

# The `erw-l3` package\*

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## Abstract

Utilities based on  $\text{\LaTeX}3$ [\[1\]](#), such as `\erw_merge_sort:nNn`.

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# Part I

## Usage

### 1 boilerplate

---

<code>\erw_keys_set:n</code>	<code>\erw_keys_set:n{&lt;keyval list&gt;}</code>
<code>\erw_keys_set:nn</code>	

---



---

<code>\erw_identity:n</code>	<code>*</code>
<code>\erw_int_incr:n</code>	<code>*</code>
<code>\erw_swap:nn</code>	<code>*</code>
<code>\erw_swap:ne</code>	<code>*</code>
<code>\erw_name_signature_cs:N</code>	<code>*</code>

---

### 2 quark

---

<code>\erw_all_q:w</code>	<code>\erw_remove_last_q:w{&lt;tokenlist&gt; \q_recursion_tail\q_recursion_stop</code>
<code>\erw_remove_first_q:w</code>	
<code>\erw_first_q:w</code>	
<code>\erw_remove_last_q:w</code>	
<code>\erw_last_q:w</code>	

---

### 3 predicate

---

<code>new_compare_p</code>	<code>\erw_keys_set:n{ new_compare_p = {&lt;name&gt;}{&lt;signature&gt;}{&lt;predicate&gt;} }</code>
Instance	
<code>erw_compare_p:nNnNn</code>	
<code>erw_int_incr_p:nn</code>	

## 4 op's on lists

---

```
\erw_remove_first:n  
\erw_remove_last:n  
\erw_first:n  
\erw_last:n  
\erw_adjacent_insert:nn  
\erw_adjacent_insert:en
```

---

## 5 algo

---

```
\erw_split_even:n      \erw_thread_sort:nnNn{<first sorted list>}{<second sorted list>}{<compare  
\erw_split_even:e      predicate name>}<|>  
\erw_merge_sort:nNn    \erw_merge_sort:nNn{<compare predicate name>}<|>{<unsorted list>}  
\thread_sort:nnNn      \erw_filter_uniq:nn{<compare predicate>}{<tokenlist>}  
\erw_filter_uniq:nn    \erw_filter_uniq:n{<ascending intergers>}  
\erw_filter_uniq:n
```

---

## 6 code

---

```
\erw_parameter:n      \erw_parameter:n{<arity>}  
\erw_parameter:nn      \erw_parameter:nn{<start pos>}{<arity>}  
\argument:nn          \erw_argument:nn{<start pos>}{<signature>}
```

---

## Part II

# Other

## 1 Bibliograhyy

- [1] The L<sup>A</sup>T<sub>E</sub>X3 Project Team. *The L<sup>A</sup>T<sub>E</sub>X3 interfaces*. <https://ctan.math.washington.edu/tex-archive/macros/latex/contrib/l3kernel/expl3.pdf>. 2019.

## 2 Support

This package is available from <https://github.com/rogard/erw-13>.

## Part III

# Implementation

```

1 <*package>
2 <@@=erw>
3 %      \ExplSyntaxOn

```

## 1 kernel

```

4 \cs_generate_variant:Nn\int_compare_p:nNn{eNe}
5 \cs_generate_variant:Nn\int_eval:n{e}
6 \cs_generate_variant:Nn\prg_new_conditional:Nnn{c}
7 \cs_generate_variant:Nn\prg_replicate:nn{e}
8 \cs_generate_variant:Nn\regex_gset:Nn{c}
9 \cs_generate_variant:Nn\regex_log:N{c}
10 \cs_generate_variant:Nn\regex_match:NnTF{c}
11 \cs_generate_variant:Nn\tl_to_str:n{e}
12 \cs_generate_variant:Nn\prop_put:Nnn{Nne}

