Numeric value expression($\mathcal{N} : E_N \mapsto \mathbb{N}$)

35. $\mathcal{N}(\langle nvexp\rangle) \triangleq \mathcal{N}(\langle nvexp_1\rangle + \langle nvexp_2\rangle)|\mathcal{N}(\langle nvexp_1\rangle - \langle nvexp_2\rangle)|\mathcal{N}(\langle nvexp_1\rangle * \langle nvexp_2\rangle)|\mathcal{N}(\langle nvexp_1\rangle / \langle nvexp_2\rangle)$
$|\mathcal{N}(length|char\_length|charactor\_length(\langle svexp\rangle)|\mathcal{N}(mod(\langle nvexp_1\rangle, \langle nvexp_2\rangle)|\mathcal{N}(abs(\langle nvexp\rangle)|\mathcal{N}(ln(\langle nvexp\rangle))$
$|\mathcal{N}(exp(\langle nvexp\rangle)|\mathcal{N}(power(\langle nvexp_1\rangle, \langle nvexp_2\rangle)|\mathcal{N}(sqrt(\langle nvexp\rangle))|\mathcal{N}(floor(\langle nvexp\rangle))|\mathcal{N}(ceil|ceiling(\langle nvexp\rangle)$
36. $\mathcal{N}(\langle nvexp_1\rangle + \langle nvexp_2\rangle) \triangleq \mathcal{N}(\langle nvexp_1\rangle) + \mathcal{N}(\langle nvexp_2\rangle)$
37. $\mathcal{N}(\langle nvexp_1\rangle - \langle nvexp_2\rangle) \triangleq \mathcal{N}(\langle nvexp_1\rangle) - \mathcal{N}(\langle nvexp_2\rangle)$
38. $\mathcal{N}(\langle nvexp_1\rangle * \langle nvexp_2\rangle) \triangleq \mathcal{N}(\langle nvexp_1\rangle) * \mathcal{N}(\langle nvexp_2\rangle)$
39. $\mathcal{N}(\langle vexp_1\rangle / \langle nvexp_2\rangle) \triangleq \mathcal{N}(\langle nvexp_1\rangle) / \mathcal{N}(\langle nvexp_2\rangle)$
40. $\mathcal{N}(length|char\_length|charactor\_length(\langle svexp\rangle) \triangleq len(\mathcal{S}(\langle svexp\rangle))$
41. $\mathcal{N}(mod(\langle nvexp_1\rangle, \langle nvexp_2\rangle) \triangleq (\mathcal{N}(\langle nvexp_1\rangle)\%\mathcal{N}(\langle nvexp_2\rangle)$
42. $\mathcal{N}(abs(\langle nvexp\rangle) \triangleq |\mathcal{N}(\langle nvexp\rangle)|$
43. $\mathcal{N}(ln(\langle nvexp\rangle) \triangleq ln(\mathcal{N}(\langle nvexp\rangle))$
44. $\mathcal{N}(exp(\langle nvexp\rangle) \triangleq e^{\mathcal{N}(\langle nvexp\rangle)}$
45. $\mathcal{N}(power(\langle nvexp_1\rangle, \langle nvexp_2\rangle) \triangleq \mathcal{N}(\langle nvexp_1\rangle)^{\mathcal{N}(\langle nvexp_2\rangle)}$
46. $\mathcal{N}(sqrt(\langle nvexp\rangle) \triangleq \sqrt{\mathcal{N}(\langle nvexp\rangle)}$
47. $\mathcal{N}(floor(\langle nvexp\rangle) \triangleq \lfloor \mathcal{N}(\langle nvexp\rangle) \rfloor$
48. $\mathcal{N}(ceil|ceiling(\langle nvexp\rangle) \triangleq \lceil \mathcal{N}(\langle nvexp\rangle) \rceil$
49. $\mathcal{N}(\langle vexp\rangle) \triangleq \mathcal{N}(\langle bvexp\rangle)|\mathcal{N}(\langle svexp\rangle)|\mathcal{N}(\langle caseexp\rangle)|\mathcal{N}(\langle castexp\rangle)|\mathcal{N}(\langle cname\rangle)|\mathcal{N}(null)$
50. $\mathcal{N}(\langle bvexp\rangle) \triangleq \mathcal{N}(cast(\langle bvexp\rangle\ as\ numeric))$
51. $\mathcal{N}(\langle svexp\rangle) \triangleq \mathcal{N}(cast(\langle svexp\rangle\ as\ numeric))$
52. $\mathcal{N}(\langle cname\rangle) \triangleq \mathcal{N}(cast(S(\langle cname\rangle)\ as\ numeric))$
53. $\mathcal{N}(caseexp) \triangleq \mathcal{N}(case\ when\ \langle bvexp\rangle\ then\ \langle vexp_1\rangle\ else\ \langle vexp_2\rangle)$
54. $\mathcal{N}(case\ when\ \langle bvexp\rangle\ then\ \langle vexp_1\rangle\ else\ \langle vexp_2\rangle) \triangleq \begin{cases} \mathcal{N}(\langle vexp_1\rangle); & \mathcal{B}(\langle bvexp\rangle) = true \\ \mathcal{N}(\langle vexp_2\rangle); & \mathcal{B}(\langle bvexp\rangle) = false \end{cases}$
55. $\mathcal{N}(\langle castexp\rangle) \triangleq \mathcal{N}(cast(\langle bvexp\rangle\ as\ numeric))|\mathcal{N}(cast(\langle svexp\rangle\ as\ numeric))$
56. $\mathcal{N}(cast(\langle bvexp\rangle\ as\ numeric)) \triangleq \begin{cases} 1; & \mathcal{B}(\langle bvexp\rangle) = true \\ 0; & \mathcal{B}(\langle bvexp\rangle) = false \\ null; & \mathcal{B}(\langle bvexp\rangle) = null \end{cases}$
57. $\mathcal{N}(cast(\langle svexp\rangle\ as\ numeric)) \triangleq \begin{cases} null; & \mathcal{S}(\langle svexp\rangle) = null \\ str2num(\mathcal{S}(\langle svexp\rangle)); & otherwise \end{cases}$
58. $\mathcal{N}(numeric\ literal) \triangleq numeric\ literal$
59. $\mathcal{N}(null) \triangleq null$

