Pensieve Header: This is a jff implementation of key elements of the bzip2 compression algorithm. When run on the Wikipedia entry for Bzip2 it is 7% worse than the true bzip2, I'm not sure why.

In[38]:=
```
urls = {"http://www.math.toronto.edu/~drorbn/papers/WKO",
    "http://en.wikipedia.org/wiki/Bzip2"};
text = StringTake[
    Import[urls[[1]], "Text"],
    All
   ];
text = StringReplace[text, "\n" → "|"]
```

Out[40]=
```
<! Generated by index.php - do not edit! >||<html>|<head>|  <link rel="stylesheet"
  type="text/css" href="/~drorbn/global.css">|  <title>Dror Bar-Natan:
  Publications: W-Knotted Objects</title>|</head>||<body bgcolor="FFFFFF">||<a
  href="/~drorbn/Copyleft/index.html">&copy;</a> ||<a href="/~drorbn/">Dror
  Bar-Natan</a>:|<a href="/~drorbn/papers/">Publications</a>:|<center>||  <div
  style="font-size:162%;color:red; margin:0; padding:0"><b>In|  Preparation</b></div>
  <span style="color:red; margin:0; padding:0">The|  information here is preliminary
  and cannot be trusted.</span>||  <h1>Finite Type Invariants of W-Knotted Objects:
  From Alexander to|  Kashiwara and Vergne</h1>|  <p>last updated Mon, 08 Mar 2010
  10:16:45 -0500.|  <br>first edition: Not yet.||</center>||<p><blockquote><b>Abstract.
  </b>|w-Knots, and more generally, w-knotted objects (w-braids, w-tangles,|etc.)
  make a class of knotted objects which is <u>w</u>ider but|<u>w</u>eaker than
  their "<u>u</u>sual" counterparts. To|get (say) w-knots from u-knots, one has to
  allow non-planar "virtual"|knot diagrams, hence enlarging the the base set of
  knots. But then one|imposes a new relation, the "overcrossings commute" relation,
  further|beyond the ordinary collection of Reidemeister moves, making w-knotted|objects
  a bit weaker once again.|<p>|The group of w-braids was studied (under the
  name|"<u>w</u>elded braids") by Fenn, Rimanyi and|Rourke <a href=#FRR>[FRR]</a>
  and was shown to|be isomorphic to the McCool group <a href=#Mc>[Mc]</a>|of
  "basis-conjugating" automorphisms of a free group <em>F<sub>n</sub></em> -|the
  smallest subgroup of <em>Aut(F<sub>n</sub>)</em> that contains both braids
  and|permutations. Brendle and Hatcher <a href=#BH>[BH]</a>,|in work that
  traces back to Goldsmith <a href=#Gol>[Gol]</a>,|have shown this group to
  be a group of movies of flying rings in|<b>R</b><sup>3</sup>. Satoh <a
  href=#Sa>[Sa]</a> studied several classes of|w-knotted objects (under the name
  "<u>w</u>eakly-virtual") and has|shown them to be closely related to certain
  classes of knotted surfaces|in <b>R</b><sup>4</sup>. So w-knotted objects are
  algebraically and topologically |interesting.|<p>|In this article we study finite
  type invariants of several|classes of w-knotted objects.  Following Berceanu
  and|Papadima <a href=#BP>[BP]</a>, we construct a|homomorphic universal finite
  type invariant of w-braids, and hence|show that the McCool group of automorphisms
  is "1-formal". We also|construct a homomorphic universal finite type invariant
  of w-tangles. We|find that the universal finite type invariant of w-knots is
  more or less|the Alexander polynomial (details inside).|<p>|Much as the spaces
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A of chord diagrams for ordinary knotted|objects are related to metrized
Lie algebras, we find that the spaces|A^w of "arrow diagrams"
for w-knotted objects are related to|not-necessarily-metrized Lie algebras. Many
questions concerning w-knotted|objects turn out to be equivalent to questions
about Lie algebras. Most|notably we find that a homomorphic universal finite type
invariant of|w-knotted trivalent graphs is essentially the same as a solution
of|the Kashiwara-Vergne [KV] conjecture and|much of the
Alekseev-Torrosian [AT]|work on Drinfel'd associators and
Kashiwara-Vergne can be re-intepreted|as a study of w-knotted trivalent graphs.|<p>|The
true value of w-knots, though, is likely to emerge later, for we|expect them to
serve as a <u>w</u>armup example for what we expect|will be even more interesting
- the study of <u>v</u>irtual|knots, or v-knots. We expect v-knotted objects
to provide the global|context whose projectivization (or "associated graded
structure")|will be the Etingof-Kazhdan theory of deformation quantization of
Lie|bialgebras [EK].|</blockquote>||<p>The paper.
