GetPauliString

```
SetDirectory @ NotebookDirectory[];
Import["../Link/QuESTlink.m"];
```

Doc

```
? GetPauliString
```

Symbol

Returns a Pauli string or a weighted sum of symbolic Pauli tensors from a variety of input formats.
GetPauliString[matrix] returns a complex–weighted sum of Pauli tensors
equivalent to the given matrix. If the input matrix is Hermitian, the output can
be passed to Chop[] in order to remove the negligible imaginary components.
GetPauliString[index] returns the basis Pauli string corresponding to the given index, where the
returned Pauli operator targeting 0 is informed by the least significant bit(s) of the index.
GetPauliString[digits] specifies the Pauli product via the
base–4 digits of its index, where the rightmost digit is the least significant.
GetPauliString[address] opens or downloads the file at address (a string, of a file location or URL), and
interprets it as a list of coefficients and Pauli codes. Each line of the file is assumed a separate
Pauli tensor with format {coeff code1 code2 ... codeN} (excluding braces) where the codes
are in {0,1,2,3} (indicating a I, X, Y, Z), for an N–qubit Pauli string, and are given in order of
increasing significance (zero qubit left). Each line must have N+1 terms, which includes the
initial real decimal coefficient. For an example, see "https://qtechtheory.org/hamil_6qbLiH.txt".
GetPauliString[..., numPaulis] forces the output to contain the
given number of Pauli operators, introducing additional Id operators upon
un–targeted qubits (unless explicitly removed with "RemoveIds"–>True).
GetPauliString[..., {targets}] specifies a list of qubits which the returned Pauli string should target
(in the given order), instead of the default targets {0, 1, 2, ...}. Targeted Ids are retained.
GetPauliString[..., {targets}, numPaulis] (in either order) specifies the targets, and
thereafter pads the output with Ids to achieve the specified number of Pauli operators.
GetPauliString accepts optional argument "RemoveIds" –> True or False
(default Automatic) which when True, retains otherwise removed Id operators.

Correctness

Matrix

Floating-point

```
test[in_?MatrixQ] := Module[
    {out, check, error},
    out = GetPauliString[in];
    check = Simplify @ Normal @ CalcPauliExpressionMatrix[out];
    error = check -in // N // Abs // Chop // Max;
    Echo[out, "output: "];
    Echo[error, "error: "];
    If[error =!= 0, Style["ERRONEOUS PAULI STRING!", Red]]]
```

```
test @ RandomComplex[(𝑖 + 1) {-10, 10}, {2, 2}]
```

» output: $(-5.46645 + 3.50889\,i)\,\mathrm{Id}_0 + (2.71247 - 1.3265\,i)\,X_0 - (4.55982 - 1.00508\,i)\,Y_0 - (2.71585 + 0.333583\,i)\,Z_0$

