Table S1: Total time (in seconds) required to solve the k QUBO models generated with QUBO-Correlation for the Classification task with different QUBO solvers. Missing values for the QPU indicate the problem did not fit on the hardware.

Dataset	N	QPU	Hybrid	SA	SD	Tabu
waveform-5000	40	39.0	394.4	57.9	7.8	474.6
SPECTF	44	48.4	426.3	72.3	9.3	522.4
covertype	54	130.1	491.5	17.0	1.9	99.1
spambase	57	65.9	487.4	107.1	15.7	598.9
nomao	118	100.1	507.5	323.6	54.3	620.9
tecator	124	95.6	504.3	374.2	57.7	623.5
USPS	256	-	541.1	1174.0	220.4	785.2
isolet	617	-	640.2	6280.7	1260.4	1735.7
Bioresponse	1776	-	1435.1	53978.2	10814.2	10531.4
SVHN_small	3072	-	3575.4	124041.7	33802.1	32440.0
gisette	5000	-	8666.3	80062.4	18811.6	18238.1

Table S2: Total time (in seconds) required to solve the k QUBO models generated with QUBO-Boosting for the Classification task with different QUBO solvers. Missing values for the QPU indicate the problem did not fit on the hardware.

Dataset	N	QPU	Hybrid	SA	SD	Tabu
waveform-5000	40	41.7	384.2	62.3	6.6	473.1
SPECTF	44	44.3	422.9	80.1	9.5	524.3
covertype	54	129.0	491.2	18.6	1.9	99.1
spambase	57	61.9	486.6	125.2	14.2	597.0
nomao	118	110.2	498.7	386.3	50.1	614.5
tecator	124	91.6	512.5	388.8	58.6	622.9
USPS	256	-	545.3	1324.5	215.0	775.9
isolet	617	-	709.5	7141.0	1224.1	1715.3
Bioresponse	1776	-	1446.0	71102.2	10639.2	10502.3
SVHN_small	3072	-	3593.6	183687.1	23886.7	23301.3
gisette	5000	-	8671.6	74620.9	14418.6	14820.1

Table S3: Total time (in seconds) required to solve the k QUBO models generated with MIQUBO for the Classification task with different QUBO solvers. Missing values for the QPU indicate the problem did not fit on the hardware.

Dataset	N	QPU	Hybrid	SA	SD	Tabu
waveform-5000	40	39.2	385.9	7.5	1.0	78.6
SPECTF	44	45.1	421.7	9.5	1.2	86.7
covertype	54	127.3	809.9	17.0	1.9	99.0
spambase	57	51.5	486.4	17.6	2.0	99.1
nomao	118	98.1	512.5	46.6	7.9	101.9
tecator	124	90.2	515.1	62.3	8.8	102.3
USPS	256	-	542.6	138.0	34.6	124.3
isolet	617	-	642.4	838.1	201.6	263.8
Bioresponse	1776	-	1423.4	11031.8	1727.8	1632.8
SVHN_small	3072	-	3591.1	23332.5	5455.9	5146.8
gisette	5000	-	8606.4	78635.7	14210.1	14610.5

Table S4: Total time (in seconds) required to solve the k QUBO models generated with QUBO-Correlation for the Ranking task with different QUBO solvers.

Dataset	F	QPU	Hybrid	SA	SD	Tabu
OHSUMED	45	154.1	436.8	13.5	1.7	89.4
MQ2007	46	472.5	444.5	15.6	1.9	91.5
MQ2008	46	122.7	436.7	15.0	1.6	91.7

Table S5: Total time (in seconds) required to solve the k QUBO models generated with QUBO-Boosting for the Ranking task with different QUBO solvers.

Dataset	F	QPU	Hybrid	SA	SD	Tabu
OHSUMED	45	382.7	441.5	15.4	1.6	89.5
MQ2007	46	407.9	441.1	16.6	1.5	91.4
MQ2008	46	57.2	442.2	17.4	1.6	91.7

Table S6: Total time (in seconds) required to solve the k QUBO models generated with MIQUBO for the Ranking task with different QUBO solvers.

Dataset	F	QPU	Hybrid	SA	SD	Tabu
OHSUMED	45	497.9	435.1	13.9	1.5	89.2
MQ2007	46	74.0	445.0	12.8	1.5	91.2
MQ2008	46	96.4	443.1	13.0	1.5	91.3

Table S7: Drill down of the time (in seconds) required to solve the QUBO models generated with QUBO-Correlation for the Classification task. The Embedding column refers to the time required to embed the problem on the QPU. The columns under QPU show the time-to-solution as observed by the local client (Total), splitted between the actual physical annealing process (Sampling) and the latency due to the data transfer as well as further waiting time after the task is queued (Latency). Note that the Latency time is more than one order of magnitude higher than the Sampling time.

