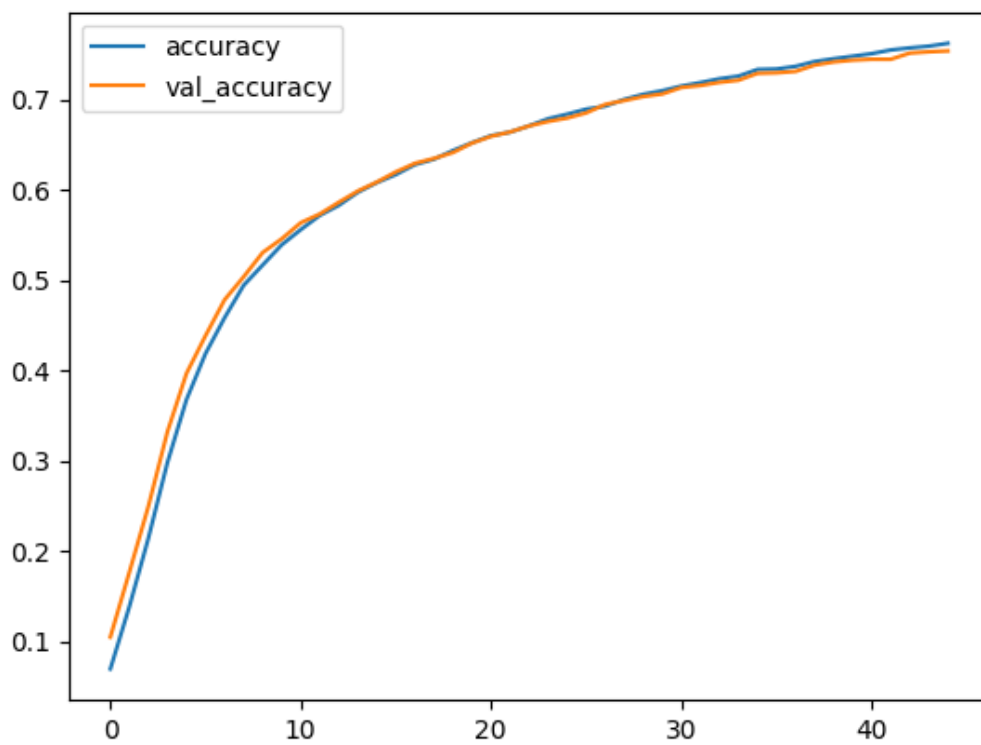
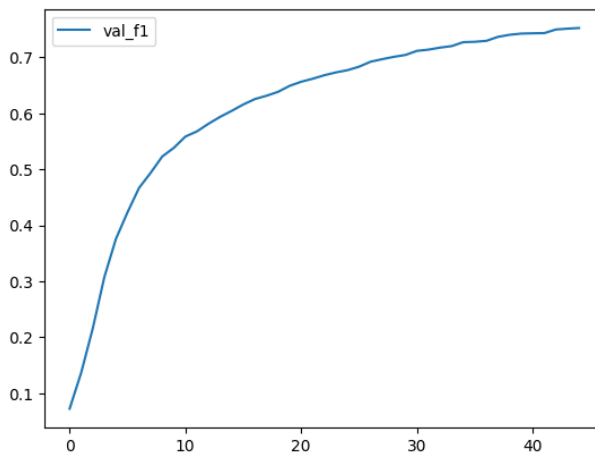
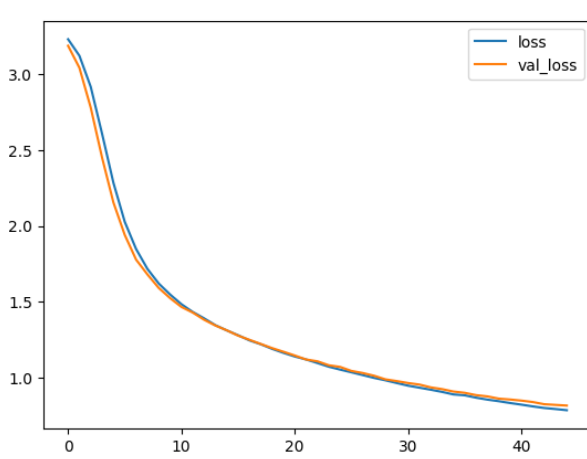
Actual	0	-615	6	4	15	6	6	13	11	0	1	6	0	8	8	16	6	40	7	1	2	17	0	2	3	0	7
	1	-10	685	1	16	4	0	18	25	3	1	0	4	1	5	5	2	4	1	1	3	0	0	0	0	0	11
	2	-4	2	724	3	31	1	2	0	2	1	1	5	0	0	7	0	3	5	2	2	2	0	1	0	0	2
	3	-14	22	1	652	0	1	3	6	1	11	6	0	2	3	52	6	4	0	2	0	7	0	3	0	3	1
	4	-12	4	40	0	695	8	2	0	1	0	1	1	1	0	5	2	2	9	3	6	1	0	0	2	0	5
	5	-1	3	0	2	4	692	3	0	2	3	0	0	1	0	0	38	5	8	4	29	0	0	0	0	3	2
	6	-28	19	10	3	5	12	515	1	2	10	0	0	1	1	5	5	140	2	26	1	2	0	1	1	9	1
	7	-10	15	0	8	0	1	0	666	1	0	24	13	10	25	0	1	0	3	0	2	8	0	7	2	2	2
	8	-0	1	1	1	1	2	0	0	544	17	2	194	0	0	1	0	1	4	6	1	0	2	1	4	6	11
	9	-4	3	0	20	0	4	12	1	29	682	0	5	0	0	1	0	1	0	10	18	2	2	0	0	4	2
	10	-5	6	1	0	1	5	0	33	1	0	678	9	3	8	0	0	1	15	0	4	2	5	4	15	3	1
	11	-1	2	8	3	1	2	0	5	193	3	3	563	0	0	0	0	0	3	0	4	2	1	0	0	5	1
	12	-7	0	0	1	0	0	2	10	0	0	1	0	737	22	0	0	1	4	0	5	3	0	6	0	1	0
	13	-23	0	0	10	0	0	0	19	0	0	10	0	35	648	2	1	0	9	0	1	12	4	22	2	2	0
	14	-2	3	3	10	1	0	1	0	0	1	0	0	1	4	763	4	3	0	0	0	2	2	0	0	0	0
	15	-2	0	0	3	1	27	4	0	0	0	0	1	1	5	0	730	5	10	0	8	0	1	0	1	0	1
	16	-35	2	5	5	6	7	119	1	5	7	1	0	1	2	9	10	559	4	1	7	5	0	2	0	6	1
	17	-22	2	6	0	7	13	0	3	3	0	14	1	5	4	1	6	6	659	0	24	0	7	0	6	4	7
	18	-4	3	3	1	3	2	28	1	3	22	0	0	0	2	2	0	4	1	718	0	0	0	0	0	0	3
	19	-2	4	1	2	6	15	0	5	6	0	4	7	0	0	2	4	3	14	1	701	0	0	0	2	19	2
	20	-6	2	1	6	0	0	1	7	0	5	4	1	1	9	5	0	5	0	1	0	696	34	14	1	0	1
	21	-0	0	0	3	0	0	0	0	0	1	2	3	2	2	0	1	2	7	1	1	39	704	2	3	27	0
	22	-1	1	0	5	0	0	0	4	0	0	2	0	8	10	0	0	1	0	0	1	15	6	745	1	0	0
	23	-8	1	0	2	0	1	1	5	5	0	31	3	2	1	0	0	2	6	1	2	0	7	2	692	24	4
	24	-0	3	0	6	0	0	12	1	2	15	1	2	1	2	0	1	8	5	4	10	0	33	1	13	680	0
	25	-5	5	3	8	17	0	5	0	6	4	2	7	2	0	0	3	3	3	3	3	0	0	0	4	0	717
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	Predicted																										

