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; William R. Bevier

EVENT: Start with the initial **nqthm** theory.

DEFINITION:

```
delete(x, l)
=  if listp(l)
    then if x = car(l) then cdr(l)
        else cons(car(l), delete(x, cdr(l))) endif
    else l endif
```

DEFINITION:

```
bagdiff(x, y)
=  if listp(y)
    then if car(y) ∈ x then bagdiff(delete(car(y), x), cdr(y))
        else bagdiff(x, cdr(y)) endif
    else x endif
```

DEFINITION:

```

bagint (x, y)
=  if listp (x)
  then if car (x) ∈ y
    then cons (car (x), bagint (cdr (x), delete (car (x), y)))
    else bagint (cdr (x), y) endif
  else nil endif

```

DEFINITION:

```

occurrences (x, l)
=  if listp (l)
  then if x = car (l) then 1 + occurrences (x, cdr (l))
  else occurrences (x, cdr (l)) endif
  else 0 endif

```

DEFINITION:

```

subbagp (x, y)
=  if listp (x)
  then if car (x) ∈ y then subbagp (cdr (x), delete (car (x), y))
  else f endif
  else t endif

```

THEOREM: listp-delete

```

listp (delete (x, l))
=  if listp (l) then (x ≠ car (l)) ∨ listp (cdr (l))
  else f endif

```

EVENT: Disable listp-delete.

THEOREM: delete-non-member
 $(x \notin y) \rightarrow (\text{delete} (x, y) = y)$

THEOREM: delete-delete
 $\text{delete} (y, \text{delete} (x, z)) = \text{delete} (x, \text{delete} (y, z))$

THEOREM: equal-occurrences-zero
 $(\text{occurrences} (x, l) = 0) = (x \notin l)$

THEOREM: member-non-list
 $(\neg \text{listp} (l)) \rightarrow (x \notin l)$

THEOREM: member-delete
 $(x \in \text{delete} (y, l))$
= if $x \in l$
 then if $x = y$ then $1 < \text{occurrences} (x, l)$
 else t endif
 else f endif

THEOREM: member-delete-implies-membership
 $(x \in \text{delete}(y, l)) \rightarrow (x \in l)$

THEOREM: occurrences-delete
 occurrences($x, \text{delete}(y, l)$)
 $= \text{if } x = y$
 $\quad \text{then if } x \in l \text{ then occurrences}(x, l) - 1$
 $\quad \text{else 0 endif}$
 $\quad \text{else occurrences}(x, l) \text{ endif}$

THEOREM: member-bagdiff
 $(x \in \text{bagdiff}(a, b)) = (\text{occurrences}(x, b) < \text{occurrences}(x, a))$

THEOREM: bagdiff-delete
 $\text{bagdiff}(\text{delete}(e, x), y) = \text{delete}(e, \text{bagdiff}(x, y))$

THEOREM: subbagp-delete
 $\text{subbagp}(x, \text{delete}(u, y)) \rightarrow \text{subbagp}(x, y)$

THEOREM: subbagp-cdr1
 $\text{subbagp}(x, y) \rightarrow \text{subbagp}(\text{cdr}(x), y)$

THEOREM: subbagp-cdr2
 $\text{subbagp}(x, \text{cdr}(y)) \rightarrow \text{subbagp}(x, y)$

THEOREM: subbagp-bagint1
 $\text{subbagp}(\text{bagint}(x, y), x)$

THEOREM: subbagp-bagint2
 $\text{subbagp}(\text{bagint}(x, y), y)$

THEOREM: occurrences-bagint
 occurrences($x, \text{bagint}(a, b)$)
 $= \text{if } \text{occurrences}(x, a) < \text{occurrences}(x, b) \text{ then occurrences}(x, a)$
 $\quad \text{else occurrences}(x, b) \text{ endif}$

THEOREM: occurrences-bagdiff
 $\text{occurrences}(x, \text{bagdiff}(a, b)) = (\text{occurrences}(x, a) - \text{occurrences}(x, b))$

THEOREM: member-bagint
 $(x \in \text{bagint}(a, b)) = ((x \in a) \wedge (x \in b))$

EVENT: Let us define the theory *bags* to consist of the following events: occurrences-bagint, bagdiff-delete, occurrences-bagdiff, member-bagint, member-bagdiff, subbagp-bagint2, subbagp-bagint1, subbagp-cdr2, subbagp-cdr1, subbagp-delete.

EVENT: Make the library "bags" and compile it.

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