WKO.pdf, <a|href="WKO.zip">WKO.zip.||<p>Related
Mathematica Notebooks. |"The Kishino Braid"| (<a
href="http://katlas.math.toronto.edu/drorbn/AcademicPensieve/Projects/WKO/The_Kishino
_Braid.nb">Source,| <a
href="http://katlas.math.toronto.edu/drorbn/AcademicPensieve/Projects/WKO/nb/The_Kishino
_Braid.pdf">PDF),|"Dimensions"| (<a
href="http://katlas.math.toronto.edu/drorbn/AcademicPensieve/Projects/WKO/Dimensions.nb"
>Source,| <a
href="http://katlas.math.toronto.edu/drorbn/AcademicPensieve/Projects/WKO/nb/Dimensions.
pdf">PDF),|"wA"| (<a
href="http://katlas.math.toronto.edu/drorbn/AcademicPensieve/Projects/WKO/wA.nb">Source<
/a>,| <a
href="http://katlas.math.toronto.edu/drorbn/AcademicPensieve/Projects/WKO/nb/wA.pdf">PDF
),|"InfinitesimalAlexanderModules"| (<a
href="http://katlas.math.toronto.edu/drorbn/AcademicPensieve/Projects/WKO/
InfinitesimalAlexanderModules.nb">Source,| <a
href="http://katlas.math.toronto.edu/drorbn/AcademicPensieve/Projects/WKO/nb/
InfinitesimalAlexanderModules.pdf">PDF).||<p>Related talks.
|Oberwolfach-0805,|<a
href="/~drorbn/Talks/MSRI-0808">MSRI-0808,|<a
href="/~drorbn/Talks/Northeastern-081028">Northeastern-081028,|<a
href="/~drorbn/Talks/Trieste-0905">Trieste-0905,|<a
href="/~drorbn/Talks/Bonn-0908">Bonn-0908.||<p>Links. <a
href="SandersonsGarden.html">SandersonsGarden.html.||<p>Related
Scratch Work is under
<a|href="http://katlas.math.toronto.edu/drorbn/AcademicPensieve/Projects/WKO/">WKO|
and
<a|href="http://katlas.math.toronto.edu/drorbn/AcademicPensieve/Projects/Arrow_Diagrams
_and_gl(N)/">Arrow_Diagrams_and_gl(N).||<p>References.|<dl>||<dt><a
name="AT">[AT]|<dd>A. Alekseev and C. Torossian,| <em>The Kashiwara-Vergne

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conjecture and Drinfeld's associators,</em>|  <a class=external
href="http://front.math.ucdavis.edu/0802.4300">arXiv:0802.4300</a>.||<dt><a
name="BP">[BP]|<dd>B. Berceanu and S. Papadima,|  <em>Universal
Representations of Braid and Braid-Permutation Groups,</em>|  <a class=external
href="http://front.math.ucdavis.edu/0708.0634">arXiv:0708.0634</a>.||<dt><a
name="BH">[BH]|<dd>T. Brendle and A. Hatcher,|  <em>Configuration
Spaces of Rings and Wickets,</em>|  <a class=external
href="http://front.math.ucdavis.edu/0805.4354">arXiv:0805.4354</a>.||<dt><a
name="EK">[EK]|<dd>P. Etingof and D. Kazhdan,|  <em>Quantization of Lie Bialgebras,
I,</em>|  Selecta Mathematica, New Series <b>2</b> (1996) 1-41,|  <a class=external|
href="http://front.math.ucdavis.edu/q-alg/9506005">arXiv:q-alg/9506005</a>.||<dt><a
name="FRR">[FRR]|<dd>R. Fenn, R. Rimanyi and C. Rourke,|  <a class=external
href="http://msp.warwick.ac.uk/~cpr/"><em>The|  Braid-Permutation
Group,</em></a>|  Topology <b>36</b> (1997) 123-135.||<dt><a
name="Gol">[Gol]|<dd>D. L. Goldsmith,|  <a class=external|
href="http://projecteuclid.org/DPubS?service=UI&version=1.0&verb=Display&handle=euclid.
