Supplementary Text S1. The complete listing of the steps of the proposed workflow
Supplementary Table S1. The proportion of images of each patient in the train, test, and validation dataset
Supplementary Table S2. The statistical summary of the linear models testing the relationship between the scores and the clinical variables
Supplementary Table S3. The R squared values for the linear models investigating the relationship between the scores and clinical variables
Supplementary Table S4. The statistical summary of the linear models testing the relationship between the patch-based scores and the clinical variables
Supplementary Table S5. The R squared values for the linear models investigating the relationship between the patch-based scores and clinical variables
Supplementary Table S6. The clinical and pathological findings of the second and third biopsy of the patient with multiple biopsies
Supplementary Figure S1. The visualization of the UMAP Results
Supplementary Figure S2. The representative glomeruli for each cluster
Supplementary Figure S3. The changes in the patch-based scores for the patient with multiple biopsies

Supplementary Text S1. The complete listing of the steps of the proposed workflow

Input: A set of cropped glomerulus images

- **Workflow 1: whole glomerulus images**
  1. Normalize the staining by the method proposed by Macenko *et al*.
  2. Remove the images with a higher proportion of white pixels
  3. Resize to 331 x 331
  4. Extract features using the global averaging the final layer of Neural Architecture Search Network (NASNet)
  5. Perform Uniform Manifold Approximation and Projection on the obtained vectors
  6. Clustering using Gaussian Mixture Models and the criteria of Bayesian information criterion
  7. Augmentation of the images
  8. Fine-tune the NASNet by the obtained cluster as the label
  9. Make predictions on the trained model with all the normalized images as the input
  10. Average the glomerulus score for each patient
  11. Test the relationship between clinical variables using the linear models
  12. Obtain the class activation mapping

- **Workflow 2: patched images**
  1. Normalize the staining by the method proposed by Macenko *et al*.
  2. Split the images into equally divided 16 patches
  3. Remove the images with a higher proportion of white pixels
  4. Resize all the patches to 96 x 96
  5. Extract features using convolutional autoencoder
  6. Clustering using Gaussian Mixture Models and the criteria of Bayesian information criterion
  7. Fine-tuning the encoders by the obtained cluster as the label
  8. Make predictions on the trained model with all the normalized patched images as the input
  9. Calculate the glomerulus score by summing the patch-based score
  10. Average the glomerulus score for each patient
  11. Test the relationship between clinical variables using the linear models
  12. Obtain the class activation mapping

Supplementary Table S1. The proportion of the glomerulus images of the patients included in train, test, and validation dataset

train_prop	test_prop	val_prop	patient_num
0.027	0.015	0.038	1
0.001	0.0	0.0	2
0.012	0.015	0.014	3
0.006	0.004	0.009	4
0.02	0.011	0.014	5
0.006	0.0	0.0	6
0.008	0.004	0.014	7
0.009	0.008	0.0	8
0.004	0.0	0.0	9
0.005	0.004	0.0	10
0.015	0.019	0.009	11
0.002	0.015	0.0	12
0.002	0.004	0.005	13
0.004	0.008	0.005	14
0.015	0.023	0.028	15
0.017	0.015	0.009	16
0.028	0.027	0.024	17
0.005	0.004	0.0	18
0.013	0.011	0.014	19
0.007	0.011	0.014	20
0.005	0.0	0.014	21
0.019	0.023	0.033	22
0.001	0.0	0.0	23
0.005	0.008	0.009	24
0.004	0.0	0.0	25
0.007	0.011	0.019	26
0.005	0.008	0.0	27
0.017	0.008	0.019	28
0.011	0.011	0.014	29
0.005	0.008	0.009	30
0.017	0.011	0.009	31
0.007	0.011	0.005	32
0.006	0.015	0.005	33
0.008	0.011	0.005	34
0.015	0.038	0.019	35
0.008	0.004	0.0	36
0.007	0.004	0.014	37
0.009	0.008	0.019	38
0.001	0.0	0.0	39
0.012	0.015	0.019	40
0.005	0.008	0.009	41
0.023	0.038	0.019	42
0.019	0.019	0.024	43

train_prop	test_prop	val_prop	patient_num
0.045	0.042	0.038	44
0.009	0.008	0.0	45
0.036	0.027	0.038	46
0.038	0.027	0.038	47
0.02	0.023	0.009	48
0.045	0.023	0.033	49
0.018	0.015	0.028	50
0.013	0.015	0.005	51
0.045	0.045	0.038	52
0.041	0.049	0.033	53
0.024	0.023	0.019	54
0.026	0.011	0.014	55
0.007	0.008	0.014	56
0.019	0.042	0.033	57
0.036	0.03	0.033	58
0.019	0.027	0.019	59
0.012	0.008	0.0	60
0.043	0.049	0.062	61
0.015	0.019	0.014	62
0.015	0.004	0.014	63
0.024	0.019	0.024	64
0.012	0.015	0.024	65
0.014	0.019	0.0	66
0.002	0.0	0.005	67

patient_num, the deidentified patient identification number; train_prop, the proportion of the glomeruli image of the respective patient used in the training; test_prop, the proportion of the glomeruli image of the respective patient used in the testing; val_prop, the proportion of the glomeruli image of the respective patient used in the validation.