Learning rate 0.001

Test accuracy: 0.7588

Test loss: 0.7973

Test f1: 0.7580



Actual	0	-541	10	10	21	14	8	17	38	0	2	0	0	8	19	19	11	30	5	4	2	18	1	3	6	1	12
	1	-13	615	0	16	11	3	21	38	2	5	2	7	2	13	9	3	5	2	8	4	2	0	0	3	1	15
	2	-14	2	655	3	51	1	7	0	1	0	4	9	0	1	19	6	2	10	1	2	7	0	1	0	0	4
	3	-21	47	2	549	0	3	6	16	3	19	9	8	1	8	58	4	0	1	3	2	22	4	4	1	1	8
	4	-17	9	57	0	639	4	3	0	0	3	2	2	1	6	8	4	9	13	5	8	2	0	1	2	1	4
	5	-4	3	2	1	4	605	8	2	6	6	0	4	0	0	0	71	13	33	2	28	0	1	1	0	6	0
	6	-40	30	13	5	11	11	453	2	3	22	1	1	2	1	2	2	141	1	34	4	4	1	3	1	10	2
	7	-23	19	0	13	1	3	1	600	3	2	37	13	18	32	0	1	0	2	0	2	11	1	8	5	5	0
	8	-0	1	2	1	1	7	0	1	493	29	3	205	0	0	0	0	1	5	9	10	2	1	1	11	3	14
	9	-0	5	3	33	0	4	9	4	20	631	0	12	0	0	1	2	5	1	20	21	6	0	0	0	15	8
	10	-3	8	7	2	5	3	0	58	1	0	594	14	4	10	0	1	2	22	0	6	9	7	2	35	5	2
	11	-0	5	12	3	2	5	0	4	218	4	5	478	0	0	1	1	3	0	0	13	8	4	1	3	17	13
	12	-5	0	0	0	1	0	0	9	0	0	2	0	710	42	1	7	3	1	0	4	2	0	9	2	1	1
	13	-33	2	0	6	3	2	0	36	0	1	22	0	46	556	2	0	1	10	0	2	12	14	46	4	1	1
	14	-7	2	9	22	2	0	5	0	0	0	0	0	2	7	731	1	3	3	1	1	3	0	1	0	0	0
	15	-5	0	1	2	2	28	4	3	0	0	0	0	1	6	2	704	6	14	0	16	0	0	0	0	6	0
	16	-43	5	7	7	12	16	122	0	6	9	2	2	0	3	9	18	483	1	8	16	7	0	3	2	16	3
	17	-30	1	9	1	22	22	0	10	4	0	28	1	7	11	1	13	10	557	1	31	0	13	2	11	12	3
	18	-6	10	2	2	2	1	23	0	3	37	1	0	3	1	1	0	12	4	680	2	2	0	0	1	0	7
	19	-2	13	1	3	16	29	8	16	14	11	8	11	4	0	1	8	14	36	4	553	0	2	1	4	37	4
	20	-12	1	2	20	0	0	2	10	0	4	7	2	2	7	6	0	1	1	1	0	667	36	17	0	1	1
	21	-1	0	0	4	1	1	0	3	1	0	5	6	1	9	0	1	1	13	0	2	51	640	14	8	38	0
	22	-2	0	0	6	0	0	0	7	0	2	4	4	9	21	0	0	2	3	0	0	31	3	705	1	0	0
	23	-7	1	0	2	0	2	4	6	9	0	43	4	0	3	0	0	1	9	0	4	0	11	5	649	34	6
	24	-1	5	0	5	0	5	18	4	7	17	3	6	3	2	0	5	3	3	5	20	4	43	0	18	622	1
	25	-9	7	8	4	15	0	3	2	10	11	1	13	3	1	0	3	6	5	3	3	2	0	3	16	2	670
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	