```

## 2 boilerplate

```

13 \msg_new:nnnn{__erw}{text}{text~is~not~loaded}{load~amsmath}
14 \cs_new:Npn \__erw_text:n #1
15 { \cs_if_exist:NTF\text{\text{#1}}{\msg_error:nn{__erw}{text}}}
16 \cs_new:Npn \__erw_empty:w #1 \q_recursion_stop {\c_empty_tl}
17 \cs_new_protected:Nn\erw_keys_set:n{ \keys_set:nn{__erw}{#1} }
18 \cs_new_protected:Nn\erw_keys_set:nn{ \keys_set:nn{__erw / #1}{#2} }
19 \cs_generate_variant:Nn\erw_apply:Nw{c}
20 \cs_new:Npn \erw_identity:n#1{#1}
21 \cs_new:Npn \erw_int_incr:n#1{\int_eval:n{#1+1}}
22 \cs_new:Npn \erw_swap:nn#1#2{#2#1}
23 \cs_generate_variant:Nn \erw_swap:nn{e}
24 \cs_new:Npn \erw_name_signature_cs:N #1
25 { \exp_last_unbraced:Ne
26   \__erw_name_signature_cs:nnn{\cs_split_function:N#1}}
27 \cs_new:Nn \__erw_name_signature_cs:nnn{#{1}{#2}}

```

## 3 quark

```

28 \msg_new:nnn{erw}{quark-only-tail}
29 {requires~tail;~got~'~#1';~\msg_line_context:}
30 \cs_new:Npn
31 \erw_all_q:w
32 #1
33 \q_recursion_stop
34 {%
35   \erw_remove_last_q:w#1\q_recursion_stop
36   \erw_last_q:w#1\q_recursion_stop
37 }
38 \cs_new:Npn
39 \erw_remove_first_q:w
40 #1 % <tokenlist ending with recursion tail>
41 \q_recursion_stop
42 {\quark_if_recursion_tail_stop:n{#1}
43   \__erw_remove_first_q:nw#1\q_recursion_stop}
44 \cs_new:Npn
45 \__erw_remove_first_q:nw

```

```

46 #1 % <head>
47 #2 % <rest>
48 \q_recursion_stop
49 {\erw_remove_last_q:w#2\q_recursion_stop
50   \erw_last_q:w#2\q_recursion_stop}
51 \cs_new:Npn
52 \erw_first_q:w
53 #1
54 \q_recursion_stop
55 {%
56   \quark_if_recursion_tail_stop:n{#1}
57   \__erw_first_q:enw{ \tl_if_head_is_group_p:n{#1}}#1\q_recursion_stop }
58 \cs_new:Npn
59 \__erw_first_q:nnw
60 #1 % <head is group>
61 #2 % <head>
62 #3 % <rest>
63 \q_recursion_stop
64 {%
65   \bool_if:nTF{#1}{{#2}}{#2}
66 }
67 \cs_generate_variant:Nn\__erw_first_q:nnw{e}
68 \cs_new:Npn
69 \erw_remove_last_q:w #1 \q_recursion_stop
70 {%
71   \quark_if_recursion_tail_stop:n{#1}
72   \__erw_remove_last_q:ew{\tl_if_head_is_group_p:n{#1}}#1\q_recursion_stop }
73 \cs_new:Npn
74 \__erw_remove_last_q:nw
75 #1 % <head is group>
76 #2 % <tokenlist>
77 \q_recursion_stop
78 { \__erw_remove_last_q:nnw{#1}#2\q_recursion_stop }
79 \cs_generate_variant:Nn\__erw_remove_last_q:nnw{e}
80 \cs_new:Npn
81 \__erw_remove_last_q:nnw
82 #1 % <head is group>
83 #2 % <head>
84 #3 % <rest>
85 \q_recursion_stop
86 {%
87   \quark_if_recursion_tail_stop:n{#3}
88   \bool_if:nTF{#1}{{#2}}{#2}
89   \__erw_remove_last_q:ew {\tl_if_head_is_group_p:n{#3}} #3 \q_recursion_stop
90 }
91 \cs_generate_variant:Nn\__erw_remove_last_q:nnw{e}
92 \cs_new:Npn
93 \erw_last_q:w #1 \q_recursion_stop
94 {\quark_if_recursion_tail_stop:n{#1}
95   \__erw_last_q:ew{\tl_if_head_is_group_p:n{#1}}#1\q_recursion_stop}
96 \cs_new:Npn
97 \__erw_last_q:nw
98 #1 % <head is group>
99 #2 % <tokenlist>

