breaking LINES and PAGES

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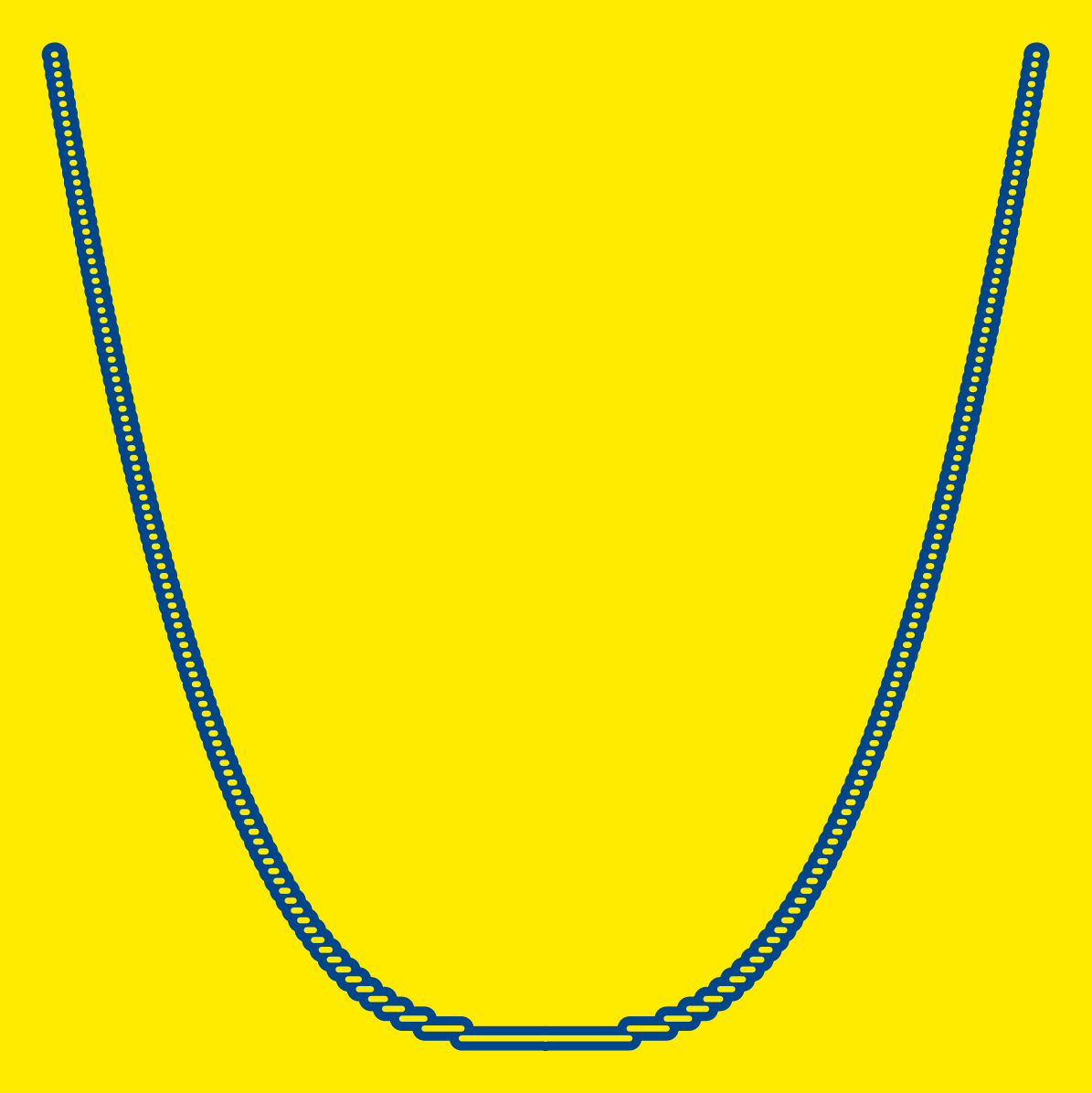
BachoTEX 2024



OVERVIEW

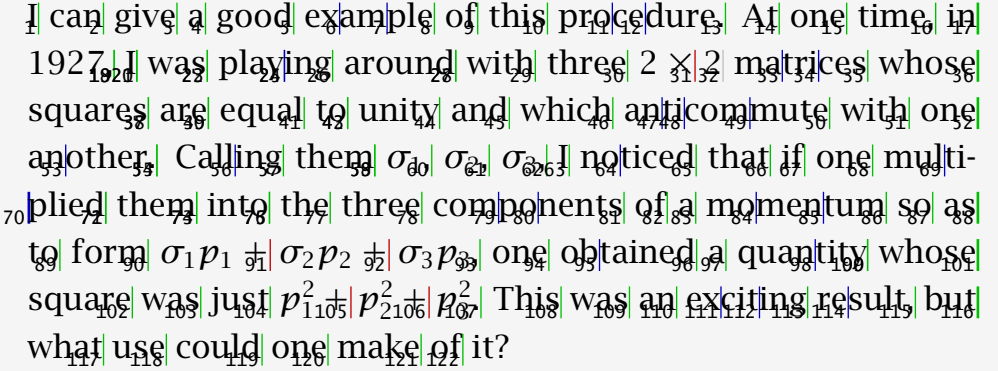
- Breaking paragraphs into lines
  - How does TEX break paragraphs into lines?
  - What are badness and demerits?
  - What parameters can we play with?
  - What is new?
- Pagebreaks
  - What are typical problems with pagebreaking?
  - What parameters can we play with?
  - What is new?

BREAKI
NGPARAGI
RAPHSINTO
DLINES

HOW DOES TEX BUILD THE PARAGRAPH?

If we would like to improve, we better first understand what is going on. We start by looking at a paragraph from P.A.M. Dirac's article "Pretty Mathematics":

> I can give a good example of this procedure. At one time, in 1927, I was playing around with three 2×2 matrices whose squares are equal to unity and which anticommute with one another. Calling them σ_1, σ_2, σ_3, I noticed that if one multiplied them into the three components of a momentum so as to form $\sigma_1 p_1 + \sigma_2 p_2 + \sigma_3 p_3$, one obtained a quantity whose square was just $p_1^2 + p_2^2 + p_3^2$. This was an exciting result, but what use could one make of it?