mmj/1029002454"><em>The|    Theory of Motion Groups,</em></a>|
Mich. Math. J. <b>28-1</b> (1981) 3-17.||<dt><a name="KV">[KV]|<dd>M.
Kashiwara and M. Vergne,|  <a class=external|
href="http://www.springerlink.com/content/v73014gx14084624/"><em>The|
Campbell-Hausdorff Formula and Invariant Hyperfunctions,</em></a>|  Invent.
Math. <b>47</b> (1978) 249-272.||<dt><a name="Mc">[Mc]|<dd>J. McCool,|  <em>On
Basis-Conjugating Automorphisms of Free Groups,</em>|  Can. J. Math. <b>38-6</b>(1986)
1525-1529.||<dt><a name="Sa">[Sa]|<dd>S. Satoh,|  <em>Virtual Knot Presentations of
Ribbon Torus Knots,</em>|  J. of Knot Theory and its Ramifications <b>9-4</b> (2000)
531-542.||</dl>||<br><br><p><center><img src=IAMRelations.png></center>||</body>|</html>
```

```
In[41]:= l = Length[charseq = Characters[text]]

Out[41]= 7660

In[42]:= Total[Length /@ Select[Split[charseq], Length[#] > 4 &]]

Out[42]= 6

In[43]:= Sort[Reverse /@ Tally[charseq]] // Reverse

Out[43]= {{676,  }, {551, e}, {482, a}, {422, t}, {369, o}, {362, r}, {357, n}, {308, s}, {273, i},
  {225, >}, {225, <}, {222, d}, {217, /}, {187, h}, {179, l}, {173, |}, {161, c},
  {140, .}, {139, m}, {137, b}, {135, u}, {124, p}, {121, f}, {112, "}, {69, g}, {67, -},
  {66, w}, {64, 0}, {64, =}, {60, k}, {58, v}, {54, ,}, {45, y}, {38, P}, {38, K}, {36, :},
  {34, A}, {31, T}, {29, j}, {28, R}, {28, 1}, {27, M}, {26, B}, {25, 8}, {23, F},
  {22, S}, {21, x}, {21, W}, {21, 5}, {21, 4}, {19, O}, {19, 2}, {19, )}, {19, (},
  {18, ]}, {18, [}, {17, D}, {17, 9}, {15, ;}, {14, 3}, {13, I}, {13, G}, {13, &},
  {11, 6}, {10, z}, {10, V}, {10, C}, {10, ~}, {10, _}, {9, N}, {9, #}, {8, q}, {8, H},
  {8, 7}, {7, L}, {6, E}, {4, X}, {4, J}, {2, U}, {2, '}, {2, !}, {1, Q}, {1, ?}, {1, %}}

In[44]:= entropy[seq_List] := Total[
    N[-# * Log[2, #]] & /@ ((Last /@ Tally[seq]) / Length[seq])
   ];
  entropy[charseq]

Out[45]= 5.24707
```

In[46]:=
```
StringJoin[pivots =
  charseq[[
   Sort[
      Range[l],
      (
        {i1, i2} = {#1, #2};
        While[charseq[[i1]] == charseq[[i2]], {i1, i2} = ({i1, i2} /. l → 0) + 1];
        OrderedQ[{charseq[[i1]], charseq[[i2]]}]
       ) &
     ] - 1 /. 0 → l
    ]]
]
```

Out[46]=
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   hhIInneenn835399118qqwwwss1levuwwwwwwwwwwwvwwfwWWytrrnddtwwvyaaaffffffffffffffffffeeeeee
    reefffffffffffffffffeelefeffnbesssssssce//////////>>>>>>>>>>>>>>>>>>TPlcVKRaHcTKlHPRVa>
   ..