```

```

100 \q_recursion_stop
101 { \__erw_last_q:nnw{#1}#2\q_recursion_stop }
102 \cs_generate_variant:Nn\__erw_last_q:nw{e}
103 \cs_new:Npn
104 \__erw_last_q:nnw
105 #1 % <head is group>
106 #2 % <head>
107 #3 % <rest>
108 \q_recursion_stop
109 {%
110 \quark_if_recursion_tail_stop_do:nn{#3}{ \bool_if:nTF{#1}{#{#2}}{#2} }
111 \__erw_last_q:ew {\tl_if_head_is_group_p:n{#3}} #3 \q_recursion_stop
112 }
113 \cs_generate_variant:Nn\__erw_last_q:nnw{e}

```

## 4 predicate

```

114 \msg_new:nnn{\__erw}{predicate-empty}
115 {empty-expression-in-predicate}
116 \prg_new_conditional:Npnn
117 \erw_and_tl:nn
118 #1 % <predicate expression>
119 #2 % <tokens>
120 {p}
121 {%^^A
122 \__erw_and_tl:nw {#1}#2 \q_recursion_tail\q_recursion_stop
123 }
124 \cs_new:Npn
125 \__erw_and_tl:nw
126 #1 % <predicate expression>
127 #2 % <value>
128 \q_recursion_stop
129 {%
130 \quark_if_recursion_tail_stop_do:nn{#2}
131 { \prg_return_true: }
132 \__erw_and_tl:nnw
133 {#1} % <predicate expression>
134 #2 % <value>
135 \q_recursion_stop
136 }
137 \cs_new:Npn
138 \__erw_and_tl:nnw
139 #1 % <predicate expression>
140 #2 % <value>
141 #3 % <rest>
142 \q_recursion_stop
143 {%
144 \bool_if:nTF
145 {#1{#2}}
146 {\__erw_and_tl:nw{#1}#3\q_recursion_stop}
147 { \prg_return_false: }
148 }
149 \cs_new:Npn \__erw_new_compare_p:nnn
150 #1 % <name>

```

```

151 #2 % <signature>
152 #3 % <code>
153 {%
154   \prg_new_conditional:cnn{#1:#2}
155   {p}
156   {%
157     \bool_if:nTF
158     {#3}
159     {\prg_return_true:}
160     {\prg_return_false:}
161   }
162 }
163 \keys_define:nn{ __erw }
164 {
165   new_compare_p.code:n = {\__erw_new_compare_p:nnn#1}
166 }
167 \erw_keys_set:n
168 {%
169   new_compare_p =
170   {erw_compare} % <name>
171   {nNnNn}
172   { \__erw_compare:eecN{ #2{#3} }{ #2{#5} }{ #1:nNn }#4 }
173 }
174 \cs_new:Npn
175   \__erw_compare:nnNN
176   #1 % <first>
177   #2 % <second>
178   #3 % <predicate>
179   #4 % <operator>
180   { #3{ #1 }#4{ #2 } }
181 \cs_generate_variant:Nn\__erw_compare:nnNN{eec}
182 \erw_keys_set:n
183 {%
184   new_compare_p =
185   {erw_int_incr}
186   {nn}
187   {\exp_args:Ne
188     \int_compare_p:nNn{ \int_eval:n{#1+1} } = {#2} }
189 }

```

## 5 keyval

```

190 \cs_new:Npn\__erw_keyval_key:w #1 = #2 \q_recursion_stop{#1}
191 \cs_new:Npn\__erw_keyval_value:w #1 = #2 \q_recursion_stop{#2}
192 \cs_new:Npn \erw_keyval_key:n#1{\__erw_keyval_key:w #1 \q_recursion_stop}
193 \cs_new:Npn \erw_keyval_value:n#1{\__erw_keyval_value:w #1 \q_recursion_stop}
194 \cs_new:Npn \erw_keyval:nn#1#2{ #1 = #2 }
195 \erw_keys_set:n
196 {
197   new_compare_p = {erw_key_compare}
198   {nNn}{ \erw_compare_p:nNnNn
199     {int_compare_p}\erw_keyval_key:n{#1}#2{#3} },
200   new_compare_p = {erw_key_compare}
201   {n}{ \erw_compare_recurse_p:nnNN{#1}

