Top-Down Programming Example: Making Change

Step #1: Goal and General Algorithm Idea

Goal: write a program to determine how many quarters, dimes, nickels, and pennies make up a given amount of change

Specification: User enters an amount as an integer

Program prints number of quarters, dimes, nickels, and pennies that make up the given amount

High-level design:
- read in amount
- figure out how many quarters are in the amount
- determine how much is left over from this
- figure out how many dimes are in what’s left over
- determine how much is left over from this
- figure out how many nickels are in what’s left over
- what’s left is the number of pennies

Step #2: Data Representation and Program Structure

Part #1: Data Representation
- Represent the amount as an integer

Part #2: Program Structure
- Read in the input
- Divide by 25 to get the number of quarters
- Get the remainder
- Divide by 10 to get the number of dimes
- Get the remainder
- Divide by 5 to get the number of nickels
- Get the remainder
- Print the number of quarters, dimes, nickels, and pennies

Part #3: Refine algorithm
1. read in the amount $A$
2. convert $A$ to an integer $IA$
3. divide $IA$ by 25 to get the number of quarters $NQ$
4. take the remainder of $IA$ when divided by 25 to get the new integer $IA$
5. divide $IA$ by 10 to get the number of dimes $ND$
6. take the remainder of $IA$ when divided by 10 to get the new integer $IA$
7. divide $IA$ by 5 to get the number of nickels $NN$
8. take the remainder of $IA$ when divided by 5 to get the new integer $IA$
9. this is the number of pennies $NP$
10. print($A$ "cents is" $NQ$ "quarters," $ND$ "dimes," $NN$ "nickels, and" $NP$ "pennies")
Step #3: Translate This Into Pseudocode

1. \( A \leftarrow \text{read("Amount of change: ")} \)
2. \( IA \leftarrow \text{int}(A) \)
3. \( NQ \leftarrow \text{intdiv}(IA, 25) \)
4. \( IA \leftarrow \text{intrem}(IA, 25) \)
5. \( ND \leftarrow \text{intdiv}(IA, 10) \)
6. \( IA \leftarrow \text{intrem}(IA, 10) \)
7. \( NN \leftarrow \text{intdiv}(IA, 5) \)
8. \( IA \leftarrow \text{intrem}(IA, 5) \)
9. \( NP \leftarrow IA \)
10. \( \text{print}(A, \ "\text{cents is"}, \ NQ, \ "\text{quarters,"}, \ ND, \ "\text{dimes,"}, \ NN, \ "\text{nicks, and"}, \ NP, \ "\text{pennies")} \)

Step #4: Translate That Into Python

This is program `make_change.py`.

```python
# read in the amount of change and make it a number
A = \text{input}(\ "Amount of change:\")
IA = \text{int}(A)
# how many quarters
NQ = IA // 25
# how many dimes in what’s left over
IA = IA % 25
ND = IA // 10
# how many nickels in what’s left over
IA = IA % 10
NN = IA // 5
# how many pennies in what’s left over
IA = IA % 5
\text{print}(A, \ "\text{cents is"}, \ NQ, \ "\text{quarters,"}, \ ND, \ "\text{dimes,"}, \ NN, \ "\text{nicks, and"}, \ IA, \ "\text{pennies")}
```