» error: 0

```
test @ RandomComplex[(𝑖 + 1) {-10, 10}, {8, 8}]
```

» output: $(-0.19252 - 0.288695\,i)\,\mathrm{Id}_2 + (0.11545 + 3.69508\,i)\,X_0 - (0.250928 + 2.50856\,i)\,X_1 - (0.804871 + 0.954984\,i)\,X_0\,X_1 - (0.821838 - 4.72319\,i)\,X_2 + (0.63525 + 5.47816\,i)\,X_0\,X_2 - (2.93399 + 0.262402\,i)\,X_1\,X_2 - (1.3494 - 3.83791\,i)\,X_0\,X_1\,X_2 + (2.48143 - 5.60003\,i)\,Y_0 + (1.61219 - 0.716751\,i)\,X_1\,Y_0 - (1.61986 + 2.62581\,i)\,X_2\,Y_0 + (0.371941 + 0.0586991\,i)\,X_1\,X_2\,Y_0 - (0.767814 + 0.396061\,i)\,Y_1 + (0.403723 - 1.62625\,i)\,X_0\,Y_1 - (2.30969 + 0.484983\,i)\,X_2\,Y_1 + (1.73829 - 2.80767\,i)\,X_0\,X_2\,Y_1 - (1.18974 - 2.21264\,i)\,Y_0\,Y_1 - (2.76329 + 0.0973354\,i)\,X_2\,Y_0\,Y_1 + (2.39845 - 0.650261\,i)\,Y_2 - (0.368235 - 0.748099\,i)\,X_0\,Y_2 + (0.893972 + 0.343677\,i)\,X_1\,Y_2 - (0.376245 + 1.48034\,i)\,X_0\,X_1\,Y_2 - (0.644271 + 0.912859\,i)\,Y_0\,Y_2 - (2.71778 + 2.20338\,i)\,X_1\,Y_0\,Y_2 - (2.74391 - 1.53434\,i)\,Y_1\,Y_2 - (3.48891 - 1.32492\,i)\,X_0\,Y_1\,Y_2 + (2.36835 - 2.30241\,i)\,Y_0\,Y_1\,Y_2 - (0.808329 - 0.748309\,i)\,Z_0 + (3.3733 + 1.5063\,i)\,X_1\,Z_0 - (1.29335 - 1.08891\,i)\,X_2\,Z_0 + (2.22537 - 0.261968\,i)\,X_1\,X_2\,Z_0 - (1.57634 - 0.194894\,i)\,Y_1\,Z_0 + (3.34679 + 2.43332\,i)\,X_2\,Y_1\,Z_0 + (0.0180943 - 3.18576\,i)\,Y_2\,Z_0 + (1.55356 + 2.20017\,i)\,X_1\,Y_2\,Z_0 - (2.04355 - 0.560713\,i)\,Y_1\,Y_2\,Z_0 - (0.320793 - 0.47847\,i)\,Z_1 - (0.970722 - 1.57062\,i)\,X_0\,Z_1 - (0.516921 - 3.76222\,i)\,X_2\,Z_1 - (1.34345 + 1.41385\,i)\,X_0\,X_2\,Z_1 - (1.0057 - 1.47725\,i)\,Y_0\,Z_1 - (1.30859 - 1.56852\,i)\,X_2\,Y_0\,Z_1 - (3.13085 + 0.195622\,i)\,Y_2\,Z_1 + (0.40834 + 2.41076\,i)\,X_0\,Y_2\,Z_1 + (1.49708 + 0.00816213\,i)\,Y_0\,Y_2\,Z_1 - (1.33062 - 1.67294\,i)\,Z_0\,Z_1 + (1.56531 - 0.341532\,i)\,X_2\,Z_0\,Z_1 + (0.734464 + 2.89216\,i)\,Y_2\,Z_0\,Z_1 + (0.312514 + 0.638253\,i)\,Z_2 + (1.13983 - 2.27273\,i)\,X_0\,Z_2 + (0.238766 + 1.2845\,i)\,X_1\,Z_2 + (1.32696 - 0.364285\,i)\,X_0\,X_1\,Z_2 + (0.230003 - 1.31637\,i)\,Y_0\,Z_2 + (0.0752104 + 2.38311\,i)\,X_1\,Y_0\,Z_2 - (3.107 + 0.236829\,i)\,Y_1\,Z_2 - (2.77443 + 1.25438\,i)\,X_0\,Y_1\,Z_2 + (3.11396 - 1.2709\,i)\,Y_0\,Y_1\,Z_2 + (3.52906 + 1.78989\,i)\,Z_0\,Z_2 - (0.00865458 - 1.42329\,i)\,X_1\,Z_0\,Z_2 - (0.0243789 - 2.74794\,i)\,Y_1\,Z_0\,Z_2 + (2.35312 - 2.73559\,i)\,Z_1\,Z_2 - (0.824337 + 0.708374\,i)\,X_0\,Z_1\,Z_2 + (2.70663 - 1.74432\,i)\,Y_0\,Z_1\,Z_2 - (0.496743 - 3.58269\,i)\,Z_0\,Z_1\,Z_2$

» error: 0

```
test @ RandomReal[{-10, 10}, {4, 4}]
```

» output: $4.75763\,\mathrm{Id}_1 + 3.2795\,X_0 - 1.94445\,X_1 + 2.01308\,X_0\,X_1 - (0. + 1.40958\,i)\,Y_0 - (0. + 2.24274\,i)\,X_1\,Y_0 - (0. + 1.58516\,i)\,Y_1 + (0. + 6.80063\,i)\,X_0\,Y_1 - 1.98863\,Y_0\,Y_1 - 3.06268\,Z_0 + 3.96595\,X_1\,Z_0 - (0. + 4.16128\,i)\,Y_1\,Z_0 + 0.109857\,Z_1 - 5.71148\,X_0\,Z_1 - (0. + 0.533919\,i)\,Y_0\,Z_1 - 1.82517\,Z_0\,Z_1$

» error: 0

```
hermitian = -i MatrixLog @ RandomVariate @ CircularUnitaryMatrixDistribution @ 4;
test @ hermitian
```