```

```

202     {int_compare_p}\erw_keyval_key:n< }
203 }
204 %^^A\cs_new_protected:Npn
205 %^^A\__erw_keyval_dispatch_build:nn
206 %^^A#1 % <|_protected>
207 %^^A#2 % <ext>
208 %^^A{
209 %^^A \use:c{cs_new#1:cpn}
210 %^^A {erw_keyval_dispatch#2:NNn}
211 %^^A ##1 % <unary>
212 %^^A ##2 % <binary>
213 %^^A ##3 % <keyval list>
214 %^^A { \use:c{__erw_keyval_dispatch#2:NNw}##1##2##3=\q_recursion_tail\q_recursion_stop }
215 %^^A \use:c{cs_new#1:cpn}
216 %^^A {_erw_keyval_dispatch#2:NNw}##1##2##3=##4\q_recursion_stop
217 %^^A { \quark_if_recursion_tail_stop_do:nn{##4}{##1{##3}}
218 %^^A \use:c{__erw_keyval_dispatch#2:Nw}##2##3=##4\q_recursion_stop }
219 %^^A \use:c{cs_new#1:cpn}
220 %^^A {_erw_keyval_dispatch#2:Nw}##1##2=##3=\q_recursion_tail\q_recursion_stop
221 %^^A {##1{##2}{##3}}
222 %^^A}
223 %^^A\__erw_keyval_dispatch_build:nn{}{}
224 %^^A\__erw_keyval_dispatch_build:nn{_protected}{_protected}

```

## 6 op's on list

```

225 \cs_new:Npn
226 \erw_remove_first:n
227 #1 % <tokenlist>
228 {\erw_remove_first_q:w#1\q_recursion_tail\q_recursion_stop}
229 \cs_generate_variant:Nn\erw_remove_first:n{e}
230 \cs_new:Npn
231 \erw_remove_last:n
232 #1 % <tokenlist>
233 {\erw_remove_last_q:w#1\q_recursion_tail\q_recursion_stop}
234 \cs_generate_variant:Nn\erw_remove_last:n{e}
235 \cs_new:Npn
236 \erw_first:n
237 #1
238 {\erw_first_q:w#1\q_recursion_tail\q_recursion_stop}
239 \cs_generate_variant:Nn\erw_first:n{e}
240 \cs_new:Npn
241 \erw_last:n
242 #1 % <tokenlist>
243 {\erw_last_q:w#1\q_recursion_tail\q_recursion_stop}
244 \cs_generate_variant:Nn\erw_last:n{e}
245 \cs_new:Npn
246 \erw_adjacent_insert:nn
247 #1 % <list>
248 #2 % <separator>
249 {%
250 \erw_first:n{#1}
251 \erw_swap:en
252 { \erw_remove_first:n{#1} }

```



```

253   {%
254     \__erw_adjacent_insert:nw
255     {#2} % <separator>
256   }
257   \q_recursion_tail
258   \q_recursion_stop
259 }
260 \cs_generate_variant:Nn\erw_adjacent_insert:nn{e}
261 \cs_new:Npn
262 \__erw_adjacent_insert:nw
263 #1 % <separator>
264 #2 % <rest>
265 \q_recursion_stop
266 {%
267   \quark_if_recursion_tail_stop:n{#2}
268   \__erw_adjacent_insert:new {#1}{\tl_if_head_is_group_p:n{#2}}#2 \q_recursion_stop
269 }
270 \cs_new:Npn
271 \__erw_adjacent_insert:nnw
272 #1 % <separator>
273 #2 % <head is group>
274 #3 % <head>
275 #4 % <rest>
276 \q_recursion_stop
277 {%
278   #1\bool_if:nTF{#2}{#{#3}}{#3}
279   \__erw_adjacent_insert:nw{#1}#4\q_recursion_stop
280 }
281 \cs_generate_variant:Nn\__erw_adjacent_insert:nnw{ne}
282 \cs_new:Npn
283 \erw_clist_tl:nn
284 #1 % <bool>
285 #2 % <list>
286 { \erw_clist_tl:nnw {#1} #2 \q_recursion_tail\q_recursion_stop }
287 \cs_new:Npn
288 \erw_clist_tl:nnw #1 #2\q_recursion_stop
289 {\quark_if_recursion_tail_stop:n{#2}
290   \erw_clist_tl:nenw {#1}
291   {\tl_if_head_is_group_p:n{#2}} #2 \q_recursion_stop}
292 \cs_generate_variant:Nn\erw_clist_tl:nnw{ne}
293 \cs_new:Npn
294 \erw_clist_tl:nnnw
295 #1 % <bool>
296 #2 % <head is group>
297 #3 % <head>
298 #4 % <rest>
299 \q_recursion_stop
300 {
301   \quark_if_recursion_tail_stop_do:nn{#4}
302   {%
303     \bool_if:nTF
304     {\bool_lazy_and_p:nn{#1}{#2}}
305     {#{#3}}{#3}
306   }