THESE ARE THE VALUES TEX CONSIDERED

1	1	0	100010000	veryloose	glue
	2	0	100010000	veryloose	glue
	3	0	100010000	veryloose	glue
	4	0	100010000	veryloose	glue
	5	0	100010000	veryloose	glue
	6	0	100012500	veryloose	disc
	7	0	100012500	veryloose	disc
	8	0	100010000	veryloose	glue
	9	0	100010000	veryloose	glue
	10	0	100010000	veryloose	glue
	11	0	100012500	veryloose	disc
	12	0	100012500	veryloose	disc
	13	0	100010000	veryloose	glue
	14	0	42938704	veryloose	glue
	15	0	2869481	veryloose	glue
	16	0	20609	loose	glue
	17	0	169	decent	glue
2	18	17	100010169	veryloose	glue
	19	2	100020100	decent	glue
	20	17	100010169	veryloose	glue
	21	2	100020169	decent	glue
	22	17	100010169	veryloose	glue
	23	3	100020121	decent	glue
	24	17	100012669	veryloose	disc
	25	5	100022669	decent	disc
	26	17	100010169	veryloose	glue
	27	17	100010169	veryloose	glue
	28	8	100020100	decent	glue
	29	17	100010169	veryloose	glue
	30	14	68119028	veryloose	glue
	31	15	20815165	veryloose	penalty
	32	15	7113081	veryloose	math
	33	15	2935485	veryloose	disc
	34	16	2413958	veryloose	disc
	35	16	315765	veryloose	glue
	36	17	493	decent	glue
3	37	36	100010493	veryloose	glue
	38	19	100020269	decent	glue
	39	36	100010493	veryloose	glue
	40	23	100020410	decent	glue
	41	36	100010493	veryloose	glue
	42	36	100010493	veryloose	glue
	43	26	100020269	decent	glue
	44	36	100010493	veryloose	glue
	45	30	75604724	veryloose	glue
	46	32	19531657	veryloose	glue
	47	33	6688341	veryloose	disc
	48	33	4006826	veryloose	disc
	49	34	2546174	veryloose	disc
	50	35	401614	veryloose	glue
	51	35	328901	tight	glue
	52	36	817	decent	glue
4	53	52	100013317	veryloose	disc
	54	52	100010817	veryloose	glue
	55	38	100020390	decent	glue
	56	52	100013317	veryloose	disc
	57	52	100010817	veryloose	glue
	58	52	100033317	veryloose	glue
	59	43	100042913	decent	glue
	60	45	76776408	veryloose	glue
	61	46	29851838	veryloose	glue
	62	47	8884665	veryloose	glue
	63	48	5254515	veryloose	glue
	64	49	3578774	veryloose	disc
	65	49	2566055	veryloose	glue
	66	50	473975	veryloose	glue
	67	50	415095	loose	glue
	68	51	348505	loose	glue
	69	52	15918	loose	disc
	70	52	3606	decent	disc
5	71	70	100013606	veryloose	glue
	72	53	100023417	decent	glue
	73	70	100013606	veryloose	glue
	74	55	100020511	decent	glue
	75	70	100013606	veryloose	glue
	76	56	100023417	decent	glue
	77	60	81825417	veryloose	glue
	78	61	30939687	veryloose	glue
	79	63	6538439	veryloose	disc
	80	64	4850158	veryloose	disc
	81	64	3589303	loose	glue
	82	65	2690664	veryloose	glue
	83	65	2579776	loose	glue
	84	66	491804	loose	disc
	85	67	427695	decent	disc
	86	68	349081	loose	glue
	87	69	20014	loose	glue
	88	70	3775	decent	glue
	89	70	16310	tight	glue
6	90	88	100013775	veryloose	glue
	91	78	69067912	veryloose	penalty
	92	79	8797339	veryloose	penalty
	93	80	4895954	veryloose	glue
	94	81	3936864	veryloose	glue
	95	82	2802725	veryloose	disc
	96	84	585325	veryloose	glue
	97	84	495168	loose	glue
	98	85	440316	decent	disc
	99	87	357198	veryloose	glue
	100	86	352562	loose	glue
	101	88	4216	decent	glue
7	102	101	100014216	veryloose	glue
	103	91	69703121	veryloose	glue
	104	92	20692940	veryloose	glue
	105	92	9300795	veryloose	penalty
	106	93	5433478	veryloose	penalty
	107	94	4114105	veryloose	glue
	108	95	2813509	loose	glue
	109	96	615950	veryloose	glue
	110	97	500497	loose	glue
	111	98	487152	veryloose	disc
	112	98	463600	loose	disc
	113	100	364226	loose	glue
	114	100	365162	decent	disc
	115	101	25452	loose	glue
	116	101	4316	decent	glue
8	117	104	25814109	veryloose	glue
	118	105	20197396	veryloose	glue
	119	105	9382020	veryloose	glue
	120	106	5651567	veryloose	glue
	121	107	4159901	veryloose	glue
	122	108	3435033	veryloose	glue

115 101 88 70 52 36 17

116 101 88 70 52 36 17

117 104 92 79 63 48 33 15

POSSIBLE BREAKPOINTS

Traditional TEX can break lines

- at glue (after words, not usually inside math),
- at kern followed by glue,
- at a discretionary (hyphenation),
- due to a penalty (also inside math).

I can give a good example of this procedure. At one time in 1927 I was playing around with three 2×2 matrices whose squares are equal to unity and which anticommute with one another. Calling them σ_1, σ_2, σ_3, I noticed that if one multiplied them into the three components of a momentum so as to form $\sigma_1 p_1 + \sigma_2 p_2 + \sigma_3 p_3$, one obtained a quantity whose square was just $p_1^2 + p_2^2 + p_3^2$. This was an exciting result, but what use could one make of it?

The selected one (116):

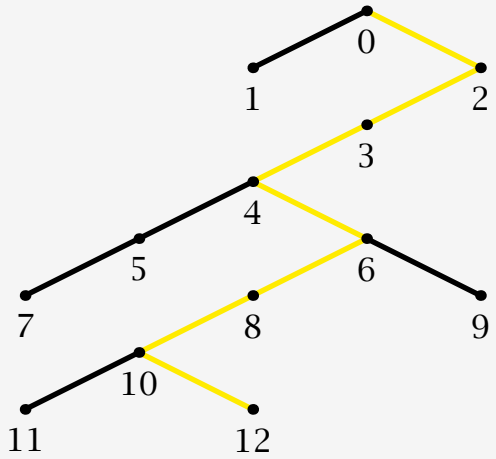
I can give a good example of this procedure. At one time in 1927 I was playing around with three 2×2 matrices whose squares are equal to unity and which anticommute with one another. Calling them σ_1, σ_2, σ_3, I noticed that if one multiplied them into the three components of a momentum so as to form $\sigma_1 p_1 + \sigma_2 p_2 + \sigma_3 p_3$, one obtained a quantity whose square was just $p_1^2 + p_2^2 + p_3^2$. This was an exciting result, but what use could one make of it?

One of the abandoned ones (117):

I can give a good example of this procedure. At one time in 1927 I was playing around with three 2×2 matrices whose squares are equal to unity and which anticommute with one another. Calling them σ_1, σ_2, σ_3, I noticed that if one multiplied them into the three components of a momentum so as to form $\sigma_1 p_1 + \sigma_2 p_2 + \sigma_3 p_3$, one obtained a quantity whose square was just $p_1^2 + p_2^2 + p_3^2$. This was an exciting result, but what use could one make of it?

