

```
def all(idx):  
    result = []  
    for a, bm in idx.items():  
        for b, cs in bm.items():  
            for c in cs:  
                result.append([a, b, c])  
    return result
```

```
def double(idx, a):  
    bm = idx.get(a)  
    if bm == None: return []  
    result = []  
    for b, cs in bm.items():  
        for c in cs:  
            result.append([b, c])  
    return result
```

```
def single(idx, a, b):  
    bm = idx.get(a)  
    if bm == None: return []  
    cs = bm.get(b)  
    if cs == None: return []  
    return [[ck] for ck in cs]
```

```
def exists(idx, a, b, c):  
    if None != idx.get(a) and None != idx[a].get(b) and c in idx[a][b]:  
        return [[]]  
    else:  
        return []
```


Query

Recipes containing ≤ 2 cups of flour

```
:find ?name
:where [?recipe :name ?name]
       [?recipe :ingredient ?i]
       [?i :unit :cups]
       [?i :quantity ?q]
       [?i :type :flour]
       [( $\leq$  ?q 2)]
```