PROBLEM SOLVING

BACK

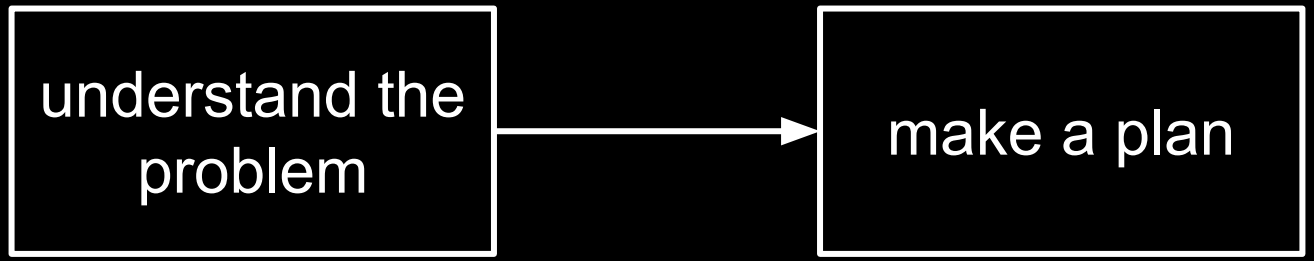
Polya's approach to problem-solving

image source: http://doi.org/10.3932/ethz-a-000099441

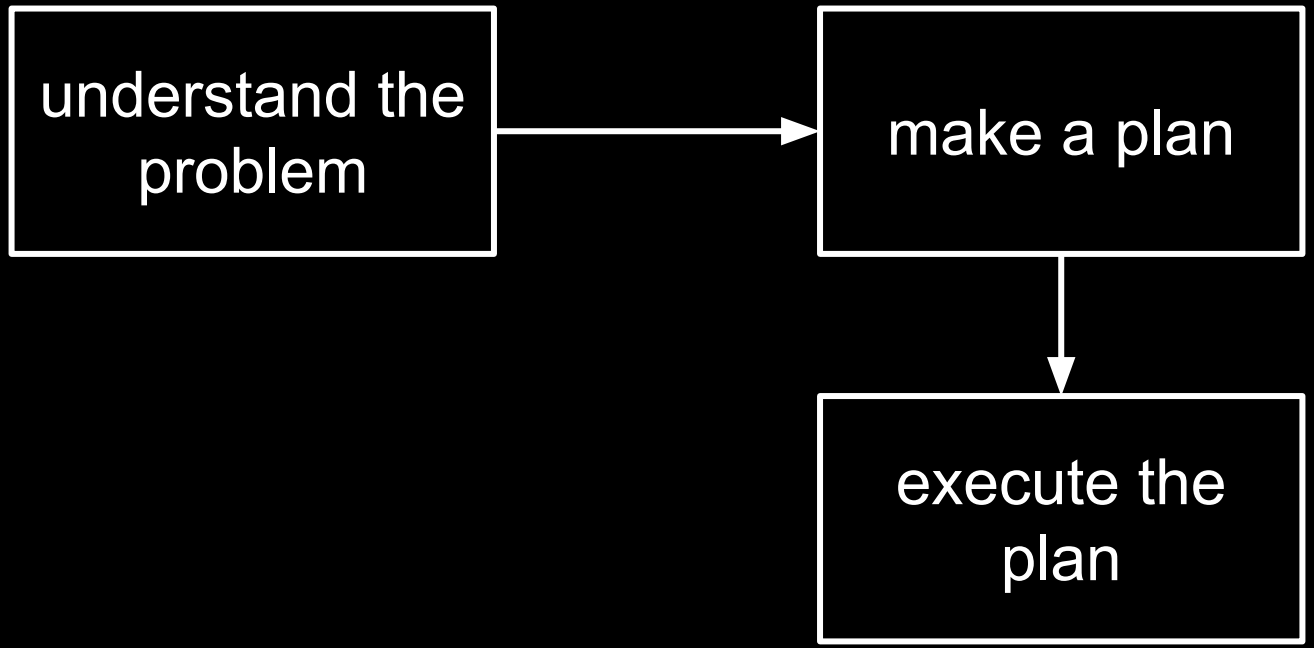
Polya's approach to problem-solving

understand the problem