TEX USUALLY DISCARDS MOST PERMITTED BREAKPOINTS

I can give a good example of this procedure. At one time, in 1927, I was playing around with three 2×2 matrices whose squares are equal to unity and which anticommute with one another. Calling them σ_1, σ_2, σ_3, I noticed that if one multiplied them into the three components of a momentum so as to form $\sigma_1 p_1 + \sigma_2 p_2 + \sigma_3 p_3$, one obtained a quantity whose square was just $p_1^2 + p_2^2 + p_3^2$. This was an exciting result, but what use could one make of it?




```
[01] b=3
[02] b=8
[03] b=8
[04] b=7
[05] b=3
[06] b=11
[07] b=0
[08] b=0
```

1	1	0	20609	loose	glue
	2	0	169	decent	glue
2	3	2	493	decent	glue
3	4	3	817	decent	glue
4	5	4	15918	loose	disc
	6	4	3606	decent	disc
5	7	5	20014	loose	glue
	8	6	3775	decent	glue
	9	6	16310	tight	glue
6	10	8	4216	decent	glue
7	11	10	25452	loose	glue
	12	10	4316	decent	glue
11	10 8 6 4 3 2				
12	10 8 6 4 3 2				

COMPARISON OF THE TWO POSSIBILITIES

The selected one (12):

> I can give a good example of this procedure. At one time, in 1927, I was playing around with three 2×2 matrices whose squares are equal to unity and which anticommute with one another. Calling them σ_1, σ_2, σ_3, I noticed that if one multiplied them into the three components of a momentum so as to form $\sigma_1 p_1 + \sigma_2 p_2 + \sigma_3 p_3$, one obtained a quantity whose square was just $p_1^2 + p_2^2 + p_3^2$. This was an exciting result, but what use could one make of it?

The abandoned one (11):

> I can give a good example of this procedure. At one time, in 1927, I was playing around with three 2×2 matrices whose squares are equal to unity and which anticommute with one another. Calling them σ_1, σ_2, σ_3, I noticed that if one multiplied them into the three components of a momentum so as to form $\sigma_1 p_1 + \sigma_2 p_2 + \sigma_3 p_3$, one obtained a quantity whose square was just $p_1^2 + p_2^2 + p_3^2$. This was an exciting result, but what use could one make of it?

BADNESS AND TOLERANCE

To each possible breakpoint (glue, disc, math, penalty) a *badness* value is calculated. If its value is less than the *(pre)tolerance*, the breakpoint is “feasible”.

TEX can do one, two (or three) runs on each paragraph:

1. Without hyphenation. Badness is compared to `pretolerance` (traditionally usually set to 100).
2. Possibly with hyphenation. Badness is compared to `tolerance` (traditionally set to 200).
3. If neither of the runs is successful and `\emergencystretch` is set to a positive value, a third run is done.

WHAT IS BADNESS?

Let ℓ be the desired length of the line. Let L be the total *natural width* of what we got so far (without stretch and shrink). Also, let $Y > 0$ be the total *stretchability* and $Z > 0$ be the total *shrinkability*. Define the *adjustment ratio* r as follows:

- If $L = \ell$ then set $r = 0$.
- If $L < \ell$ then set $r = (\ell - L)/Y$.
- If $L > \ell$ then set $r = (\ell - L)/Z$.

The *badness* β of the breakpoint is defined as

$$\beta = \begin{cases} +\infty, & r < -1; \\ \lfloor 100|r|^3 + 0.5 \rfloor, & \text{otherwise.} \end{cases}$$

BADNESS IN OUR TEST PARAGRAPH

I can give a good example of this procedure. At one time, in 1927, I was playing around with three 2×2 matrices whose squares are equal to unity and which anticommute with one another. Calling them σ_1, σ_2, σ_3, I noticed that if one multiplied them into the three components of a momentum so as to form $\sigma_1 p_1 + \sigma_2 p_2 + \sigma_3 p_3$, one obtained a quantity whose square was just $p_1^2 + p_2^2 + p_3^2$. This was an exciting result, but what use could one make of it?

Above we used `pretolerance=`100 and `tolerance=`200.

Did TEX use the second run?

```
[01] b=3
[02] b=8
[03] b=8
[04] b=7
[05] b=3
[06] b=11
[07] b=0
[08] b=0
```

PROHIBIT HYPHENATION

I can give a good example of this procedure. At one time, in 1927, I was playing around with three 2×2 matrices whose squares are equal to unity and which anticommute with one another. Calling them σ_1, σ_2, σ_3, I noticed that if one multiplied them into the three components of a momentum so as to form $\sigma_1 p_1 + \sigma_2 p_2 + \sigma_3 p_3$, one obtained a quantity whose square was just $p_1^2 + p_2^2 + p_3^2$. This was an exciting result, but what use could one make of it?

Here we did `\setupalign[nothyphenated]`.

```
[01] b=3
[02] b=8
[03] b=8
[04] b=1000000
[05] b=36
[06] b=66
[07] b=12
[08] b=0
```

PROHIBIT HYPHENATION, MORE TOLERANT

I can give a good example of this procedure. At one time in 1927, I was playing around with three 2×2 matrices whose squares are equal to unity and which anticommute with one another. Calling them σ_1, σ_2, σ_3, I noticed that if one multiplied them into the three components of a momentum so as to form $\sigma_1 p_1 + \sigma_2 p_2 + \sigma_3 p_3$, one obtained a quantity whose square was just $p_1^2 + p_2^2 + p_3^2$. This was an exciting result but what use could one make of it?

Here we did `\setupalign[nothyphenated,verytolerant]`.

```
[01] b=93
[02] b=524
[03] b=46
[04] b=88
[05] b=61
[06] b=12
[07] b=0
[08] b=0
```

HOW TO CALCULATE DEMERITS?

> I can give a good example of this procedure. At one time, in 1927, I was playing around with three 2×2 matrices whose squares are equal to unity and which anticommute with one another. Calling them σ_1, σ_2, σ_3, I noticed that if one multiplied them into the three components of a momentum so as to form $\sigma_1 p_1 + \sigma_2 p_2 + \sigma_3 p_3$, one obtained a quantity whose square was just $p_1^2 + p_2^2 + p_3^2$. This was an exciting result, but what use could one make of it?

Let β be the badness, ℓ the line penalty (10), π the possible penalty, and α the additional demerits that correspond to a certain breakpoint. Then the demerits δ for that breakpoint is defined by

$$\delta = \begin{cases} (\ell+\beta)^2 + \pi^2 + \alpha, & \text{if } \pi \ge 0; \\ (\ell+\beta)^2 - \pi^2 + \alpha, & \text{if } -\infty < \pi < 0; \\ (\ell+\beta)^2 + \alpha, & \text{if } \pi = -\infty. \end{cases}$$

1	1	0	20609	loose	glue
	2	0	169	decent	glue
2	3	2	493	decent	glue
3	4	3	817	decent	glue
4	5	4	15918	loose	disc
	6	4	3606	decent	disc
5	7	5	20014	loose	glue
	8	6	3775	decent	glue
	9	6	16310	tight	glue
6	10	8	4216	decent	glue
7	11	10	25452	loose	glue
	12	10	4316	decent	glue
11	10 8 6 4 3 2				
12	10 8 6 4 3 2				

WHAT PENALTIES DO WE HAVE HERE?

We add `\showmakeup[penalty]` to see the penalties in action.