```

```

307 \bool_if:nTF{\bool_lazy_and_p:nn{#1}{#2}}
308 {{#3}}{#3},
309 \erw_clist_tl:nnw {#1} #4 \q_recursion_stop
310 }
311 \cs_generate_variant:Nn\erw_clist_tl:nnnw{ne}
312 \prg_new_conditional:Npnn
313 \erw_if_in_clist:nn
314 #1 % <value>
315 #2 % <clist>
316 {p}
317 { \__erw_clist_if_in:nw {#1} #2, \q_recursion_tail \q_recursion_stop }
318 \cs_new:Npn
319 \__erw_clist_if_in:nw #1 #2 \q_recursion_stop
320 {%
321 \quark_if_recursion_tail_stop:n{#2}
322 \__erw_clist_if_in:nnw {#1} #2 \q_recursion_stop
323 }
324 \cs_new:Nn
325 \__erw_clist_if_in:nn
326 {\__erw_clist_if_in:nw{#1} #2 \q_recursion_stop}
327 \cs_new:Npn
328 \__erw_clist_if_in:nnw #1 #2, #3 \q_recursion_stop
329 {%
330 \quark_if_recursion_tail_stop_do:nn{#3}
331 {%
332 \str_if_eq:nnTF{#1}{#2}
333 {\prg_return_true:}{\prg_return_false:}
334 }
335 \str_if_eq:nnTF{#1}{#2}
336 {\prg_return_true:}
337 {\__erw_clist_if_in:nw {#1} #3 \q_recursion_stop}
338 \__erw_empty:w\q_recursion_stop
339 }

```

## 7 algo

### 7.1 split

```

340 \cs_new:Npn
341 \erw_split_even:n
342 #1 % <tokenlist>
343 {%
344 \tl_if_empty:nF{#1}
345 {%
346 \exp_last_unbraced:Ne
347 \__erw_split_even:nnnw
348 {%
349 {\__erw_split_even_threshold:n{#1}} % <count>
350 {\tl_if_head_is_group_p:n{#1}} % <head is group>
351 }
352 #1 % <tokenlist>
353 \q_recursion_tail
354 \q_recursion_stop
355 }

```

```

356 }
357 \cs_generate_variant:Nn\erw_split_even:n{e}
358 \cs_new:Npn
359 \__erw_split_even_threshold:n
360 #1 % <tokenlist>
361 {\exp_args:Ne
362   \int_div_round:nn{\tl_count:n{#1}}{2}}
363 \cs_new:Npn
364 \__erw_split_even:nnnw
365 #1 % <threshold>
366 #2 % <head is group>
367 #3 % <head>
368 #4 % <rest>
369 \q_recursion_stop
370 {%
371   \quark_if_recursion_tail_stop_do:nn{#4}
372   { { \bool_if:nTF{#2}{{#3}}{#3} }{} }
373   \exp_last_unbraced:Ne
374   \__erw_split_even:nnnw
375   {%
376     {1} % <left size>
377     { \tl_if_head_is_group_p:n{#4} }
378     {#1} % <threshold count>
379     { \bool_if:nTF{#2}{{#3}}{#3} } % <left list>
380   }
381   #4 % <right list>
382   \q_recursion_stop
383 }
384 \cs_new:Npn
385 \__erw_split_even:nnnw
386 #1 % <left size>
387 #2 % <right head is group>
388 #3 % <threshold count>
389 #4 % <left list>
390 #5 % <right head>
391 #6 % <right rest>
392 \q_recursion_stop
393 {%
394   \bool_if:nTF
395   { \int_compare_p:nNn {#1}<{#3} }
396   {%
397     \exp_last_unbraced:Ne
398     \__erw_split_even:nnnw
399     {
400       { \int_eval:n{#1+1} } % <left size>
401       { \tl_if_head_is_group_p:n{#6} } % <right head is group>
402       {#3} % <threshold count>
403       {#4\bool_if:nTF{#2}{{#5}}{#5}} % <left list>
404     }
405     #6
406     \q_recursion_stop
407   }
408   {%
409     {#4}

