

Module Interface Specification for Software Engineering

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2 Symbols, Abbreviations and Acronyms

See SRS Documentation [here](#)

Contents

1	Revision History	i
2	Symbols, Abbreviations and Acronyms	ii
3	Introduction	1
4	Notation	1
5	Module Decomposition	8
6	MIS of Report Manager	10
6.1	Module	10
6.2	Uses	10
6.3	Syntax	10
6.3.1	Exported Constants	10
6.3.2	Exported Access Programs	11
6.4	Semantics	11
6.4.1	State Variables	11
6.4.2	Environment Variables	11
6.4.3	Assumptions	11
6.4.4	Access Routine Semantics	11
6.4.5	Local Functions	11
7	MIS of Account Creation Interface	11
7.1	Module	11
7.2	Uses	11
7.3	Syntax	12
7.3.1	Exported Constants	12
7.3.2	Exported Access Programs	12
7.4	Semantics	12
7.4.1	State Variables	12
7.4.2	Environment Variables	12
7.4.3	Assumptions	12
7.4.4	Access Routine Semantics	12
7.4.5	Local Functions	12
8	MIS of Project Manager	12
8.1	Module	12
8.2	Uses	13
8.3	Syntax	13
8.3.1	Exported Constants	13
8.3.2	Exported Access Programs	13

8.4	Semantics	13
8.4.1	State Variables	13
8.4.2	Environment Variables	13
8.4.3	Assumptions	13
8.4.4	Access Routine Semantics	13
8.4.5	Local Functions	14
9	MIS of Project Collection Manager	14
9.1	Module	14
9.2	Uses	14
9.3	Syntax	14
9.3.1	Exported Constants	14
9.3.2	Exported Access Programs	14
9.4	Semantics	14
9.4.1	State Variables	14
9.4.2	Environment Variables	14
9.4.3	Assumptions	14
9.4.4	Access Routine Semantics	15
9.4.5	Local Functions	15
10	MIS of Project Database Connector	15
10.1	Module	15
10.2	Uses	15
10.3	Syntax	15
10.3.1	Exported Constants	15
10.3.2	Exported Access Programs	15
10.4	Semantics	15
10.4.1	State Variables	15
10.4.2	Environment Variables	15
10.4.3	Assumptions	16
10.4.4	Access Routine Semantics	16
10.4.5	Local Functions	16
11	MIS of Core Image Database Connector	16
11.1	Module	16
11.2	Uses	16
11.3	Syntax	16
11.3.1	Exported Constants	16
11.3.2	Exported Access Programs	17
11.4	Semantics	17
11.4.1	State Variables	17
11.4.2	Environment Variables	17
11.4.3	Assumptions	17

11.4.4	Access Routine Semantics	17
11.4.5	Local Functions	18
12	MIS of Account Database Connector	18
12.1	Module	18
12.2	Uses	18
12.3	Syntax	18
12.3.1	Exported Constants	18
12.3.2	Exported Access Programs	18
12.4	Semantics	18
12.4.1	State Variables	18
12.4.2	Environment Variables	18
12.4.3	Assumptions	18
12.4.4	Access Routine Semantics	19
12.4.5	Local Functions	19
13	MIS of Account Database	19
13.1	Module	19
13.2	Uses	19
13.3	Syntax	20
13.3.1	Exported Constants	20
13.3.2	Exported Access Programs	20
13.4	Semantics	20
13.4.1	State Variables	20
13.4.2	Environment Variables	20
13.4.3	Assumptions	20
13.4.4	Access Routine Semantics	20
13.4.5	Local Functions	21
14	MIS of Account Update Interface	21
14.1	Module	21
14.2	Uses	21
14.3	Syntax	21
14.3.1	Exported Constants	21
14.3.2	Exported Access Programs	21
14.4	Semantics	21
14.4.1	State Variables	21
14.4.2	Environment Variables	21
14.4.3	Assumptions	21
14.4.4	Access Routine Semantics	21
14.4.5	Local Functions	22

15 MIS of Login Interface	22
15.1 Module	22
15.2 Uses	22
15.3 Syntax	22
15.3.1 Exported Constants	22
15.3.2 Exported Access Programs	22
15.4 Semantics	22
15.4.1 State Variables	22
15.4.2 Environment Variables	22
15.4.3 Assumptions	22
15.4.4 Access Routine Semantics	23
15.4.5 Local Functions	23
16 MIS of Access Token	23
16.1 Module	23
16.2 Uses	23
16.3 Syntax	23
16.3.1 Exported Constants	23
16.3.2 Exported Access Programs	23
16.4 Semantics	23
16.4.1 State Variables	23
16.4.2 Environment Variables	24
16.4.3 Assumptions	24
16.4.4 Access Routine Semantics	24
16.4.5 Local Functions	24
17 MIS of Account Creation Interface	24
17.1 Module	24
17.2 Uses	24
17.3 Syntax	24
17.3.1 Exported Constants	24
17.3.2 Exported Access Programs	24
17.4 Semantics	25
17.4.1 State Variables	25
17.4.2 Environment Variables	25
17.4.3 Assumptions	25
17.4.4 Access Routine Semantics	25
17.4.5 Local Functions	25
18 MIS of Account Database	25
18.1 Module	25
18.2 Uses	25
18.3 Syntax	25

18.3.1	Exported Constants	25
18.3.2	Exported Access Programs	26
18.4	Semantics	26
18.4.1	State Variables	26
18.4.2	Environment Variables	26
18.4.3	Assumptions	26
18.4.4	Access Routine Semantics	26
18.4.5	Local Functions	27
19	MIS of Account Update Interface	27
19.1	Module	27
19.2	Uses	27
19.3	Syntax	27
19.3.1	Exported Constants	27
19.3.2	Exported Access Programs	27
19.4	Semantics	27
19.4.1	State Variables	27
19.4.2	Environment Variables	27
19.4.3	Assumptions	27
19.4.4	Access Routine Semantics	27
19.4.5	Local Functions	28
20	MIS of Login Interface	28
20.1	Module	28
20.2	Uses	28
20.3	Syntax	28
20.3.1	Exported Constants	28
20.3.2	Exported Access Programs	28
20.4	Semantics	28
20.4.1	State Variables	28
20.4.2	Environment Variables	28
20.4.3	Assumptions	28
20.4.4	Access Routine Semantics	29
20.4.5	Local Functions	29
21	MIS of Access Token	29
21.1	Module	29
21.2	Uses	29
21.3	Syntax	29
21.3.1	Exported Constants	29
21.3.2	Exported Access Programs	29
21.4	Semantics	29
21.4.1	State Variables	29

21.4.2	Environment Variables	30
21.4.3	Assumptions	30
21.4.4	Access Routine Semantics	30
21.4.5	Local Functions	30
22	MIS of Labeler	30
22.1	Module	30
22.2	Uses	30
22.3	Syntax	30
22.3.1	Exported Constants	30
22.3.2	Exported Access Programs	31
22.4	Semantics	31
22.4.1	State Variables	31
22.4.2	Environment Variables	31
22.4.3	Assumptions	31
22.4.4	Access Routine Semantics	31
22.4.5	Local Functions	32
23	MIS of Client	32
23.1	Module	32
23.2	Uses	32
23.3	Syntax	32
23.3.1	Exported Constants	32
23.3.2	Exported Access Programs	32
23.4	Semantics	33
23.4.1	State Variables	33
23.4.2	Environment Variables	33
23.4.3	Assumptions	33
23.4.4	Access Routine Semantics	33
23.4.5	Local Functions	33
24	MIS of User	34
24.1	Module	34
24.2	Uses	34
24.3	Syntax	34
24.3.1	Exported Constants	34
24.3.2	Exported Access Programs	34
24.4	Semantics	34
24.4.1	State Variables	34
24.4.2	Environment Variables	34
24.4.3	Assumptions	34
24.4.4	Access Routine Semantics	35
24.4.5	Local Functions	35

25 MIS of Account Creation Controller	35
25.1 Module	35
25.2 Uses	35
25.3 Syntax	35
25.3.1 Exported Constants	35
25.3.2 Exported Access Programs	36
25.4 Semantics	36
25.4.1 State Variables	36
25.4.2 Environment Variables	36
25.4.3 Assumptions	36
25.4.4 Access Routine Semantics	36
25.4.5 Local Functions	37
26 MIS of Account Update Controller	37
26.1 Module	37
26.2 Uses	37
26.3 Syntax	38
26.3.1 Exported Constants	38
26.3.2 Exported Access Programs	38
26.4 Semantics	38
26.4.1 State Variables	38
26.4.2 Environment Variables	38
26.4.3 Assumptions	38
26.4.4 Access Routine Semantics	38
26.4.5 Local Functions	38
27 MIS of Authentication Controller	39
27.1 Module	39
27.2 Uses	39
27.3 Syntax	39
27.3.1 Exported Constants	39
27.3.2 Exported Access Programs	39
27.4 Semantics	39
27.4.1 State Variables	39
27.4.2 Environment Variables	39
27.4.3 Assumptions	39
27.4.4 Access Routine Semantics	39
27.4.5 Local Functions	40
28 MIS of Satellite Image Request Interface	40
28.1 Module	40
28.2 Uses	40
28.3 Syntax	40

28.3.1	Exported Constants	40
28.3.2	Exported Access Programs	40
28.4	Semantics	40
28.4.1	State Variables	40
28.4.2	Environment Variables	40
28.4.3	Assumptions	40
28.4.4	Access Routine Semantics	41
28.4.5	Local Functions	41
29	MIS of Satellite Image Request Controller	41
29.1	Module	41
29.2	Uses	41
29.3	Syntax	41
29.3.1	Exported Constants	41
29.3.2	Exported Access Programs	41
29.4	Semantics	41
29.4.1	State Variables	41
29.4.2	Environment Variables	42
29.4.3	Assumptions	42
29.4.4	Access Routine Semantics	42
29.4.5	Local Functions	42
30	MIS of Satellite Image Request	42
30.1	Module	42
30.2	Uses	42
30.3	Syntax	42
30.3.1	Exported Constants	42
30.3.2	Exported Access Programs	43
30.4	Semantics	43
30.4.1	State Variables	43
30.4.2	Environment Variables	43
30.4.3	Assumptions	43
30.4.4	Access Routine Semantics	43
30.4.5	Local Functions	44
31	MIS of Project Creation Interface	44
31.1	Module	44
31.2	Uses	44
31.3	Syntax	44
31.3.1	Exported Constants	44
31.3.2	Exported Access Programs	44
31.4	Semantics	44
31.4.1	State Variables	44

31.4.2	Environment Variables	44
31.4.3	Assumptions	44
31.4.4	Access Routine Semantics	45
31.4.5	Local Functions	45
32	MIS of Project Creation Controller	45
32.1	Module	45
32.2	Uses	45
32.3	Syntax	45
32.3.1	Exported Constants	45
32.3.2	Exported Access Programs	45
32.4	Semantics	45
32.4.1	State Variables	45
32.4.2	Environment Variables	46
32.4.3	Assumptions	46
32.4.4	Access Routine Semantics	46
32.4.5	Local Functions	46
33	MIS of Project	46
33.1	Module	46
33.2	Uses	46
33.3	Syntax	46
33.3.1	Exported Constants	46
33.3.2	Exported Access Programs	47
33.4	Semantics	47
33.4.1	State Variables	47
33.4.2	Environment Variables	47
33.4.3	Assumptions	47
33.4.4	Access Routine Semantics	47
33.4.5	Local Functions	48
34	MIS of Service Request Failure Interface	48
34.1	Module	48
34.2	Uses	48
34.3	Syntax	48
34.3.1	Exported Constants	48
34.3.2	Exported Access Programs	48
34.4	Semantics	49
34.4.1	State Variables	49
34.4.2	Environment Variables	49
34.4.3	Assumptions	49
34.4.4	Access Routine Semantics	49
34.4.5	Local Functions	49

35 MIS of Image Upload Interface	49
35.1 Module	49
35.2 Uses	49
35.3 Syntax	49
35.3.1 Exported Constants	49
35.3.2 Exported Access Programs	49
35.4 Semantics	50
35.4.1 State Variables	50
35.4.2 Environment Variables	50
35.4.3 Assumptions	50
35.4.4 Access Routine Semantics	50
35.4.5 Local Functions	50
36 MIS of Report Interface	50
36.1 Module	50
36.2 Uses	50
36.3 Syntax	50
36.3.1 Exported Constants	50
36.3.2 Exported Access Programs	50
36.4 Semantics	51
36.4.1 State Variables	51
36.4.2 Environment Variables	51
36.4.3 Assumptions	51
36.4.4 Access Routine Semantics	51
36.4.5 Local Functions	51
37 MIS of Report Controller	51
37.1 Module	51
37.2 Uses	51
37.3 Syntax	51
37.3.1 Exported Constants	51
37.3.2 Exported Access Programs	51
37.4 Semantics	52
37.4.1 State Variables	52
37.4.2 Environment Variables	52
37.4.3 Assumptions	52
37.4.4 Access Routine Semantics	52
37.4.5 Local Functions	52
38 MIS of Report	52
38.1 Module	52
38.2 Uses	52
38.3 Syntax	52