Supplementary Table S2. The statistical summary of the linear models testing the relationship between the scores and the clinical variables

Estimate	Std. Error	t value	p-value	Variables	Cluster	Bonf	Sig
45.218	3.653	12.378	0.0	Age	(Intercept)	nan	nan
-34.252	33.33	-1.028	0.308	Age	Cluster1	1.0	False
44.421	5.25	8.461	0.0	Age	(Intercept)	nan	nan
-12.768	28.173	-0.453	0.652	Age	Cluster2	1.0	False
31.773	4.024	7.896	0.0	Age	(Intercept)	nan	nan
107.063	34.711	3.084	0.003	Age	Cluster3	0.036	True
47.275	4.372	10.814	0.0	Age	(Intercept)	nan	nan
-56.934	42.641	-1.335	0.186	Age	Cluster4	1.0	False
49.095	5.586	8.788	0.0	Age	(Intercept)	nan	nan
-245.419	183.937	-1.334	0.187	Age	Cluster5	1.0	False
50.713	3.58	14.165	0.0	Age	(Intercept)	nan	nan
-81.885	27.767	-2.949	0.004	Age	Cluster6	0.053	False
43.431	3.37	12.887	0.0	Age	(Intercept)	nan	nan
-528.05	1135.17	-0.465	0.643	Age	Cluster7	1.0	False
65.621	8.925	7.352	0.0	Age	(Intercept)	nan	nan
-171.069	63.442	-2.696	0.009	Age	Cluster8	0.107	False
39.602	3.505	11.3	0.0	Age	(Intercept)	nan	nan
192.1	191.297	1.004	0.319	Age	Cluster9	1.0	False
37.923	2.921	12.982	0.0	Age	(Intercept)	nan	nan
67.573	29.699	2.275	0.026	Age	Cluster10	0.314	False
29.794	4.827	6.172	0.0	Age	(Intercept)	nan	nan
104.36	36.089	2.892	0.005	Age	Cluster11	0.062	False
43.667	4.514	9.674	0.0	Age	(Intercept)	nan	nan
-14.887	41.752	-0.357	0.723	Age	Cluster12	1.0	False
1.138	0.1	11.344	0.0	SCr	(Intercept)	nan	nan
-2.011	0.916	-2.196	0.032	SCr	Cluster1	0.379	False
1.147	0.146	7.839	0.0	SCr	(Intercept)	nan	nan
-1.081	0.785	-1.377	0.173	SCr	Cluster2	1.0	False
0.589	0.108	5.43	0.0	SCr	(Intercept)	nan	nan
3.844	0.935	4.109	0.0	SCr	Cluster3	0.001	True
1.215	0.12	10.143	0.0	SCr	(Intercept)	nan	nan
-2.843	1.169	-2.432	0.018	SCr	Cluster4	0.213	False
1.296	0.154	8.439	0.0	SCr	(Intercept)	nan	nan
-11.873	5.055	-2.349	0.022	SCr	Cluster5	0.262	False
1.182	0.102	11.562	0.0	SCr	(Intercept)	nan	nan
-2.099	0.793	-2.647	0.01	SCr	Cluster6	0.122	False
1.018	0.095	10.728	0.0	SCr	(Intercept)	nan	nan
-23.93	31.964	-0.749	0.457	SCr	Cluster7	1.0	False
1.829	0.242	7.56	0.0	SCr	(Intercept)	nan	nan
-6.323	1.719	-3.678	0.0	SCr	Cluster8	0.006	True
0.945	0.1	9.487	0.0	SCr	(Intercept)	nan	nan

Estimate	Std. Error	t value	p-value	Variables	Cluster	Bonf	Sig
1.483	5.439	0.273	0.786	SCr	Cluster9	1.0	False
0.7	0.07	10.061	0.0	SCr	(Intercept)	nan	nan
4.125	0.707	5.832	0.0	SCr	Cluster10	0.0	True
0.466	0.127	3.664	0.0	SCr	(Intercept)	nan	nan
4.176	0.951	4.389	0.0	SCr	Cluster11	0.001	True
1.156	0.125	9.276	0.0	SCr	(Intercept)	nan	nan
-2.041	1.153	-1.771	0.081	SCr	Cluster12	0.974	False
1.842	0.37	4.983	0.0	UPro	(Intercept)	nan	nan
-5.475	3.373	-1.623	0.109	UPro	Cluster1	1.0	False
1.684	0.537	3.138	0.003	UPro	(Intercept)	nan	nan
-1.858	2.88	-0.645	0.521	UPro	Cluster2	1.0	False
0.161	0.404	0.399	0.691	UPro	(Intercept)	nan	nan
12.343	3.485	3.542	0.001	UPro	Cluster3	0.009	True
2.335	0.432	5.406	0.0	UPro	(Intercept)	nan	nan
-10.971	4.213	-2.604	0.011	UPro	Cluster4	0.136	False
2.491	0.56	4.45	0.0	UPro	(Intercept)	nan	nan
-40.262	18.43	-2.185	0.032	UPro	Cluster5	0.39	False
2.052	0.376	5.464	0.0	UPro	(Intercept)	nan	nan
-6.603	2.913	-2.267	0.027	UPro	Cluster6	0.32	False
1.75	0.34	5.15	0.0	UPro	(Intercept)	nan	nan
-173.126	114.447	-1.513	0.135	UPro	Cluster7	1.0	False
3.442	0.926	3.716	0.0	UPro	(Intercept)	nan	nan
-15.171	6.584	-2.304	0.024	UPro	Cluster8	0.292	False
1.567	0.36	4.35	0.0	UPro	(Intercept)	nan	nan
-13.946	19.66	-0.709	0.481	UPro	Cluster9	1.0	False
0.582	0.273	2.132	0.037	UPro	(Intercept)	nan	nan
12.267	2.773	4.423	0.0	UPro	Cluster10	0.0	True
-0.271	0.473	-0.573	0.569	UPro	(Intercept)	nan	nan
13.738	3.539	3.882	0.0	UPro	Cluster11	0.003	True
2.271	0.444	5.11	0.0	UPro	(Intercept)	nan	nan
-9.644	4.111	-2.346	0.022	UPro	Cluster12	0.264	False
127.987	3.329	38.444	0.0	SBP	(Intercept)	nan	nan
-44.925	30.374	-1.479	0.144	SBP	Cluster1	1.0	False
131.188	4.735	27.708	0.0	SBP	(Intercept)	nan	nan
-42.068	25.408	-1.656	0.103	SBP	Cluster2	1.0	False
111.445	3.499	31.853	0.0	SBP	(Intercept)	nan	nan
129.289	30.181	4.284	0.0	SBP	Cluster3	0.001	True
134.002	3.816	35.117	0.0	SBP	(Intercept)	nan	nan
-112.482	37.219	-3.022	0.004	SBP	Cluster4	0.043	True
129.972	5.143	25.273	0.0	SBP	(Intercept)	nan	nan
-210.265	169.332	-1.242	0.219	SBP	Cluster5	1.0	False
127.333	3.465	36.747	0.0	SBP	(Intercept)	nan	nan
-31.079	26.876	-1.156	0.252	SBP	Cluster6	1.0	False
123.508	3.1	39.836	0.0	SBP	(Intercept)	nan	nan
286.412	1044.305	0.274	0.785	SBP	Cluster7	1.0	False
144.633	8.241	17.55	0.0	SBP	(Intercept)	nan	nan
-150.247	58.579	-2.565	0.013	SBP	Cluster8	0.151	False