Model 2

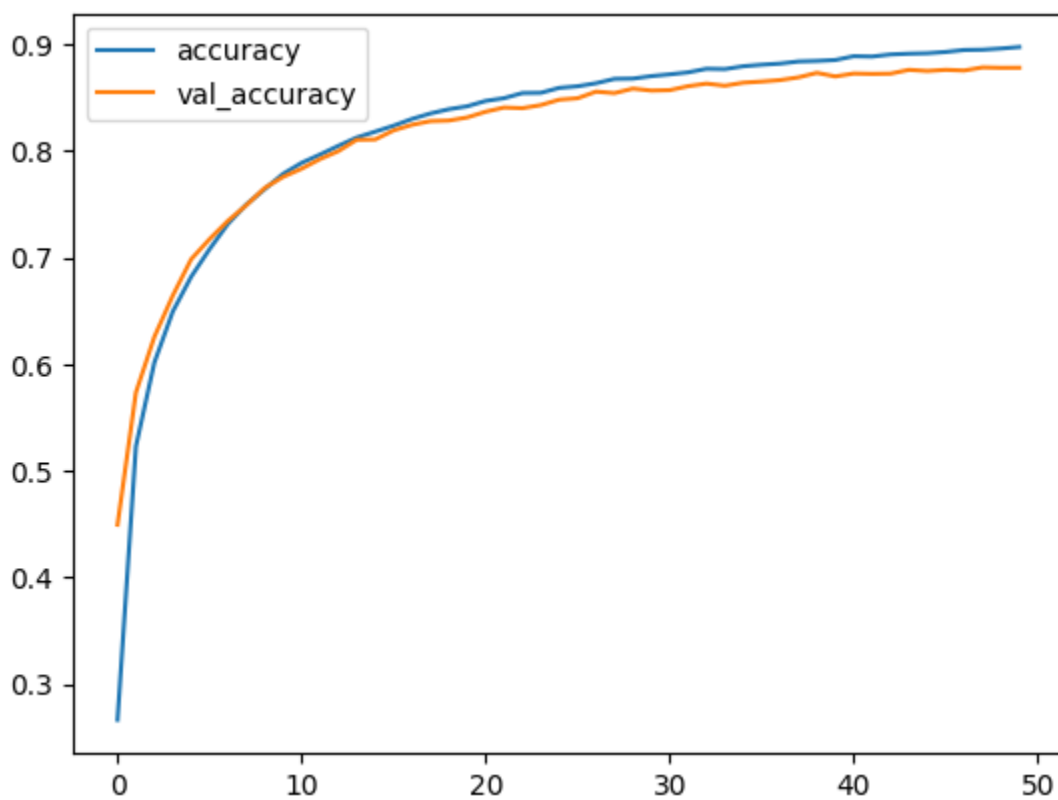
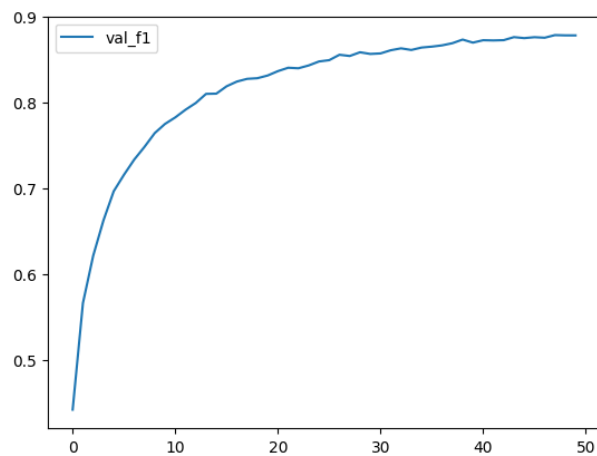
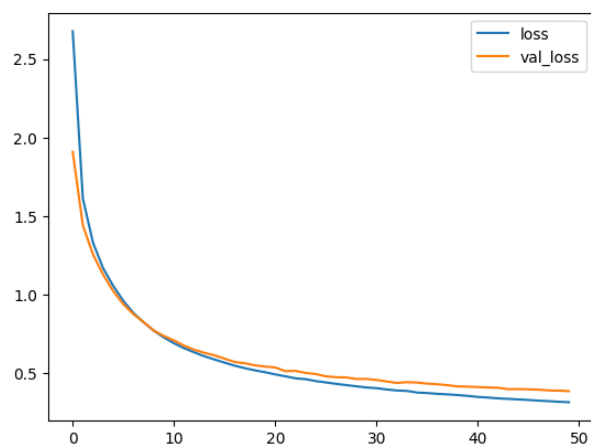
```
# learning rate
lr = [0.005, 0.0025, 0.001, 0.00075]
for lrate in lr:
    model = FNN(
        loss=CategoricalCrossEntropyLoss(),
        optimizer=SGD(learning_rate=lrate),
        learning_rate=lrate,
        layers=[
            Flatten(),
            DenseLayer(input_size, 1024, ReLU()),
            DropoutLayer(dropout_rate=0.3),
            DenseLayer(1024, 512, ReLU()),
            DropoutLayer(dropout_rate=0.2),
            DenseLayer(512, 64, ReLU()),
            DropoutLayer(dropout_rate=0.1),
            DenseLayer(64, output_size, Softmax()),
        ]
    )
```

epoch : 50

Batch size: 64

Learning rate: 0.005

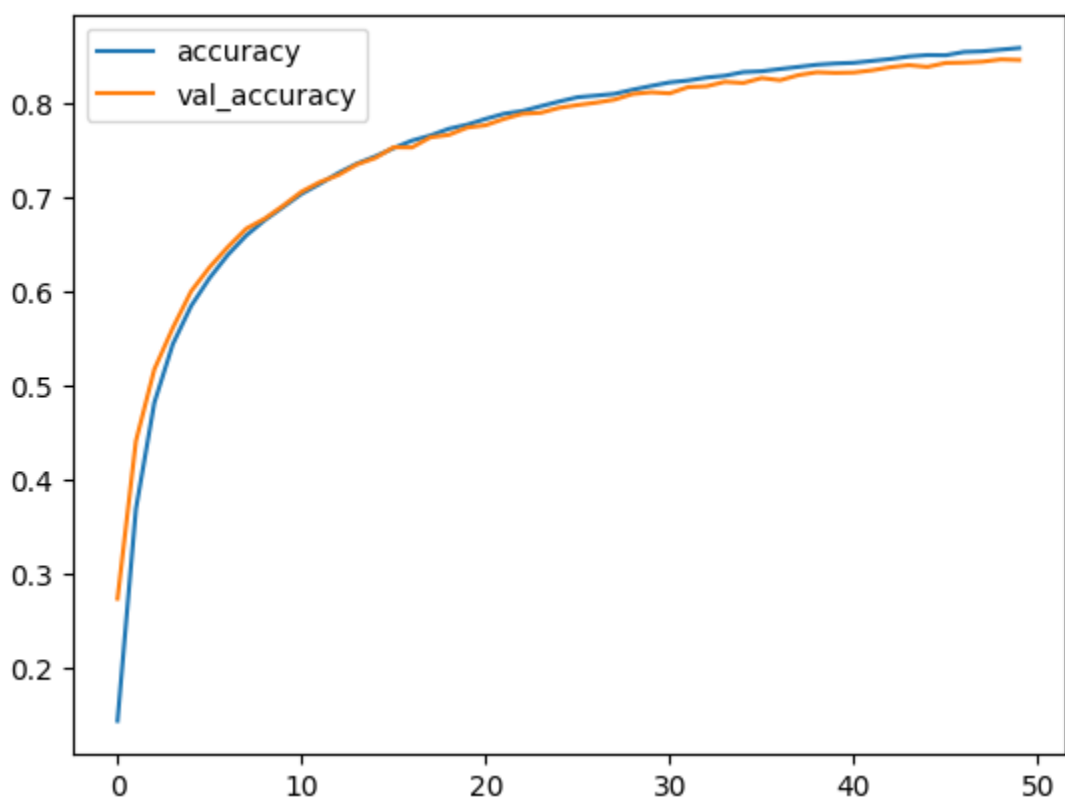
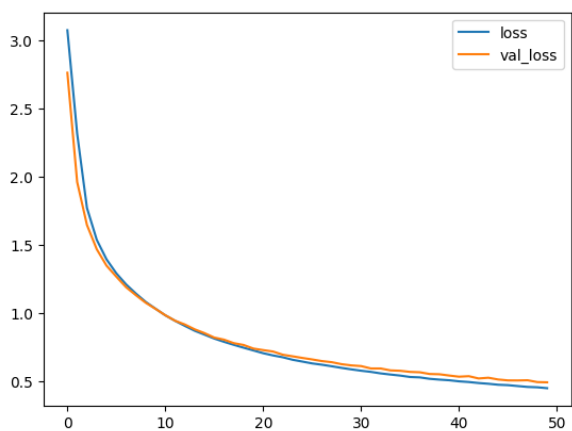
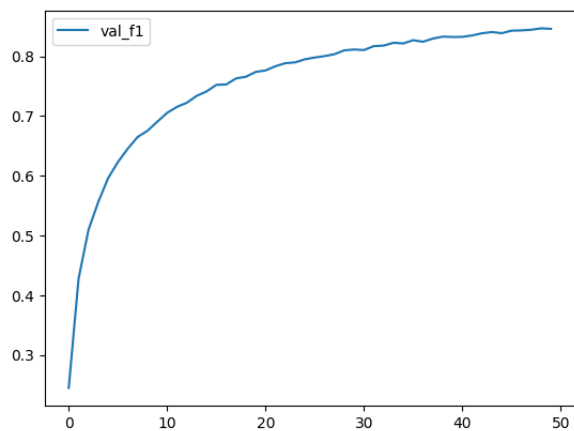
test loss: 0.38948337996316845, test accuracy: 0.8771634615384616, test f1:
0.8769679654957349