38.3.1	Exported Constants	52
38.3.2	Exported Access Programs	53
38.4	Semantics	53
38.4.1	State Variables	53
38.4.2	Environment Variables	53
38.4.3	Assumptions	53
38.4.4	Access Routine Semantics	53
38.4.5	Local Functions	54
39	MIS of Project Selection Interface	54
39.1	Module	54
39.2	Uses	54
39.3	Syntax	54
39.3.1	Exported Constants	54
39.3.2	Exported Access Programs	54
39.4	Semantics	54
39.4.1	State Variables	54
39.4.2	Environment Variables	54
39.4.3	Assumptions	55
39.4.4	Access Routine Semantics	55
39.4.5	Local Functions	55
40	MIS of Project Selection Controller	55
40.1	Module	55
40.2	Uses	55
40.3	Syntax	55
40.3.1	Exported Constants	55
40.3.2	Exported Access Programs	55
40.4	Semantics	55
40.4.1	State Variables	55
40.4.2	Environment Variables	56
40.4.3	Assumptions	56
40.4.4	Access Routine Semantics	56
40.4.5	Local Functions	56
41	MIS of Labeling Interface	56
41.1	Module	56
41.2	Uses	56
41.3	Syntax	56
41.3.1	Exported Constants	56
41.3.2	Exported Access Programs	56
41.4	Semantics	57
41.4.1	State Variables	57

41.4.2	Environment Variables	57
41.4.3	Assumptions	57
41.4.4	Access Routine Semantics	57
41.4.5	Local Functions	57
42	MIS of Labeling Controller	57
42.1	Module	57
42.2	Uses	58
42.3	Syntax	58
42.3.1	Exported Constants	58
42.3.2	Exported Access Programs	58
42.4	Semantics	58
42.4.1	State Variables	58
42.4.2	Environment Variables	58
42.4.3	Assumptions	58
42.4.4	Access Routine Semantics	58
42.4.5	Local Functions	59
43	MIS of Image	59
43.1	Module	59
43.2	Uses	59
43.3	Syntax	59
43.3.1	Exported Constants	59
43.3.2	Exported Access Programs	59
43.4	Semantics	59
43.4.1	State Variables	59
43.4.2	Environment Variables	59
43.4.3	Assumptions	60
43.4.4	Access Routine Semantics	60
43.4.5	Local Functions	60
44	MIS of Label Server	61
44.1	Module	61
44.2	Uses	61
44.3	Syntax	61
44.3.1	Exported Constants	61
44.3.2	Exported Access Programs	61
44.4	Semantics	61
44.4.1	State Variables	61
44.4.2	Environment Variables	61
44.4.3	Assumptions	61
44.4.4	Access Routine Semantics	61
44.4.5	Local Functions	62

45 MIS of Label Database Connector	63
45.1 Module	63
45.2 Uses	63
45.3 Syntax	63
45.3.1 Exported Constants	63
45.3.2 Exported Access Programs	63
45.4 Semantics	63
45.4.1 State Variables	63
45.4.2 Environment Variables	63
45.4.3 Assumptions	63
45.4.4 Access Routine Semantics	63
45.4.5 Local Functions	64
46 MIS of Label Database	65
46.1 Module	65
46.2 Uses	65
46.3 Syntax	65
46.3.1 Exported Constants	65
46.3.2 Exported Access Programs	65
46.4 Semantics	65
46.4.1 State Variables	65
46.4.2 Environment Variables	65
46.4.3 Assumptions	65
46.4.4 Access Routine Semantics	65
46.4.5 Local Functions	66
47 MIS of ImageObject Database Connector	67
47.1 Module	67
47.2 Uses	67
47.3 Syntax	67
47.3.1 Exported Constants	67
47.3.2 Exported Access Programs	67
47.4 Semantics	67
47.4.1 State Variables	67
47.4.2 Environment Variables	67
47.4.3 Assumptions	67
47.4.4 Access Routine Semantics	67
47.4.5 Local Functions	68
48 MIS of ImageObject Database	69
48.1 Module	69
48.2 Uses	69
48.3 Syntax	69

48.3.1	Exported Constants	69
48.3.2	Exported Access Programs	69
48.4	Semantics	69
48.4.1	State Variables	69
48.4.2	Environment Variables	69
48.4.3	Assumptions	69
48.4.4	Access Routine Semantics	69
48.4.5	Local Functions	70
49	MIS of Labeller Database Connector	71
49.1	Module	71
49.2	Uses	71
49.3	Syntax	71
49.3.1	Exported Constants	71
49.3.2	Exported Access Programs	71
49.4	Semantics	71
49.4.1	State Variables	71
49.4.2	Environment Variables	71
49.4.3	Assumptions	71
49.4.4	Access Routine Semantics	71
49.4.5	Local Functions	72
50	MIS of Labeller Database	73
50.1	Module	73
50.2	Uses	73
50.3	Syntax	73
50.3.1	Exported Constants	73
50.3.2	Exported Access Programs	73
50.4	Semantics	73
50.4.1	State Variables	73
50.4.2	Environment Variables	73
50.4.3	Assumptions	73
50.4.4	Access Routine Semantics	73
50.4.5	Local Functions	74
51	MIS of Object Extraction Manager	75
51.1	Module	75
51.2	Uses	75
51.3	Syntax	75
51.3.1	Exported Constants	75
51.3.2	Exported Access Programs	75
51.4	Semantics	75
51.4.1	State Variables	75

51.4.2	Environment Variables	75
51.4.3	Assumptions	75
51.4.4	Access Routine Semantics	75
51.4.5	Local Functions	76
52	MIS of Label Confidence Service	77
52.1	Module	77
52.2	Uses	77
52.3	Syntax	77
52.3.1	Exported Constants	77
52.3.2	Exported Access Programs	77
52.4	Semantics	77
52.4.1	State Variables	77
52.4.2	Environment Variables	77
52.4.3	Assumptions	77
52.4.4	Access Routine Semantics	77
52.4.5	Local Functions	78
53	MIS of Object Extraction Service	79
53.1	Module	79
53.2	Uses	79
53.3	Syntax	79
53.3.1	Exported Constants	79
53.3.2	Exported Access Programs	79
53.4	Semantics	79
53.4.1	State Variables	79
53.4.2	Environment Variables	79
53.4.3	Assumptions	79
53.4.4	Access Routine Semantics	79
53.4.5	Local Functions	80
54	MIS of Image Prior Analyzer	81
54.1	Module	81
54.2	Uses	81
54.3	Syntax	81
54.3.1	Exported Constants	81
54.3.2	Exported Access Programs	81
54.4	Semantics	81
54.4.1	State Variables	81
54.4.2	Environment Variables	81
54.4.3	Assumptions	81
54.4.4	Access Routine Semantics	81
54.4.5	Local Functions	81

55 MIS of Labeller Expertise Calculator	82
55.1 Module	82
55.2 Uses	82
55.3 Syntax	82
55.3.1 Exported Constants	82
55.3.2 Exported Access Programs	82
55.4 Semantics	82
55.4.1 State Variables	82
55.4.2 Environment Variables	82
55.4.3 Assumptions	82
55.4.4 Access Routine Semantics	82
55.4.5 Local Functions	83
56 MIS of Image Service Manager	84
56.1 Module	84
56.2 Uses	84
56.3 Syntax	84
56.3.1 Exported Constants	84
56.3.2 Exported Access Programs	84
56.4 Semantics	84
56.4.1 State Variables	84
56.4.2 Environment Variables	84
56.4.3 Assumptions	84
56.4.4 Access Routine Semantics	84
56.4.5 Local Functions	85
57 MIS of Image Mask Service	86
57.1 Module	86
57.2 Uses	86
57.3 Syntax	86
57.3.1 Exported Constants	86
57.3.2 Exported Access Programs	86
57.4 Semantics	86
57.4.1 State Variables	86
57.4.2 Environment Variables	86
57.4.3 Assumptions	86
57.4.4 Access Routine Semantics	86
57.4.5 Local Functions	86
58 MIS of Image Selection Service	87
58.1 Module	87
58.2 Uses	87
58.3 Syntax	87

58.3.1	Exported Constants	87
58.3.2	Exported Access Programs	87
58.4	Semantics	87
58.4.1	State Variables	87
58.4.2	Environment Variables	87
58.4.3	Assumptions	87
58.4.4	Access Routine Semantics	87
58.4.5	Local Functions	88
59	MIS of ModelComparisonEvaluation	89
59.1	6.1 Module	89
59.2	6.2 Uses	89
59.3	6.3 Syntax	89
59.3.1	6.3.1 Exported Constants	89
59.3.2	6.3.2 Exported Access Programs	89
59.4	6.4 Semantics	89
59.4.1	6.4.1 State Variables	89
59.4.2	6.4.2 Environment Variables	89
59.4.3	6.4.3 Assumptions	89
59.4.4	6.4.4 Access Routine Semantics	90
59.4.5	6.4.5 Local Functions	90
60	MIS of CrossValidationEvaluation	91
60.1	6.1 Module	91
60.2	6.2 Uses	91
60.3	6.3 Syntax	91
60.3.1	6.3.1 Exported Constants	91
60.3.2	6.3.2 Exported Access Programs	91
60.4	6.4 Semantics	91
60.4.1	6.4.1 State Variables	91
60.4.2	6.4.2 Environment Variables	91
60.4.3	6.4.3 Assumptions	91
60.4.4	6.4.4 Access Routine Semantics	92
60.4.5	6.4.5 Local Functions	92
61	MIS of ModelTrainingService	93
61.1	6.1 Module	93
61.2	6.2 Uses	93
61.3	6.3 Syntax	93
61.3.1	6.3.1 Exported Constants	93
61.3.2	6.3.2 Exported Access Programs	93
61.4	6.4 Semantics	93
61.4.1	6.4.1 State Variables	93

61.4.2	6.4.2 Environment Variables	93
61.4.3	6.4.3 Assumptions	93
61.4.4	6.4.4 Access Routine Semantics	94
61.4.5	6.4.5 Local Functions	94
62	MIS of ModelEvaluationService	95
62.1	6.1 Module	95
62.2	6.2 Uses	95
62.3	6.3 Syntax	95
62.3.1	6.3.1 Exported Constants	95
62.3.2	6.3.2 Exported Access Programs	95
62.4	6.4 Semantics	95
62.4.1	6.4.1 State Variables	95
62.4.2	6.4.2 Environment Variables	95
62.4.3	6.4.3 Assumptions	95
62.4.4	6.4.4 Access Routine Semantics	96
62.4.5	6.4.5 Local Functions	96
63	MIS of ModelManager	97
63.1	6.1 Module	97
63.2	6.2 Uses	97
63.3	6.3 Syntax	97
63.3.1	6.3.1 Exported Constants	97
63.3.2	6.3.2 Exported Access Programs	97
63.4	6.4 Semantics	97
63.4.1	6.4.1 State Variables	97
63.4.2	6.4.2 Environment Variables	97
63.4.3	6.4.3 Assumptions	98
63.4.4	6.4.4 Access Routine Semantics	98
63.4.5	6.4.5 Local Functions	98
64	MIS of ModelCreation (Abstract)	99
64.1	6.1 Module	99
64.2	6.2 Uses	99
64.3	6.3 Syntax	99
64.3.1	6.3.1 Exported Constants	99
64.3.2	6.3.2 Exported Access Programs	99
64.4	6.4 Semantics	99
64.4.1	6.4.1 State Variables	99
64.4.2	6.4.2 Environment Variables	99
64.4.3	6.4.3 Assumptions	99
64.4.4	6.4.4 Access Routine Semantics	99
64.4.5	6.4.5 Local Functions	100

65 MIS of MLModelDatabase	101
65.1 6.1 Module	101
65.2 6.2 Uses	101
65.3 6.3 Syntax	101
65.3.1 6.3.1 Exported Constants	101
65.3.2 6.3.2 Exported Access Programs	101
65.4 6.4 Semantics	101
65.4.1 6.4.1 State Variables	101
65.4.2 6.4.2 Environment Variables	101
65.4.3 6.4.3 Assumptions	101
65.4.4 6.4.4 Access Routine Semantics	102
65.4.5 6.4.5 Local Functions	102
66 MIS of OtherModelCreation	103
66.1 6.1 Module	103
66.2 6.2 Uses	103
66.3 6.3 Syntax	103
66.3.1 6.3.1 Exported Constants	103
66.3.2 6.3.2 Exported Access Programs	103
66.4 6.4 Semantics	103
66.4.1 6.4.1 State Variables	103
66.4.2 6.4.2 Environment Variables	103
66.4.3 6.4.3 Assumptions	103
66.4.4 6.4.4 Access Routine Semantics	103
66.4.5 6.4.5 Local Functions	104
67 MIS of CNNModelCreation	104
67.1 6.1 Module	104
67.2 6.2 Uses	104
67.3 6.3 Syntax	104
67.3.1 6.3.1 Exported Constants	104
67.3.2 6.3.2 Exported Access Programs	104
67.4 6.4 Semantics	104
67.4.1 6.4.1 State Variables	104
67.4.2 6.4.2 Environment Variables	104
67.4.3 6.4.3 Assumptions	104
67.4.4 6.4.4 Access Routine Semantics	105
67.4.5 6.4.5 Local Functions	105
68 Exception Handling	105
68.1 Frontend Handling (React)	105
68.2 Backend Handling (Python)	105

3 Introduction

The following document details the Module Interface Specifications for OrbitWatch, a crowd-sourced datalabelling platform which aims to improve the process of extracting information from satellite images.

Complementary documents include the System Requirement Specifications and Module Guide. The full documentation and implementation can be found at <https://github.com/OKKM-insights/OKKM.insights/>

4 Notation

The structure of the MIS for modules comes from Hoffman and Strooper (1995), with the addition that template modules have been adapted from Ghezzi et al. (2003). The mathematical notation comes from Chapter 3 of Hoffman and Strooper (1995). For instance, the symbol $:=$ is used for a multiple assignment statement and conditional rules follow the form $(c_1 \Rightarrow r_1 | c_2 \Rightarrow r_2 | \dots | c_n \Rightarrow r_n)$.