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We have here horizontal penalties

- `hyphenpenalty` set to 50 (not shown, used in calculations),
- mathematics penalties (later),

and vertical penalties (discussed later)

- `brokenpenalty` set to 100,
- `clubpenalty` set to 2000,
- `widowpenalty` set to 2000.

ONE EXAMPLE CALCULATION

I can give a good example of this procedure. At one time, in 1927, I was playing around with three 2×2 matrices whose squares are equal to unity and which anticommute with one another. Calling them σ_1, σ_2, σ_3, I noticed that if one multiplied them into the three components of a momentum so as to form $\sigma_1 p_1 + \sigma_2 p_2 + \sigma_3 p_3$, one obtained a quantity whose square was just $p_1^2 + p_2^2 + p_3^2$. This was an exciting result, but what use could one make of it?

We calculate the demerits of the linebreak after line 4.

The line penalty is $\ell = 10$, the badness is $\beta = 7$. The hyphenation penalty costs $\pi = 50$. No additional demerits, so $\alpha = 0$. Thus, the demerits δ is given by

$$\delta = (\ell + \beta)^2 + \pi^2 + \alpha = (10 + 7)^2 + 50^2 + 0 = 2789.$$

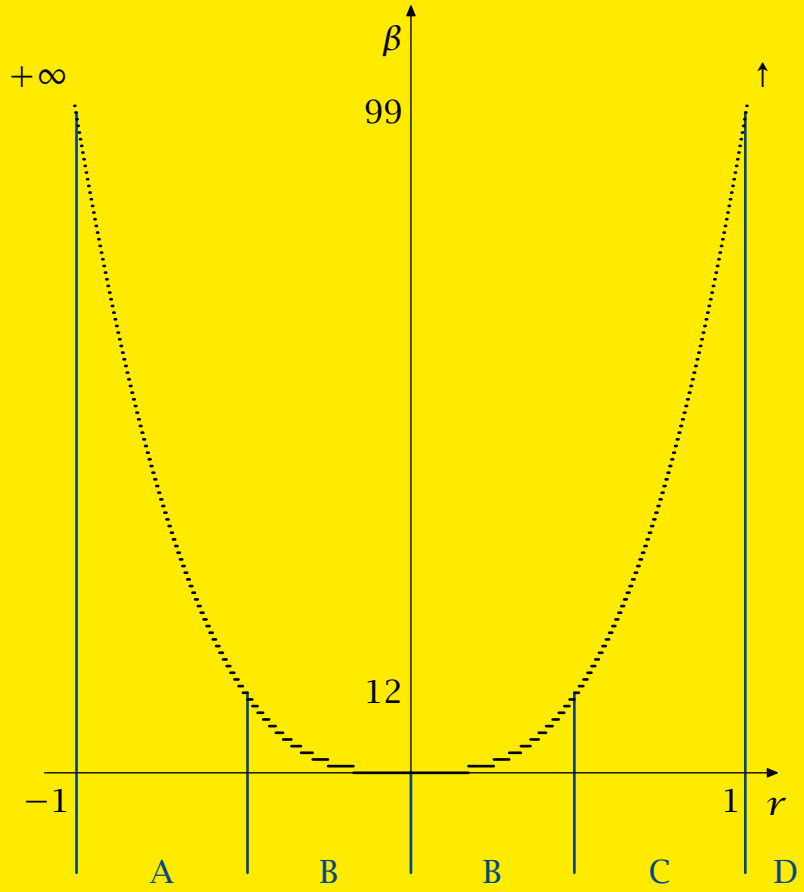
This is consistent with the table, since

$$817 + 2789 = 3606.$$

Homework: What is the badness of breakpoint 5? (Answer: 41)

```
[01] b=3
[02] b=8
[03] b=8
[04] b=7
[05] b=3
[06] b=11
[07] b=0
[08] b=0
```

1	1	0	20609	loose	glue
	2	0	169	decent	glue
2	3	2	493	decent	glue
3	4	3	817	decent	glue
4	5	4	15918	loose	disc
	6	4	3606	decent	disc
5	7	5	20014	loose	glue
	8	6	3775	decent	glue
	9	6	16310	tight	glue
6	10	8	4216	decent	glue
7	11	10	25452	loose	glue
	12	10	4316	decent	glue
11	10 8 6 4 3 2				
12	10 8 6 4 3 2				



ADJACENT CLASSES

Every line gets a fitness class.

A. Tight

B. Decent

C. Loose

D. Very loose

If the current line has a different fitness class than the previous, `\adjdemerits` (usually set to 10000) is added to the demerits.

Granular is defined as

```
\fitnessdemerits 9
  99 9000    0 % very loose
  42 6000  500 % loose
  12 4500 1000 % almost loose
   2 3000 1000 % barely loose
   0 1500 1500 % decent
   2 1000 3000 % barely tight
  12 1000 4500 % almost tight
  42  500 6000 % tight
  99    0 9000 % very tight
```

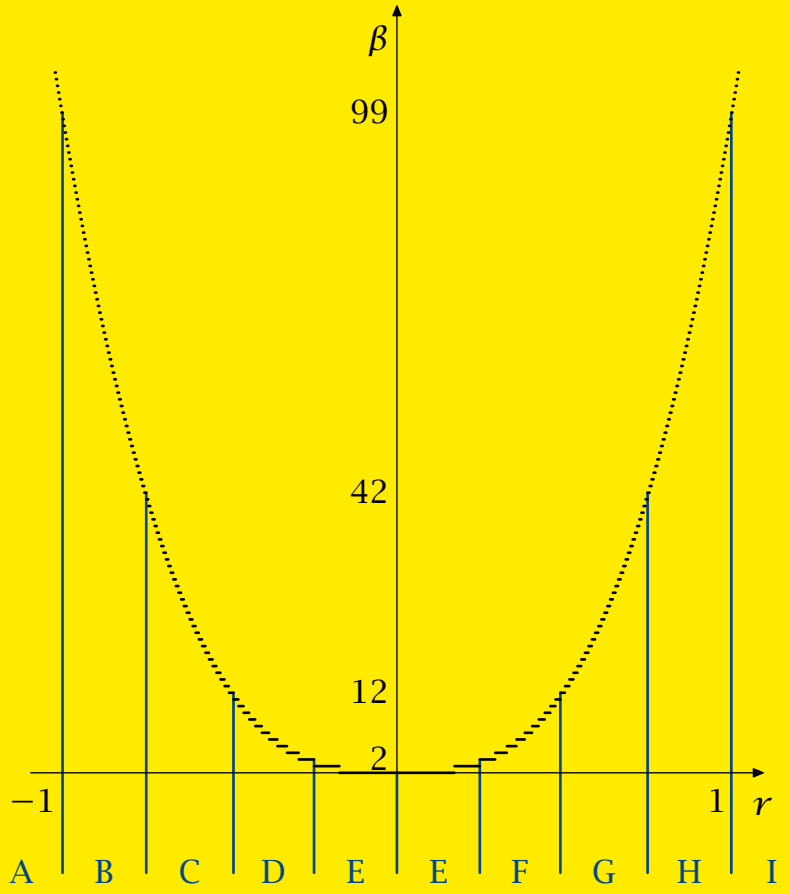
WHAT IS LOOSE?