Actual	0	668	4	6	13	5	2	11	8	0	0	6	1	1	7	7	4	29	7	0	1	8	0	0	3	0	9
	1	8	721	1	7	4	0	12	19	0	0	0	4	1	4	1	1	2	2	5	1	0	0	0	0	0	7
	2	0	0	733	2	30	0	3	0	0	0	1	7	0	0	5	1	2	7	4	2	1	0	1	0	0	1
	3	9	21	1	693	0	1	2	3	1	5	0	3	1	2	37	10	2	2	1	1	4	0	0	0	0	1
	4	4	5	25	1	733	5	1	0	0	0	0	3	0	0	1	3	1	6	1	5	1	0	1	2	0	2
	5	1	0	0	1	3	717	6	0	1	0	0	1	0	0	0	25	3	8	3	29	0	0	0	0	1	1
	6	20	20	9	2	4	6	582	0	0	7	0	0	0	1	2	2	124	2	13	0	1	0	0	0	5	0
	7	6	9	0	5	0	1	0	708	1	0	15	10	9	17	0	1	0	2	0	4	5	0	4	1	1	1
	8	1	0	2	1	1	1	1	2	541	15	0	214	0	0	0	0	0	5	4	1	1	0	1	3	0	6
	9	0	2	0	9	1	1	6	0	21	712	0	4	0	0	0	0	1	0	11	15	0	1	0	1	11	4
	10	2	5	1	0	3	2	0	19	1	1	722	4	0	2	0	0	0	13	0	4	2	2	1	13	2	1
	11	0	2	7	2	2	2	0	5	158	3	6	601	0	0	0	0	1	1	0	1	1	0	0	1	5	2
	12	5	1	0	0	0	0	0	9	0	0	0	0	744	20	0	0	0	2	0	3	2	0	10	2	1	1
	13	15	1	0	7	0	0	1	18	0	1	6	0	17	698	1	0	1	3	0	1	6	3	14	4	3	0
	14	2	1	5	19	1	0	2	0	0	0	0	0	0	3	758	2	3	0	1	0	3	0	0	0	0	0
	15	0	0	0	3	2	15	0	0	0	0	0	0	0	1	0	753	7	12	0	2	0	0	0	0	3	2
	16	34	2	2	5	6	8	89	1	1	1	0	0	1	2	8	6	609	3	1	5	3	0	2	1	6	4
	17	8	1	4	0	5	6	0	1	1	0	13	1	3	1	0	10	3	696	0	19	0	12	0	8	6	2
	18	3	6	2	0	0	3	11	1	2	11	0	1	0	1	0	0	2	0	756	1	0	0	0	0	0	0
	19	0	8	1	1	5	10	0	3	5	3	3	1	0	0	2	0	2	4	1	731	0	0	0	3	16	1
	20	5	0	2	4	0	0	2	4	0	3	3	1	0	4	4	0	0	1	1	0	725	31	8	0	2	0
	21	0	0	0	4	0	0	0	0	0	1	0	2	0	1	0	0	1	10	0	1	35	718	3	4	20	0
	22	1	1	0	2	0	0	0	2	0	0	2	0	3	13	0	0	1	0	0	1	8	1	763	0	2	0
	23	3	0	0	1	2	1	0	1	0	0	27	2	1	4	0	0	2	6	0	3	1	5	1	719	17	4
	24	0	4	0	1	0	0	9	2	1	8	1	0	0	0	0	1	8	6	1	9	5	22	0	8	714	0
	25	5	0	4	4	6	0	5	1	5	1	0	6	0	0	0	0	1	2	1	4	0	0	0	3	0	752
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
		Predicted																									

Learning rate: 0.0025

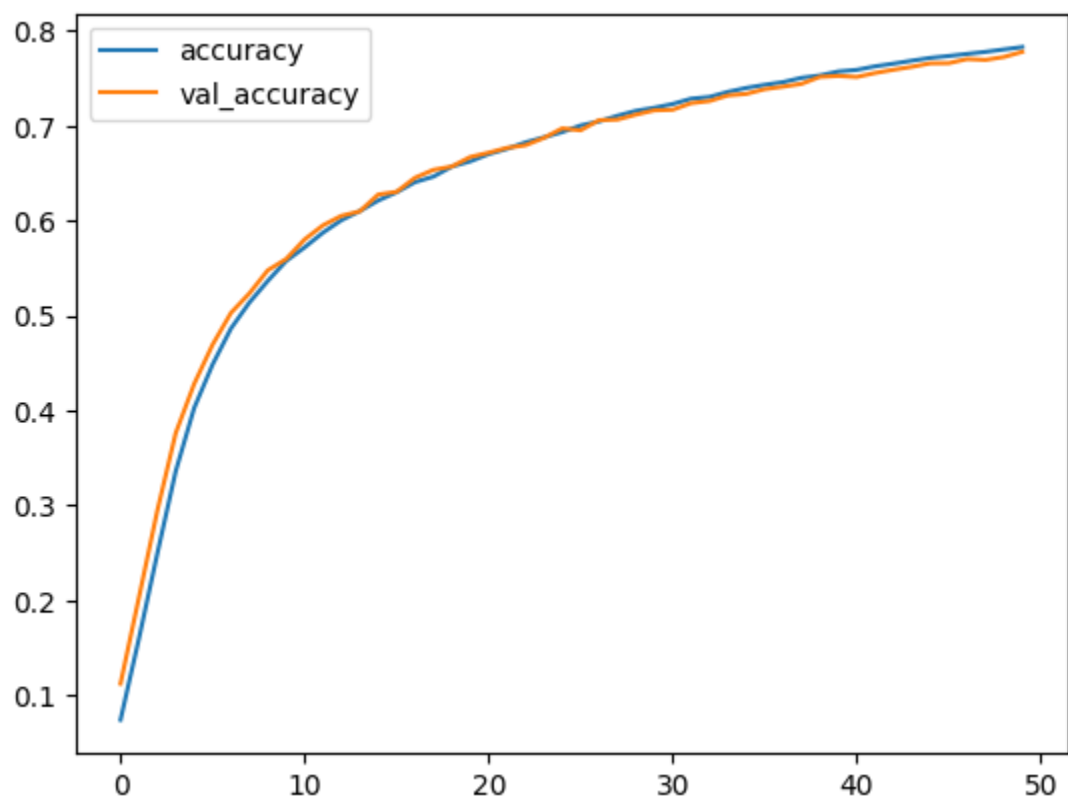
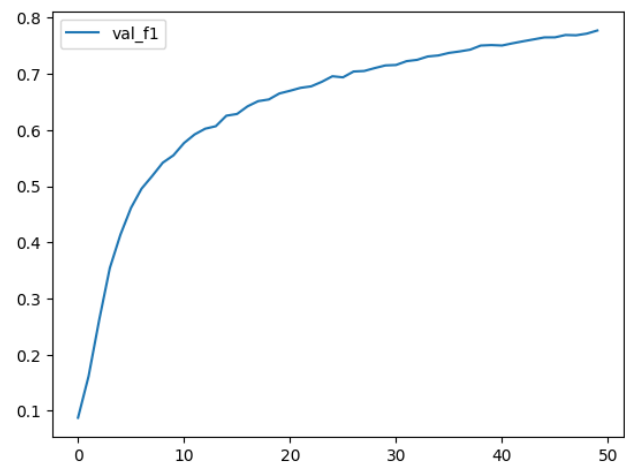
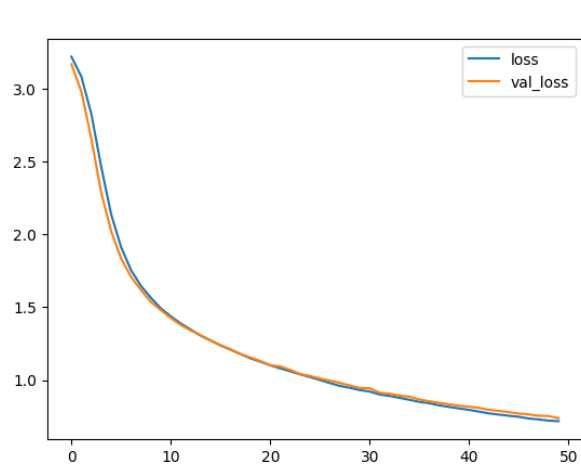
test loss: 0.49303265428495935, test accuracy: 0.8479326923076923, test f1:
0.8477188075617893