Dataset	F	Embedding	QPU		
			Total	Sampling	Latency
waveform-5000	40	2.9	39.0	0.9	38.1
SPECTF	44	3.5	48.4	1.1	47.3
covertype	54	7.1	130.1	1.1	129.0
spambase	57	17.7	65.9	1.2	64.8
nomao	118	54.3	100.1	1.6	98.5
tecator	124	125.2	95.6	1.5	94.2

Table S8: Drill down of the time (in seconds) required to solve the QUBO models generated with QUBO-Boosting for the Classification task. The Embedding column refers to the time required to embed the problem on the QPU. The columns under QPU show the time-to-solution as observed by the local client (Total), splitted between the actual physical annealing process (Sampling) and the latency due to the data transfer as well as further waiting time after the task is queued (Latency). Note that the Latency time is more than one order of magnitude higher than the Sampling time.

Dataset	F	Embedding	QPU		
			Total	Sampling	Latency
waveform-5000	40	4.4	41.7	0.8	40.9
SPECTF	44	7.0	44.3	0.9	43.4
covertype	54	18.6	129.0	1.4	127.6
spambase	57	31.2	61.9	1.4	60.6
nomao	118	138.1	110.2	1.6	108.6
tecator	124	287.1	91.6	1.6	90.0

Table S9: Drill down of the time (in seconds) required to solve the QUBO models generated with MIQUBO for the Classification task. The Embedding column refers to the time required to embed the problem on the QPU. The columns under QPU show the time-to-solution as observed by the local client (Total), splitted between the actual physical annealing process (Sampling) and the latency due to the data transfer as well as further waiting time after the task is queued (Latency). Note that the Latency time is more than one order of magnitude higher than the Sampling time.

Dataset	F	Embedding	QPU		
			Total	Sampling	Latency
waveform-5000	40	7.0	39.2	0.9	38.3
SPECTF	44	5.3	45.1	1.1	44.0
covertype	54	7.9	127.3	1.2	126.1
spambase	57	14.2	51.5	1.0	50.5
nomao	118	209.9	98.1	1.6	96.5
tecator	124	164.6	90.2	1.5	88.7

Table S10: Drill down of the time (in seconds) required to solve the QUBO models generated with QUBO-Correlation for the Ranking task. The Embedding column refers to the time required to embed the problem on the QPU. The columns under QPU show the time-to-solution as observed by the local client (Total), splitted between the actual physical annealing process (Sampling) and the latency due to the data transfer as well as further waiting time after the task is queued (Latency). Note that the Latency time is more than one order of magnitude higher than the Sampling time.

Dataset	F	Embedding	QPU		
			Total	Sampling	Latency
OHSUMED	45	10.5	154.1	1.1	153.0
MQ2007	46	11.7	472.5	1.0	471.5
MQ2008	46	7.9	122.7	1.2	121.6

Table S11: Drill down of the time (in seconds) required to solve the QUBO models generated with QUBO-Boosting for the Ranking task. The Embedding column refers to the time required to embed the problem on the QPU. The columns under QPU show the time-to-solution as observed by the local client (Total), splitted between the actual physical annealing process (Sampling) and the latency due to the data transfer as well as further waiting time after the task is queued (Latency). Note that the Latency time is more than one order of magnitude higher than the Sampling time.

Dataset	F	Embedding	QPU		
			Total	Sampling	Latency
OHSUMED	45	8.8	382.7	1.2	381.5
MQ2007	46	17.5	407.9	1.0	406.9
MQ2008	46	9.7	57.2	1.0	56.2

Table S12: Drill down of the time (in seconds) required to solve the QUBO models generated with MIQUBO for the Ranking task. The Embedding column refers to the time required to embed the problem on the QPU. The columns under QPU show the time-to-solution as observed by the local client (Total), splitted between the actual physical annealing process (Sampling) and the latency due to the data transfer as well as further waiting time after the task is queued (Latency). Note that the Latency time is more than one order of magnitude higher than the Sampling time.

Dataset	F	Embedding	QPU		
			Total	Sampling	Latency
OHSUMED	45	7.2	497.9	1.0	496.9
MQ2007	46	17.0	74.0	1.0	72.9
MQ2008	46	10.3	96.4	1.2	95.3