We can define our own fitness classes.

The default setup is given by

```
\fitnessdemerits 5
  % very loose
  99 0 0
  % loose
  12 0 0
  % decent
   0 0 0 % adjdemerits
  % decent
  12 0 0
  % tight
  99 0 0
```

but it also uses `\adjdemerits` (10000).



ADJACENT CLASSES (GRANULAR)

A. Very tight
B. Tight
C. Almost tight
D. Barely tight
E. Decent
F. Barely loose
G. Almost loose
H. Loose
I. Very loose

TRADITIONAL VS. GRANULAR

I can give a good example of this procedure. At one time, in 1927, I was playing around with three 2×2 matrices whose squares are equal to unity and which anticommute with one another. Calling them σ_1, σ_2, σ_3, I noticed that if one multiplied them into the three components of a momentum so as to form $\sigma_1 p_1 + \sigma_2 p_2 + \sigma_3 p_3$, one obtained a quantity whose square was just $p_1^2 + p_2^2 + p_3^2$. This was an exciting result, but what use could one make of it?

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```
[01] b=3
[02] b=8
[03] b=8
[04] b=7
[05] b=3
[06] b=11
[07] b=0
[08] b=0
```

```
1   1   0  20609  loose   glue
    2   0    169  decent  glue
2   3   2    493  decent  glue
3   4   3    817  decent  glue
4   5   4  15918  loose   disc
    6   4   3606  decent  disc
5   7   5  20014  loose   glue
    8   6   3775  decent  glue
    9   6  16310  tight   glue
6  10   8   4216  decent  glue
7  11  10  25452  loose   glue
   12  10   4316  decent  glue
11  10 8 6 4 3 2
12  10 8 6 4 3 2
```

```
[01] b=3
[02] b=8
[03] b=8
[04] b=7
[05] b=3
[06] b=11
[07] b=0
[08] b=0
```

```
1   1   0  25609  loose        glue
    2   0   4669  barelyloose  glue
2   3   2   4993  barelyloose  glue
3   4   3   5317  barelyloose  glue
4   5   4  17918  almostloose  disc
    6   4   8106  barelyloose  disc
5   7   5  32514  loose        glue
    8   6   8275  barelyloose  glue
    9   6  20810  almosttight  glue
6  10   8   8716  barelyloose  glue
7  11  10  33452  loose        glue
   12  10  11316  decent       glue
11  10 8 6 4 3 2
12  10 8 6 4 3 2
```

WHICH ONE DO YOU LIKE BEST?

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NARROWER, TRADITIONAL

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```
[01] b=77
[02] b=10
[03] b=12
[04] b=0
[05] b=0
[06] b=8
[07] b=64
[08] b=0
[09] b=0
```

1	1	0	17569	loose	glue
2	2	1	26033	loose	math
	3	1	30469	decent	disc
3	4	2	30002	loose	glue
	5	3	43453	decent	disc
	6	2	45422	tight	disc
	7	3	43069	decent	disc
4	8	4	77631	veryloose	glue
	9	4	40227	decent	glue
	10	5	43553	decent	glue
	11	7	77018	tight	disc
5	12	8	87775	decent	glue
	13	10	46153	decent	disc
	14	9	53456	tight	disc
	15	11	99618	decent	disc
6	16	13	536477	decent	penalty
	17	15	111643	tight	glue
7	18	16	551953	loose	glue
	19	17	629868	veryloose	penalty
	20	17	608204	tight	penalty
8	21	18	595809	veryloose	glue
	22	18	562053	decent	glue
	23	19	640012	decent	glue
	24	20	618304	decent	glue

21	18	16	13	10	5	3	1
22	18	16	13	10	5	3	1
23	19	17	15	11	7	3	1

NARROWER, GRANULAR

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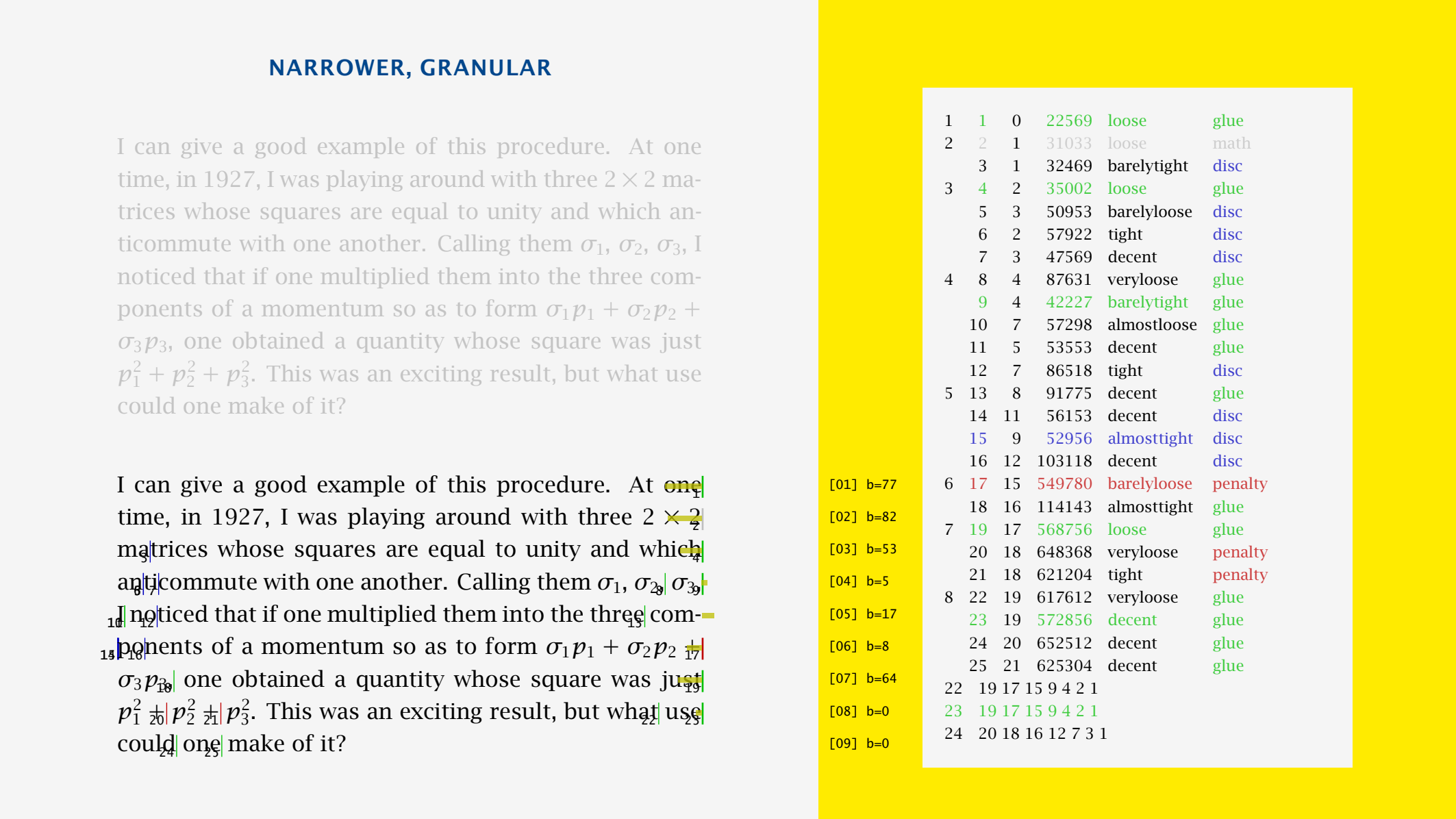

```
[01] b=77
[02] b=82
[03] b=53
[04] b=5
[05] b=17
[06] b=8
[07] b=64
[08] b=0
[09] b=0
```