The following table summarizes the primitive data types used by Software Engineering.

Data Type	Notation	Description
character	char	a single symbol or digit
integer	\mathbb{Z}	a number without a fractional component in $(-\infty, \infty)$
natural number	\mathbb{N}	a number without a fractional component in $[1, \infty)$
real	\mathbb{R}	any number in $(-\infty, \infty)$
date	Date	provides a specific date and time

The specification of Software Engineering uses some derived data types: sequences, strings, and tuples. Sequences are lists filled with elements of the same data type. Strings are sequences of characters. Tuples contain a list of values, potentially of different types. In addition, Software Engineering uses functions, which are defined by the data types of their inputs and outputs. Local functions are described by giving their type signature followed by their specification.

System Components

MLModel

Represents a machine learning model, identified by attributes such as:

- **model_name**

- **model_path**
- **model_type**
- Metadata about the model (e.g., training parameters, architecture)

ModelTrainingRun

Captures the details of a model's training process, including:

- **training_data_path**
- Evaluation metrics
- Parameters used during training

ModelEvaluationRun

Represents the evaluation process for a model, containing:

- **evaluation_data_path**
- Evaluation metrics (e.g., precision, recall)

ModelDeployment

Tracks the deployment details of a machine learning model, such as:

- **deployment_environment** (e.g., Production, Staging)
- **deployment_date**

Account

Describes user accounts in the system with attributes like:

- **username**
- **email**
- **account_type** (e.g., Client, Labeler, Admin)
- Security-related fields such as **password_hash** and **last_login**

AccountModification

Maintains a log of changes made to user accounts, tracking:

- **field_modified**
- **old_value**
- **new_value**

LoginAttempt

Records login attempts for security purposes, including:

- **username**
- **attempt_time**
- Whether the attempt was successful

Project

Defines a labeling or analysis project, identified by:

- **project_name**
- **description**
- Associated metadata

User

Represents individuals (e.g., labelers, managers) working within the system, including:

- **username**
- **role**

ProjectAssignment

Tracks which users are assigned to specific projects, identified by:

- **project_id**
- **user_id**

SatelliteImage

Represents images (e.g., satellite imagery) linked to specific projects, with attributes like:

- **image_path**
- **acquisition_date**

LabelingTask

Encapsulates a labeling activity, defined by:

- **status**
- **start_time**
- **end_time**
- The user assigned to the task

Report

Represents generated reports for projects, with fields like:

- **report_data**
- **generation_date**
- The user who generated the report

ServiceRequest

Tracks requests for services such as image acquisition or data processing, with attributes like:

- **request_type**
- **status**

Image

Represents standalone images within the system, identified by:

- **image_path**
- **upload_date**

Labeller

Represents individuals performing labeling tasks, identified by:

- **labeller_name**

Object

Represents specific objects detected in an image, with attributes like:

- **bounding_box_coordinates**
- **object_type**

Label

Represents annotations made by a labeller, linking to specific objects in an image and storing information like:

- **label_text**
- **timestamp**
- **labeller_id**

The following diagram display additional details on the relationship between datatypes

Project Creation and
Selection Subsystem

Project	
PK	<u>project_id</u> INT AUTO INCREMENT
	project_name VARCHAR(255) NOT NULL description TEXT creation_date DATETIME DEFAULT CURRENT_TIMESTAMP

User	
PK	<u>user_id</u> INT AUTO INCREMENT
	username VARCHAR(255) UNIQUE NOT NULL -- Add more user details as needed (e.g., name, email, password, etc.) role VARCHAR(50) -- e.g., 'Labeler', 'Manager', 'Coordinator'

ProjectAssignment	
PK	<u>user_id</u> INT
PK	<u>project_id</u> INT
PK	<u>project_assignment_id</u> INT AUTO INCREMENT
	assignment_date DATETIME DEFAULT CURRENT_TIMESTAMP FOREIGN KEY (project_id) REFERENCES Project(project_id) FOREIGN KEY (user_id) REFERENCES User(user_id)

SatelliteImage	
PK	<u>project_id</u> INT, -- Link to the project the image belongs to
PK	<u>image_id</u> INT AUTO INCREMENT
	image_path VARCHAR(255), -- Or BLOB if storing directly acquisition_date DATE -- Add other relevant metadata FOREIGN KEY (project_id) REFERENCES Project(project_id)

LabelingTask	
PK	<u>image_id</u> INT
PK	<u>project_id</u> INT
PK	<u>labeling_task_id</u> INT AUTO INCREMENT
	assigned_to INT, -- User assigned to this task status VARCHAR(50) DEFAULT 'Pending', -- e.g., 'Pending', 'Completed' start_time DATETIME end_time DATETIME FOREIGN KEY (project_id) REFERENCES Project(p FOREIGN KEY (image_id) REFERENCES SatelliteIm FOREIGN KEY (assigned_to) REFERENCES User(u

Report	
PK	<u>project_id</u> INT
PK	<u>report_id</u> INT AUTO INCREMENT
	generated_by INT, -- User who generated the report generation_date DATETIME DEFAULT CURRENT_T report_data TEXT, -- Or a link to a file if large FOREIGN KEY (project_id) REFERENCES Project(p FOREIGN KEY (generated_by) REFERENCES User(u

ServiceRequest	
PK	<u>project_id</u> INT
PK	<u>request_id</u> INT AUTO INCREMENT
	requested_by INT request_date DATETIME DEFAULT CURRENT_TIME request_type VARCHAR(255), -- e.g., 'Image Acquisi status VARCHAR(50) DEFAULT 'Pending' FOREIGN KEY (project_id) REFERENCES Project(p FOREIGN KEY (requested_by) REFERENCES User(u

Computer Vision
Model Creation
Subsystem

MLModel	
PK	<u>model_id</u> INT AUTO INCREMENT
	model_name VARCHAR(255) NOT NULL model_path VARCHAR(255), -- Path to the model file model_type VARCHAR(255), -- e.g., 'Classification', 'Re creation_date DATETIME DEFAULT CURRENT_TIM last_modified DATETIME description TEXT version VARCHAR(50), -- Versioning of the model metadata JSON -- Store model metadata like training

ModelTrainingRun	
PK	<u>model_id</u> INT
PK	<u>training_run_id</u> INT AUTO INCREMENT
	start_time DATETIME end_time DATETIME training_data_path VARCHAR(255), -- Path to the tra evaluation_metrics JSON, -- Store evaluation metrics training_parameters JSON, -- Store training paramete FOREIGN KEY (model_id) REFERENCES MLModel

ModelEvaluationRun	
PK	<u>model_id</u> INT
PK	<u>evaluation_run_id</u> INT AUTO INCREMENT
	start_time DATETIME end_time DATETIME evaluation_data_path VARCHAR(255), -- Path to the evaluation_metrics JSON, -- Store evaluation metrics FOREIGN KEY (model_id) REFERENCES MLModel

ModelDeployment	
PK	<u>model_id</u> INT
PK	<u>deployment_id</u> INT AUTO INCREMENT
	deployment_date DATETIME DEFAULT CURRENT_ deployment_environment VARCHAR(255), -- e.g., 'Pr deployed_by INT, -- User who deployed the model FOREIGN KEY (model_id) REFERENCES MLModel -- Add foreign key reference to user table if needed

Client/ Labeller
Management
Subsystem

Account	
PK	<u>account_id INT AUTO INCREMENT</u>
	username VARCHAR(255) UNIQUE NOT NULL password_hash VARCHAR(255) NOT NULL, -- Store email VARCHAR(255) UNIQUE full_name VARCHAR(255) account_type VARCHAR(50) CHECK (account_type creation_date DATETIME DEFAULT CURRENT_TIM last_login DATETIME -- Add other account-related fields as needed (e.g., a

AccountModification	
PK	<u>account_id INT</u>
PK	<u>modification_id INT AUTO INCREMENT</u>
	modified_by INT, -- User who made the modification (modification_date DATETIME DEFAULT CURRENT_ field_modified VARCHAR(255), -- e.g., 'email', 'full_na old_value TEXT new_value TEXT FOREIGN KEY (account_id) REFERENCES Account FOREIGN KEY (modified_by) REFERENCES Account

LoginAttempt	
PK	<u>attempt_id INT AUTO INCREMENT</u>
	username VARCHAR(255) attempt_time DATETIME DEFAULT CURRENT_TIME successful BOOLEAN ip_address VARCHAR(45) -- For tracking location of

Label Collection and
Aggregation
Subsystem

Image	
PK	<u>image_id INT AUTO INCREMENT</u>
	image_data BLOB, -- Or VARCHAR for file paths if st image_path VARCHAR(255) upload_date DATETIME

Labeller	
PK	<u>labeller_id INT AUTO INCREMENT</u>
	labeller_name VARCHAR(255)

Object	
PK	<u>image_id INT</u>
PK	<u>object_id INT AUTO INCREMENT</u>
	bounding_box_coordinates VARCHAR(255), -- Store object_type VARCHAR(255) FOREIGN KEY (image_id) REFERENCES Image(im

Label	
PK	<u>labeller_id INT</u>
PK	<u>object_id INT</u>
PK	<u>image_id INT</u>
PK	<u>label_id INT AUTO INCREMENT</u>
	label_text VARCHAR(255) timestamp DATETIME FOREIGN KEY (image_id) REFERENCES Image(image_id) FOREIGN KEY (object_id) REFERENCES Object(object_id) FOREIGN KEY (labeller_id) REFERENCES Labeller(labeller_id)

5 Module Decomposition

The following table is taken directly from the Module Guide document for this project.

Level 1	Level 2
Hardware-Hiding Mod- ule	

Table 1: Module Hierarchy

Level 1	Level 2
Behaviour-Hiding Module	Account Creation Interface
	Account Database
	Account Update Interface
	Login Interface
	Access Token
	Labeler
	Client
	User
	Satellite Image Request Interface
	Satellite Image Request
	Project Creation Interface
	Project
	Service Request Failure Interface
	Image Upload Interface
	Report Interface
	Report
	Project Selection Interface
	Labeling Interface
	Image
	Label Server
	Label Database Connector
	Label Database
	ImageObject Database Connector
	ImageObject Database
	Labeller Database Connector
	Labeller Database
	Object Extraction Manager
	Image Service Manager
	ModelCreation (Abstract Class)
	CNNModelCreation
	OtherModelCreation
	ModelManager
	MLModelDatabase

Table 2: Module Hierarchy

Level 1	Level 2
Software Decision Module	Account Creation Controller
	Account Database Connector
	Account Update Controller
	Authentication Controller
	Satellite Image Request Controller
	Project Creation Controller
	Report Controller
	Project Selection Controller
	Labeling Controller
	Label Confidence Service
	Object Extraction Service
	Image Prior Analyzer
	Labeller Expertise Calculator
	Image Mask Service
	Image Selection Service
	ModelComparision Evaluation
	CrossValidation Evaluation
	ModelTrainingService
	ModelEvaluationService

Table 3: Module Hierarchy

6 MIS of Report Manager

6.1 Module

RM (ReportManager)

6.2 Uses

LabelDBConnector⁴⁵
ObjectsOnImageDBConnector⁴⁷
RawImageDBConnector¹¹
ProjectDBConnector¹⁰

6.3 Syntax

6.3.1 Exported Constants

None

6.3.2 Exported Access Programs

Name	In	Out	Exceptions
generateReport	projectId: String	Report	DatabaseException

6.4 Semantics

6.4.1 State Variables

None

6.4.2 Environment Variables

None

6.4.3 Assumptions

None

6.4.4 Access Routine Semantics

generateReport(projectId: String)

- output: Returns a Report object that aggregates data from the label, object-on-image, raw image, and project databases.
- exception: DatabaseException: Thrown if there is an issue communicating with any of the underlying databases.

6.4.5 Local Functions

Any helper methods used internally to combine or transform the data (e.g., formatting label lists, summarizing object data) are not exported and thus not specified here.

7 MIS of Account Creation Interface

7.1 Module

Account Creation Interface

7.2 Uses

Account Creation Controller²⁵

7.3 Syntax

7.3.1 Exported Constants

None

7.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	Enum[labeler, client]	-	-
submitForm	list[(string, string)]	-	-

7.4 Semantics

7.4.1 State Variables

None

7.4.2 Environment Variables

win: 2D sequence of coloured pixels

7.4.3 Assumptions

None

7.4.4 Access Routine Semantics

renderPage(userType):

- transition: win := Modify window so that it shows a registration form that asks for the necessary information depending on if the user is a labeler or client.

submitForm(formData):

- transition: Passes the submitted form data to the Account Creation Controller for validation and processing.

7.4.5 Local Functions

None

8 MIS of Project Manager

8.1 Module

PM (ProjectManager)

8.2 Uses

ProjectCollectionManager⁹

CoreImageDBConnector¹¹

8.3 Syntax

8.3.1 Exported Constants

None

8.3.2 Exported Access Programs

Name	In	Out	Exceptions
createProject	projectName: String, metadata: Map(String, String)	Project	DatabaseException
addImageToProject	projectId: String, byte[]	void	DatabaseException

8.4 Semantics

8.4.1 State Variables

None

8.4.2 Environment Variables

None

8.4.3 Assumptions

None

8.4.4 Access Routine Semantics

createProject(projectName, metadata)

- output: Returns a newly created Project object with a unique identifier and any associated metadata.
- exception: **ProjectAlreadyExistsException**: Thrown if a project with the same name or identifier already exists. **DatabaseException**: Thrown if any error occurs while writing to the database.

addImageToProject(projectId, imageData)

- exception: **InvalidImageException**: Thrown if the image data is corrupted or unsupported. **ProjectNotFoundException**: Thrown if the target project does not exist in the system. **DatabaseException**: Thrown if a database error occurs while storing the image.