» output: $\left(0.898086 + 7.92877 \times 10^{-16}\,i\right)\mathrm{Id}_1 + \left(0.112934 - 3.60822 \times 10^{-16}\,i\right)X_0 + \left(0.222711 - 4.71845 \times 10^{-16}\,i\right)X_1 - \left(0.319842 - 2.08167 \times 10^{-17}\,i\right)X_0\,X_1 + \left(0.230335 + 9.71445 \times 10^{-17}\,i\right)Y_0 - \left(0.432674 - 1.38778 \times 10^{-17}\,i\right)X_1\,Y_0 - \left(0.0179855 - 1.80411 \times 10^{-16}\,i\right)Y_1 + \left(0.59857 + 9.71445 \times 10^{-17}\,i\right)X_0\,Y_1 - \left(0.557891 + 1.59595 \times 10^{-16}\,i\right)Y_0\,Y_1 + \left(0.595317 + 3.51282 \times 10^{-17}\,i\right)Z_0 - \left(0.110489 + 8.32667 \times 10^{-17}\,i\right)X_1\,Z_0 - \left(0.393185 - 2.08167 \times 10^{-16}\,i\right)Y_1\,Z_0 + \left(0.392412 + 2.2714 \times 10^{-16}\,i\right)Z_1 - \left(0.0875894 + 1.94289 \times 10^{-16}\,i\right)X_0\,Z_1 - \left(0.612786 + 1.52656 \times 10^{-16}\,i\right)Y_0\,Z_1 + \left(0.639762 + 9.67108 \times 10^{-17}\,i\right)Z_0\,Z_1$

» error: 0

```
test @ Table[0., 2, 2]
```

» output: $0. + 0.\,i$

» error: 0

Integer

```
test @ RandomInteger[{-10, 10}, {2, 2}]
```

» output: $-\frac{9\,\mathrm{Id}_0}{2} - 6\,X_0 + 4\,i\,Y_0 + \frac{5\,Z_0}{2}$

» error: 0

```
test @ RandomInteger[{-10, 10}, {4, 4}]
```

» output: $-\frac{5\,\mathrm{Id}_1}{4} - \frac{7\,X_0}{2} - \frac{5\,X_0\,X_1}{2} - \frac{i\,Y_0}{2} + \frac{9}{2}\,i\,X_1\,Y_0 - 4\,i\,Y_1 + \frac{3}{2}\,i\,X_0\,Y_1 + \frac{Y_0\,Y_1}{2} - \frac{Z_0}{4} + 2\,X_1\,Z_0 + 2\,i\,Y_1\,Z_0 + \frac{27\,Z_1}{4} - \frac{X_0\,Z_1}{2} + \frac{5}{2}\,i\,Y_0\,Z_1 + \frac{3\,Z_0\,Z_1}{4}$

» error: 0

```
test @ Table[1, {i, 8}, {i, 8}]
```

» output: $\mathrm{Id}_2 + X_0 + X_1 + X_0\,X_1 + X_2 + X_0\,X_2 + X_1\,X_2 + X_0\,X_1\,X_2$

» error: 0

```
test @ Table[0, {i, 8}, {i, 8}]
```

» output: 0

» error: 0

```
test[ IdentityMatrix[8] ]
```

» output: Id_2

» error: 0

Symbolic

```
test @ {{a, b}, {c, d}}
```

» output: $\frac{1}{2}\,(a+d)\,\mathrm{Id}_0+\frac{1}{2}\,(b+c)\,X_0+\frac{1}{2}\,(i\,b-i\,c)\,Y_0+\frac{1}{2}\,(a-d)\,Z_0$

» error: 0

```
test[ a IdentityMatrix[4] ]
```

» output: $a\,\mathrm{Id}_1$

» error: 0

```
test @ Table[a, {i, 8}, {i, 8}]
```

» output: $a\,\mathrm{Id}_2+a\,X_0+a\,X_1+a\,X_0\,X_1+a\,X_2+a\,X_0\,X_2+a\,X_1\,X_2+a\,X_0\,X_1\,X_2$

» error: 0

```
test @ RandomChoice[{a, b, c, d}, {4, 4}]
```

» output: $\frac{1}{4}\,(2\,a+b+c)\,\mathrm{Id}_1+\frac{1}{4}\,(a+c+2\,d)\,X_0+\frac{1}{4}\,(2\,a+c+d)\,X_1+\frac{1}{4}\,(b+2\,c+d)\,X_0\,X_1+$
$\frac{1}{4}\,(-i\,a+i\,c)\,Y_0+\frac{1}{4}\,(-i\,b+2\,i\,c-i\,d)\,X_1\,Y_0+\frac{1}{4}\,(i\,c-i\,d)\,Y_1+\frac{1}{4}\,(-i\,b+i\,d)\,X_0\,Y_1+$
$\frac{1}{4}\,(-b+d)\,Y_0\,Y_1+\frac{1}{4}\,(-b+c)\,Z_0+\frac{1}{4}\,(-2\,a+c+d)\,X_1\,Z_0+\frac{1}{4}\,(i\,c-i\,d)\,Y_1\,Z_0+$
$\frac{1}{4}\,(-b+c)\,Z_1+\frac{1}{4}\,(-a+c)\,X_0\,Z_1+\frac{1}{4}\,(i\,a+i\,c-2\,i\,d)\,Y_0\,Z_1+\frac{1}{4}\,(-2\,a+b+c)\,Z_0\,Z_1$