Estimate	Std. Error	t value	p-value	Variables	Cluster	Bonf	Sig
122.513	3.235	37.876	0.0	SBP	(Intercept)	nan	nan
116.14	176.557	0.658	0.513	SBP	Cluster9	1.0	False
118.223	2.557	46.228	0.0	SBP	(Intercept)	nan	nan
91.673	25.999	3.526	0.001	SBP	Cluster10	0.009	True
113.229	4.463	25.369	0.0	SBP	(Intercept)	nan	nan
91.134	33.368	2.731	0.008	SBP	Cluster11	0.097	False
128.599	4.103	31.344	0.0	SBP	(Intercept)	nan	nan
-47.939	37.95	-1.263	0.211	SBP	Cluster12	1.0	False
-0.106	0.052	-2.029	0.123	UOB_+/- - -	Cluster1	nan	False
-0.034	0.046	-0.733	0.82	UOB_+ - -	Cluster1	nan	False
-0.056	0.037	-1.532	0.306	UOB_2+ - -	Cluster1	nan	False
-0.058	0.037	-1.595	0.276	UOB_3+ - -	Cluster1	nan	False
0.03	0.062	0.491	0.943	UOB_+/- - -	Cluster2	nan	False
0.094	0.054	1.728	0.219	UOB_+ - -	Cluster2	nan	False
0.017	0.043	0.399	0.971	UOB_2+ - -	Cluster2	nan	False
0.008	0.043	0.19	0.998	UOB_3+ - -	Cluster2	nan	False
0.041	0.047	0.868	0.731	UOB_+/- - -	Cluster3	nan	False
0.011	0.042	0.259	0.994	UOB_+ - -	Cluster3	nan	False
0.055	0.033	1.674	0.241	UOB_2+ - -	Cluster3	nan	False
0.041	0.033	1.229	0.481	UOB_3+ - -	Cluster3	nan	False
0.046	0.041	1.129	0.547	UOB_+/- - -	Cluster4	nan	False
-0.019	0.036	-0.532	0.926	UOB_+ - -	Cluster4	nan	False
0.001	0.029	0.022	1.0	UOB_2+ - -	Cluster4	nan	False
0.012	0.029	0.433	0.962	UOB_3+ - -	Cluster4	nan	False
0.001	0.01	0.083	1.0	UOB_+/- - -	Cluster5	nan	False
-0.002	0.008	-0.236	0.996	UOB_+ - -	Cluster5	nan	False
0.004	0.007	0.641	0.873	UOB_2+ - -	Cluster5	nan	False
0.003	0.007	0.494	0.942	UOB_3+ - -	Cluster5	nan	False

Estimate	Std. Error	t value	p-value	Variables	Cluster	Bonf	Sig
-0.22	0.051	-4.331	0.0	UOB_+/- - -	Cluster6	nan	True
-0.153	0.045	-3.422	0.003	UOB_+ - -	Cluster6	nan	True
-0.178	0.036	-4.988	0.0	UOB_2+ - -	Cluster6	nan	True
-0.181	0.036	-5.078	0.0	UOB_3+ - -	Cluster6	nan	True
0.001	0.002	0.586	0.902	UOB_+/- - -	Cluster7	nan	False
0.001	0.001	0.535	0.925	UOB_+ - -	Cluster7	nan	False
0.001	0.001	1.104	0.565	UOB_2+ - -	Cluster7	nan	False
0.001	0.001	0.97	0.659	UOB_3+ - -	Cluster7	nan	False
0.024	0.027	0.91	0.701	UOB_+/- - -	Cluster8	nan	False
0.011	0.023	0.478	0.947	UOB_+ - -	Cluster8	nan	False
-0.003	0.019	-0.146	0.999	UOB_2+ - -	Cluster8	nan	False
0.008	0.019	0.417	0.966	UOB_3+ - -	Cluster8	nan	False
0.004	0.009	0.412	0.968	UOB_+/- - -	Cluster9	nan	False
0.006	0.008	0.763	0.8	UOB_+ - -	Cluster9	nan	False
0.01	0.006	1.515	0.315	UOB_2+ - -	Cluster9	nan	False
0.007	0.006	1.147	0.536	UOB_3+ - -	Cluster9	nan	False
0.014	0.058	0.242	0.995	UOB_+/- - -	Cluster10	nan	False
0.014	0.051	0.285	0.991	UOB_+ - -	Cluster10	nan	False
0.049	0.04	1.227	0.482	UOB_2+ - -	Cluster10	nan	False
0.051	0.04	1.254	0.465	UOB_3+ - -	Cluster10	nan	False
0.094	0.046	2.061	0.115	UOB_+/- - -	Cluster11	nan	False
0.047	0.04	1.18	0.513	UOB_+ - -	Cluster11	nan	False
0.056	0.032	1.757	0.208	UOB_2+ - -	Cluster11	nan	False
0.06	0.032	1.87	0.168	UOB_3+ - -	Cluster11	nan	False

Estimate	Std. Error	t value	p-value	Variables	Cluster	Bonf	Sig
0.071	0.042	1.673	0.241	UOB_+/- - -	Cluster12	nan	False
0.023	0.037	0.617	0.886	UOB_+ - -	Cluster12	nan	False
0.042	0.03	1.419	0.366	UOB_2+ - -	Cluster12	nan	False
0.048	0.03	1.617	0.266	UOB_3+ - -	Cluster12	nan	False

Estimate, the estimated coefficients of the linear model or ANOVA; Std. Error, the standard error for the estimate; t value, t-statistic; p-value, p-value (for UOB, adjusted by Dunnett's method); Variables, clinical variables assessed with the score of the cluster (for UOB, the pair of comparison); Cluster, the cluster assessed with the clinical variables; Bonf, the p-value corrected by Bonferroni procedure for continuous variables; Sig, statistical significance.