```

```

410     {%
411         \bool_if:nTF{#2}{#{#5}}{#5}
412         \erw_remove_last_q:w#6\q_recursion_stop\erw_last_q:w#6\q_recursion_stop}
413     }
414 }

```

## 7.2 thread sort

```

415 \cs_new:Npn
416 \erw_thread_sort:nnNn
417 #1 % <first sorted list>
418 #2 % <second sorted list>
419 #3 % <compare predicate name>
420 #4 % <compare operator>
421 {%
422     \__erw_thread_sort:nNnnn
423     {#3} % <compare predicate name>
424     #4 % <compare operator>
425     {\c_empty_tl} % <accum>
426     {#1}
427     {#2}
428 }
429 \cs_generate_variant:Nn\erw_thread_sort:nnNn{ee}
430 \cs_new:Npn
431 \__erw_thread_sort:nNnnn
432 #1 % <compare predicate name>
433 #2 % <compare operator>
434 #3 % <sorted>
435 #4 % <first>
436 #5 % <second>
437 {%
438     \__erw_thread_sort:nNnw
439     {#1} % <compare predicate name>
440     {#2} % <compare operator>
441     {#3} % <sorted>
442     #4 \q_recursion_tail% <first>
443     \q_stop
444     #5 \q_recursion_tail% <second>
445     \q_recursion_stop
446 }
447 \cs_generate_variant:Nn\__erw_thread_sort:nNnnn{nNnee}
448 \cs_new:Npn
449 \__erw_thread_sort:nNnw
450 #1 % <compare predicate name>
451 #2 % <compare operator>
452 #3 % <sorted>
453 #4 % <first>
454 \q_stop
455 #5 % <second>
456 \q_recursion_stop
457 {%
458     \quark_if_recursion_tail_stop_do:nn{#4}
459     { #3 \erw_all_q:w #5 \q_recursion_stop }
460     \quark_if_recursion_tail_stop_do:nn{#5}
461     { #3 \erw_all_q:w #4 \q_recursion_stop }

```

```

462 \__erw_thread_sort:nNneeww
463 {#1}#2{#3}
464 { \tl_if_head_is_group_p:n{#4} }
465 { \tl_if_head_is_group_p:n{#5} }
466 #4\q_stop
467 #5\q_recursion_stop
468 }
469 \cs_new:Npn
470 \__erw_thread_sort:nNnnnw
471 #1 % <compare predicate name>
472 #2 % <compare operator>
473 #3 % <sorted>
474 #4 % <head is begin>
475 #5 % <head is begin>
476 #6 % <first head>
477 #7 % <first rest>
478 \q_stop
479 #8 % <second head>
480 #9 % <second rest>
481 \q_recursion_stop
482 {%
483 \bool_if:nTF
484 { \use:c{#1:nNn}{#6}#2{#8} }
485 {%
486 \__erw_thread_sort:nNnee
487 {#1}
488 #2
489 {#3\bool_if:nTF{#4}{{#6}}{#6}}
490 {\erw_all_q:w#7\q_recursion_stop}
491 {\bool_if:nTF{#5}{{#8}}{#8}\erw_all_q:w#9\q_recursion_stop}
492 }
493 {%
494 \__erw_thread_sort:nNnee
495 {#1}
496 #2
497 {#3\bool_if:nTF{#5}{{#8}}{#8}}
498 {\bool_if:nTF{#4}{{#6}}{#6}\erw_all_q:w#7\q_recursion_stop}
499 {\erw_all_q:w#9\q_recursion_stop}
500 }
501 }
502 \cs_generate_variant:Nn\__erw_thread_sort:nNnnnw{nNnee}