» error: 0

numQubits

```
m = RandomInteger[{-10, 10}, {4, 4}];
GetPauliString[m, 5]
GetPauliString[m, 5, "RemoveIds" → True];
CalcPauliExpressionMatrix[%] === CalcPauliExpressionMatrix[%%]
```

$-\mathrm{Id}_0\,\mathrm{Id}_1\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4+\frac{5}{4}\,\mathrm{Id}_1\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4\,X_0-\frac{13}{4}\,\mathrm{Id}_0\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4\,X_1+$
$\frac{3}{4}\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4\,X_0\,X_1-\frac{29}{4}\,i\,\mathrm{Id}_1\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4\,Y_0+\frac{9}{4}\,i\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4\,X_1\,Y_0+$
$\frac{1}{4}\,i\,\mathrm{Id}_0\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4\,Y_1+\frac{19}{4}\,i\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4\,X_0\,Y_1-\frac{9}{4}\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4\,Y_0\,Y_1+$
$\mathrm{Id}_1\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4\,Z_0+\frac{13}{4}\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4\,X_1\,Z_0+\frac{7}{4}\,i\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4\,Y_1\,Z_0+$
$\frac{3}{2}\,\mathrm{Id}_0\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4\,Z_1-\frac{7}{4}\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4\,X_0\,Z_1-\frac{5}{4}\,i\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4\,Y_0\,Z_1-\frac{1}{2}\,\mathrm{Id}_2\,\mathrm{Id}_3\,\mathrm{Id}_4\,Z_0\,Z_1$

```
True
```

targets

```
m = RandomInteger[{-10, 10}, {2, 2}];
GetPauliString[m]
GetPauliString[m, {5}]
```

$$-4\,\mathrm{Id}_0 - \frac{9\,X_0}{2} - \frac{7\,i\,Y_0}{2} - Z_0$$

$$-4\,\mathrm{Id}_5 - \frac{9\,X_5}{2} - \frac{7\,i\,Y_5}{2} - Z_5$$

```
m = RandomComplex[{-1 - i, 1 + i}, {4, 4}];
pA = GetPauliString[m];
mA = KroneckerProduct[CalcPauliExpressionMatrix[pA], IdentityMatrix[4]];
pB = GetPauliString[m, {2, 3}];
mB = CalcPauliExpressionMatrix[pB];

mA - mB // Abs // Max
```

```
0.
```

RemoveIds

```
m = RandomInteger[{-10, 10}, {4, 4}];
GetPauliString[m];
GetPauliString[m, "RemoveIds" → False]
CalcPauliExpressionMatrix[%] === CalcPauliExpressionMatrix[%%]
```

$$-\frac{25}{4}\,\mathrm{Id}_0\,\mathrm{Id}_1 - \frac{\mathrm{Id}_1\,X_0}{2} + 7\,\mathrm{Id}_0\,X_1 + \frac{X_0\,X_1}{4} - \frac{11}{2}\,i\,\mathrm{Id}_1\,Y_0 + \frac{3}{4}\,i\,X_1\,Y_0 + 2\,i\,\mathrm{Id}_0\,Y_1 - \frac{23}{4}\,i\,X_0\,Y_1 + \frac{Y_0\,Y_1}{4} + \frac{9\,\mathrm{Id}_1\,Z_0}{4} + \frac{3\,X_1\,Z_0}{2} - \frac{1}{2}\,i\,Y_1\,Z_0 - \frac{13\,\mathrm{Id}_0\,Z_1}{4} + 4\,X_0\,Z_1 - \frac{7\,Z_0\,Z_1}{4}$$

```
True
```

Index

```
GetPauliString[4^1 - 1]
GetPauliString[4^2 - 1]
GetPauliString[4^3 - 1]
```

$$Z_0$$

$$Z_0\,Z_1$$

$$Z_0\,Z_1\,Z_2$$

```
GetPauliString[5]
```

$$X_0\,X_1$$

numQubits

```
GetPauliString[0]
GetPauliString[0, 2]
GetPauliString[0, 3]
```

Id_0

$Id_0\ Id_1$

$Id_0\ Id_1\ Id_2$

targets

```
GetPauliString[0]
GetPauliString[0, {52}]
```

Id_0

Id_{52}

```
GetPauliString[123]
GetPauliString[123, {9, 8, 7, 6}]
```

$X_3\ Y_1\ Z_0\ Z_2$

$X_6\ Y_8\ Z_7\ Z_9$

```
(* notice Id0 is automatically excluded *)
GetPauliString[124]
```

$X_3\ Z_1\ Z_2$

```
(* notice Id2Id3 is included (to make all targets present) *)
GetPauliString[3, {1, 2, 3}]
```