8.4.5 Local Functions

Internal helper methods (e.g., validation, transformations) are not exported.

9 MIS of Project Collection Manager

9.1 Module

PCM (ProjectCollectionManager)

9.2 Uses

ProjectDBConnector¹⁰

9.3 Syntax

9.3.1 Exported Constants

None

9.3.2 Exported Access Programs

Name	In	Out	Exceptions
getAvailableProjects	None	List(Project)	DatabaseException

9.4 Semantics

9.4.1 State Variables

None

9.4.2 Environment Variables

None

9.4.3 Assumptions

None

9.4.4 Access Routine Semantics

getAvailableProjects()

- output: Returns a list of existing Project objects (could be filtered by user permissions or some criteria, if applicable).
- exception: **ProjectAlreadyExistsException**: Thrown if a project with the same name or identifier already exists.

9.4.5 Local Functions

Internal helper methods (e.g., transformations) are not exported.

10 MIS of Project Database Connector

10.1 Module

PDBC (ProjectDBConnector)

10.2 Uses

MySQL - ProjectDB

10.3 Syntax

10.3.1 Exported Constants

None

10.3.2 Exported Access Programs

Name	In	Out	Exceptions
fetchProject	projectId: String	Project	DatabaseException
fetchProjectList	None	List(Project)	DatabaseException
storeProject	project : Project	None	DatabaseException

10.4 Semantics

10.4.1 State Variables

None

10.4.2 Environment Variables

databaseConnection: connection to relational database

10.4.3 Assumptions

None

10.4.4 Access Routine Semantics

storeProject(project : Project)

- output: No direct output; success indicates the Project was successfully stored.
- exception: **DatabaseException**: Thrown if there is an issue communicating with any of the underlying databases. **DuplicateProjectException**: Thrown if the project already exists

fetchProjectList()

- output: Returns a list of all Project objects stored in the database.
- exception: **DatabaseException**: Thrown if there is an issue communicating with any of the underlying databases.

fetchProject(projectId : String)

- output: Returns the Project object corresponding to the given projectId.
- exception: **DatabaseException**: Thrown if there is an issue communicating with any of the underlying databases. **ProjectNotFoundException**: Thrown if the project with the given ID does not exist.

10.4.5 Local Functions

Any database query-building or data-mapping helpers remain internal and are not exported.

11 MIS of Core Image Database Connector

11.1 Module

CIDBC (CoreImageDBConnector)

11.2 Uses

MySQL - CoreImageDB

11.3 Syntax

11.3.1 Exported Constants

None

11.3.2 Exported Access Programs

Name	In	Out	Exceptions
storeImage	projectId: String imageData: byte[]	String	DatabaseException
fetchImage	imageId: String	Image	DatabaseException
fetchImagesForProject	projectId: String	List(Image)	DatabaseException

11.4 Semantics

11.4.1 State Variables

None

11.4.2 Environment Variables

databaseConnection: connection to relational database

11.4.3 Assumptions

None

11.4.4 Access Routine Semantics

storeImage(projectId, imageData)

- output: Returns a newly generated String identifier (imageId) that uniquely identifies the stored image in the database.
- exception: **DatabaseException**: Thrown if there is an issue communicating with any of the underlying databases. **ProjectNotFoundException**: Thrown if the specified projectId does not exist in the database.

fetchImage(imageId)

- output: Returns an Image object (or equivalent data structure) for the given imageId, including any relevant metadata or binary content.
- exception: **DatabaseException**: Thrown if there is an issue communicating with any of the underlying databases. **ImageNotFoundException**: Thrown if no image with the specified imageId exists in the database.

fetchImagesForProject(projectId)

- output: Returns a list of Image objects associated with the specified projectId.
- exception: **DatabaseException**: Thrown if there is an issue communicating with any of the underlying databases. **ProjectNotFoundException**: Thrown if the project with the given ID does not exist.

11.4.5 Local Functions

Any database query-building or data-mapping helpers remain internal and are not exported.

12 MIS of Account Database Connector

12.1 Module

Account Database Connector

12.2 Uses

Account Database¹⁸

12.3 Syntax

12.3.1 Exported Constants

None

12.3.2 Exported Access Programs

Name	In	Out	Exceptions
insertUser	User	-	-
retrieveUser	string	User	-
updateUser	User	-	-
userExists	string	boolean	-
makeDBConnection	credentials	-	-

12.4 Semantics

12.4.1 State Variables

None

12.4.2 Environment Variables

databaseConnection: connection to relational database

12.4.3 Assumptions

None

12.4.4 Access Routine Semantics

insertUser(user):

- transition: Request to insert user into database through databaseConection.

retrieveUser(email):

- output:

$$\begin{cases} \text{User where User.email} == \text{email}, & \text{if userExists(email)} \\ \text{null}, & \text{otherwise} \end{cases}$$

updateUser(user):

- transition:

$$\begin{cases} \text{Request to update user in database,} & \text{if userExists(user.email)} \\ \text{Do nothing} & \text{otherwise} \end{cases}$$

userExists(email):

- output: out :=

$$\exists \text{User} \in \text{Database s.t. User.email} == \text{email}$$

makeDBConnection(credentials):

- transition: databaseConnection := connection is established with database if credentials are correct

12.4.5 Local Functions

None

13 MIS of Account Database

13.1 Module

Account Database

13.2 Uses

None

13.3 Syntax

13.3.1 Exported Constants

None

13.3.2 Exported Access Programs

Name	In	Out	Exceptions
insertUser	User	-	-
retrieveUser	string	User	-
updateUser	User	-	-
userExists	string	boolean	-

13.4 Semantics

13.4.1 State Variables

None

13.4.2 Environment Variables

databaseConnection: connection to Application

13.4.3 Assumptions

None

13.4.4 Access Routine Semantics

insertUser(user):

- transition: Insert user into database.

retrieveUser(email):

- output:

$$\begin{cases} \text{User where User.email == email,} & \text{if userExists(email)} \\ \text{null,} & \text{otherwise} \end{cases}$$

updateUser(user):

- transition:

$$\begin{cases} \text{Update user in database,} & \text{if userExists(user.email)} \\ \text{Do nothing} & \text{otherwise} \end{cases}$$

userExists(email):

- output: out :=

$$\exists \text{ User} \in \text{Database s.t. User.email == email}$$

13.4.5 Local Functions

None

14 MIS of Account Update Interface

14.1 Module

Account Update Interface

14.2 Uses

Account Update Controller²⁶

14.3 Syntax

14.3.1 Exported Constants

None

14.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	User	-	-
submitForm	list[(string, string)]	-	-

14.4 Semantics

14.4.1 State Variables

None

14.4.2 Environment Variables

win: 2D sequence of coloured pixels

14.4.3 Assumptions

None

14.4.4 Access Routine Semantics

renderPage(userInfo):

- transition: win := Modify window so that it shows a form with the current user's information. This information can be changed by the user.

submitForm(formData):

- transition: Passes the submitted changes to the Account Update Controller for validation and processing.

14.4.5 Local Functions

None

15 MIS of Login Interface

15.1 Module

Login Interface

15.2 Uses

Authentication Controller²⁷

15.3 Syntax

15.3.1 Exported Constants

None

15.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	-	-	-
submitForm	list[(string, string)]	-	-

15.4 Semantics

15.4.1 State Variables

None

15.4.2 Environment Variables

win: 2D sequence of coloured pixels

15.4.3 Assumptions

None

15.4.4 Access Routine Semantics

renderPage():

- transition: win := Modify window so that it shows a login form.

submitForm(formData):

- transition: Passes the submitted credentials to the Authentication Controller for validation.

15.4.5 Local Functions

None

16 MIS of Access Token

16.1 Module

Access Token

16.2 Uses

None

16.3 Syntax

16.3.1 Exported Constants

None

16.3.2 Exported Access Programs

Name	In	Out	Exceptions
isExpired	-	boolean	-
renew	-	-	-

16.4 Semantics

16.4.1 State Variables

- tokenValue: string
- expirationTime: Date
- userID: string

16.4.2 Environment Variables

None

16.4.3 Assumptions

None

16.4.4 Access Routine Semantics

isExpired():

- output: $\text{out} := \text{currentTime} > \text{expirationTime}$

renew():

- transition: $\text{expirationTime} := \text{expirationTime} + 5 \text{ hours}$

16.4.5 Local Functions

None

17 MIS of Account Creation Interface

17.1 Module

Account Creation Interface

17.2 Uses

Account Creation Controller²⁵

17.3 Syntax

17.3.1 Exported Constants

None

17.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	Enum[labeler, client]	-	-
submitForm	list[(string, string)]	-	-

17.4 Semantics

17.4.1 State Variables

None

17.4.2 Environment Variables

win: 2D sequence of coloured pixels

17.4.3 Assumptions

None

17.4.4 Access Routine Semantics

renderPage(userType):

- transition: win := Modify window so that it shows a registration form that asks for the necessary information depending on if the user is a labeler or client.

submitForm(formData):

- transition: Passes the submitted form data to the Account Creation Controller for validation and processing.

17.4.5 Local Functions

None

18 MIS of Account Database

18.1 Module

Account Database

18.2 Uses

Relational Database

18.3 Syntax

18.3.1 Exported Constants

None

18.3.2 Exported Access Programs

Name	In	Out	Exceptions
insertUser	User	-	-
retrieveUser	string	User	-
updateUser	User	-	-
userExists	string	boolean	-

18.4 Semantics

18.4.1 State Variables

None

18.4.2 Environment Variables

databaseConnection: connection to relational database

18.4.3 Assumptions

None

18.4.4 Access Routine Semantics

insertUser(user):

- transition: Insert user into database through databaseConection.

retrieveUser(email):

- output:
$$\begin{cases} \text{User where User.email == email,} & \text{if userExists(email)} \\ \text{null,} & \text{otherwise} \end{cases}$$

updateUser(user):

- transition:
$$\begin{cases} \text{Update user in database through databaseConection,} & \text{if userExists(user.email)} \\ \text{Do nothing} & \text{otherwise} \end{cases}$$

userExists(email):

- output: out :=
$$\exists \text{ User} \in \text{Database s.t. User.email} = \text{email}$$

18.4.5 Local Functions

None

19 MIS of Account Update Interface

19.1 Module

Account Update Interface

19.2 Uses

Account Update Controller²⁶

19.3 Syntax

19.3.1 Exported Constants

None

19.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	User	-	-
submitForm	list[(string, string)]	-	-

19.4 Semantics

19.4.1 State Variables

None

19.4.2 Environment Variables

win: 2D sequence of coloured pixels

19.4.3 Assumptions

None

19.4.4 Access Routine Semantics

renderPage(userInfo):

- transition: win := Modify window so that it shows a form with the current user's information. This information can be changed by the user.

submitForm(formData):

- transition: Passes the submitted changes to the Account Update Controller for validation and processing.

19.4.5 Local Functions

None

20 MIS of Login Interface

20.1 Module

Login Interface

20.2 Uses

Authentication Controller[27](#)

20.3 Syntax

20.3.1 Exported Constants

None

20.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	-	-	-
submitForm	list[(string, string)]	-	-

20.4 Semantics

20.4.1 State Variables

None

20.4.2 Environment Variables

win: 2D sequence of coloured pixels

20.4.3 Assumptions

None

20.4.4 Access Routine Semantics

renderPage():

- transition: win := Modify window so that it shows a login form.

submitForm(formData):

- transition: Passes the submitted credentials to the Authentication Controller for validation.