Supplementary Table S3. The R squared values for the linear models investigating the relationship between the scores and clinical variables

R2	Variable	Cluster
0.016	Age	Cluster1
0.003	Age	Cluster2
0.126	Age	Cluster3
0.026	Age	Cluster4
0.026	Age	Cluster5
0.116	Age	Cluster6
0.003	Age	Cluster7
0.099	Age	Cluster8
0.015	Age	Cluster9
0.073	Age	Cluster10
0.112	Age	Cluster11
0.002	Age	Cluster12
0.068	SCr	Cluster1
0.028	SCr	Cluster2
0.204	SCr	Cluster3
0.082	SCr	Cluster4
0.077	SCr	Cluster5
0.096	SCr	Cluster6
0.008	SCr	Cluster7
0.17	SCr	Cluster8
0.001	SCr	Cluster9
0.34	SCr	Cluster10
0.226	SCr	Cluster11
0.045	SCr	Cluster12
0.038	UPro	Cluster1
0.006	UPro	Cluster2
0.16	UPro	Cluster3
0.093	UPro	Cluster4
0.067	UPro	Cluster5
0.072	UPro	Cluster6
0.034	UPro	Cluster7
0.074	UPro	Cluster8
0.008	UPro	Cluster9
0.229	UPro	Cluster10
0.186	UPro	Cluster11
0.077	UPro	Cluster12
0.032	SBP	Cluster1
0.04	SBP	Cluster2
0.218	SBP	Cluster3
0.122	SBP	Cluster4
0.023	SBP	Cluster5
0.02	SBP	Cluster6

R2	Variable	Cluster
0.001	SBP	Cluster7
0.091	SBP	Cluster8
0.007	SBP	Cluster9
0.159	SBP	Cluster10
0.102	SBP	Cluster11
0.024	SBP	Cluster12
0.071	UOB	Cluster1
0.074	UOB	Cluster2
0.066	UOB	Cluster3
0.053	UOB	Cluster4
0.022	UOB	Cluster5
0.316	UOB	Cluster6
0.021	UOB	Cluster7
0.04	UOB	Cluster8
0.043	UOB	Cluster9
0.045	UOB	Cluster10
0.073	UOB	Cluster11
0.06	UOB	Cluster12

R2, R-squared values for the linear models; Variable, clinical variables; Cluster, the cluster assessed with the clinical variables

Supplementary Table S4. The statistical summary of the linear models testing the relationship between the patch-based scores and the clinical variables

Estimate	Std. Error	t value	p-value	Variables	Cluster	Bonf	Sig
34.753	4.041	8.601	0.0	Age	(Intercept)	nan	nan
2.267	1.019	2.225	0.03	Age	Cluster1	0.295	False
45.283	3.553	12.745	0.0	Age	(Intercept)	nan	nan
-16.969	15.437	-1.099	0.276	Age	Cluster2	1.0	False
35.498	3.403	10.431	0.0	Age	(Intercept)	nan	nan
4.96	1.91	2.597	0.012	Age	Cluster3	0.116	False
42.355	2.605	16.26	0.0	Age	(Intercept)	nan	nan
-0.105	1.724	-0.061	0.952	Age	Cluster4	1.0	False
49.037	5.434	9.025	0.0	Age	(Intercept)	nan	nan
-3.24	2.369	-1.368	0.176	Age	Cluster5	1.0	False
50.495	5.467	9.236	0.0	Age	(Intercept)	nan	nan
-2.775	1.684	-1.648	0.104	Age	Cluster6	1.0	False
49.421	4.453	11.099	0.0	Age	(Intercept)	nan	nan
-3.301	1.781	-1.854	0.068	Age	Cluster7	0.682	False
41.313	2.916	14.167	0.0	Age	(Intercept)	nan	nan
2.226	4.17	0.534	0.595	Age	Cluster8	1.0	False
42.37	2.547	16.634	0.0	Age	(Intercept)	nan	nan
-0.212	2.609	-0.081	0.936	Age	Cluster9	1.0	False
46.578	4.249	10.963	0.0	Age	(Intercept)	nan	nan
-1.831	1.531	-1.196	0.236	Age	Cluster10	1.0	False
0.669	0.11	6.083	0.0	SCr	(Intercept)	nan	nan
0.09	0.028	3.232	0.002	SCr	Cluster1	0.019	True
1.057	0.1	10.555	0.0	SCr	(Intercept)	nan	nan
-0.516	0.435	-1.185	0.24	SCr	Cluster2	1.0	False
0.626	0.085	7.376	0.0	SCr	(Intercept)	nan	nan
0.249	0.048	5.23	0.0	SCr	Cluster3	0.0	True
0.965	0.074	13.12	0.0	SCr	(Intercept)	nan	nan
0.001	0.049	0.029	0.977	SCr	Cluster4	1.0	False
1.166	0.153	7.615	0.0	SCr	(Intercept)	nan	nan
-0.096	0.067	-1.439	0.155	SCr	Cluster5	1.0	False
1.356	0.148	9.139	0.0	SCr	(Intercept)	nan	nan
-0.132	0.046	-2.885	0.005	SCr	Cluster6	0.053	False
1.279	0.121	10.574	0.0	SCr	(Intercept)	nan	nan
-0.145	0.048	-2.994	0.004	SCr	Cluster7	0.039	True
0.862	0.08	10.788	0.0	SCr	(Intercept)	nan	nan
0.24	0.114	2.101	0.039	SCr	Cluster8	0.395	False
0.978	0.072	13.608	0.0	SCr	(Intercept)	nan	nan
-0.027	0.074	-0.372	0.711	SCr	Cluster9	1.0	False
1.221	0.115	10.584	0.0	SCr	(Intercept)	nan	nan
-0.109	0.042	-2.618	0.011	SCr	Cluster10	0.11	False
0.662	0.416	1.592	0.116	UPro	(Intercept)	nan	nan