$Id_2\ Id_3\ Z_1$

RemoveIds

```
GetPauliString[4, "RemoveIds" → False]
```

$Id_0\ X_1$

```
GetPauliString[0, 5, "RemoveIds" → False]
```

$Id_0\ Id_1\ Id_2\ Id_3\ Id_4$

```
GetPauliString[56 921, 10, "RemoveIds" → False]
```

$Id_8\ Id_9\ X_0\ X_2\ X_3\ X_6\ Y_1\ Y_4\ Z_5\ Z_7$

```
GetPauliString[0, "RemoveIds" → True]
```

Id_0

```
GetPauliString[0, 5, "RemoveIds" → True]
```

Id_4

```
GetPauliString[1, "RemoveIds" → True]
```

X_0

Digits

```
GetPauliString[{0, 0, 0}]
```

Id_0

```
GetPauliString[{0, 0, 0}, 4]
```

$Id_0\ Id_1\ Id_2\ Id_3$

```
GetPauliString[{0, 0, 0}, 4, "RemoveIds" → True]
```

Id_3

```
GetPauliString[{1, 0, 0}, {1, 2, 3}]
```

$Id_1\ Id_2\ X_3$

Address

File

```
setTmpFile[str_] := (
    DeleteFile["tmp.txt"];
    WriteString["tmp.txt", str])
```

```
setTmpFile[ "12.3 0"];
GetPauliString["tmp.txt"]
```

$12.3\ Id_0$

```
setTmpFile[".1 0 1 2 3"];
GetPauliString["tmp.txt"]
```

$0.1\ X_1\ Y_2\ Z_3$

```
setTmpFile["99 0 1 2 3\n33 3 2 1 0"];
GetPauliString["tmp.txt"]
```

$33\ X_2\ Y_1\ Z_0 + 99\ X_1\ Y_2\ Z_3$

URL

```
GetPauliString["https://qtechtheory.org/hamil_6qbLiH.txt"][[ ;; 20]]
```

$$-6.52209\ Id_0 - 0.00168947\ X_0 + 0.000335609\ X_1 + 0.00233908\ X_0\ X_1 - 0.00518865\ X_2 - 2.32678 \times 10^{-6}\ X_0\ X_2 - 0.00238276\ X_1\ X_2 - 0.000333484\ X_0\ X_1\ X_2 + 0.0561302\ X_3 + 0.0000211588\ X_0\ X_3 + 0.0000198838\ X_0\ X_1\ X_3 - 0.000133652\ X_2\ X_3 - 0.0000311241\ X_1\ X_2\ X_3 + 0.000547046\ X_4 + 0.00165752\ X_3\ X_4 - 0.00600013\ X_0\ X_3\ X_4 - 0.00812442\ X_2\ X_3\ X_4 + 0.000447423\ X_5 - 0.0000517994\ X_0\ X_5 + 0.00019084\ X_0\ X_1\ X_5$$

RemoveIds

```
setTmpFile[".1 1 0 0 0 0 0"];
GetPauliString["tmp.txt"]
setTmpFile[".1 1 0 0 0 0 0"];
GetPauliString["tmp.txt", "RemoveIds" → False]
```

$$0.1\ X_0$$

$$0.1\ Id_1\ Id_2\ Id_3\ Id_4\ Id_5\ X_0$$

numQubits

```
setTmpFile[".1 1 0 0"];
GetPauliString["tmp.txt", 10]

setTmpFile[".1 1 0 0"];
GetPauliString["tmp.txt", 10, "RemoveIds" → True]
```

$$0.1\ Id_1\ Id_2\ Id_3\ Id_4\ Id_5\ Id_6\ Id_7\ Id_8\ Id_9\ X_0$$

$$0.1\ X_0$$

```
GetPauliString["https://qtechtheory.org/hamil_6qbLiH.txt", 20][[ ;; 10]]
```