Actual	0	632	3	6	9	13	3	12	12	0	1	5	0	7	9	19	8	36	3	4	2	5	0	2	2	0	7
	1	11	697	0	18	5	0	16	22	1	0	0	5	1	3	4	0	1	2	2	0	1	0	1	1	0	9
	2	3	0	717	3	32	1	3	0	1	0	1	6	0	0	10	2	2	8	2	3	1	0	2	1	0	2
	3	16	23	1	641	1	3	3	3	0	10	5	2	1	9	50	6	7	0	0	1	9	1	0	0	3	5
	4	10	8	30	0	704	7	1	0	1	0	0	1	0	1	4	2	4	12	5	4	0	0	1	1	0	4
	5	2	2	0	3	2	695	2	0	2	3	2	1	0	0	0	45	3	8	2	25	0	0	0	0	3	0
	6	21	22	11	5	7	10	530	0	0	9	1	1	0	2	5	3	137	2	23	0	0	0	0	1	8	2
	7	16	17	0	11	0	0	1	655	0	0	28	14	13	23	0	1	0	2	0	4	3	0	3	5	4	0
	8	0	1	1	2	2	3	0	0	556	20	1	185	0	0	0	0	2	5	5	2	0	2	0	3	0	10
	9	1	1	0	23	1	2	4	1	32	675	0	5	0	1	0	0	1	0	18	15	2	2	0	0	8	8
	10	3	3	3	2	0	4	0	34	1	0	685	8	2	4	0	0	0	9	0	8	5	3	2	18	3	3
	11	0	3	9	1	1	4	0	0	199	3	6	552	0	1	1	1	0	2	0	3	1	2	0	3	7	1
	12	4	0	0	1	1	0	0	7	0	0	1	0	737	23	0	4	1	2	0	3	3	0	7	2	3	1
	13	22	1	0	8	1	1	1	23	0	1	11	0	32	657	1	1	1	5	0	0	5	1	23	4	0	1
	14	5	4	3	16	1	1	2	0	0	0	0	0	0	2	756	0	4	1	2	0	2	0	1	0	0	0
	15	3	0	0	4	1	29	4	0	0	1	1	0	0	2	1	732	3	9	0	6	0	1	0	0	3	0
	16	35	3	1	2	8	13	103	0	3	2	0	1	0	3	10	8	580	3	6	3	3	1	1	1	8	2
	17	17	0	4	0	11	12	1	4	2	0	20	2	3	5	1	13	6	652	1	16	1	9	1	10	6	3
	18	5	5	1	3	1	4	19	1	1	22	0	1	0	1	1	0	2	1	731	1	0	0	0	0	0	0
	19	2	4	1	3	7	9	1	0	8	2	8	4	1	1	1	2	2	14	1	711	0	0	1	3	14	0
	20	6	1	3	7	0	0	2	3	0	2	3	0	1	2	8	0	1	0	1	0	707	34	17	1	1	0
	21	0	0	0	4	0	0	0	1	0	1	2	1	0	3	0	1	1	12	1	1	41	697	3	3	28	0
	22	0	1	0	3	0	0	0	3	0	0	2	1	8	12	0	0	1	0	0	2	12	4	748	1	2	0
	23	2	0	0	2	2	2	0	5	6	2	33	3	2	2	0	0	1	4	0	0	0	4	3	700	25	2
	24	0	2	0	5	0	0	11	1	0	11	0	4	1	1	0	2	4	6	2	13	4	36	1	8	688	0
	25	4	5	3	3	9	0	5	3	7	2	1	6	2	1	0	1	1	3	1	3	0	0	0	6	1	733
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
		Predicted																									

Learning rate: 0.001

test loss: 0.7346842407856224, test accuracy: 0.7780769230769231, test f1:
0.7773129243972582



