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

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## Step #4: Translate That Into Python

This is program *change0.py*.

```python
# read in the amount of change and make it a number
A = input("Amount of change: ")
IA = 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
print A, "cents is", NQ, "quarters,", ND, "dimes,", NN, "nickels, and",\
      IA, "pennies"
```