20.4.5 Local Functions

None

21 MIS of Access Token

21.1 Module

Access Token

21.2 Uses

None

21.3 Syntax

21.3.1 Exported Constants

None

21.3.2 Exported Access Programs

Name	In	Out	Exceptions
isExpired	-	boolean	-
renew	-	-	-

21.4 Semantics

21.4.1 State Variables

- tokenValue: string
- expirationTime: Date
- userID: string

21.4.2 Environment Variables

None

21.4.3 Assumptions

None

21.4.4 Access Routine Semantics

isExpired():

- output: $\text{out} := \text{currentTime} > \text{expirationTime}$

renew():

- transition: $\text{expirationTime} := \text{expirationTime} + 5 \text{ hours}$

21.4.5 Local Functions

None

22 MIS of Labeler

22.1 Module

Labeler

22.2 Uses

Extends User²⁴

22.3 Syntax

22.3.1 Exported Constants

None

22.3.2 Exported Access Programs

Name	In	Out	Exceptions
getFirstName	-	string	-
getLastName	-	string	-
getSkills	-	list[string]	-
getAvailability	-	int	-
setFirstName	string	-	-
setLastName	string	-	-
setSkills	list[string]	-	-
setAvailability	int	-	-

22.4 Semantics

22.4.1 State Variables

- firstName: string
- lastName: string
- skills: list[string]
- availability: int

22.4.2 Environment Variables

None

22.4.3 Assumptions

None

22.4.4 Access Routine Semantics

getFirstName():

- output: out := firstName

getLastName():

- output: out := lastName

getSkills():

- output: out := skills

getAvailability():

- output: out := availability

setFirstName(newfn):

- transition: firstName := newfn

setLastName(newln):

- transition: lastName := newln

setSkills(newSkills):

- transition: skills := newSkills

setAvailability(newAvail):

- transition: availability := newAvail

22.4.5 Local Functions

None

23 MIS of Client

23.1 Module

Client

23.2 Uses

Extends User[24](#)

23.3 Syntax

23.3.1 Exported Constants

None

23.3.2 Exported Access Programs

Name	In	Out	Exceptions
getCompanyName	-	string	-
getIndustry	-	string	-
getTypicalProject	-	Image	-
setCompanyName	string	-	-
setIndustry	string	-	-
setTypicalProject	string	-	-

23.4 Semantics

23.4.1 State Variables

- companyName: string
- industry: string
- typicalProject: string

23.4.2 Environment Variables

None

23.4.3 Assumptions

None

23.4.4 Access Routine Semantics

getCompanyName():

- output: out := companyName

getIndustry():

- output: out := industry

getTypicalProject():

- output: out := typicalProject

setCompanyName(newcn):

- transition: companyName := newcn

setIndustry(newIndustry):

- transition: industry := newIndustry

setTypicalProject(newtp):

- transition: typicalProject := newtp

23.4.5 Local Functions

None

24 MIS of User

24.1 Module

User

24.2 Uses

None

24.3 Syntax

24.3.1 Exported Constants

None

24.3.2 Exported Access Programs

Name	In	Out	Exceptions
getEmail	-	string	-
getPassword	-	string	-
getProfilePic	-	Image	-
setEmail	string	-	-
setPassword	string	-	-
setProfilePic	string	-	-

24.4 Semantics

24.4.1 State Variables

- email: string
- password: string
- profilePic: image

24.4.2 Environment Variables

None

24.4.3 Assumptions

None

24.4.4 Access Routine Semantics

getEmail():

- output: out := email

getPassword():

- output: out := password

getProfilePic():

- output: out := profilePic

setEmail(newEmail):

- transition: email := newEmail

setPassword(newPassword):

- transition: password := newPassword

setProfilePic(newProfilePic):

- transition: profilePic := newProfilePic

24.4.5 Local Functions

None

25 MIS of Account Creation Controller

25.1 Module

Account Creation Controller

25.2 Uses

Account Creation Interface[17](#)

Account Database[18](#)

User[24](#)

Labeler[22](#)

Client[23](#)

25.3 Syntax

25.3.1 Exported Constants

None

25.3.2 Exported Access Programs

Name	In	Out	Exceptions
validateForm	list[(string, string)], Enum[labeler, client]	boolean	-
createUser	list[(string, string)], Enum[labeler, client]	User	-
uploadUser	User	-	DatabaseException

25.4 Semantics

25.4.1 State Variables

None

25.4.2 Environment Variables

None

25.4.3 Assumptions

Assumes AccountDatabase is operational when calling uploadUser.

25.4.4 Access Routine Semantics

validateForm(formData, userType):

- output: $\text{out} := \text{hasRequiredFields}(\text{formData}, \text{userFields}) \wedge \text{isValidEmail}(\text{formData.email}) \wedge \text{isValidPassword}(\text{formData.password}) \wedge$

$$\begin{cases} \text{hasRequiredFields}(\text{formData}, \text{labelerFields}), & \text{if } \text{userType} = \text{"labeler"} \\ \text{hasRequiredFields}(\text{formData}, \text{clientFields}), & \text{if } \text{userType} = \text{"client"} \\ \text{true}, & \text{otherwise} \end{cases}$$

Where:

$$\begin{aligned} \text{userFields} &= \{\text{email}, \text{password}\} \\ \text{labelerFields} &= \{\text{firstName}, \text{lastName}, \text{skills}, \text{availability}\} \\ \text{clientFields} &= \{\text{companyName}, \text{industry}, \text{typicalProject}\} \end{aligned}$$

createUser(formData, userType):

- output: $\text{out} :=$

$$\begin{cases} \text{Labeler}(\text{formData.email}, \text{formData.password}, \text{formData.firstName}, \\ \text{formData.lastName}, \text{formData.skills}, \text{int}(\text{formData.availability})), & \text{if userType} = \text{"labeler"} \\ \text{Client}(\text{formData.email}, \text{formData.password}, \text{formData.companyName}, \\ \text{formData.industry}, \text{formData.typicalProject}) & \text{if userType} = \text{"client"} \end{cases}$$

uploadUser(newUser):

- transition: Passes the User object to the AccountDatabase for storage.
- exception: Throws DatabaseException if storage fails.

25.4.5 Local Functions

- hasRequiredFields(data, fields) = $\forall \text{field} \in \text{fields}, (\text{data}[\text{field}] \neq \text{""})$
- isValidEmail(email) = $\text{email} \in V \wedge \text{email} \neg \in \text{Registered Emails}$

Let E represent the set of all email addresses, and let V represent the set of all valid email addresses. A valid email address conforms to the general pattern:

$$V = (\forall \text{email} \in E \mid \text{email matches the pattern } [\text{a-zA-Z0-9+.-}]+\text{@}[\text{a-zA-Z0-9.-}]+[\text{a-zA-Z}])$$

- isValidPassword(password) = *(password matches the pattern $(?=[\text{a-z}])(?=[\text{A-Z}])(?=[\text{0-9}])(?=[\text{\#}\text{\$}\text{\%}\text{\&}])[\text{a-zA-Z0-9}\text{\#}\text{\$}\text{\%}\text{\&}]\{8,\}$)*

26 MIS of Account Update Controller

26.1 Module

Account Update Controller

26.2 Uses

Account Update Interface[19](#)

Account Database[18](#)

User[24](#)

26.3 Syntax

26.3.1 Exported Constants

None

26.3.2 Exported Access Programs

Name	In	Out	Exceptions
validateForm	list[(string, string)]	boolean	-
getUser	string	-	-
requestUpdate	User	-	DatabaseException

26.4 Semantics

26.4.1 State Variables

- user: User

26.4.2 Environment Variables

None

26.4.3 Assumptions

Assumes AccountDatabase is operational when calling requestUpdate.

26.4.4 Access Routine Semantics

validateForm(formData):

- output: $\text{out} := \forall \text{data} \in \text{formData}, (\text{data}[1] \neq "")$

getUser(email):

- transition: $\text{user} := \text{AccountDatabase.retreiveUser}(\text{email})$

requestUpdate(updatedUser):

- transition: Passes the updated User object to the AccountDatabase for modifications.
- exception: Throws DatabaseException if storage fails.

26.4.5 Local Functions

None

27 MIS of Authentication Controller

27.1 Module

Authentication Controller

27.2 Uses

Login Interface[41](#)

Account Database[18](#)

Access Token[21](#)

27.3 Syntax

27.3.1 Exported Constants

None

27.3.2 Exported Access Programs

Name	In	Out	Exceptions
validCredentials	(string, string)	boolean	-
generateAccessToken	string	-	-

27.4 Semantics

27.4.1 State Variables

- token: AccessToken

27.4.2 Environment Variables

None

27.4.3 Assumptions

Assumes AccountDatabase is operational when calling validCredentials.

27.4.4 Access Routine Semantics

validCredentials(email, password):

- output: $\text{out} := \text{AccountDatabase.retreiveUser(email)} \neq \text{null}$
 $\wedge \text{AccountDatabase.retreiveUser(email).getPassword()} == \text{password}$

generateAccessToken(email):

- transition: token := AccessToken(email)

27.4.5 Local Functions

None

28 MIS of Satellite Image Request Interface

28.1 Module

Satellite Image Request Interface

28.2 Uses

Satellite Image Request Controller²⁹

28.3 Syntax

28.3.1 Exported Constants

None

28.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	-	-	-
submitForm	list[(string, string)]	-	-

28.4 Semantics

28.4.1 State Variables

None

28.4.2 Environment Variables

win: 2D sequence of coloured pixels

28.4.3 Assumptions

None

28.4.4 Access Routine Semantics

renderPage():

- transition: win := Modify window so that it shows a form requesting information regarding an image request.

submitForm(formData):

- transition: Passes the submitted changes to the Satellite Image Request Controller for validation and processing.

28.4.5 Local Functions

None

29 MIS of Satellite Image Request Controller

29.1 Module

Satellite Image Request Controller

29.2 Uses

Satellite Image Request Interface[28](#)

Satellite Image Request[30](#)

29.3 Syntax

29.3.1 Exported Constants

None

29.3.2 Exported Access Programs

Name	In	Out	Exceptions
validateForm	list[(string, string)]	boolean	-
requestImages	SatelliteImageRequest	-	-

29.4 Semantics

29.4.1 State Variables

None

29.4.2 Environment Variables

None

29.4.3 Assumptions

None

29.4.4 Access Routine Semantics

validateForm(formData):

- output: $\text{out} := \forall \text{data} \in \text{formData}, (\text{data}[1] \neq "")$

requestImages(imgRequest):

- transition: Passes imgRequest to third party image provider to be processed.

29.4.5 Local Functions

- calculateCost(imgRequest): $\text{out} :=$ Use information given to calculate the cost of a request using third party rates

30 MIS of Satellite Image Request

30.1 Module

Satellite Image Request

30.2 Uses

None

30.3 Syntax

30.3.1 Exported Constants

None

30.3.2 Exported Access Programs

Name	In	Out	Exceptions
getLocation	-	(float, float)	-
getRadius	-	float	-
getDate	-	Date	-
setLocation	(float, float)	-	-
setRadius	float	-	-
setDate	Date	-	-

30.4 Semantics

30.4.1 State Variables

- locationX: float
- locationY: float
- radius: float
- date: Date

30.4.2 Environment Variables

None

30.4.3 Assumptions

None

30.4.4 Access Routine Semantics

getLocation():

- output: out := (locationX, locationY)

getRadius():

- output: out := radius

getDate():

- output: out := date

setLocation(x, y):

- transition: locationX, locationY := x, y

setRadius(newRadius):

- transition: radius := newRadius

setDate(newDate):

- transition: date := newDate

30.4.5 Local Functions

None

31 MIS of Project Creation Interface

31.1 Module

Project Creation Interface

31.2 Uses

Project Creation Controller³²

31.3 Syntax

31.3.1 Exported Constants

None

31.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	-	-	-
submitForm	list[(string, string)]	-	-

31.4 Semantics

31.4.1 State Variables

None

31.4.2 Environment Variables

win: 2D sequence of coloured pixels

31.4.3 Assumptions

None

31.4.4 Access Routine Semantics

renderPage():

- transition: win := Modify window so that it shows a form requesting information regarding creating a new project.

submitForm(formData):

- transition: Passes the submitted changes to the Project Creation Controller for validation and processing.

31.4.5 Local Functions

None

32 MIS of Project Creation Controller

32.1 Module

Project Creation Controller

32.2 Uses

Project Manager⁸

Project Creation Interface³¹

Project³³

32.3 Syntax

32.3.1 Exported Constants

None

32.3.2 Exported Access Programs

Name	In	Out	Exceptions
validateForm	list[(string, string)]	boolean	-
createNewProject	list[(string, string)]	Project	-

32.4 Semantics

32.4.1 State Variables

None

32.4.2 Environment Variables

None

32.4.3 Assumptions

None

32.4.4 Access Routine Semantics

validateForm(formData):

- output: $\text{out} := \forall \text{data} \in \text{formData}, (\text{data}[1] \neq "")$

createNewProject(formData):

- output: $\text{out} := \text{Project}(\text{formData.name}, \text{formData.description}, \text{formData.labelClasses.split}(), \text{Date}(\text{formData.startDate}), \text{Date}(\text{formData.endDate}))$

32.4.5 Local Functions

- calculateEstimatedCost(project): $\text{out} :=$ Use information given to calculate the estimated cost of a project.

33 MIS of Project

33.1 Module

Project

33.2 Uses

None

33.3 Syntax

33.3.1 Exported Constants

None

33.3.2 Exported Access Programs

Name	In	Out	Exceptions
getProjectID	-	int	-
getName	-	string	-
getDescription	-	string	-
getLabelClasses	-	list[Enum[string]]	-
getTimePeriod	-	(Date, Date)	-
setName	string	-	-
setDescription	string	-	-
setLabelClasses	list[Enum[string]]	-	-
setTimePeriod	(Date, Date)	-	-

33.4 Semantics

33.4.1 State Variables

- projectID: int
- name: string
- description: string
- labelClasses: list[Enum[String]]
- startDate: Date
- endDate: Date

33.4.2 Environment Variables

None

33.4.3 Assumptions

None

33.4.4 Access Routine Semantics

getProjectID():

- output: out := projectID

getName():

- output: out := name

getDescription():

- output: out := description

getLabelClasses():

- output: out := labelClasses

getTimePeriod():

- output: out := (startDate, endDate)

setName(newName):

- transition: name := newName

setDescription(newDesc):

- transition: description := newDesc

setLabelClasses(newlc):

- transition: labelClasses := newlc

setTimePeriod(start, end):

- transition: startDate, endDate := start, end

33.4.5 Local Functions

None

34 MIS of Service Request Failure Interface

34.1 Module

Service Request Failure Interface

34.2 Uses

34.3 Syntax

34.3.1 Exported Constants

None

34.3.2 Exported Access Programs

Name	In	Out	Exceptions
displayErrorInfo	-	-	-

34.4 Semantics

34.4.1 State Variables

None

34.4.2 Environment Variables

win: 2D sequence of coloured pixels

34.4.3 Assumptions

None

34.4.4 Access Routine Semantics

displayErrorInfo():

- transition: win := Modify window so that it shows a warning to the user that their request has failed.