Estimate	Std. Error	t value	p-value	Variables	Cluster	Bonf	Sig
0.214	0.105	2.038	0.046	UPro	Cluster1	0.455	False
1.405	0.367	3.829	0.0	UPro	(Intercept)	nan	nan
-0.187	1.595	-0.117	0.907	UPro	Cluster2	1.0	False
0.396	0.331	1.198	0.235	UPro	(Intercept)	nan	nan
0.714	0.186	3.849	0.0	UPro	Cluster3	0.003	True
1.465	0.266	5.513	0.0	UPro	(Intercept)	nan	nan
-0.128	0.176	-0.729	0.468	UPro	Cluster4	1.0	False
2.12	0.555	3.82	0.0	UPro	(Intercept)	nan	nan
-0.359	0.242	-1.481	0.143	UPro	Cluster5	1.0	False
2.318	0.557	4.165	0.0	UPro	(Intercept)	nan	nan
-0.32	0.171	-1.864	0.067	UPro	Cluster6	0.668	False
2.12	0.455	4.657	0.0	UPro	(Intercept)	nan	nan
-0.346	0.182	-1.899	0.062	UPro	Cluster7	0.62	False
1.294	0.299	4.33	0.0	UPro	(Intercept)	nan	nan
0.181	0.427	0.423	0.674	UPro	Cluster8	1.0	False
1.383	0.261	5.303	0.0	UPro	(Intercept)	nan	nan
-0.025	0.267	-0.093	0.926	UPro	Cluster9	1.0	False
1.698	0.437	3.885	0.0	UPro	(Intercept)	nan	nan
-0.139	0.157	-0.881	0.381	UPro	Cluster10	1.0	False
116.649	3.689	31.617	0.0	SBP	(Intercept)	nan	nan
2.254	0.93	2.423	0.018	SBP	Cluster1	0.182	False
123.946	3.295	37.619	0.0	SBP	(Intercept)	nan	nan
1.054	14.315	0.074	0.942	SBP	Cluster2	1.0	False
116.32	3.035	38.331	0.0	SBP	(Intercept)	nan	nan
5.714	1.703	3.356	0.001	SBP	Cluster3	0.013	True
125.487	2.368	52.99	0.0	SBP	(Intercept)	nan	nan
-1.884	1.567	-1.202	0.234	SBP	Cluster4	1.0	False
125.967	5.058	24.907	0.0	SBP	(Intercept)	nan	nan
-0.88	2.205	-0.399	0.691	SBP	Cluster5	1.0	False
132.872	4.989	26.634	0.0	SBP	(Intercept)	nan	nan
-2.952	1.537	-1.921	0.059	SBP	Cluster6	0.59	False
131.875	4.05	32.563	0.0	SBP	(Intercept)	nan	nan
-3.579	1.619	-2.21	0.031	SBP	Cluster7	0.306	False
122.413	2.664	45.952	0.0	SBP	(Intercept)	nan	nan
3.96	3.809	1.04	0.302	SBP	Cluster8	1.0	False
125.174	2.322	53.896	0.0	SBP	(Intercept)	nan	nan
-2.441	2.379	-1.026	0.309	SBP	Cluster9	1.0	False
126.684	3.929	32.242	0.0	SBP	(Intercept)	nan	nan
-1.087	1.415	-0.768	0.445	SBP	Cluster10	1.0	False
0.514	1.666	0.308	0.988	UOB_+/- - -	Cluster1	nan	False
1.999	1.464	1.366	0.396	UOB_+ - -	Cluster1	nan	False
1.938	1.166	1.662	0.246	UOB_2+ - -	Cluster1	nan	False
2.009	1.166	1.723	0.221	UOB_3+ - -	Cluster1	nan	False

Estimate	Std. Error	t value	p-value	Variables	Cluster	Bonf	Sig
-0.18	0.114	-1.587	0.279	UOB_+/- - -	Cluster2	nan	False
-0.086	0.1	-0.866	0.731	UOB_+ - -	Cluster2	nan	False
-0.081	0.08	-1.013	0.628	UOB_2+ - -	Cluster2	nan	False
-0.116	0.08	-1.458	0.344	UOB_3+ - -	Cluster2	nan	False
0.51	0.88	0.58	0.905	UOB_+/- - -	Cluster3	nan	False
0.242	0.773	0.313	0.987	UOB_+ - -	Cluster3	nan	False
0.981	0.616	1.593	0.277	UOB_2+ - -	Cluster3	nan	False
0.802	0.616	1.302	0.434	UOB_3+ - -	Cluster3	nan	False
0.498	1.022	0.488	0.944	UOB_+/- - -	Cluster4	nan	False
0.23	0.897	0.257	0.994	UOB_+ - -	Cluster4	nan	False
0.231	0.715	0.324	0.986	UOB_2+ - -	Cluster4	nan	False
0.878	0.715	1.228	0.482	UOB_3+ - -	Cluster4	nan	False
-0.088	0.712	-0.124	1.0	UOB_+/- - -	Cluster5	nan	False
0.462	0.626	0.739	0.816	UOB_+ - -	Cluster5	nan	False
-0.616	0.498	-1.236	0.476	UOB_2+ - -	Cluster5	nan	False
-0.641	0.498	-1.286	0.445	UOB_3+ - -	Cluster5	nan	False
1.141	1.033	1.105	0.564	UOB_+/- - -	Cluster6	nan	False
-0.444	0.907	-0.49	0.943	UOB_+ - -	Cluster6	nan	False
0.117	0.723	0.161	0.999	UOB_2+ - -	Cluster6	nan	False
-0.135	0.723	-0.187	0.998	UOB_3+ - -	Cluster6	nan	False
1.141	0.953	1.198	0.501	UOB_+/- - -	Cluster7	nan	False
-0.709	0.837	-0.848	0.744	UOB_+ - -	Cluster7	nan	False
-0.258	0.667	-0.387	0.974	UOB_2+ - -	Cluster7	nan	False
-0.541	0.667	-0.811	0.769	UOB_3+ - -	Cluster7	nan	False

