2    # Chapter 2. Walk the Walk: When Computation Really Happens

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4    [Second to third paragraph of Chapter 2]

5    While we now have a good picture of what computation *is*, we have only seen one aspect of what computation

6    actually does, _____, the transformation of representation. But there are additional details that _____

7    attention. Therefore, to expand understanding beyond the *static* representation through algorithms, I discuss

8    the dynamic behavior of computation.

9     The great thing about an algorithm is that it can be used repeatedly to solve different problems. How does

10    this work? And how is it actually possible that one fixed algorithm description can _____ different

11    computations? Moreover, we have said that computation results from executing an algorithm, but who or

12    what is executing the algorithm? What are the skills needed to execute an algorithm? Can anybody do it?

13    And finally, _____ it is great to have an algorithm for solving a problem, we have to ask at what cost.

14    Only when an algorithm can deliver a solution to a problem fast enough and with the resources allocated is

15    it a viable option.

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17    [Second to forth paragraphs of *The Cost of Living*]

18    Having figured out an algorithm to solve a problem is one thing, but ensuring that an actual computation

19    generated by the algorithm will produce a solution quickly is an entirely different matter. Related is the

20    question of whether the computer in charge has enough resources available to perform the computation in

21    the first place.

22     For example, when Hansel and Gretel _____ the pebble trace back home, the entire computation takes

23    as many steps as the number of pebbles that Hansel dropped. Note that step here means "step of the

24    algorithm" and not "step as a part of walking." In particular, one step of the algorithm generally corresponds

25    to several steps taken by Hansel and Gretel through the forest. Thus the number of pebbles is a _____ of

26    the execution time of the algorithm, since one step of the algorithm is _____ for each pebble. Thinking

27    about the number of steps an algorithm needs to perform its task is _____ its runtime complexity.

28     Moreover, the algorithm works only if Hansel and Gretel have enough pebbles to cover the path from their

29    home to the place in the forest where they are left by their parents. This is an example of a resource _____.

30    A shortfall of pebbles could be due either to a limited availability of pebbles, which would be a limit of external

31    resources, or to the limited space offered by Hansel's pockets, which would be a limit of the computer. To

32    judge an algorithm's space complexity means to ask how much space a computer needs to execute the

33    algorithm. In the example, this amounts to asking how many pebbles are needed to find a path of a particular

34    length and whether Hansel's pockets are big enough to carry them all.

35    [First three paragraphs of *Cost Growth*]

36    Since information _____ runtime complexity for an algorithm is given as a function, it can _____ the
37    differences in runtime for different computations. This approach reflects the fact that algorithms typically
38    require more time for _____ inputs.

39        The complexity of Hansel and Gretel's algorithm can be characterized by the rule "The runtime is
40    proportional to the number of pebbles," which means that the ratio of the number of footsteps to pebble is
41    constant. In other words, if a path were doubled in length and thus had _____ as many pebbles, the
42    runtime would double as well. Note that this does not mean that the number of footsteps is identical to the
43    number of pebbles, only that it increases and decreases in the same way as the input.

44        This relationship is called *linear*, and it _____ itself as a straight line in a graph that plots the number
45    of footsteps needed for any number of pebbles. _____ we say that the algorithm has linear
46    runtime complexity. We also sometime say, _____, the algorithm is linear.

47        Linear algorithms are very good, and in many cases the best one can hope for. To see an example of a
48    different runtime complexity, consider the algorithm that Hansel executes when dropping the pebble. In the
49    _____ version of the story he has all the pebbles in his pocket and thus can drop them as they go into
50    the forest. This is clearly a linear algorithm (with respect to the number of pebbles), since Hansel only takes
51    a constant number of footsteps to reach the location for dropping _____ pebble.