String value expression($\mathcal{S} : E_S \mapsto \mathbb{S}$)

60. $\mathcal{S}(\langle svexp\rangle) \triangleq \mathcal{S}(\langle svexp_1\rangle||\langle svexp_2\rangle)|\mathcal{S}(substring(\langle svexp_1\rangle\ in\ \langle nvexp_2\rangle))|\mathcal{S}(ltrim(\langle svexp\rangle))|\mathcal{S}(rtrim(\langle svexp\rangle))$
$|\mathcal{S}(lower(\langle svexp\rangle))|\mathcal{S}(upper(\langle svexp\rangle))$
61. $\mathcal{S}(\langle svexp_1\rangle||\langle svexp_2\rangle) \triangleq \mathcal{S}(\langle svexp_1\rangle)||\mathcal{S}(\langle svexp_2\rangle)$
62. $\mathcal{S}(substring(\langle svexp_1\rangle\ in\ \langle nvexp_2\rangle)) \triangleq \mathcal{S}(\langle svexp_1\rangle)[\mathcal{N}(\langle nvexp_2\rangle), len(\mathcal{S}(\langle svexp_1\rangle))]$
63. $\mathcal{S}(lower(\langle svexp\rangle)) \triangleq s_{lower}$
$s_{lower} : (len(s_{lower}) = len(\mathcal{S}(\langle svexp\rangle))) \wedge (\forall i \in (0, len(\mathcal{S}(\langle svexp\rangle))), s_{lower}[i] = \mathcal{S}(\langle svexp\rangle)[i] + 32$
64. $\mathcal{S}(upper(\langle svexp\rangle)) \triangleq s_{upper}$
$s_{upper} : (len(s_{upper}) = len(\mathcal{S}(\langle svexp\rangle))) \wedge (\forall i \in (0, len(\mathcal{S}(\langle svexp\rangle))), s_{upper}[i] = \mathcal{S}(\langle svexp\rangle)[i] - 32$
65. $\mathcal{S}(\langle vexp\rangle) \triangleq \mathcal{S}(\langle bvexp\rangle)|\mathcal{S}(\langle nvexp\rangle)|\mathcal{S}(\langle caseexp\rangle)|\mathcal{S}(\langle castexp\rangle)|\mathcal{S}(\langle cname\rangle)|\mathcal{S}(null)$
66. $\mathcal{S}(\langle bvexp\rangle) \triangleq \mathcal{S}(cast(\langle bvexp\rangle\ as\ string))$
67. $\mathcal{S}(\langle nvexp\rangle) \triangleq \mathcal{S}(cast(\langle nvexp\rangle)\ as\ string)$
68. $\mathcal{S}(caseexp) \triangleq \mathcal{S}(case\ when\ \langle bvexp\rangle\ then\ \langle vexp_1\rangle\ else\ \langle vexp_2\rangle)$
69. $\mathcal{S}(case\ when\ \langle bvexp\rangle\ then\ \langle vexp_1\rangle\ else\ \langle vexp_2\rangle) \triangleq \begin{cases} \mathcal{S}(\langle vexp_1\rangle); & \mathcal{B}(\langle bvexp\rangle) = true \\ \mathcal{S}(\langle vexp_2\rangle); & \mathcal{B}(\langle bvexp\rangle) = false \end{cases}$
70. $\mathcal{S}(\langle castexp\rangle) \triangleq \mathcal{S}(cast(\langle bvexp\rangle\ as\ string))|\mathcal{S}(cast(\langle nvexp\rangle\ as\ string))$
71. $\mathcal{S}(cast(\langle bvexp\rangle\ as\ string)) \triangleq \begin{cases} 1; & \mathcal{B}(\langle bvexp\rangle) = true \\ 0; & \mathcal{B}(\langle bvexp\rangle) = false \\ null; & \mathcal{B}(\langle bvexp\rangle) = null \end{cases}$
72. $\mathcal{S}(cast(\langle nvexp\rangle\ as\ string)) \triangleq \begin{cases} null; & \mathcal{N}(\langle nvexp\rangle) = null \\ num2str(\mathcal{N}(\langle nvexp\rangle)); & otherwise \end{cases}$
73. $\mathcal{S}(\langle cname\rangle) \triangleq \mathcal{S}(cast(S(\langle cname\rangle)\ as\ string))$
74. $\mathcal{S}(string\ literal) \triangleq string\ literal$
75. $\mathcal{S}(null) \triangleq null$

Fig. 5: The full list of semantic definition for numeric expression and string expression