Lab 7: First Order Logic
Sanghamitra R
1BM22CS237

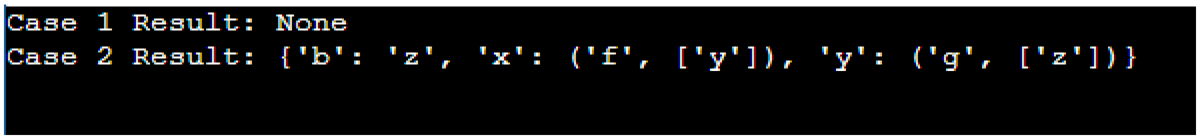
Code:

```
def unify(expr1, expr2, subst=None):
    if subst is None:
        subst = {}

    # Apply substitutions to both expressions
    expr1 = apply_substitution(expr1, subst)
    expr2 = apply_substitution(expr2, subst)

    # Base case: Identical expressions
    if expr1 == expr2:
        return subst

    # If expr1 is a variable
    if is_variable(expr1):
        return unify_variable(expr1, expr2, subst)

    # If expr2 is a variable
    if is_variable(expr2):
        return unify_variable(expr2, expr1, subst)

    # If both are compound expressions (e.g., f(a), P(x, y))
    if is_compound(expr1) and is_compound(expr2):
        if expr1[0] != expr2[0] or len(expr1[1]) != len(expr2[1]):
            return None  # Predicate/function symbols or arity mismatch
        for arg1, arg2 in zip(expr1[1], expr2[1]):
            subst = unify(arg1, arg2, subst)
            if subst is None:
                return None
        return subst

    # If they don't unify
    return None


def unify_variable(var, expr, subst):
    """Handle variable unification."""
    if var in subst:  # Variable already substituted
        return unify(subst[var], expr, subst)
    if occurs_check(var, expr, subst):  # Occurs-check
```

```python
        return None
    subst[var] = expr
    return subst


def apply_substitution(expr, subst):
    """Apply the current substitution set to an expression."""
    if is_variable(expr) and expr in subst:
        return apply_substitution(subst[expr], subst)
    if is_compound(expr):
        return (expr[0], [apply_substitution(arg, subst) for arg in expr[1]])
    return expr


def occurs_check(var, expr, subst):
    """Check for circular references."""
    if var == expr:
        return True
    if is_compound(expr):
        return any(occurs_check(var, arg, subst) for arg in expr[1])
    if is_variable(expr) and expr in subst:
        return occurs_check(var, subst[expr], subst)
    return False


def is_variable(expr):
    """Check if the expression is a variable."""
    return isinstance(expr, str) and expr.islower()


def is_compound(expr):
    """Check if the expression is a compound expression."""
    return isinstance(expr, tuple) and len(expr) == 2 and isinstance(expr[1], list)


# Testing the algorithm with the given cases
if __name__ == "__main__":
    # Case 1: p(f(a), f(b)) and p(x, x)
    expr1 = ("p", [("f", ["a"]), ("g", ["b"])])
    expr2 = ("p", ["x", "x"])
    result = unify(expr1, expr2)
    print("Case 1 Result:", result)

    # Case 2: p(b, x, f(g(z))) and p(z, f(y), f(y))
```

```
expr1 = ("p", ["b", "x", ("f", [("g", ["z"])])])
expr2 = ("p", ["z", ("f", ["y"]), ("f", ["y"])])
result = unify(expr1, expr2)
print("Case 2 Result:", result)
```

Output:



```
Case 1 Result: None
Case 2 Result: {'b': 'z', 'x': ('f', ['y']), 'y': ('g', ['z'])}
```