Estimate	Std. Error	t value	p-value	Variables	Cluster	Bonf	Sig
-0.119	0.424	-0.282	0.991	UOB_+/- - -	Cluster8	nan	False
0.443	0.372	1.191	0.506	UOB_+ - -	Cluster8	nan	False
0.348	0.296	1.173	0.518	UOB_2+ - -	Cluster8	nan	False
0.254	0.296	0.856	0.739	UOB_3+ - -	Cluster8	nan	False
-0.296	0.676	-0.438	0.96	UOB_+/- - -	Cluster9	nan	False
-0.458	0.594	-0.771	0.795	UOB_+ - -	Cluster9	nan	False
-0.31	0.473	-0.655	0.866	UOB_2+ - -	Cluster9	nan	False
0.1	0.473	0.212	0.997	UOB_3+ - -	Cluster9	nan	False
-3.119	1.06	-2.943	0.014	UOB_+/- - -	Cluster10	nan	True
-1.679	0.931	-1.803	0.191	UOB_+ - -	Cluster10	nan	False
-2.35	0.742	-3.168	0.007	UOB_2+ - -	Cluster10	nan	True
-2.609	0.742	-3.518	0.003	UOB_3+ - -	Cluster10	nan	True

Estimate, the estimated coefficients of the linear model or ANOVA; Std. Error, the standard error for the estimate; t value, t-statistic; p-value, p-value (for UOB, adjusted by Dunnett's method); Variables, clinical variables assessed with the score of the cluster (for UOB, the pair of comparison); Cluster, the cluster assessed with the clinical variables; Bonf, the p-value corrected by Bonferroni procedure for continuous variables; Sig, statistical significance.

Supplementary Table S5. The R squared values for the linear models investigating the relationship between the patch-based scores and clinical variables

R2	Variable	Cluster
0.07	Age	Cluster1
0.018	Age	Cluster2
0.093	Age	Cluster3
0.0	Age	Cluster4
0.028	Age	Cluster5
0.04	Age	Cluster6
0.05	Age	Cluster7
0.004	Age	Cluster8
0.0	Age	Cluster9
0.021	Age	Cluster10
0.137	SCr	Cluster1
0.021	SCr	Cluster2
0.293	SCr	Cluster3
0.0	SCr	Cluster4
0.03	SCr	Cluster5
0.112	SCr	Cluster6
0.12	SCr	Cluster7
0.063	SCr	Cluster8
0.002	SCr	Cluster9
0.094	SCr	Cluster10
0.059	UPro	Cluster1
0.0	UPro	Cluster2
0.183	UPro	Cluster3
0.008	UPro	Cluster4
0.032	UPro	Cluster5
0.05	UPro	Cluster6
0.052	UPro	Cluster7
0.003	UPro	Cluster8
0.0	UPro	Cluster9
0.012	UPro	Cluster10
0.082	SBP	Cluster1
0.0	SBP	Cluster2
0.146	SBP	Cluster3
0.021	SBP	Cluster4
0.002	SBP	Cluster5
0.053	SBP	Cluster6
0.069	SBP	Cluster7
0.016	SBP	Cluster8
0.016	SBP	Cluster9
0.009	SBP	Cluster10
0.062	UOB	Cluster1
0.052	UOB	Cluster2

R2	Variable	Cluster
0.059	UOB	Cluster3
0.061	UOB	Cluster4
0.114	UOB	Cluster5
0.048	UOB	Cluster6
0.084	UOB	Cluster7
0.052	UOB	Cluster8
0.059	UOB	Cluster9
0.187	UOB	Cluster10