```

### 7.3 merge sort

```

503 \cs_new:Npn
504 \erw_merge_sort:nNn
505 #1 % <compare predicate name>
506 #2 % <compare operator>
507 #3 % <unsorted list>
508 {%
509 \tl_if_empty:nF{#3}
510 {%
511 \__erw_sort_merge:enNw
512 {\tl_if_head_is_group_p:n{#3}} % <head is group>
513 {#1} % <compare predicate name>

```

```

514     #2 % <compare operator>
515     #3 % <unsorted list>
516     \q_recursion_tail
517     \q_recursion_stop
518 }
519 }
520 \cs_generate_variant:Nn\erw_merge_sort:nNn{nNe}
521 \cs_new:Npn
522 \__erw_sort_merge:nnNw
523 #1 % <head is group>
524 #2 % <compare predicate name>
525 #3 % <compare operator>
526 #4 % <unsorted list head>
527 #5 % <unsorted list rest>
528 \q_recursion_stop
529 {%
530   \quark_if_recursion_tail_stop_do:nn{#5}
531   { \bool_if:nTF{#1}{{#4}}{{#4}} }
532   \exp_last_unbraced:Ne
533   \__erw_sort_merge:nnnN
534   {%
535     \erw_split_even:e
536     {%
537       \bool_if:nTF{#1}{{#4}}{{#4}}
538       \erw_all_q:w#5\q_recursion_stop
539     }
540   } % <first sorted list>{<second sorted list>}
541   {#2} % <compare predicate name>
542   #3 % <compare operator>
543   \__erw_empty:w \q_recursion_stop
544 }
545 \cs_generate_variant:Nn\__erw_sort_merge:nnNw{e}
546 \cs_new:Npn
547 \__erw_sort_merge:nnnN
548 #1 % <left unsorted list>
549 #2 % <right unsorted list>
550 #3 % <compare predicate name>
551 #4 % <compare operator>
552 {%
553   \erw_thread_sort:eeNn
554   {%
555     \__erw_sort_merge:enNw
556     {\tl_if_head_is_group_p:n{#1}}
557     {#3} % <compare predicate name>
558     #4 % <compare operator>
559     #1 % <unsorted list>
560     \q_recursion_tail
561     \q_recursion_stop
562   } % <first sorted list>
563   {%
564     \__erw_sort_merge:enNw
565     {\tl_if_head_is_group_p:n{#2}}
566     {#3} % <compare predicate name>
567     #4 % <compare operator>

```

```

568     #2 % <unsorted list>
569     \q_recursion_tail
570     \q_recursion_stop
571 } % <second sorted list>
572 {#3} % <compare predicate name>
573 #4 % <operator>
574 }

```

## 7.4 filter

```

575 \msg_new:nnn{__erw}{tokenlist-incr}
576 {expecting~an~ascending~tokenlist~got~#1~followed-by~#2}
577 \cs_new:Npn
578 __erw_filter_uniq:nnw
579 #1 % <compare predicate>
580 #2 % <greatest>
581 #3 % <tokenlist>
582 \q_recursion_stop
583 { %
584   \quark_if_recursion_tail_stop:n{#3}
585   __erw_filter_uniq_aux:nnw{#1}{#2}#3\q_recursion_stop}
586 \cs_new:Npn
587 __erw_filter_uniq_aux:nw
588 #1 % <compare predicate>
589 #2 % <tokenlist head>
590 #3 % <tokenlist rest>
591 \q_recursion_stop
592 {%
593   {#2}
594   __erw_filter_uniq:nnw
595   {#1} % <compare predicate>
596   {#2} #3 % <tokenlist>
597   \q_recursion_stop }
598 \cs_new:Npn
599 __erw_filter_uniq_aux:nnw
600 #1 % <compare predicate>
601 #2 % <last>
602 #3 % <head token>
603 #4 % <rest token>
604 \q_recursion_stop
605 { %
606   \bool_if:nTF{\use:c{#1:nNn}{#3}<{#2}}
607   {\msg_error:nnnn{__erw}{tokenlist-incr}{#2}{#3}}
608   {%
609     \bool_if:nF
610     {\use:c{#1:nNn}{#3}={#2}}
611   % ^^A   {#3}}
612   {\tl_if_single_token:nTF{#3}{#3}{#3}}
613 }
614 \quark_if_recursion_tail_stop:n{#4}
615 % ^^A __erw_filter_uniq:nnw{#1}{#3}#4\q_recursion_stop }
616 __erw_filter_uniq:nnw{#1}{#3}#4\q_recursion_stop }
617 \cs_new:Npn
618 __erw_filter_uniq:nw
619 #1 % <compare predicate>