Actual	0	-579	6	5	12	14	6	17	29	0	1	8	0	3	13	22	2	28	5	1	4	20	1	5	7	0	12
	1	-15	625	1	30	11	1	22	38	1	3	1	9	1	4	10	0	4	1	7	2	0	0	2	0	1	11
	2	-7	1	654	2	55	1	11	0	2	1	4	9	0	0	24	1	2	9	3	3	3	0	3	0	0	5
	3	-22	39	2	582	1	1	12	7	4	9	8	5	1	8	58	8	4	0	0	2	11	5	4	0	2	5
	4	-11	7	48	0	661	9	2	1	1	1	3	1	2	0	6	4	6	15	7	7	2	0	2	1	0	3
	5	-0	3	1	3	6	634	3	3	4	4	2	1	0	1	1	54	7	27	4	34	0	2	0	2	3	1
	6	-25	19	13	3	14	14	474	3	0	18	0	0	2	2	10	141	3	32	3	5	1	1	1	1	12	2
	7	-27	19	0	13	0	2	0	593	2	1	33	17	14	39	1	2	0	4	0	1	12	2	4	8	6	0
	8	-1	2	0	3	1	1	1	1	507	29	3	197	0	0	0	0	2	6	9	9	1	3	0	6	2	16
	9	-1	5	0	30	1	5	8	1	23	651	0	13	0	0	0	0	4	1	5	24	9	3	0	0	10	6
	10	-6	5	4	1	2	5	0	53	2	1	610	8	7	5	0	0	1	31	0	10	5	10	3	25	3	3
	11	-0	6	10	5	0	2	0	3	179	7	11	540	0	0	0	2	0	3	1	6	6	3	0	3	8	5
	12	-13	0	0	0	0	0	0	8	0	0	3	0	705	44	1	3	2	2	0	6	2	1	6	2	2	0
	13	-24	2	0	13	1	1	0	38	0	1	25	0	40	569	5	1	1	7	0	6	14	10	34	4	2	2
	14	-3	1	9	18	1	0	1	1	0	0	0	0	5	4	736	0	9	5	1	0	5	0	1	0	0	0
	15	-3	0	0	4	2	28	4	1	0	0	0	0	1	2	2	703	7	19	0	17	0	0	0	0	7	0
	16	-46	3	1	3	11	19	98	1	3	7	1	1	2	2	16	11	520	5	7	15	8	0	2	3	12	3
	17	-29	2	3	2	23	21	0	7	3	0	48	0	9	4	1	19	9	545	0	33	0	10	0	12	13	7
	18	-4	2	1	3	3	2	23	2	0	36	0	0	1	1	4	0	5	2	703	2	3	1	1	0	0	1
	19	-1	10	2	3	11	27	7	8	13	4	7	9	2	2	1	3	7	18	1	627	0	3	1	5	26	2
	20	-12	1	1	16	0	0	3	11	2	2	2	0	1	6	5	0	1	0	1	0	681	38	16	0	1	0
	21	-1	1	0	2	0	1	0	0	1	0	3	2	2	7	0	1	1	13	0	2	45	671	4	9	33	1
	22	-2	1	0	6	0	0	0	5	0	1	5	0	13	16	0	0	0	2	0	1	21	5	720	1	0	1
	23	-8	0	0	5	2	2	4	9	6	0	50	4	3	0	0	0	1	7	0	2	0	14	1	651	28	3
	24	-2	4	0	4	1	6	12	4	5	17	1	3	5	4	0	2	5	6	3	24	2	45	2	22	619	2
	25	-5	5	8	9	13	1	5	1	7	6	10	6	2	0	0	0	5	4	2	6	0	0	0	11	3	691
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	

Model 3

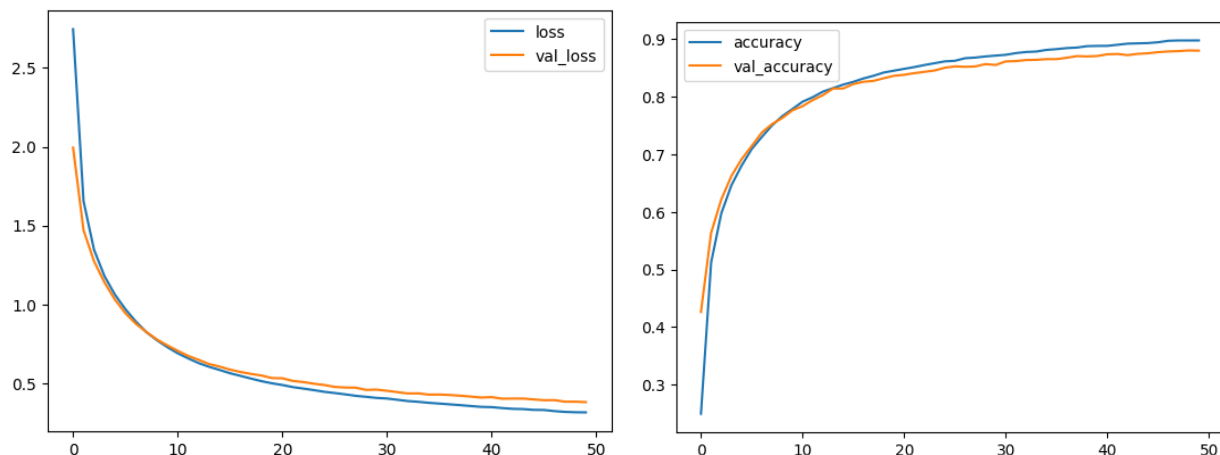
```
# learning rate
lr = [0.005, 0.0025, 0.001, 0.00075]
for lrate in lr:
    model = FNN(
        loss=CategoricalCrossEntropyLoss(),
        optimizer=SGD(learning_rate=lrate),
        learning_rate=lrate,
        layers=[
            Flatten(),
            DenseLayer(input_size, 1024, ReLU()),
            DropoutLayer(dropout_rate=0.3),
            DenseLayer(1024, 256, ReLU()),
            DropoutLayer(dropout_rate=0.2),
            DenseLayer(256, 128, ReLU()),
            DropoutLayer(dropout_rate=0.1),
            DenseLayer(128, output_size, Softmax()),
        ]
    )
```