$$-6.52209\ Id_0\ Id_1\ Id_2\ Id_3\ Id_4\ Id_5\ Id_6\ Id_7\ Id_8\ Id_9\ Id_{10}\ Id_{11}\ Id_{12}\ Id_{13}\ Id_{14}\ Id_{15}\ Id_{16}\ Id_{17}\ Id_{18}\ Id_{19} - 0.00168947\ Id_1\ Id_2\ Id_3\ Id_4\ Id_5\ Id_6\ Id_7\ Id_8\ Id_9\ Id_{10}\ Id_{11}\ Id_{12}\ Id_{13}\ Id_{14}\ Id_{15}\ Id_{16}\ Id_{17}\ Id_{18}\ Id_{19}\ X_0 + 0.000335609\ Id_0\ Id_2\ Id_3\ Id_4\ Id_5\ Id_6\ Id_7\ Id_8\ Id_9\ Id_{10}\ Id_{11}\ Id_{12}\ Id_{13}\ Id_{14}\ Id_{15}\ Id_{16}\ Id_{17}\ Id_{18}\ Id_{19}\ X_1 + 0.00233908\ Id_2\ Id_3\ Id_4\ Id_5\ Id_6\ Id_7\ Id_8\ Id_9\ Id_{10}\ Id_{11}\ Id_{12}\ Id_{13}\ Id_{14}\ Id_{15}\ Id_{16}\ Id_{17}\ Id_{18}\ Id_{19}\ X_0\ X_1 - 0.00518865\ Id_0\ Id_1\ Id_3\ Id_4\ Id_5\ Id_6\ Id_7\ Id_8\ Id_9\ Id_{10}\ Id_{11}\ Id_{12}\ Id_{13}\ Id_{14}\ Id_{15}\ Id_{16}\ Id_{17}\ Id_{18}\ Id_{19}\ X_2 - 2.32678 \times 10^{-6}\ Id_1\ Id_3\ Id_4\ Id_5\ Id_6\ Id_7\ Id_8\ Id_9\ Id_{10}\ Id_{11}\ Id_{12}\ Id_{13}\ Id_{14}\ Id_{15}\ Id_{16}\ Id_{17}\ Id_{18}\ Id_{19}\ X_0\ X_2 - 0.00238276\ Id_0\ Id_3\ Id_4\ Id_5\ Id_6\ Id_7\ Id_8\ Id_9\ Id_{10}\ Id_{11}\ Id_{12}\ Id_{13}\ Id_{14}\ Id_{15}\ Id_{16}\ Id_{17}\ Id_{18}\ Id_{19}\ X_1\ X_2 - 0.000333484\ Id_3\ Id_4\ Id_5\ Id_6\ Id_7\ Id_8\ Id_9\ Id_{10}\ Id_{11}\ Id_{12}\ Id_{13}\ Id_{14}\ Id_{15}\ Id_{16}\ Id_{17}\ Id_{18}\ Id_{19}\ X_0\ X_1\ X_2 + 0.0561302\ Id_0\ Id_1\ Id_2\ Id_4\ Id_5\ Id_6\ Id_7\ Id_8\ Id_9\ Id_{10}\ Id_{11}\ Id_{12}\ Id_{13}\ Id_{14}\ Id_{15}\ Id_{16}\ Id_{17}\ Id_{18}\ Id_{19}\ X_3 + 0.0000211588\ Id_1\ Id_2\ Id_4\ Id_5\ Id_6\ Id_7\ Id_8\ Id_9\ Id_{10}\ Id_{11}\ Id_{12}\ Id_{13}\ Id_{14}\ Id_{15}\ Id_{16}\ Id_{17}\ Id_{18}\ Id_{19}\ X_0\ X_3$$

targets

```
setTmpFile["3 1 2 3"];
GetPauliString["tmp.txt", {5, 6, 7}]
```

$$3\ X_5\ Y_6\ Z_7$$

```
setTmpFile["3 1 2 3\n3 3 2 1"];
GetPauliString["tmp.txt", {5, 6, 7}]
```

$$3\ X_7\ Y_6\ Z_5 + 3\ X_5\ Y_6\ Z_7$$

```
GetPauliString[
  "https://qtechtheory.org/hamil_6qbLiH.txt", {9, 8, 7, 6, 5, 4}][[ ;; 10]]
```

$$\begin{aligned}&-6.52209\ Id_4\ Id_5\ Id_6\ Id_7\ Id_8\ Id_9 + 0.000447423\ Id_5\ Id_6\ Id_7\ Id_8\ Id_9\ X_4 + \\ &0.000547046\ Id_4\ Id_6\ Id_7\ Id_8\ Id_9\ X_5 + 0.0661688\ Id_6\ Id_7\ Id_8\ Id_9\ X_4\ X_5 + \\ &0.0561302\ Id_4\ Id_5\ Id_7\ Id_8\ Id_9\ X_6 - 0.00630859\ Id_5\ Id_7\ Id_8\ Id_9\ X_4\ X_6 + \\ &0.00165752\ Id_4\ Id_7\ Id_8\ Id_9\ X_5\ X_6 + 0.00562722\ Id_7\ Id_8\ Id_9\ X_4\ X_5\ X_6 - \\ &0.00518865\ Id_4\ Id_5\ Id_6\ Id_8\ Id_9\ X_7 - 0.0000777401\ Id_5\ Id_6\ Id_8\ Id_9\ X_4\ X_7\end{aligned}$$

Combinations of arguments

```
GetPauliString[20]
GetPauliString[20, 6]
```

$$X_1\ X_2$$

$$Id_0\ Id_3\ Id_4\ Id_5\ X_1\ X_2$$

```
GetPauliString[20, {1, 3, 5}]
GetPauliString[20, {1, 3, 5}, 6]
```

$$Id_1\ X_3\ X_5$$

$$Id_0\ Id_1\ Id_2\ Id_4\ X_3\ X_5$$

```
GetPauliString[20, {1, 3, 5}, "RemoveIds" → True]
GetPauliString[20, {1, 3, 5}, 6, "RemoveIds" → True]
```

$$X_3\ X_5$$

$$X_3\ X_5$$

Errors

Matrix

```
GetPauliString @ {{1, 2, 3}}
GetPauliString @ IdentityMatrix[6]
```

GetPauliString: Matrix must be square with a power−of−2 number of rows and columns.