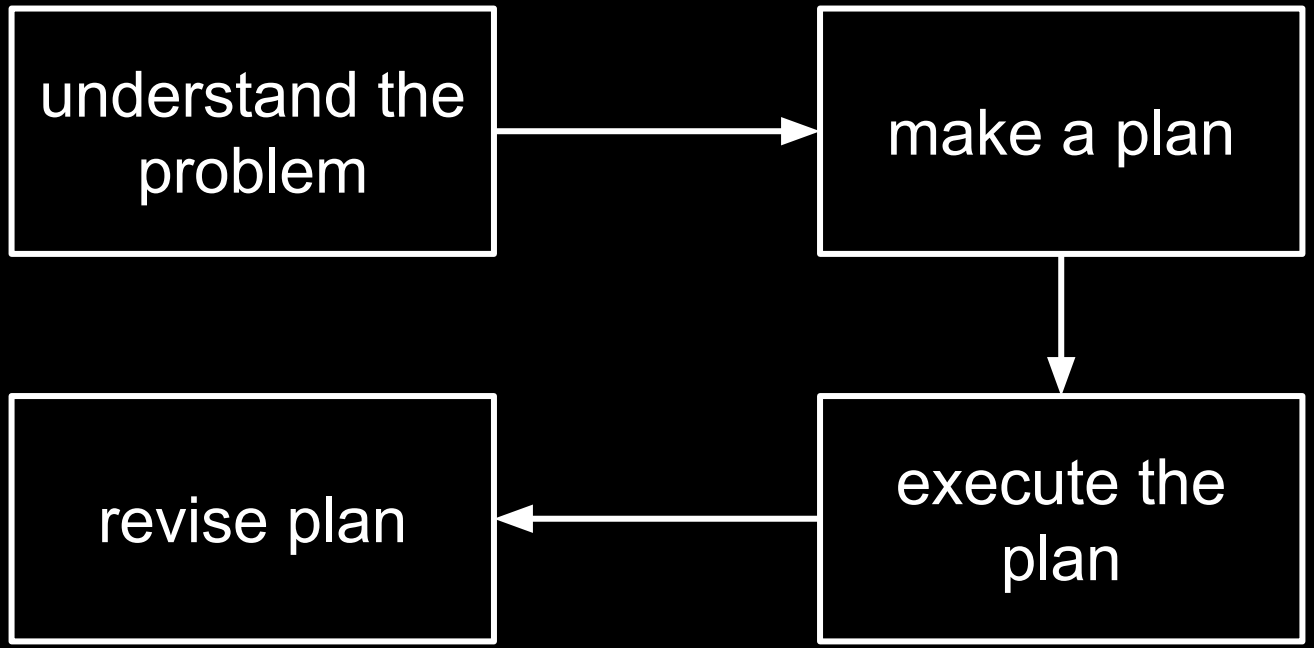
Polya's approach to problem-solving



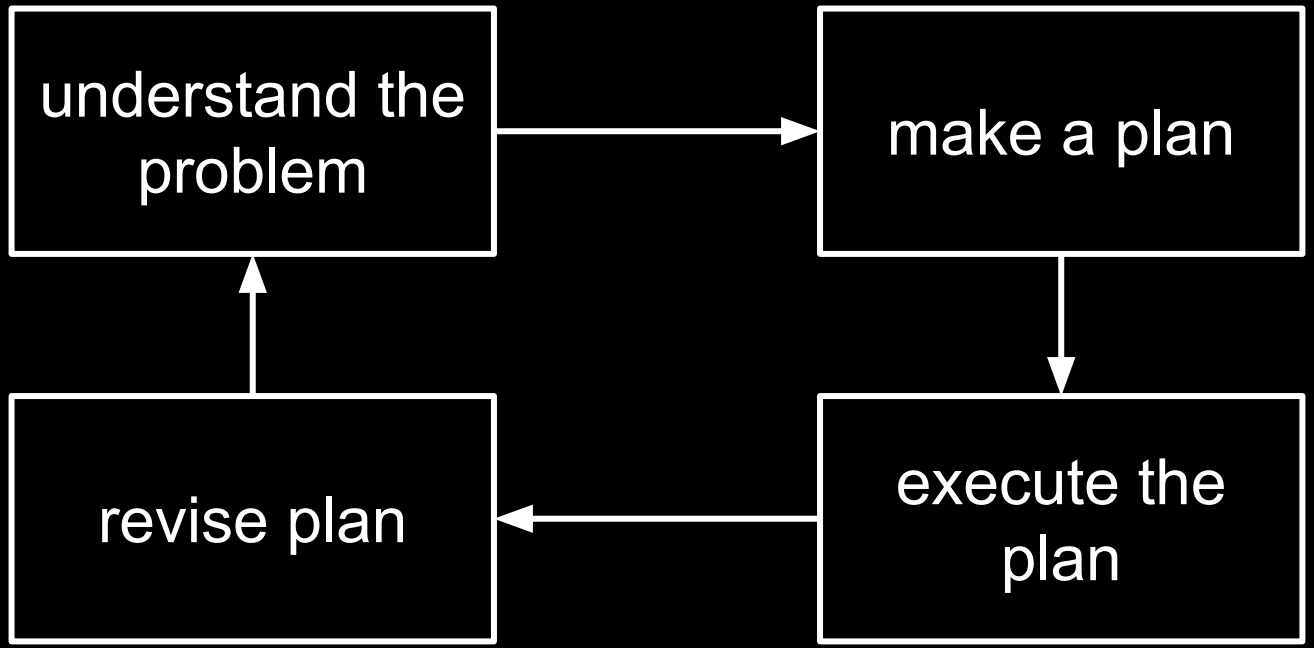
Polya's approach to problem-solving



Polya's approach to problem-solving

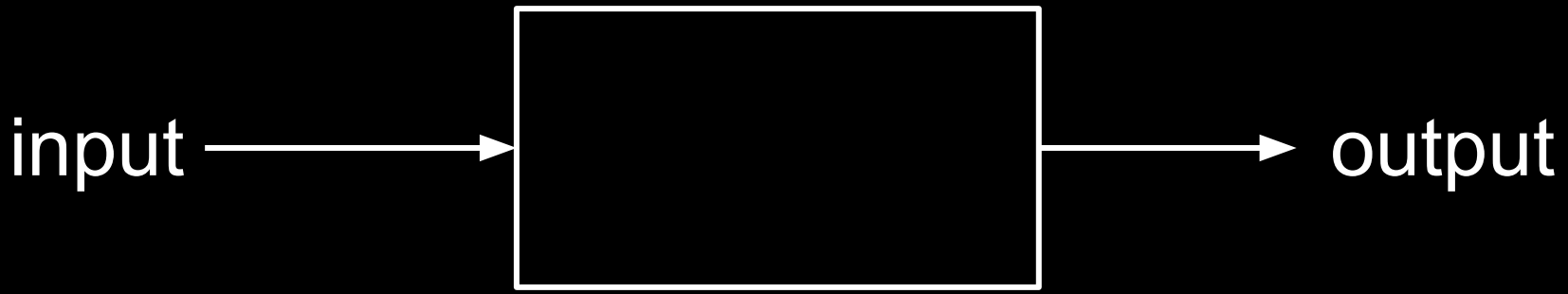


Polya's approach to problem-solving