   >>>>........>.....>>>>.|||>>||:,,,>,n||:]]]]]]]]]]>|||||||||s>|....|||||||te,,>,"""",,,
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   rrbbaaaaaaaaappaaaaaaaaaaaaaabbbbbmabvaaammambbpbbpbbu """"mmdb"md"md"euuurm1uubdpbd"bb""
   md"""""mbbdbbbbud"""""dmmm"mb"umumpuuuuu"""ct2>>>>5729>>>>)>g)
   ns0sdsstsrJhhsABTssPRLAhnMDDsJthJsJSRC >S>sCMs"
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   pppppppppppppppppppsnnsnnggvvv0e6vrr    >>>>>lntdss>pg5>y.....dr,           >s.y..sn
   sf p        > fas!resfrfer|||||||||||||||||||||||||||||||    | |.|  ||||)|||
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   ff:eedttlelaes!o.nnended,naaaaaaaaaaaaa"aaaaaalll aaaaaaaal  aad.tsy
   seeeeeehss,se>ed,de .. fyffede. .elfsers.fdtdf ,;;odnsrfd.8...ad.ee
   d.faaaaaaaaaeeawo,:addddddddnstpy>sps>ysstss.nnpynssshtpetsytskrn,e,erndd;;erseo.
   t:noyekeye"wg,sflf,.f.eoefdeseaeegds>eeanvtdd..d
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|                     xxxxxSShttciiiiiuuiieeMmmPPpprrBBnMwwwwwpGG
mmlvvvvvvvs>" pw>>>>nnnrhrrllllllllllrr  |ww hbKKKKKbBllllllllll"
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niaaaaaaaaaaaaaaaaaio         |   |      |     rr   aa  r
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>///////<<<<<<<dddddddddddddddnntttstqQsssssPPP....MmeerrrtttttlrqqjjoqL.mdddf
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nnnnnnneeeeeeeeeeeeraenee&oiiiii&oroo–"aaaaiKKKK–  ––>oo (        |
||  >>>>>>wooeeoiiiii.  //"         r||ooorr| w/      >>">"/////////
eegeeeeeeeeeeeeeeeeeerrrraalldlplgrrldrdbbrdrrdnllll  nnlttptletttttTHiiiiiiaa..
```

In[47]:= **alphabet = Union[pivots]**

```
Out[47]= {!, ♯, %, &, (, ), _, –, =, ~, [, ], |, <, >, ., ,, ;, ", ?, ', /, :,  , 0, 1, 2,
 3, 4, 5, 6, 7, 8, 9, a, A, b, B, c, C, d, D, e, E, f, F, g, G, h, H, i, I, j, J, k,
 K, l, L, m, M, n, N, o, O, p, P, q, Q, r, R, s, S, t, T, u, U, v, V, w, W, x, X, y, z}
```

In[48]:=
```
codeseq = Table[
  k = Position[alphabet, pivots[[i]]][[1, 1]];
  alphabet[[Range[k]]] = RotateRight[alphabet[[Range[k]]]];
  k,
  {i, l}
 ]
```

Out[48]= {73, 15, 11, 1, 1, 1, 1, 1, 1, 1, 1, 28, 17, 83, 63, 71, 39, 73, 48, 54, 2, 69, 3, 35, 58, 36, 1, 1,
1, 1, 1, 12, 2, 1, 1, 1, 16, 63, 1, 3, 1, 1, 1, 1, 33, 67, 6, 1, 11, 2, 1, 1, 3, 32, 43, 44,
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