34.4.5 Local Functions

None

35 MIS of Image Upload Interface

35.1 Module

Image Upload Interface

35.2 Uses

Project Manager⁸

35.3 Syntax

35.3.1 Exported Constants

None

35.3.2 Exported Access Programs

Name	In	Out	Exceptions
displayUploadImages		-	-

35.4 Semantics

35.4.1 State Variables

None

35.4.2 Environment Variables

win: 2D sequence of coloured pixels

35.4.3 Assumptions

None

35.4.4 Access Routine Semantics

displayUploadImages():

- transition: win := Modify window so that it allows users to upload images.

35.4.5 Local Functions

- validateImage(image): out :=

image.extension \in {svg, jpeg, png}

36 MIS of Report Interface

36.1 Module

Report Interface

36.2 Uses

Report Controller³⁷

36.3 Syntax

36.3.1 Exported Constants

None

36.3.2 Exported Access Programs

Name	In	Out	Exceptions
displayStats	-	-	-

36.4 Semantics

36.4.1 State Variables

None

36.4.2 Environment Variables

win: 2D sequence of coloured pixels

36.4.3 Assumptions

None

36.4.4 Access Routine Semantics

displayStats():

- transition: win := Modify window so that it shows project specific statistics.

36.4.5 Local Functions

None

37 MIS of Report Controller

37.1 Module

Report Controller

37.2 Uses

Report Interface³⁶

Report³⁸

37.3 Syntax

37.3.1 Exported Constants

None

37.3.2 Exported Access Programs

Name	In	Out	Exceptions
getProjectStats	string	-	-
exportLabeledImages	-	-	-

37.4 Semantics

37.4.1 State Variables

- report: Report

37.4.2 Environment Variables

fm: External systems file manager

37.4.3 Assumptions

None

37.4.4 Access Routine Semantics

getProjectStats(projectID):

- transition: report := Report of statistics for project with projectID

exportLabeledImages():

- transition: fm := given labeled images to download to device.

37.4.5 Local Functions

None

38 MIS of Report

38.1 Module

Report

38.2 Uses

None

38.3 Syntax

38.3.1 Exported Constants

None

38.3.2 Exported Access Programs

Name	In	Out	Exceptions
getLabeledImages	-	list[Image]	-
getReviewedImages	-	list[Image]	-
getEndDate	-	Date	-
getTotalLabelers	-	int	-
getAccuracy	-	int	-
getClassCount	-	list[(string, int)]	-

38.4 Semantics

38.4.1 State Variables

- labeledImages: list[Image]
- reviewedImages: list[Image]
- endDate: Date
- totalLabelers: int
- accuracyOfLabelers: int
- classCount: list[(string, int)]

38.4.2 Environment Variables

None

38.4.3 Assumptions

None

38.4.4 Access Routine Semantics

getLabeledImages():

- output: out := labeledImages

getReviewedImages():

- output: out := reviewedImages

getEndDate():

- output: out := endDate

getTotalLabelers():

- output: `out := totalLabelers`

`getAccuracyOfLabelers()`:

- output: `out := accuracyOfLabelers`

`getClassCount()`:

- output: `out := classCount`

38.4.5 Local Functions

None

39 MIS of Project Selection Interface

39.1 Module

Project Selection Interface

39.2 Uses

Project Selection Controller⁴⁰

39.3 Syntax

39.3.1 Exported Constants

None

39.3.2 Exported Access Programs

Name	In	Out	Exceptions
<code>displayActiveProjects</code>	-	-	-

39.4 Semantics

39.4.1 State Variables

None

39.4.2 Environment Variables

`win`: 2D sequence of coloured pixels

39.4.3 Assumptions

None

39.4.4 Access Routine Semantics

displayActiveProjects():

- transition: win := Modify window so that it shows all active projects and a small description of each.

39.4.5 Local Functions

None

40 MIS of Project Selection Controller

40.1 Module

Project Selection Controller

40.2 Uses

Project Collection Manager⁹

Project Selection Interface³⁹

Project³³

40.3 Syntax

40.3.1 Exported Constants

None

40.3.2 Exported Access Programs

Name	In	Out	Exceptions
getActiveProjects	-	-	-
selectProject	Project	-	-

40.4 Semantics

40.4.1 State Variables

- activeProjects: list[Project]

40.4.2 Environment Variables

win: 2D sequence of coloured pixels

40.4.3 Assumptions

None

40.4.4 Access Routine Semantics

getActiveProjects():

- transition: activeProjects := All projects marked as active in the project database

selectProject(project):

- transition: win := redirects users to labeling interface of that project

40.4.5 Local Functions

None

41 MIS of Labeling Interface

41.1 Module

Labeling Interface

41.2 Uses

Labeling Controller⁴²

Image⁴³

41.3 Syntax

41.3.1 Exported Constants

None

41.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	-	-	-
displayImage	Image	-	-
skipImage	-	-	-
selectLabelClass	-	-	-

41.4 Semantics

41.4.1 State Variables

- projectImages: list[Image]
- currImage: int
- currLabelClass: Enum[string]

41.4.2 Environment Variables

win: 2D sequence of coloured pixels

41.4.3 Assumptions

None

41.4.4 Access Routine Semantics

renderPage():

- transition: win := Modify window so that it shows labeling tools along with a picture to label.

displayImage(img):

- transition: win := Modify window so that the picture it is showing is img.

skipImage():

- transition: currentImage := (currentImage + 1) % projectImages.length
win := Modify window so that the picture it is showing is projectImages[currentImage].

selectLabelClass():

- transition: currLabelClass := the label class the user has selected on win.

41.4.5 Local Functions

None

42 MIS of Labeling Controller

42.1 Module

Labeling Controller

42.2 Uses

Labeling Interface[41](#)

Label[4](#)

42.3 Syntax

42.3.1 Exported Constants

None

42.3.2 Exported Access Programs

Name	In	Out	Exceptions
getProjectImages	string	-	-
addLabel	Label	-	-
removeLabel	string	-	-
submitLabels	list[Label]	-	-

42.4 Semantics

42.4.1 State Variables

- labels: list[Label]

42.4.2 Environment Variables

None

42.4.3 Assumptions

None

42.4.4 Access Routine Semantics

getProjectImages(projectID):

- output: out := All images from project with projectID

addLabel(lbl):

- transition: labels := labels \cup {lbl}

removeLabel(lblID):

- transition: labels := $\{\ell \in \text{labels} \mid \ell.\text{id} \neq \text{lblID}\}$

submitLabels(lbls):

- transition: labels are sent to be added to the Label Database

42.4.5 Local Functions

None

43 MIS of Image

43.1 Module

Image

43.2 Uses

None

43.3 Syntax

43.3.1 Exported Constants

None

43.3.2 Exported Access Programs

Name	In	Out	Exceptions
getProjectID	-	int	-
getImageID	-	int	-
getDimensions	-	(float, float)	-
getImageData	-	binary	-

43.4 Semantics

43.4.1 State Variables

- projectID: int
- imageID: int
- width: float
- height: float
- imageData: binary

43.4.2 Environment Variables

None

43.4.3 Assumptions

None

43.4.4 Access Routine Semantics

getProjectID():

- output: out := projectID

getImageID():

- output: out := imageID

getDimensions():

- output: out := (width, height)

getImageData():

- output: out := imageData

43.4.5 Local Functions

None

44 MIS of Label Server

44.1 Module

Label Server

44.2 Uses

Labeling Controller⁴²

Label Database Connector⁴⁵

44.3 Syntax

44.3.1 Exported Constants

None

44.3.2 Exported Access Programs

Name	In	Out	Exceptions
acceptLabel	Label	-	ValueError, Conne- ctionError

44.4 Semantics

44.4.1 State Variables

None

44.4.2 Environment Variables

LabelDatabaseConnector

44.4.3 Assumptions

Label Objects are given to the label server in JSON format. Exceptions will be thrown based on failure to match this standard.

44.4.4 Access Routine Semantics

acceptLabel(object o):

- transition: Transition occurs in LabelDatabaseConnector
- output: Standard HTTP response codes

- exception: Let L be the set of valid Labels. Throw `ValueError` if $\neg(o \in L)$
Throw `ConnectionError` if `ConnectionError` is raised by `LabelDatabaseConnector`

44.4.5 Local Functions

`JSONLabeltoLabel`: converts a JSON object into a Label object.

45 MIS of Label Database Connector

45.1 Module

Label Database Connector

45.2 Uses

Label Database⁴⁶

45.3 Syntax

45.3.1 Exported Constants

None

45.3.2 Exported Access Programs

Name	In	Out	Exceptions
pushLabel	Label	-	ValueError, ConnectionError
makeDB Connection	Label	-	ConnectionError
getLabels	String	list[Label]	ValueError, ConnectionError

45.4 Semantics

45.4.1 State Variables

None

45.4.2 Environment Variables

None

45.4.3 Assumptions

45.4.4 Access Routine Semantics

pushLabel(Label l):

- transition: Transition occurs in LabelDatabase
- exception: Let L be the set of valid Labels. Throw `ValueError` if $\neg(l \in L)$
Throw `ConnectionError` if `ConnectionError` is raised by `makeDBConnection`

`makeDBConnection()`:

- transition: If successful, connection occurs
- exception: Throw `ConnectionError` if connection is not accepted by LabelDatabase

`getLabels(String q)`:

- output: list of labels satisfying the provided query
- exception: Let Q be the set of valid Queries. Throw `ValueError` if $\neg(q \in Q)$
Throw `ConnectionError` if `ConnectionError` is raised by `makeDBConnection`

45.4.5 Local Functions

None

46 MIS of Label Database

46.1 Module

Label Database

46.2 Uses

None

46.3 Syntax

46.3.1 Exported Constants

None

46.3.2 Exported Access Programs

Name	In	Out	Exceptions
pushLabel	Label	-	ValueError
makeDB Conne- ction	Label	-	ConnectionError
getLabels	String	list[Label]	ValueError

46.4 Semantics

46.4.1 State Variables

labels: labels stored in the database users: list of authenticated users

46.4.2 Environment Variables

None

46.4.3 Assumptions

46.4.4 Access Routine Semantics

pushLabel(Label l):

- transition: $\text{labels} := \text{labels} \cup l$
- exception: Let L be the set of valid Labels. Throw ValueError if $\neg(l \in L)$
Throw ConnectionError if $\neg(\text{requestor} \in \text{users})$

makeDBConnection(credentials):

- transition: if credentials are valid, $\text{users} := \text{users} \cup \text{credentials.user}$
- exception: Throw `ConnectionError` if credentials are not valid

`getLabels(String q):`

- output: list of labels satisfying the provided query
- exception: Let Q be the set of valid Queries. Throw `ValueError` if $\neg(q \in Q)$
Throw `ConnectionError` if $\neg(\text{requestor} \in \text{users})$

46.4.5 Local Functions

None

47 MIS of ImageObject Database Connector

47.1 Module

ImageObject Database Connector

47.2 Uses

ImageObject Database[48](#)

47.3 Syntax

47.3.1 Exported Constants

None

47.3.2 Exported Access Programs

Name	In	Out	Exceptions
push Image Object	ImageObject	-	ValueError, ConnectionError
makeDB Connection	ImageObject	-	ConnectionError
get Image Objects	String	list[ImageObject]	ValueError, ConnectionError

47.4 Semantics

47.4.1 State Variables

None

47.4.2 Environment Variables

None

47.4.3 Assumptions

47.4.4 Access Routine Semantics

pushLabel(ImageObject l):

- transition: Transition occurs in ImageObjectDatabase
- exception: Let L be the set of valid ImageObjects. Throw ValueError if $\neg(l \in L)$
Throw ConnectionError if ConnectionError is raised by makeDBConnection

makeDBConnection():

- transition: If successful, connection occurs
- exception: Throw ConnectionError if connection is not accepted by ImageObjectDatabase

getLabels(String q):

- transition:
- output: list of ImageObjects satisfying the provided query
- exception: Let Q be the set of valid Queries. Throw ValueError if $\neg(q \in Q)$
Throw ConnectionError if ConnectionError is raised by makeDBConnection

47.4.5 Local Functions

None

48 MIS of ImageObject Database

48.1 Module

ImageObject Database

48.2 Uses

None

48.3 Syntax

48.3.1 Exported Constants

None

48.3.2 Exported Access Programs

Name	In	Out	Exceptions
push Image Object	ImageObject	-	ValueError
makeDB Connection	ImageObject	-	ConnectionError
get Image Objects	String	list[ImageObject]	ValueError

48.4 Semantics

48.4.1 State Variables

ImageObjects: ImageObjects stored in the database users: list of authenticated users

48.4.2 Environment Variables

None

48.4.3 Assumptions

48.4.4 Access Routine Semantics

pushLabel(ImageObject l):

- transition: $\text{ImageObjects} := \text{ImageObjects} \cup l$
- exception: Let L be the set of valid ImageObjects. Throw ValueError if $\neg(l \in L)$
Throw ConnectionError if $\neg(\text{requestor} \in \text{users})$

makeDBConnection(credentials):

- transition: if credentials are valid, $\text{users} := \text{users} \cup \text{credentials.user}$
- exception: Throw `ConnectionError` if credentials are not valid

getLabels(String q):

- output: list of `ImageObjects` satisfying the provided query
- exception: Let Q be the set of valid Queries. Throw `ValueError` if $\neg(q \in Q)$
Throw `ConnectionError` if $\neg(\text{requestor} \in \text{users})$

48.4.5 Local Functions

None

=====

49 MIS of Labeller Database Connector

49.1 Module

Labeller Database Connector

49.2 Uses

Labeller Database[50](#)