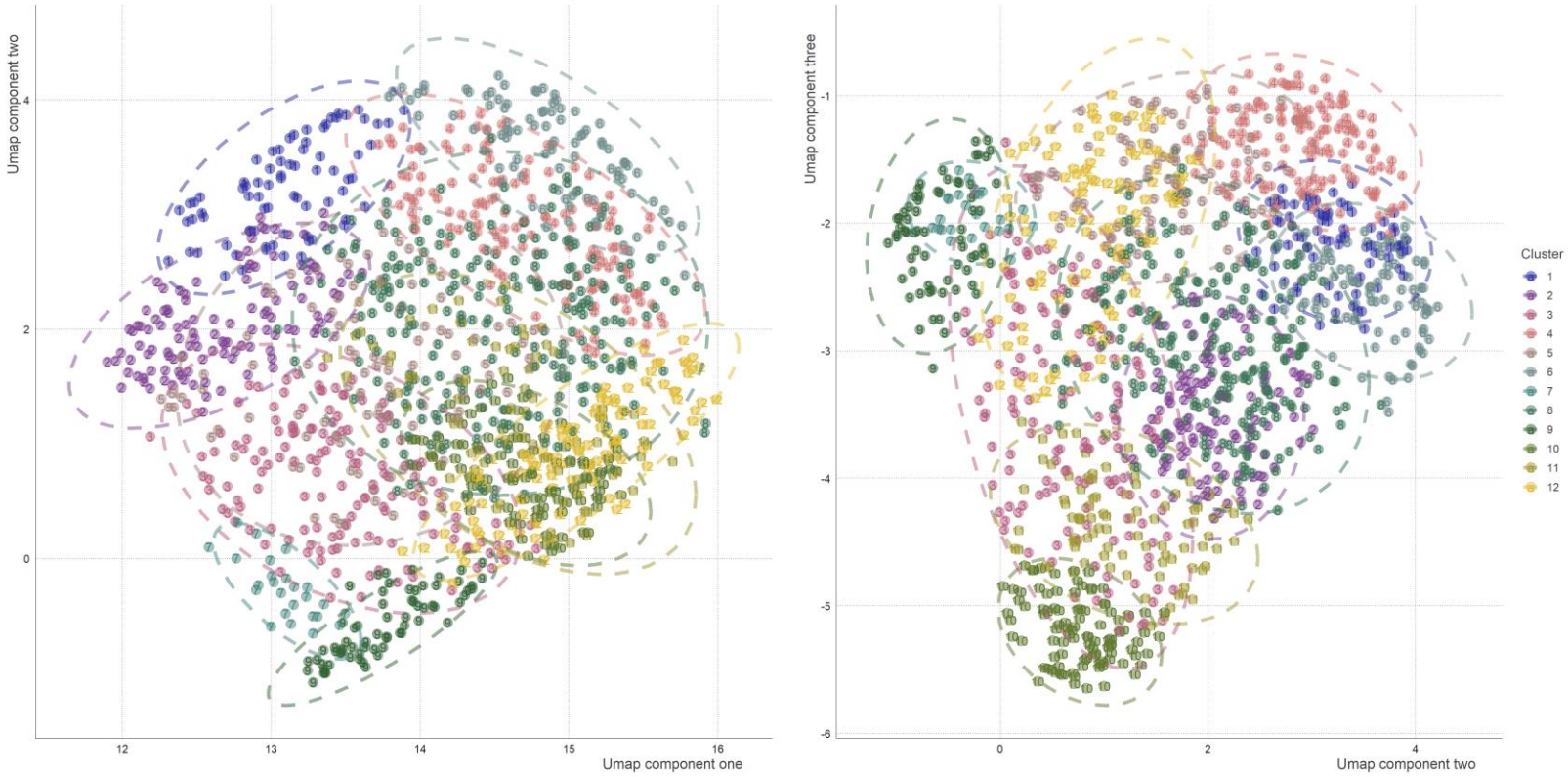
R2, R-squared values for the linear models; Variable, clinical variables; Cluster, the cluster assessed with the clinical variables

Supplementary Table S6. The clinical and pathological findings of the second and third biopsy of the patient with multiple biopsies

	Age	SCr	UPro	UOB	SBP	M	E	S	T	C	GS	SS	AD	CC	FC
Second_biopsy	39	0.63	0.3	2+	125	0	0	1	1	0	3	2	1	0	0
Third_biopsy	43	0.77	2	2+	124	0	0	1	0	1	9	1	2	3	1

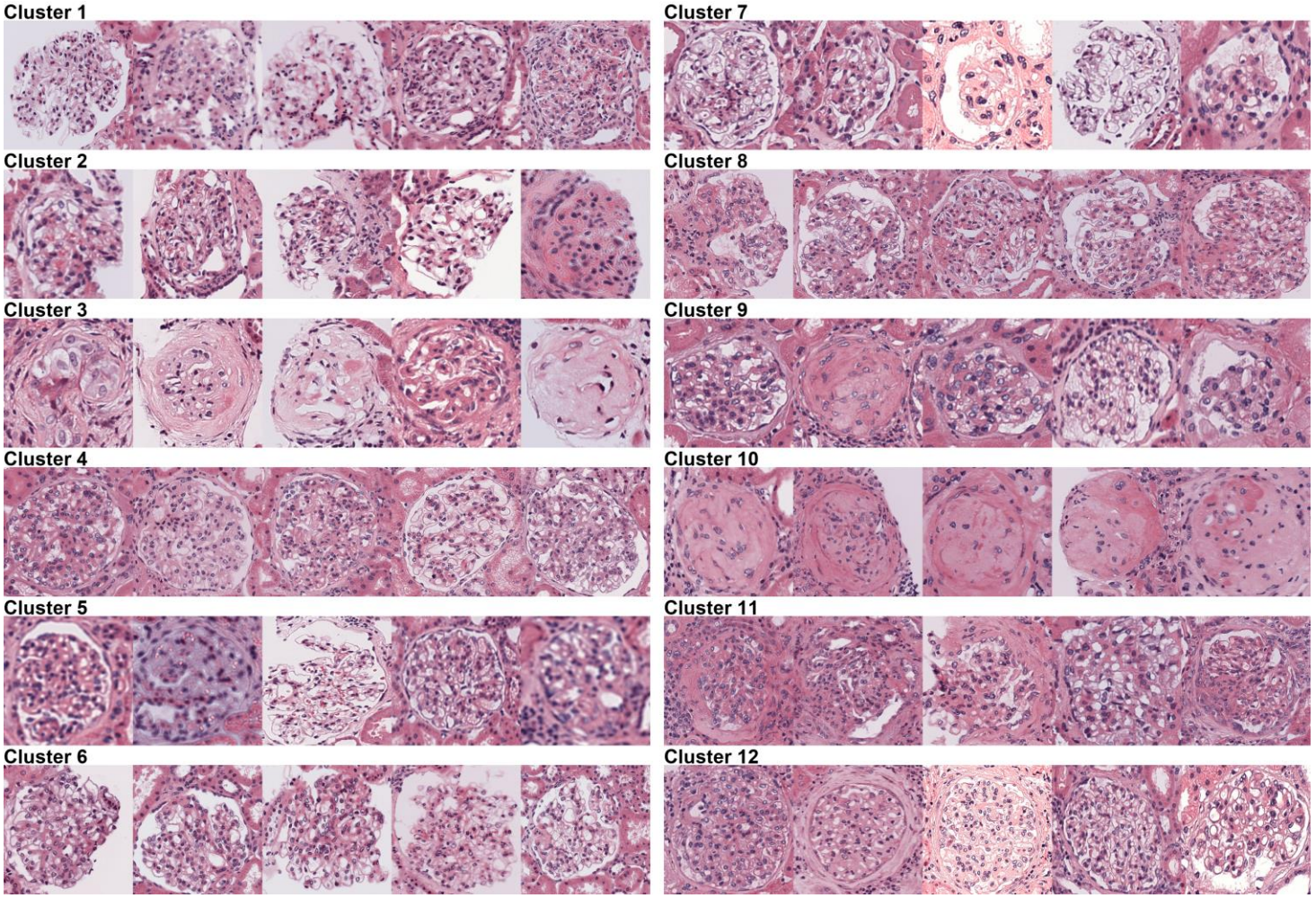
UOB, urinary occult blood; SBP, systolic blood pressure; SCr, serum creatinine value; UPro, urinary protein excretion; GS, global sclerosis; SS, segmental sclerosis; AD, adhesion; CC, cellular crescent; FC, fibrocellular crescent