1	1	0	22569	loose	glue
2	2	1	31033	loose	math
	3	1	32469	barelytight	disc
3	4	2	35002	loose	glue
	5	3	50953	barelyloose	disc
	6	2	57922	tight	disc
	7	3	47569	decent	disc
4	8	4	87631	veryloose	glue
	9	4	42227	barelytight	glue
	10	7	57298	almostloose	glue
	11	5	53553	decent	glue
	12	7	86518	tight	disc
5	13	8	91775	decent	glue
	14	11	56153	decent	disc
	15	9	52956	almosttight	disc
	16	12	103118	decent	disc
6	17	15	549780	barelyloose	penalty
	18	16	114143	almosttight	glue
7	19	17	568756	loose	glue
	20	18	648368	veryloose	penalty
	21	18	621204	tight	penalty
8	22	19	617612	veryloose	glue
	23	19	572856	decent	glue
	24	20	652512	decent	glue
	25	21	625304	decent	glue

22 19 17 15 9 4 2 1

23 19 17 15 9 4 2 1

24 20 18 16 12 7 3 1

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. . . AND NARROWER . . .

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. . . UNTIL WE GET TOO NARROW!

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What can we do to avoid overful hboxes?

OR ARE WE? WE CAN TRY EMERGENCYSTRETCH!

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Is the solution to always enable `emergencystretch`?

To get expansion, do

```
\definefontfeature
  [default]
  [default]
  [hz=quality]
```

before loading the font, and then

```
\setupalign[expansion]
```

WE CAN ALSO TRY EXPANSION

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Is the solution to always enable `expansion`?

WE CAN USE MORE RUNS ON PARAGRAPHS

I can give a good example of this procedure. At one time, in 1927, I was playing around with three 2×2 matrices whose squares are equal to unity and which anticommute with one another. Calling them σ_1, σ_2, σ_3, I noticed that if one multiplied them into the three components of a momentum so as to form $\sigma_1 p_1 + \sigma_2 p_2 + \sigma_3 p_3$, one obtained a quantity whose square was just $p_1^2 + p_2^2 + p_3^2$. This was an exciting result, but what use could one make of it?

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Enable with

```
\setupalignpass[bachotex]
```

WE CAN USE MORE RUNS ON PARAGRAPHS

```
\startsetups align:pass:bachotex
  \pretolerance 50
  \tolerance    100
  \parpasses    3
    threshold            0.025pt
    tolerance            200
    extrahyphenpenalty    75
  next
    threshold            0.025pt
    tolerance            300
    extrahyphenpenalty    50
  next
    threshold            0.025pt
    tolerance            200
    extrahyphenpenalty    25
    adjustspacing          3
    adjustspacingstep      1
    adjustspacingshrink   20
    adjustspacingstretch  20
    emergencystretch     .25\bodyfontsize
  \relax
  \linebreakpasses\plusone
\stopsetups
```

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ANOTHER EXAMPLE OF ALIGNPASSES

```
\startsetups align:pass:hca
    \pretolerance 100
    \tolerance    200
    \parpasses    4
        threshold           0.025pt
        tolerance           200
      next
        threshold           0.025pt
        tolerance           800
      next
        threshold           0.025pt
        tolerance           1600
      next
        threshold           0.025pt
        tolerance           1600
        emergencystretch    \bodyfontsize
    \relax
\stopsetups
```

HYPHENATION PENALTIES AND DEMERITS

We control hyphenations with the penalties `\hyphenpenalty` (50) and `\exhyphenpenalty` (50).

The `\doublehyphendemerits` (10000) is added in case of multiple consecutive hyphenated lines. A `\finalhyphendemerits` (5000) is inserted if the second-last line is hyphenated.

AVOIDING ORPHANS

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```
\orphanpenalty1000
```

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```
\orphanpenalties 3 10000 5000 2500
```

PENALTY BEFORE AND AFTER MATH

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```
\preinlinepenalty  321  \postinlinepenalty 123
```

PENALTY BEFORE AND AFTER SHORT MATH

In this problem we shall deal with lattice points inside a circle K, that is, with points enclosed by the circle K. We do not include here the lattice points on the circle itself. Prove that there exist circles containing 0 lattice points, 1 lattice point, 2 lattice points, etc. We can associate with every number n (natural or zero) a circle containing exactly n points.

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```
\preshortinlinepenalty 333
```

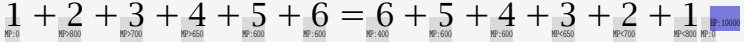
There is also `\postshortinlinepenalty`, and one can as well try `\shortinlinemaththreshold 1em`.

PENALTIES AT BEGINNING AND END OF MATH

By default we get 700 after binary operators and 500 after relations.

No other penalties are added inside math.

```
\setmathpostpenalty  \mathbinarycode   600
\setmathpostpenalty  \mathrelationcode 400
\mathforwardpenalties  3 200 100 50
\mathbackwardpenalties 3 200 100 50
```



PENALTIES MULTIPLIERS

$$(1+2+3+4+\ldots+10)^2 = 1^3+2^3+3^3+4^3+\ldots+10^3$$

```
\mathinlinepenaltyfactor 1500 % default
\mathdisplaypenaltyfactor1000 % default
\setmathpostpenalty  \mathbinarycode   600
\setmathpostpenalty  \mathrelationcode 400
\mathforwardpenalties  3 200 100 50
\mathbackwardpenalties 3 200 100 50
```

$$(1+2+3+4+\ldots+10)^2 = 1^3+2^3+3^3+4^3+\ldots+10^3$$

PENALTIES AFTER PUNCTUATION IN MATH?

$(1, 2, 3, 4, \ldots, 100)$

```
\definemathnesting
  [ntuple]
  [left=(,
   right=),
   inlinefactor=500]

\m {       (a, b, \ldots, c) +
    \ntuple{a, b, \ldots, c} +
           (a, b, \ldots, c)}
```

$(a, b, \ldots, c) + (a, b, \ldots, c) + (a, b, \ldots, c)$

In the bottom paragraph we inserted

```
\toddlerpenalty200
```

This adds a penalty of 200 after single character words, like ‘I’.