$Failed

GetPauliString: Matrix must be square with a power−of−2 number of rows and columns.

$Failed

```
m = RandomInteger[{-10, 10}, {2^3, 2^3}];
GetPauliString[m, 2]
```

GetPauliString: The specified number of qubits (2) was fewer than that suggested (3) by the matrix's dimension.

$Failed

```
m = RandomInteger[{-10, 10}, {4, 4}];
GetPauliString[m, {0}]
```

GetPauliString: The specified number of qubits (1) was fewer than that suggested (2) by the matrix's dimension.

$Failed

```
GetPauliString[RandomInteger[{-10, 10}, {2, 2}], {1, 2, 3}, 3]
```

GetPauliString: The requested number of Pauli operators (3) cannot be fewer than the number in the targeted Pauli string (4).

$Failed

```
m = RandomInteger[{-10, 10}, {4, 4}];
GetPauliString[m, {}]
GetPauliString[m, 2, {}]
GetPauliString[m, {}, 2]
```

GetPauliString: Optional list of target qubits must not be empty.

$Failed

GetPauliString: Optional list of target qubits must not be empty.

$Failed

GetPauliString: Optional list of target qubits must not be empty.

$Failed

```
m = RandomInteger[{-10, 10}, {4, 4}];
GetPauliString[m, 4, {1, 2, 3}]
```

$$-\frac{5}{4}\,\mathrm{Id}_0\,\mathrm{Id}_1\,\mathrm{Id}_2\,\mathrm{Id}_3+\mathrm{Id}_0\,\mathrm{Id}_2\,\mathrm{Id}_3\,X_1+\frac{1}{4}\,\mathrm{Id}_0\,\mathrm{Id}_1\,\mathrm{Id}_3\,X_2-\frac{1}{4}\,\mathrm{Id}_0\,\mathrm{Id}_3\,X_1\,X_2+$$
$$\frac{7}{2}\,i\,\mathrm{Id}_0\,\mathrm{Id}_2\,\mathrm{Id}_3\,Y_1+\frac{5}{4}\,i\,\mathrm{Id}_0\,\mathrm{Id}_3\,X_2\,Y_1-\frac{11}{4}\,i\,\mathrm{Id}_0\,\mathrm{Id}_1\,\mathrm{Id}_3\,Y_2-\frac{7}{4}\,i\,\mathrm{Id}_0\,\mathrm{Id}_3\,X_1\,Y_2+$$
$$\frac{29}{4}\,\mathrm{Id}_0\,\mathrm{Id}_3\,Y_1\,Y_2+\frac{15}{4}\,\mathrm{Id}_0\,\mathrm{Id}_2\,\mathrm{Id}_3\,Z_1-\frac{5}{4}\,\mathrm{Id}_0\,\mathrm{Id}_3\,X_2\,Z_1+\frac{19}{4}\,i\,\mathrm{Id}_0\,\mathrm{Id}_3\,Y_2\,Z_1-$$
$$\frac{1}{4}\,\mathrm{Id}_0\,\mathrm{Id}_1\,\mathrm{Id}_3\,Z_2-2\,\mathrm{Id}_0\,\mathrm{Id}_3\,X_1\,Z_2-\frac{1}{2}\,i\,\mathrm{Id}_0\,\mathrm{Id}_3\,Y_1\,Z_2-\frac{13}{4}\,\mathrm{Id}_0\,\mathrm{Id}_3\,Z_1\,Z_2$$

```
GetPauliString[m, "BadOption" → True]
```

••• OptionValue: Unknown option BadOption for GetPauliString.

$$-\frac{5\,\mathrm{Id}_1}{4}+X_0+\frac{X_1}{4}-\frac{X_0\,X_1}{4}+\frac{7\,i\,Y_0}{2}+\frac{5}{4}\,i\,X_1\,Y_0-\frac{11\,i\,Y_1}{4}-\frac{7}{4}\,i\,X_0\,Y_1+$$
$$\frac{29\,Y_0\,Y_1}{4}+\frac{15\,Z_0}{4}-\frac{5\,X_1\,Z_0}{4}+\frac{19}{4}\,i\,Y_1\,Z_0-\frac{Z_1}{4}-2\,X_0\,Z_1-\frac{1}{2}\,i\,Y_0\,Z_1-\frac{13\,Z_0\,Z_1}{4}$$

```
GetPauliString[m, {2, 0}, E → 2]
```