49.3 Syntax

49.3.1 Exported Constants

None

49.3.2 Exported Access Programs

Name	In	Out	Exceptions
push la- beller	labeller	-	ValueError, Connec- tionError
makeDB Connec- tion	credentials	-	ConnectionError
get labeller	String	list[labeller]	ValueError, Connec- tionError

49.4 Semantics

49.4.1 State Variables

None

49.4.2 Environment Variables

None

49.4.3 Assumptions

49.4.4 Access Routine Semantics

pushLabeller(Labeller o):

- transition: Transition occurs in LabellerDatabase
- exception: Let O be the set of valid Labellers. Throw `ValueError` if $\neg(o \in O)$
Throw `ConnectionError` if `ConnectionError` is raised by `makeDBConnection`

`makeDBConnection()`:

- transition: If successful, connection occurs
- exception: Throw `ConnectionError` if connection is not accepted by LabellerDatabase

`getLabeller(String q)`:

- output: list of Labellers satisfying the provided query
- exception: Let Q be the set of valid Queries. Throw `ValueError` if $\neg(q \in Q)$
Throw `ConnectionError` if `ConnectionError` is raised by `makeDBConnection`

49.4.5 Local Functions

None

50 MIS of Labeller Database

50.1 Module

Labeller Database

50.2 Uses

None

50.3 Syntax

50.3.1 Exported Constants

None

50.3.2 Exported Access Programs

Name	In	Out	Exceptions
push La- beller	Labeller	-	ValueError
makeDB Conne- ction	Credentials	-	ConnectionError
get La- beller	String	list[Labeller]	ValueError

50.4 Semantics

50.4.1 State Variables

Labellers: Labellers stored in the database users: list of authenticated users

50.4.2 Environment Variables

None

50.4.3 Assumptions

50.4.4 Access Routine Semantics

pushLabeller(Labeller o):

- transition: $\text{Labellers} := \text{Labellers} \cup o$
- exception: Let O be the set of valid Labellers. Throw ValueError if $\neg(o \in O)$
Throw ConnectionError if $\neg(\text{requestor} \in \text{users})$

makeDBConnection(credentials):

- transition: if credentials are valid, $\text{users} := \text{users} \cup \text{credentials.user}$
- exception: Throw `ConnectionError` if credentials are not valid

getLabeller(String q):

- output: list of Labeller satisfying the provided query
- exception: Let Q be the set of valid Queries. Throw `ValueError` if $\neg(q \in Q)$
Throw `ConnectionError` if $\neg(\text{requestor} \in \text{users})$

50.4.5 Local Functions

None

51 MIS of Object Extraction Manager

51.1 Module

Object Extraction Manager

51.2 Uses

ImageObject Database Connector[47](#)

Label Database Connector[45](#)

Labeller Database Connector[49](#)

Image Prior Analyzer[54](#)

Label Confidence Service[52](#)

Object Extraction Service[53](#)

Labeller Expertise Calculator[55](#)

51.3 Syntax

51.3.1 Exported Constants

None

51.3.2 Exported Access Programs

Name	In	Out	Exceptions
getObjects	projectID	-	ValueError

51.4 Semantics

51.4.1 State Variables

None

51.4.2 Environment Variables

None

51.4.3 Assumptions

51.4.4 Access Routine Semantics

getObjects(ProjectID p):

- transition: Updates ImageObject database with identified objects & confidence and updates labeller expertise rating in labeller database

- exception: Let P be the set of assigned ProjectIDs. Throw `ValueError` if $\neg(p \in P)$

51.4.5 Local Functions

52 MIS of Label Confidence Service

52.1 Module

Label Confidence Service

52.2 Uses

None

52.3 Syntax

52.3.1 Exported Constants

None

52.3.2 Exported Access Programs

Name	In	Out	Exceptions
getConfidencdist	list[label], list[labeller], list[ImageObject]	list[list[float]]	ValueError

52.4 Semantics

52.4.1 State Variables

None

52.4.2 Environment Variables

None

52.4.3 Assumptions

52.4.4 Access Routine Semantics

getConfidence(list[label] labels , list[labeller] labellers, list[ImageObject] imageobjects):

- output: return the confidence label of each extracted object
- exception: Let L be the set of valid Labels. Throw ValueError if $(\exists \text{label} \in \text{labels} \mid \neg(\text{label} \in L))$
Let X be the set of valid Labellers. Throw ValueError if $(\exists \text{labeller} \in \text{labellers} \mid \neg(\text{labeller} \in X))$
Let I be the set of valid ImageObjects. Throw ValueError if $(\exists \text{imageobject} \in \text{imageobjects} \mid$

$\neg(\text{imageobject} \in \text{I})$

- calculation: confidence = $(|\text{Likelihood} - (1 - \text{prediction})|)$

52.4.5 Local Functions

53 MIS of Object Extraction Service

53.1 Module

Object Extraction Service

53.2 Uses

None

53.3 Syntax

53.3.1 Exported Constants

None

53.3.2 Exported Access Programs

Name	In	Out	Exceptions
getObjects	list[label], list[labeller], list[ImageObject], list[list[float]]	list[ImageObject]	ValueError

53.4 Semantics

53.4.1 State Variables

None

53.4.2 Environment Variables

None

53.4.3 Assumptions

53.4.4 Access Routine Semantics

getConfidence(list[label] labels, list[labeller] labellers, list[ImageObject] imageobjects, list[list[float]] confidence):

- output: returns a list of extracted image objects
- exception: Let L be the set of valid Labels. Throw ValueError if $(\exists \text{label} \in \text{labels} \mid \neg(\text{label} \in L))$
Let X be the set of valid Labellers. Throw ValueError if $(\exists \text{labeller} \in \text{labellers} \mid$

$\neg(\text{labeller} \in X)$

Let I be the set of valid ImageObjects. Throw ValueError if $(\exists \text{imageobject} \in \text{imageobjects} | :$

$\neg(\text{imageobject} \in I)$

Throw ValueError if $(\exists i, j | x = \text{confidence}[i][j] : \neg(x \in \mathbb{R}))$

53.4.5 Local Functions

54 MIS of Image Prior Analyzer

54.1 Module

Image Prior Analyzer

54.2 Uses

None

54.3 Syntax

54.3.1 Exported Constants

None

54.3.2 Exported Access Programs

Name	In	Out	Exceptions
getPriors	list[image]	list[list[float]]	ValueError

54.4 Semantics

54.4.1 State Variables

None

54.4.2 Environment Variables

None

54.4.3 Assumptions

54.4.4 Access Routine Semantics

getPriors(list[image] Images):

- output: returns a list of priors for each pixel in the given images
- exception: Let I be the set of valid Images. Throw ValueError if $(\exists \text{image} \in \text{images} : \neg(\text{image} \in I))$

54.4.5 Local Functions

55 MIS of Labeller Expertise Calculator

55.1 Module

Labeller Expertise Calculator

55.2 Uses

None

55.3 Syntax

55.3.1 Exported Constants

None

55.3.2 Exported Access Programs

Name	In	Out	Exceptions
getExpertise	list[label], list[labeller], list[ImageObject], list[list[float]]	list[dict[string, tuple[float, float]]]	ValueError

55.4 Semantics

55.4.1 State Variables

None

55.4.2 Environment Variables

None

55.4.3 Assumptions

55.4.4 Access Routine Semantics

getObjects(list[label] labels, list[labeller] labellers, list[ImageObject] imageobjects):

- output: return the weighed success rate for each class a labeler has contributed to
- exception: Let L be the set of valid Labels. Throw ValueError if $(\exists \text{label} \in \text{labels} \mid \neg(\text{label} \in L))$
Let X be the set of valid Labellers. Throw ValueError if $(\exists \text{labeller} \in \text{labellers} \mid \neg(\text{labeller} \in X))$

Let I be the set of valid ImageObjects. Throw ValueError if $(\exists \text{imageobject} \in \text{imageobjects} \mid \neg(\text{imageobject} \in I))$
 Throw ValueError if $(\exists i, j \mid x = \text{confidence}[i][j] : \neg(x \in \mathbb{R}))$

- Formula for Expertise: Each labeller contains a float value alpha and beta. For each pixel (i, j) in an image, if the consensus matches the user prediction:

$$\alpha = \alpha + \frac{\text{confidence}[i][j]}{\text{size_of_image}}$$

If it does not match,

$$\beta = \beta + \frac{\text{confidence}[i][j]}{\text{size_of_image}}$$

55.4.5 Local Functions

56 MIS of Image Service Manager

56.1 Module

Image Service Manager

56.2 Uses

ImageObject Database Connector[47](#)

Labeller Database Connector[49](#)

Image Mask Service[57](#)

Image Selection Service[58](#)

56.3 Syntax

56.3.1 Exported Constants

None

56.3.2 Exported Access Programs

Name	In	Out	Exceptions
getNextImages	labellerID, projectID, int	List[Image]	ValueError

56.4 Semantics

56.4.1 State Variables

None

56.4.2 Environment Variables

None

56.4.3 Assumptions

56.4.4 Access Routine Semantics

getNextImages(LabellerID l, ProjectID p, int n):

- output: return the next n images based on which are more relevant
- exception: Let P be the set of assigned ProjectIDs. Throw ValueError if $\neg(p \in P)$
Let L be the set of assigned LabellerIDs. Throw ValueError if $\neg(l \in L)$
Throw ValueError if $\neg(n \in \mathbb{N})$

56.4.5 Local Functions

57 MIS of Image Mask Service

57.1 Module

Image Mask Service

57.2 Uses

None

57.3 Syntax

57.3.1 Exported Constants

None

57.3.2 Exported Access Programs

Name	In	Out	Exceptions
getImageMask	Image	Image	ValueError

57.4 Semantics

57.4.1 State Variables

None

57.4.2 Environment Variables

None

57.4.3 Assumptions

57.4.4 Access Routine Semantics

getImageMask(Image i):

- output: returns a modified image to improve the labeller's efficiency or accuracy
- exception: Let I be the set of valid Images. Throw ValueError if $\neg(i \in I)$

57.4.5 Local Functions

58 MIS of Image Selection Service

58.1 Module

Image Selection Service

58.2 Uses

58.3 Syntax

58.3.1 Exported Constants

None

58.3.2 Exported Access Programs

Name	In	Out	Exceptions
getNextImages	List[Image], List[ImageObjects], Labeller	List[Image]	ValueError

58.4 Semantics

58.4.1 State Variables

None

58.4.2 Environment Variables

None

58.4.3 Assumptions

58.4.4 Access Routine Semantics

getNextImages(List[Image] Images, List[ImageObjects] ImageObjects, Labeller labeller):

- output: return the next n images based on which are more relevant
- exception: Let L be the set of valid Labellers. Throw ValueError if $(\neg(\text{labeller} \in L))$
Let X be the set of valid Images. Throw ValueError if $(\exists \text{Image} \in \text{Images} \mid \neg(\text{Image} \in X))$
Let I be the set of valid ImageObjects. Throw ValueError if $(\exists \text{imageobject} \in \text{imageobjects} \mid \neg(\text{imageobject} \in I))$

58.4.5 Local Functions

None

59 MIS of ModelComparisonEvaluation

59.1 6.1 Module

Name: ModelComparisonEvaluation

59.2 6.2 Uses

- TestDataset (Holds test samples and true labels)
- EvaluationResult (Stores metrics from an evaluation)

59.3 6.3 Syntax

59.3.1 6.3.1 Exported Constants

None

59.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
evaluateModel	String modelId, Test-Dataset testData	EvaluationResult	ModelNotFoundError, ValueError

59.4 6.4 Semantics

59.4.1 6.4.1 State Variables

- comparisonMetrics: Map<String, Float> (Stores metric-name to numeric value)
- benchmarkModelId: String (ID of the benchmark model)

59.4.2 6.4.2 Environment Variables

None

59.4.3 6.4.3 Assumptions

- The modelId provided must exist in the system.
- testData must be valid and non-empty.

59.4.4 6.4.4 Access Routine Semantics

`evaluateModel(modelId, testData):`

- **transition:** Updates `comparisonMetrics` by comparing the given model with the benchmark.
- **output:** Returns an `EvaluationResult` with metrics (e.g., accuracy, precision).
- **exception:**
 - `ModelNotFoundError` if `modelId` does not exist.
 - `ValueError` if `testData` is invalid.

59.4.5 6.4.5 Local Functions

`None`

60 MIS of CrossValidationEvaluation

60.1 6.1 Module

Name: CrossValidationEvaluation

60.2 6.2 Uses

- TestDataset
- EvaluationResult

60.3 6.3 Syntax

60.3.1 6.3.1 Exported Constants

None

60.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
evaluateModel	String modelId, Test-Dataset testData	EvaluationResult	ModelNotFoundError, ValueError

60.4 6.4 Semantics

60.4.1 6.4.1 State Variables

- kFolds: Integer
- ValidationMetrics: Map<String, Float> (Aggregated cross-validation metrics)

60.4.2 6.4.2 Environment Variables

None

60.4.3 6.4.3 Assumptions

- $kFolds \geq 2$.
- testData is large enough for multiple folds.

60.4.4 6.4.4 Access Routine Semantics

`evaluateModel(modelId, testData):`

- **transition:** Runs cross-validation and updates `ValidationMetrics`.
- **output:** An `EvaluationResult` (e.g., average accuracy).
- **exception:**
 - `ModelNotFoundError` if the model does not exist.
 - `ValueError` if `testData` is invalid or too small.