Supplementary Figure S1. The visualization of the UMAP Results



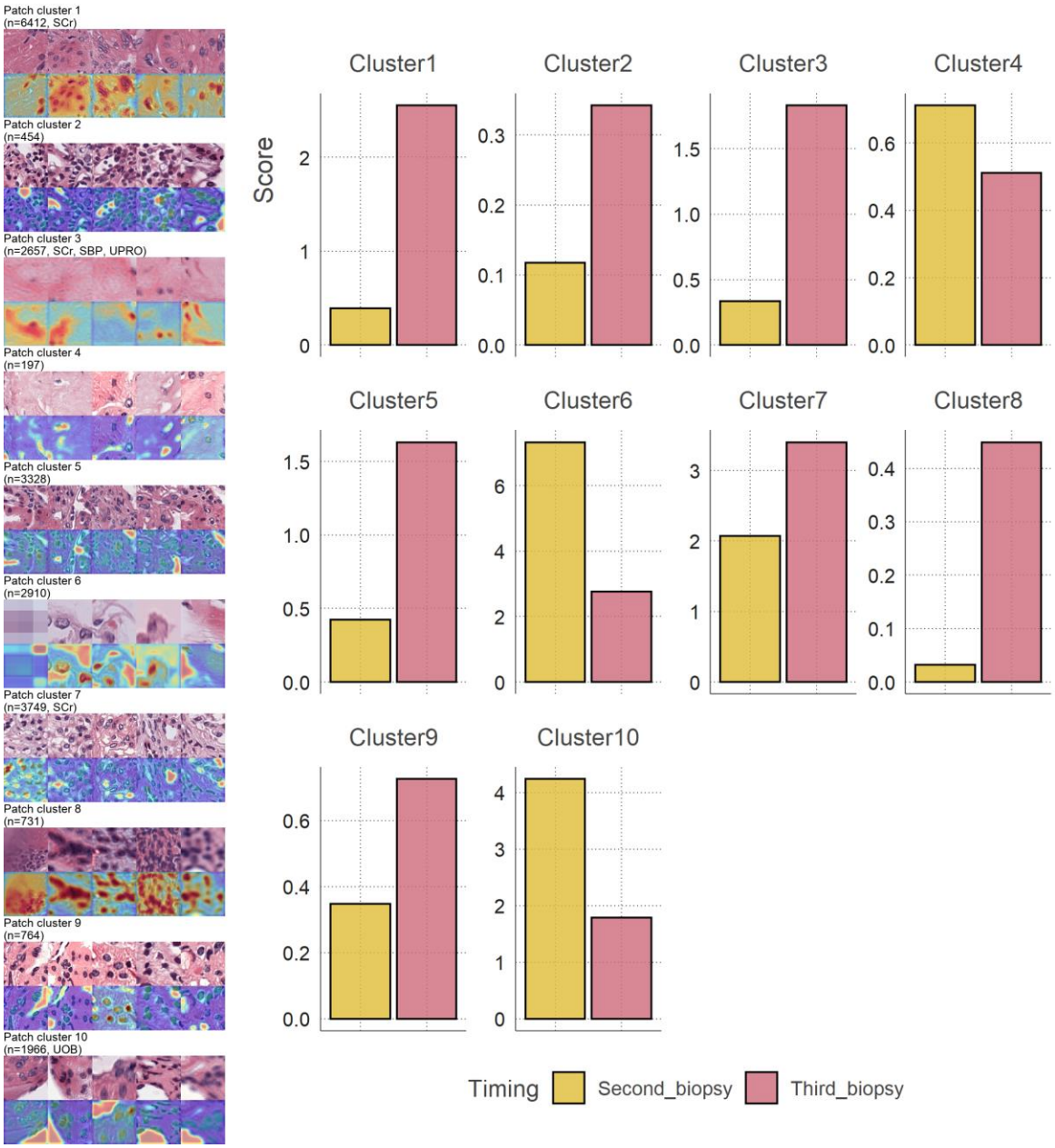
Components one, two, and three of the UMAP results are visualized. Each point represents a glomerulus, with the color representing the class of the glomerulus. UMAP, Uniform Manifold Approximation and Projection

Supplementary Figure S2. The representative glomeruli for each cluster



The representative glomeruli of each cluster, which had the highest five probability of the cluster were shown. From left to right in ascending order.

Supplementary Figure S3. The changes in the patch-based scores for the patient with multiple biopsies



The left panel shows the clustered patches and the rationale behind the clustering visualized by Score-weighted class activation mapping. The number of patches in the class, along with the clinical variables which had a significant relationship with the score of the patch class are shown. The right panel shows the bar plot depicting the score of the second and third biopsies. UOB, urinary occult blood; SBP, systolic blood pressure; SCr, serum creatinine value; UPro, urinary protein excretion