epoch : 50

Batch size: 64

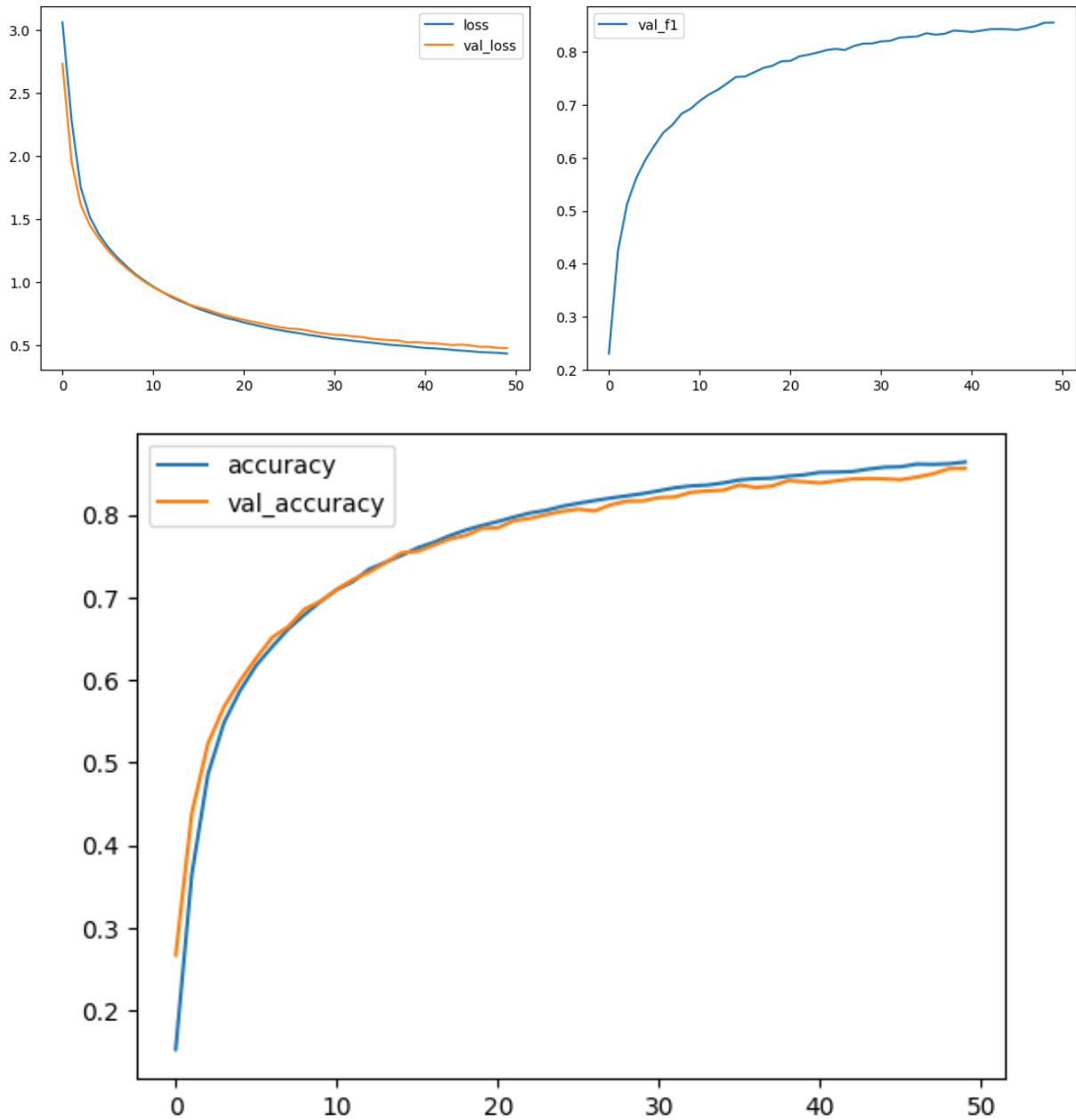
Learning rate: 0.005

test loss: 0.3740598363955921, test accuracy: 0.881201923076923, test f1:
0.8810479945586394



Learning rate: 0.0025

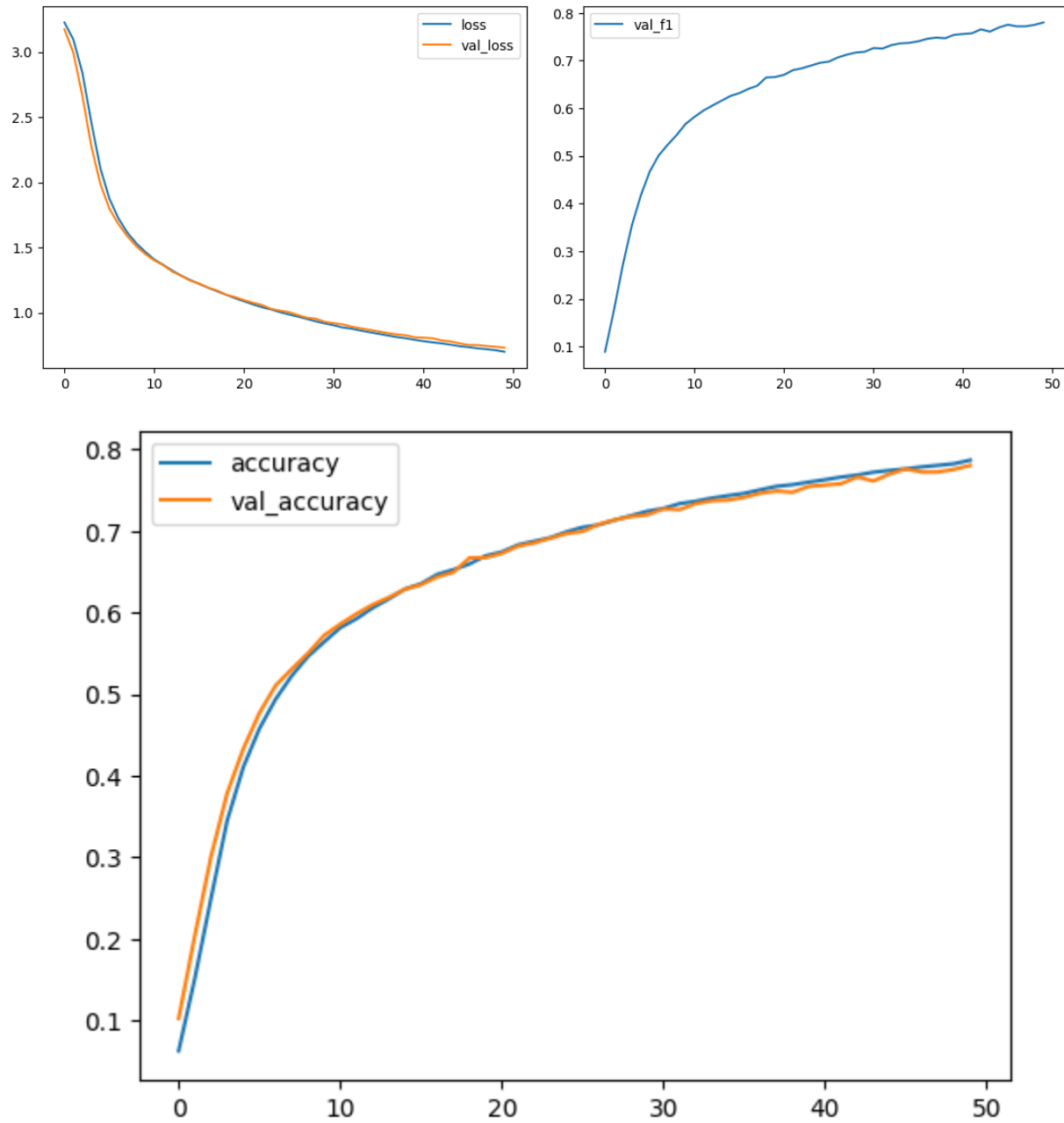
test loss: 0.4787475552579321, test accuracy: 0.8514903846153846, test f1:
0.8512685049100903