60.4.5 6.4.5 Local Functions

None

61 MIS of ModelTrainingService

61.1 6.1 Module

Name: ModelTrainingService

61.2 6.2 Uses

- TrainingParams
- TrainingData
- ModelConfig
- TrainingResult

61.3 6.3 Syntax

61.3.1 6.3.1 Exported Constants

None

61.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
trainModel	TrainingData data, ModelConfig modelConfig	TrainingResult	ValueError, ResourceUnavailableError
stopTraining	String modelId	void	ModelNotFoundError

61.4 6.4 Semantics

61.4.1 6.4.1 State Variables

- trainingParameters: TrainingParams
- trainingStatus: String (“Not Started”, “In Progress”, “Completed”, etc.)

61.4.2 6.4.2 Environment Variables

None

61.4.3 6.4.3 Assumptions

- System has enough resources (GPU, memory) to train the model.

61.4.4 6.4.4 Access Routine Semantics

`trainModel(data, modelConfig):`

- **transition:** Sets `trainingStatus` to “In Progress” and, upon completion, “Completed”.
- **output:** Returns a `TrainingResult` with metrics (loss, accuracy, etc.).
- **exception:**
 - `ValueError` if `data` or `modelConfig` is invalid.
 - `ResourceUnavailableError` if required resources are not available.

`stopTraining(modelId):`

- **transition:** If the model is training, changes status to “Stopped” or “Cancelled”.
- **exception:**
 - `ModelNotFoundError` if the model does not exist or is not training.

61.4.5 6.4.5 Local Functions

None

62 MIS of ModelEvaluationService

62.1 6.1 Module

Name: ModelEvaluationService

62.2 6.2 Uses

- TestDataset
- EvaluationResult

62.3 6.3 Syntax

62.3.1 6.3.1 Exported Constants

None

62.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
evaluateModel	String modelId, Test-Dataset testData	EvaluationResult	ModelNotFoundError, ValueError
fetchEvaluationMetrics	String modelId	Map<String,Float>	ModelNotFoundError

62.4 6.4 Semantics

62.4.1 6.4.1 State Variables

- evaluationMetrics: Map<String, Float>
- valuationStatus: String (“Pending”, “In Progress”, “Completed”)

62.4.2 6.4.2 Environment Variables

None

62.4.3 6.4.3 Assumptions

- The modelId references a trained model.

62.4.4 6.4.4 Access Routine Semantics

`evaluateModel(modelId, testData):`

- **transition:** Sets `valuationStatus` to “In Progress” and updates `evaluationMetrics`.
- **output:** An `EvaluationResult` (accuracy, loss, etc.).
- **exception:**
 - `ModelNotFoundError` if `modelId` is invalid.
 - `ValueError` if `testData` is invalid or empty.

`fetchEvaluationMetrics(modelId):`

- **output:** Returns the `evaluationMetrics` for the model.
- **exception:**
 - `ModelNotFoundError` if the `modelId` does not exist or no metrics are found.

62.4.5 6.4.5 Local Functions

None

63 MIS of ModelManager

63.1 6.1 Module

Name: ModelManager

63.2 6.2 Uses

- ModelParameters
- MLModel

63.3 6.3 Syntax

63.3.1 6.3.1 Exported Constants

None

63.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
createModel	ModelParameters params	void	ValueError
updateModelStatus	String modelId, String status	void	ModelNotFoundError
fetchModel	String modelId	MLModel	ModelNotFoundError
deleteModel	String modelId	void	ModelNotFoundError

63.4 6.4 Semantics

63.4.1 6.4.1 State Variables

- modelID: String
- status: String (“Training”, “Evaluating”, “Completed”, etc.)
- createdAt: Date
- updatedAt: Date

63.4.2 6.4.2 Environment Variables

None

63.4.3 6.4.3 Assumptions

- A unique modelID is generated upon creation.

63.4.4 6.4.4 Access Routine Semantics

createModel(params):

- **transition:** Instantiates a new MLModel, sets modelID, createdAt, updatedAt, status = “Created”.
- **exception:**
 - ValueError if params are invalid.

updateModelStatus(modelId, status):

- **transition:** Updates status and updatedAt of the specified model.
- **exception:**
 - ModelNotFoundError if the modelId does not exist.

fetchModel(modelId):

- **output:** Returns the MLModel object.
- **exception:**
 - ModelNotFoundError if no model with modelId exists.

deleteModel(modelId):

- **transition:** Removes the model from storage.
- **exception:**
 - ModelNotFoundError if modelId is invalid.

63.4.5 6.4.5 Local Functions

None

64 MIS of ModelCreation (Abstract)

64.1 6.1 Module

Name: ModelCreation (Abstract Base Class)

64.2 6.2 Uses

- ModelParameters
- MLModel

64.3 6.3 Syntax

64.3.1 6.3.1 Exported Constants

None

64.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
createModel	-	MLModel	NotImplementedError

64.4 6.4 Semantics

64.4.1 6.4.1 State Variables

- modelType: String
- creationParams: ModelParameters

64.4.2 6.4.2 Environment Variables

None

64.4.3 6.4.3 Assumptions

- Concrete subclasses must override the createModel method.

64.4.4 6.4.4 Access Routine Semantics

createModel():

- **output:** A fully instantiated MLModel.
- **exception:**
 - NotImplementedError if called from the abstract class.

64.4.5 6.4.5 Local Functions

None

65 MIS of MLModelDatabase

65.1 6.1 Module

Name: MLModelDatabase

65.2 6.2 Uses

- MLModel

65.3 6.3 Syntax

65.3.1 6.3.1 Exported Constants

None

65.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
saveModel	MLModel model	void	DatabaseError
fetchModel	String modelId	MLModel	ModelNotFoundError, DatabaseError
deleteModel	String modelId	void	ModelNotFoundError, DatabaseError
updateModel	String Map<String, updates	modelId, Any?	void ModelNotFoundError, DatabaseError

65.4 6.4 Semantics

65.4.1 6.4.1 State Variables

- dbConnection: Connection (Active DB connection)

65.4.2 6.4.2 Environment Variables

- External database system (accessed via dbConnection)

65.4.3 6.4.3 Assumptions

- dbConnection is valid and open.

65.4.4 6.4.4 Access Routine Semantics

saveModel(model):

- **transition:** Inserts or updates the model in the database.
- **exception:**
 - DatabaseError if insertion fails.

fetchModel(modelId):

- **output:** Returns the MLModel from the database.
- **exception:**
 - ModelNotFoundError if the modelId is not found.
 - DatabaseError if a DB error occurs.

deleteModel(modelId):

- **transition:** Removes the model record.
- **exception:**
 - ModelNotFoundError if modelId is not found.
 - DatabaseError on DB error.

updateModel(modelId, updates):

- **transition:** Updates the specified fields of the model in the database.
- **exception:**
 - ModelNotFoundError if modelId is not found.
 - DatabaseError if the update operation fails.

65.4.5 6.4.5 Local Functions

None

66 MIS of OtherModelCreation

66.1 6.1 Module

Name: OtherModelCreation

66.2 6.2 Uses

- MLModel
- ModelCreation (abstract base class)

66.3 6.3 Syntax

66.3.1 6.3.1 Exported Constants

None

66.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
createModel	-	MLModel	ValueError

66.4 6.4 Semantics

66.4.1 6.4.1 State Variables

- modelType: String (e.g., “Decision Tree”, “SVM”)
- hyperparameters: Map<String, Any>

66.4.2 6.4.2 Environment Variables

None

66.4.3 6.4.3 Assumptions

- hyperparameters are valid for modelType.

66.4.4 6.4.4 Access Routine Semantics

createModel():

- **output:** Returns an instantiated MLModel of modelType.
- **exception:**
 - ValueError if the modelType/hyperparameters combination is invalid.

66.4.5 6.4.5 Local Functions

None

67 MIS of CNNModelCreation

67.1 6.1 Module

Name: CNNModelCreation

67.2 6.2 Uses

- ModelCreation (abstract)
- MLModel

67.3 6.3 Syntax

67.3.1 6.3.1 Exported Constants

None

67.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
createModel	-	MLModel	ValueError

67.4 6.4 Semantics

67.4.1 6.4.1 State Variables

- layers: List<LayerConfig> (Defines structure of each CNN layer)
- activatedFunctions: List<String> (Activation functions for each layer)

67.4.2 6.4.2 Environment Variables

None

67.4.3 6.4.3 Assumptions

- The layers and activatedFunctions lists are valid and aligned.

67.4.4 6.4.4 Access Routine Semantics

createModel():

- **output:** Instantiates a CNN MLModel with specified layers and activation functions.
- **exception:**
 - ValueError if layers or activatedFunctions are invalid or mismatched.

67.4.5 6.4.5 Local Functions

None

68 Exception Handling

The application implements a structured approach to exception handling across both frontend and backend components.

68.1 Frontend Handling (React)

In the frontend, exceptions are typically caught using try-catch blocks or via global error boundaries for unhandled UI errors. Frontend errors (e.g., API failures, rendering issues) are logged to the browser console. User-friendly fallback UIs are displayed where applicable.

68.2 Backend Handling (Python)

On the backend, exceptions are handled at multiple levels—locally in functions with try-catch blocks, or via packages (e.g., Flask/Waiter error handlers). Critical exceptions (e.g., database failures) are logged with severity levels (DEBUG, INFO, WARNING, ERROR, CRITICAL) using structured logging. Some exceptions are propagated to the frontend as HTTP error responses with sanitized messages to avoid exposing sensitive details.

References

Carlo Ghezzi, Mehdi Jazayeri, and Dino Mandrioli. *Fundamentals of Software Engineering*. Prentice Hall, Upper Saddle River, NJ, USA, 2nd edition, 2003.

Daniel M. Hoffman and Paul A. Strooper. *Software Design, Automated Testing, and Maintenance: A Practical Approach*. International Thomson Computer Press, New York, NY, USA, 1995. URL <http://citeseer.ist.psu.edu/428727.html>.

69 Appendix

Appendix — Reflection

[Not required for CAS 741 projects —SS]

The information in this section will be used to evaluate the team members on the graduate attribute of Problem Analysis and Design.

The purpose of reflection questions is to give you a chance to assess your own learning and that of your group as a whole, and to find ways to improve in the future. Reflection is an important part of the learning process. Reflection is also an essential component of a successful software development process.

Reflections are most interesting and useful when they're honest, even if the stories they tell are imperfect. You will be marked based on your depth of thought and analysis, and not based on the content of the reflections themselves. Thus, for full marks we encourage you to answer openly and honestly and to avoid simply writing "what you think the evaluator wants to hear."

Please answer the following questions. Some questions can be answered on the team level, but where appropriate, each team member should write their own response:

1. What went well while writing this deliverable? Everyone did a great job contributing their ideas and expertise to design each part of our application. We decided to use diagrams to express our designs before jumping into the documentation. This worked really well as it allowed everyone to have a better understanding of how our system would interact. When we had to specify our modules, a lot of the hard work was already complete due to have the diagrams.
2. What pain points did you experience during this deliverable, and how did you resolve them? A major pain point we faced was that a team member could no longer meet in person due to extraneous circumstances. This hindered our ability to effectively communicate as a team due to factors like time difference. To solve this, we rescheduled our meetings to a reasonable time for all members, and moved all meetings and communications online for the time being.
3. Which of your design decisions stemmed from speaking to your client(s) or a proxy (e.g. your peers, stakeholders, potential users)? For those that were not, why, and where did they come from? From talking to our supervisor, we determined that we would need our system to be able to pre-process images in an effective way so we took that into considering when designing the project creation subsystem. Also, our decision to have modules do standardized formatting stemmed from our usage of 3rd-party applications such as our image distributor. Due to the possibility of change, we knew that formatting outside information to a way our application could process it would be the best way to go about it. In general, for our other decisions we used the software principles we have learned through out our education including modularity, seperation of concern, and architecture that supports scalability.
4. While creating the design doc, what parts of your other documents (e.g. requirements, hazard analysis, etc), it any, needed to be changed, and why? When creating this design

document, we realized some functionality we want is not really specified much in the srs. For example, we have very little regarding the ai model part of our application. We also realized some of the requirements that we will not be able to focus on, such as the financial aspect of the app. We now must consider how to document what we need to in the srs, and possibly modify our vnv plan.

5. What are the limitations of your solution? Put another way, given unlimited resources, what could you do to make the project better? (LO_ProbSolutions) While our current design addresses core functionality, key limitations include the lack of financial features (e.g., payment processing or fund distribution) and support for media types beyond images, such as videos. Additionally, the accuracy and reliability of our ML models and labeling services could be improved. With more resources, we would implement human-in-the-loop validation to manually review uncertain model predictions during training, adopt active learning to prioritize low-confidence samples for human annotation, and enforce inter-annotator agreement checks to reduce labeling inconsistencies. We would also audit the training data for biases and introduce synthetic examples to cover edge cases, while allowing end-users to flag incorrect labels for model retraining.
6. Give a brief overview of other design solutions you considered. What are the benefits and tradeoffs of those other designs compared with the chosen design? From all the potential options, why did you select the documented design? We considered an approach where we would store all data as files on a server somewhere, however we decided that using a database would better fit our project due to the relation between the data and the usefulness of SQL statements. The downside of this approach is it requires more time to set up, but we believe the payoff is worth it. We also considered having one large system rather than many sub-systems. This would eliminate a lot of the communication and data transfer overhead. However, we believe that with this sub-system design, we have the ability to have or remove parts of the system much more easily. If we don't have time to get to a sub-system, our application can still function. (LO_Explores)