••• OptionValue: Unknown option E for GetPauliString.

```
$Failed
```

Index

```
GetPauliString[-1]
```

••• GetPauliString: Index must be positive or zero.

```
$Failed
```

```
GetPauliString[1, 0]
```

••• GetPauliString: Invalid arguments. See ?GetPauliString

```
$Failed
```

```
GetPauliString[123, 2]
```

••• GetPauliString: The given index (123) exceeds the maximum possible (15 = 4^2–1) for the given number of Pauli operators (2).

```
$Failed
```

```
GetPauliString[123, {2, 4}]
```

••• GetPauliString: The given index (123) exceeds the maximum possible (15 = 4^2–1) for the given number of Pauli operators (2).

```
$Failed
```

```
GetPauliString[0, {1, 2, 7}, 3]
```

GetPauliString: The requested number of Pauli operators (3) cannot be fewer than the number in the targeted Pauli string (8).

```
$Failed
```

```
GetPauliString[123, blah]
```

GetPauliString: Invalid arguments. See ?GetPauliString

```
$Failed
```

```
GetPauliString[3, 1, "BadOption" → True]
```

OptionValue: Unknown option BadOption for GetPauliString.

Z_0

```
GetPauliString[123, {9, 8, 7, 6}, 5]
```

GetPauliString: The requested number of Pauli operators (5) cannot be fewer than the number in the targeted Pauli string (10).

```
$Failed
```

```
GetPauliString[0, {}]
```

GetPauliString: Optional list of target qubits must not be empty.

```
$Failed
```

```
GetPauliString[2, {2, 0}, E → 2]
```

OptionValue: Unknown option E for GetPauliString.

```
$Failed
```

Digits

```
GetPauliString[{1, 0, 0}, {1, 2, 3, 4}]
```

$Id_1\ Id_2\ Id_4\ X_3$

```
GetPauliString[{4, 0, 0}]
GetPauliString[{-1, 0, 0}]
```

GetPauliString: Each individual digit must be one of 0 (denoting Id), 1 (X), 2 (Y) or 3 (Z).

```
$Failed
```

GetPauliString: Each individual digit must be one of 0 (denoting Id), 1 (X), 2 (Y) or 3 (Z).

```
$Failed
```

```
GetPauliString[{a, b, c}]
```

GetPauliString: Invalid arguments. See ?GetPauliString

```
$Failed
```

```
GetPauliString[{0, 0, 0}, 2]
```

GetPauliString: The overriden number of qubits was fewer than the number of given digits.

```
$Failed
```

```
GetPauliString[{0, 0, 0}, 0]
```

GetPauliString: Invalid arguments. See ?GetPauliString

```
$Failed
```

Address

```
setTmpFile["eh"];
GetPauliString["tmp.txt"]
```

GetPauliString: Parsing the file failed due to the below error:

ReadList: Invalid real number found when reading from tmp.txt.

```
$Failed
```

```
setTmpFile[".1 1 0 0 0 0 0"];
GetPauliString["tmp.txt", 4]
```

GetPauliString: The specified number of qubits (4) was fewer than that encoded in the file (6).

```
$Failed
```

```
GetPauliString["https://qtechtheory.org/hamil_6qbLiH.txt", {9, 8, 7, 5, 4}]
```

GetPauliString: The specified number of qubits (5) was fewer than that encoded in the file (6).

```
$Failed
```

```
GetPauliString["https://qtechtheory.org/hamil_6qbLiH.txt", {9, 9, 9, 9, 9, 9}]
GetPauliString["https://qtechtheory.org/hamil_6qbLiH.txt",
 {-1, -2, -3, -4, -5, -6}]
```

GetPauliString: Target qubits must be list of unique, non-negative and integers.

```
$Failed
```

GetPauliString: Target qubits must be list of unique, non-negative and integers.

```
$Failed
```

```
GetPauliString["https://qtechtheory.org/hamil_6qbLiH.txt", -1]
```

GetPauliString: Invalid arguments. See ?GetPauliString

```
$Failed
```

```
GetPauliString[
  "https://qtechtheory.org/hamil_6qbLiH.txt", "BadOption" → True][[ ;; 5]]
```

OptionValue: Unknown option BadOption for GetPauliString.

$$-6.52209\ \mathrm{Id}_0 - 0.00168947\ \mathrm{X}_0 + 0.000335609\ \mathrm{X}_1 + 0.00233908\ \mathrm{X}_0\ \mathrm{X}_1 - 0.00518865\ \mathrm{X}_2$$

Combinations of arguments

```
GetPauliString[120, {1, 3, 4, 6}, 3]
```

GetPauliString: The requested number of Pauli operators (3) cannot be fewer than the number in the targeted Pauli string (7).

```
$Failed
```