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A FEW COMMENTS

- We do not know how to “beat” the settings from plain TEX.
- But a good setup can minimize the manual tweaks needed.
- A lot is penalty driven, even in displayed formulas.
- Finding the right values of penalties and demerits is not easy.
- Not much would have been done without the possibilities to trace and debug in ConTEXt.


PAGE BREAKS

DO YOU SEE ANY PROBLEMS HERE?

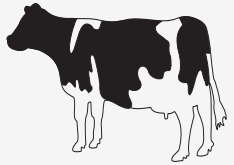
1 A Chapter

1.1 A Section

Thus, I came to the conclusion that the designer of a new system must not only be the implementer and first large–scale user; the designer should also write the first user manual.

The separation of any of these four components would have hurt TEX significantly. If I had not participated fully in all these activities, literally hundreds of improvements would never have been made, because I would never have thought of them or perceived why they were important.

But a system cannot be successful if it is too strongly influenced by a single person. Once the initial design is complete and fairly robust, the real test begins as people with many different viewpoints undertake their own experiments.



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1.2 A Section

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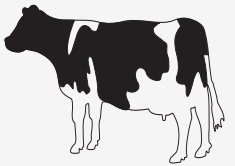

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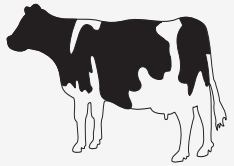

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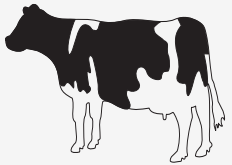

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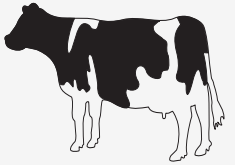

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FLUSHING TO THE BOTTOM IS NOT THE SOLUTION

1 A Chapter

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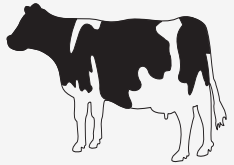

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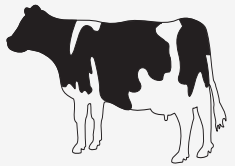

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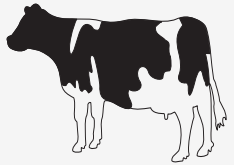

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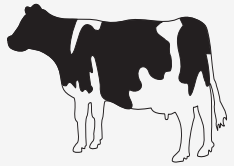

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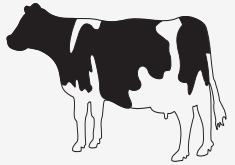

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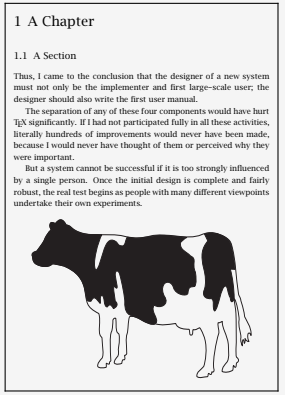
LIMITING THE STRETCH HELPS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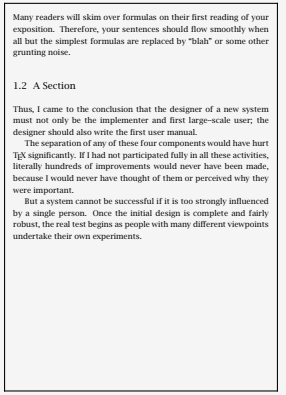
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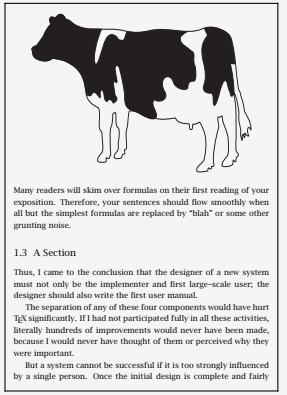

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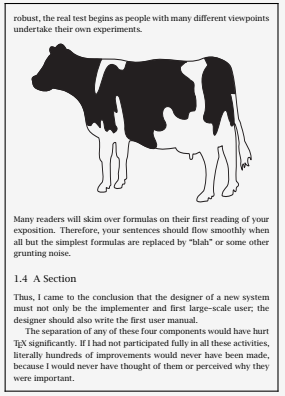
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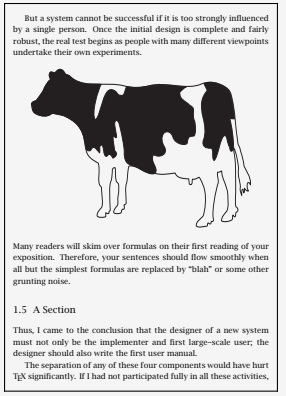
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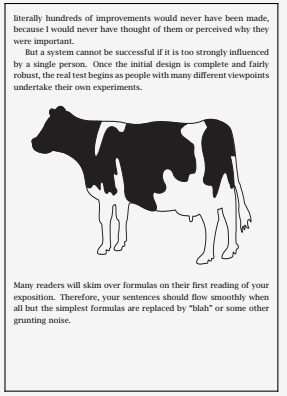
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AVOIDING CLUBS

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THIS IS WHAT WE GET BY DEFAULT

1
The leap-frog

A Flea, a Grasshopper, and a Leap-frog once wanted to see which could jump highest; and they invited the whole world, and everybody else besides who chose to come to see the festival. Three famous jumpers were they, as everyone would say, when they all met together in the room.

"I will give my daughter to him who jumps highest," exclaimed the King; "for it is not so amusing where there is no prize to jump for."

The Flea was the first to step forward. He had exquisite manners, and bowed to the company on all sides; for he had noble blood, and was, moreover, accustomed to the society of man alone; and that makes a great difference.

Then came the Grasshopper. He was considerably heavier, but he was well-mannered, and wore a green uniform, which he had by right of birth; he said, moreover, that he belonged to a very ancient Egyptian family, and that in the house where he then was, he was thought much of. The fact was, he had been just brought out of the fields, and put in a pasteboard house, three stories high, all made of court-cards, with the colored side inwards; and doors and windows cut out of the body of the Queen of Hearts. "I sing so well," said he, "that sixteen native grasshoppers who have chirped from infancy, and yet got no house built of cards to live in, grew thinner than they were before for sheer vexation when they heard me."

It was thus that the Flea and the Grasshopper gave an account of themselves, and thought they were quite good enough to marry a Princess.

The Leap-frog said nothing; but people gave it as their opinion, that he therefore thought the more; and when the housedog snuffed at him with his nose, he confessed the Leap-frog was of good family. The old councillor, who had had three orders given him to make him hold his tongue, asserted that the Leap-frog was a prophet; for that one could see on his back, if there would be a severe or mild winter, and that was what one could not see even on the back of the man who writes the almanac.

"I say nothing, it is true," exclaimed the King; "but I have my own opinion, notwithstanding."

Now the trial was to take place. The Flea jumped so high that nobody could see where he went to; so they all asserted he had not jumped at all; and that was dishonorable.

The Grasshopper jumped only half as high; but he leaped into the King's face, who said that was ill-mannered.

The Leap-frog stood still for a long time lost in thought; it was believed at last he would not jump at all.