```

```

620 #2 % <tokenlist>
621 {%
622   \quark_if_recursion_tail_stop_do:nn{#2}{\c_empty_tl}
623   \__erw_filter_uniq_aux:nw {#1}#2 \q_recursion_stop}
624 \cs_new:Npn
625 \erw_filter_uniq:nn
626 #1 % <compare predicate>
627 #2 % <tokenlist>
628 {%
629   \__erw_filter_uniq_aux:nw
630   {#1} % <compare predicate>
631   #2
632   \q_recursion_tail % <head token>
633   \q_recursion_stop}
634 \cs_new:Npn
635 \erw_filter_uniq:n
636 #1 % <ascending integers>
637 { \erw_filter_uniq:nn{int_compare_p}{#1} }
638 \cs_generate_variant:Nn\erw_filter_uniq:nn{ne}

```

## 8 code

```

639 \keys_define:nn{__erw}
640 { clist_map_inline.code:n = \__erw_map_inline_clist:nnn#1 }
641 \cs_new_protected:Npn
642 \__erw_map_inline_clist:nnn
643 #1 % <clist>
644 #2 % <signature>
645 #3 % <code>
646 {
647   \cs_new_protected:cn
648   {__erw_do:#2}{#3}
649   \clist_map_inline:nn
650   {#1}
651   {\use:c{__erw_do:#2}##1}
652 }
653 \cs_new:Npn
654 \erw_parameter:n
655 #1 % ^^A <arity>
656 {## #1}
657 \cs_new:Npn
658 \__erw_parameter_aux:nn
659 #1 % <finish>
660 #2 % <start>
661 { \int_step_function:nnN {#2}{#1}\erw_parameter:n}
662 \cs_new:Npn
663 \erw_parameter:nn
664 #1 % <start>
665 #2 % <count>
666 {%
667   \exp_args:Ne
668   \__erw_parameter_aux:nn
669   {\int_eval:n{#1+#2-1}}{#1}}
670 \cs_new:Npn

```



```

671 \erw_argument:nn
672 #1 % <position>
673 #2 % <signature>
674 {\_erw_argument:nw{#1}#2\q_recursion_tail\q_recursion_stop}
675 \cs_new:Npn
676 \__erw_argument_unit:nn
677 #1 % <position>
678 #2 % <n|N>
679 {\use:c{\_erw_argument_#2:w} #1 \q_recursion_stop}
680 \cs_new:Npn\_erw_argument_n:w #1 \q_recursion_stop{## #1}}
681 \cs_new:Npn\_erw_argument_N:w #1 \q_recursion_stop{## #1}
682 \cs_new:Npn
683 \__erw_argument:nw
684 #1 % <position>
685 #2 % <signature list>
686 \q_recursion_stop
687 { \quark_if_recursion_tail_stop:n{#2}
688   \__erw_argument:nnw{#1}#2\q_recursion_stop }
689 \cs_new:Npn
690 \__erw_argument:nnw
691 #1 % <position>
692 #2 % <n|N>
693 #3 % <signature rest>
694 \q_recursion_stop
695 {%
696   \__erw_argument_unit:nn{#1}{#2}
697   \exp_args:Ne
698   \__erw_argument:nw
699   {\erw_int_incr:n{#1}}#3\q_recursion_stop }
700 \ProcessKeysOptions{\_erw}
701 \ExplSyntaxOff
702 \endpackage

```