Actual	0	-632	8	2	7	12	4	14	16	0	1	3	0	5	6	18	5	37	7	1	3	5	0	2	2	1	9
	1	-11	692	1	12	4	1	18	27	3	1	0	2	1	4	5	2	4	3	3	0	0	0	0	0	0	6
	2	-2	1	715	1	41	1	4	0	0	1	1	8	0	0	9	1	3	5	0	2	2	0	1	1	0	1
	3	-18	23	3	649	0	0	3	5	1	14	3	2	1	5	47	5	4	2	1	1	6	1	3	0	1	2
	4	-7	5	31	0	710	1	2	0	0	2	2	3	0	1	4	4	4	12	3	6	0	0	0	1	1	1
	5	-2	0	1	0	4	691	4	0	3	1	0	2	0	0	0	37	3	14	3	31	0	0	1	0	2	1
	6	-18	15	3	3	8	12	545	1	1	8	0	1	1	1	6	3	139	0	19	3	0	0	1	0	11	1
	7	-16	20	0	5	0	2	0	655	2	1	24	14	16	24	0	0	1	3	0	0	6	1	4	3	3	0
	8	-0	1	1	2	2	2	0	0	541	24	2	198	1	0	0	0	1	4	6	2	0	1	1	2	0	9
	9	-1	1	0	18	0	2	5	1	30	690	0	7	0	0	0	0	2	0	7	20	3	2	0	0	7	4
	10	-4	8	2	1	0	4	0	31	1	1	680	5	3	3	0	0	1	12	0	6	3	1	6	24	3	1
	11	-0	3	5	0	0	2	0	1	167	4	5	597	0	0	0	1	1	3	0	3	2	1	1	1	1	2
	12	-6	0	0	0	0	0	0	8	0	0	4	0	743	18	0	2	0	6	0	4	1	0	4	2	1	1
	13	-17	0	0	8	0	1	1	28	0	0	10	0	25	660	1	0	0	5	0	4	7	4	24	3	1	1
	14	-9	1	5	16	4	0	2	0	0	1	0	0	0	3	751	0	4	0	0	0	4	0	0	0	0	0
	15	-5	0	0	5	1	27	3	1	0	0	0	0	1	2	1	730	9	5	0	6	0	1	0	0	3	0
	16	-30	5	1	6	12	13	92	0	2	1	1	0	1	2	7	5	591	2	1	11	5	0	0	0	9	3
	17	-10	3	6	1	10	8	1	3	1	0	20	1	3	4	0	7	2	683	1	13	0	6	0	6	7	4
	18	-4	3	0	0	2	1	23	1	2	25	0	1	0	1	2	0	1	1	732	0	0	0	0	0	0	1
	19	-2	3	3	1	5	8	1	3	5	6	4	3	1	1	1	1	3	8	2	721	0	1	0	2	10	5
	20	-6	0	1	4	0	0	0	7	0	1	2	1	0	3	5	0	1	0	1	0	716	40	10	1	1	0
	21	-0	0	0	4	0	0	0	0	0	1	4	1	0	5	0	3	1	10	0	2	36	705	2	5	21	0
	22	-1	0	0	4	0	0	0	1	0	0	4	0	5	14	0	0	0	0	0	1	14	6	749	1	0	0
	23	-2	1	0	2	1	2	1	2	2	1	29	1	3	1	0	0	1	5	0	1	1	6	2	705	26	5
	24	-0	3	0	4	0	1	13	3	2	8	2	2	2	0	0	3	5	6	2	16	4	21	1	16	686	0
	25	-4	1	2	0	10	0	4	1	7	2	1	3	0	1	0	2	3	5	2	6	0	0	0	4	1	741
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	

Learning rate: 0.001

test loss: 0.723144904547535, test accuracy: 0.7813942307692308, test f1:
0.7805492979592032



Actual	0	-564	7	4	13	13	7	13	29	0	2	7	0	9	17	23	11	29	7	2	1	21	0	6	3	0	12
	1	-16	643	1	14	16	1	20	31	2	4	1	8	1	5	5	2	4	1	9	1	0	0	1	0	0	14
	2	-12	0	675	2	47	1	9	0	3	0	1	8	0	1	16	4	1	8	1	6	1	1	2	0	0	1
	3	-16	36	3	588	1	1	7	10	1	14	8	6	2	6	49	10	6	2	4	1	13	3	4	1	2	6
	4	-16	7	49	0	651	8	2	1	1	1	1	2	1	3	6	4	8	17	9	6	1	0	0	3	0	3
	5	-1	3	2	1	8	633	5	1	7	2	2	4	0	1	0	54	10	28	2	26	0	2	1	2	3	2
	6	-28	24	13	2	9	12	456	3	1	18	2	1	3	2	5	7	151	3	25	3	5	0	5	2	20	0
	7	-18	15	0	18	1	2	0	616	6	0	33	12	14	28	1	2	1	4	0	3	10	3	6	6	1	0
	8	-0	2	1	2	1	1	0	1	557	23	2	167	1	0	0	0	1	4	5	9	1	1	1	5	1	14
	9	-3	7	1	31	0	2	6	2	27	637	0	12	0	0	0	0	4	2	15	22	3	1	0	1	11	13
	10	-7	6	6	3	3	4	0	45	2	0	602	10	3	10	0	2	2	31	0	4	4	10	7	33	3	3
	11	-0	5	10	4	0	5	0	1	237	2	10	482	0	0	0	0	2	5	0	3	5	2	2	5	10	10
	12	-9	1	0	0	0	0	1	7	0	0	1	0	720	32	0	2	1	3	0	6	3	0	7	2	5	0
	13	-25	2	0	11	0	1	1	28	0	0	24	0	48	569	3	0	2	11	0	1	15	9	43	6	0	1
	14	-7	5	6	20	5	1	3	0	0	0	0	0	1	9	725	1	11	2	0	0	4	0	0	0	0	0
	15	-6	0	0	1	2	35	4	1	0	0	0	0	1	3	1	707	10	14	0	6	2	3	0	0	3	1
	16	-47	5	3	3	6	15	78	1	2	7	1	1	1	2	11	11	568	3	5	11	6	0	1	2	8	2
	17	-27	2	6	1	15	17	0	8	3	0	36	3	6	8	1	19	7	567	1	31	0	6	3	13	15	5
	18	-6	11	2	1	1	3	24	1	2	32	0	1	2	1	3	0	5	5	699	1	0	0	0	0	0	0
	19	-1	6	3	0	7	21	4	17	16	10	8	8	3	2	1	2	3	21	0	626	0	1	0	6	30	4
	20	-13	0	1	18	0	0	1	5	0	3	7	1	1	7	5	0	4	1	1	0	667	37	26	1	0	1
	21	-1	0	0	2	0	0	0	0	2	1	4	1	2	5	0	0	1	16	0	2	36	676	7	4	40	0
	22	-2	0	0	5	0	0	1	5	0	1	5	2	6	20	0	0	0	1	0	1	17	4	729	1	0	0
	23	-6	0	1	2	0	4	4	7	4	1	41	3	1	3	0	0	3	6	0	2	1	8	2	668	28	5
	24	-1	3	0	4	0	3	10	4	3	16	2	2	6	2	0	2	3	6	3	20	4	36	0	15	654	1
	25	-3	5	2	6	11	1	2	4	4	8	4	13	2	3	0	2	4	4	6	2	3	0	0	16	4	691
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	