"I only hope he is not unwell," said the house-dog; when, pop! he made a jump all on one side into the lap of the Princess, who was sitting on a little golden stool close by.

Hereupon the King said, "There is nothing above my daughter; therefore to bound up to her is the highest jump that can be made; but for this, one must possess understanding, and the Leap-frog has shown that he has understanding. He is brave and intellectual."

And so he won the Princess.

"It's all the same to me," said the Flea. "She may have the old Leap-frog, for all I care. I jumped the highest; but in this world merit seldom meets its reward. A fine exterior is what people look at now-a-days."

The Flea then went into foreign service, where, it is said, he was killed.

The Grasshopper sat without on a green bank, and reflected on worldly things; and he said too, "Yes, a fine exterior is everything–a fine exterior is what people care about." And then he began chirping his peculiar melancholy song, from which we have taken this history; and which may, very possibly, be all untrue, although it does stand here printed in black and white.

WHY DO WE GET THE UNEVEN PAGES?

2

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4

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Top

WE CAN FLUSH TO THE BOTTOM

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BUT THAT DOES NOT ALWAYS WORK

1
The swineherd

There was once a poor Prince, who had a kingdom. His kingdom was very small, but still quite large enough to marry upon; and he wished to marry.

It was certainly rather cool of him to say to the Emperor's daughter, "Will you have me?" But so he did; for his name was renowned far and wide; and there were a hundred princesses who would have answered, "Yes!" and "Thank you kindly." We shall see what this princess said.

Listen!

It happened that where the Prince's father lay buried, there grew a rose tree–a most beautiful rose tree, which blossomed only once in every five years, and even then bore only one flower, but that was a rose! It smelt so sweet that all cares and sorrows were forgotten by him who inhaled its fragrance.

And furthermore, the Prince had a nightingale, who could sing in such a manner that it seemed as though all sweet melodies dwelt in her little throat. So the Princess was to have the rose, and the nightingale; and they were accordingly put into large silver caskets, and sent to her.

The Emperor had them brought into a large hall, where the Princess was playing at "Visiting," with the ladies of the court; and when she saw the caskets with the presents, she clapped her hands for joy.

"Ah, if it were but a little pussy-cat!" said she; but the rose tree, with its beautiful rose came to view.

"Oh, how prettily it is made!" said all the court ladies.

"It is more than pretty," said the Emperor, "it is charming!"

But the Princess touched it, and was almost ready to cry.

"Fie, papa!" said she. "It is not made at all, it is natural!"

"Let us see what is in the other casket, before we get into a bad humor," said the Emperor. So the nightingale came forth and sang so delightfully that at first no one could say anything ill-humored of her.

"Superbe! Charmant!" exclaimed the ladies; for they all used to chatter French, each one worse than her neighbor.

"How much the bird reminds me of the musical box that belonged to our blessed Empress," said an old knight. "Oh yes! These are the same tones, the same execution."

"Yes! yes!" said the Emperor, and he wept like a child at the remembrance.

"I will still hope that it is not a real bird," said the Princess.

"Yes, it is a real bird," said those who had brought it. "Well then let the bird fly," said the Princess; and she positively refused to see the Prince.

However, he was not to be discouraged; he daubed his face over brown and black; pulled his cap over his ears, and knocked at the door.

"Good day to my lord, the Emperor!" said he. "Can I have employment at the palace?"

"Why, yes," said the Emperor. "I want some one to take care of the pigs, for we have a great many of them."

So the Prince was appointed "Imperial Swineherd." He had a dirty little room close by the pigsty; and there he sat the whole day, and worked. By the evening he had made a pretty little kitchen-pot. Little bells were hung all round it; and when the

WE CAN FLUSH TO THE BOTTOM, WITH DEPTH

4
The leap-frog

A Flea, a Grasshopper, and a Leap-frog once wanted to see which could jump highest; and they invited the whole world, and everybody else besides who chose to come to see the festival. Three famous jumpers were they, as everyone would say, when they all met together in the room.

"I will give my daughter to him who jumps highest," exclaimed the King; "for it is not so amusing where there is no prize to jump for."

The Flea was the first to step forward. He had exquisite manners, and bowed to the company on all sides; for he had noble blood, and was, moreover, accustomed to the society of man alone; and that makes a great difference.

Then came the Grasshopper. He was considerably heavier, but he was well-mannered, and wore a green uniform, which he had by right of birth; he said, moreover, that he belonged to a very ancient Egyptian family, and that in the house where he then was, he was thought much of. The fact was, he had been just brought out of the fields, and put in a pasteboard house, three stories high, all made of court-cards, with the colored side inwards; and doors and windows cut out of the body of the Queen of Hearts. "I sing so well," said he, "that sixteen native grasshoppers who have chirped from infancy, and yet got no house built of cards to live in, grew thinner than they were before for sheer vexation when they heard me."

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It was thus that the Flea and the Grasshopper gave an account of themselves, and thought they were quite good enough to marry a Princess.

The Leap-frog said nothing; but people gave it as their opinion, that he therefore thought the more; and when the housedog snuffed at him with his nose, he confessed the Leap-frog was of good family. The old councillor, who had had three orders given him to make him hold his tongue, asserted that the Leap-frog was a prophet; for that one could see on his back, if there would be a severe or mild winter, and that was what one could not see even on the back of the man who writes the almanac.

"I say nothing, it is true," exclaimed the King; "but I have my own opinion, notwithstanding."

Now the trial was to take place. The Flea jumped so high that nobody could see where he went to; so they all asserted he had not jumped at all; and that was dishonorable.

The Grasshopper jumped only half as high; but he leaped into the King's face, who said that was ill-mannered.

The Leap-frog stood still for a long time lost in thought; it was believed at last he would not jump at all.

"I only hope he is not unwell," said the house-dog; when, pop! he made a jump all on one side into the lap of the Princess, who was sitting on a little golden stool close by.

Hereupon the King said, "There is nothing above my daughter; therefore to bound up to her is the highest jump that can be made; but for this, one must possess understanding, and the Leap-frog has shown that he has understanding. He is brave and intellectual."

And so he won the Princess.

"It's all the same to me," said the Flea. "She may have the

11

old Leap-frog, for all I care. I jumped the highest; but in this world merit seldom meets its reward. A fine exterior is what people look at now-a-days."

The Flea then went into foreign service, where, it is said, he was killed.

The Grasshopper sat without on a green bank, and reflected on worldly things; and he said too, "Yes, a fine exterior is everything–a fine exterior is what people care about." And then he began chirping his peculiar melancholy song, from which we have taken this history; and which may, very possibly, be all untrue, although it does stand here printed in black and white.

12

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WHAT ABOUT THIS?

5
The leap-frog

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"I will give my daughter to him who jumps highest," exclaimed the King; "for it is not so amusing where there is no prize to jump for."

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WE CAN USE VERTICAL EXPANSION

6
The leap-frog

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A FEW MORE COMMENTS

- We do not claim that we can in general “beat” the settings from plain TEX.
- Our feeling is that we need less manual tweaks.
- Repeated: We could not do this without the possibilities to trace and debug in ConTEXt.