%%problem_solving_polya%%

a model to represent problems

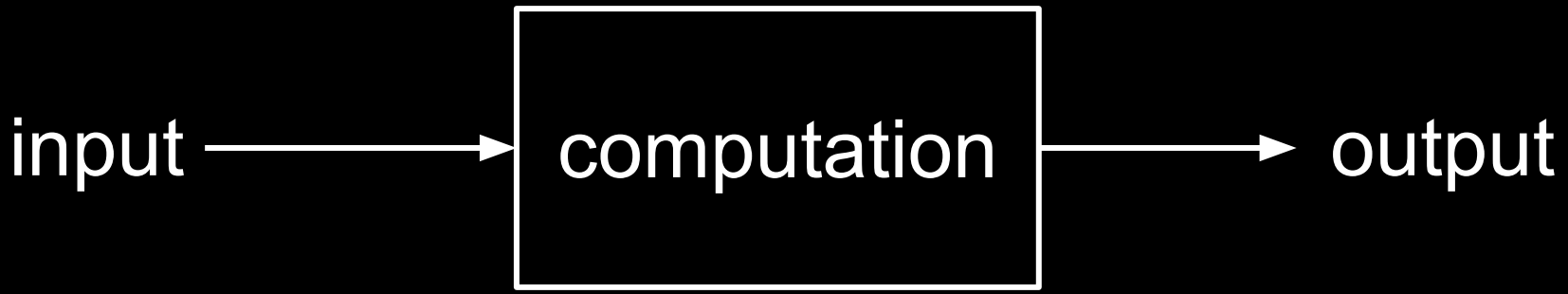


%%problem_solving_input_blackbox_output%%

a model to represent problems

%%problem_solving_input_solution_output%%

a model to represent problems

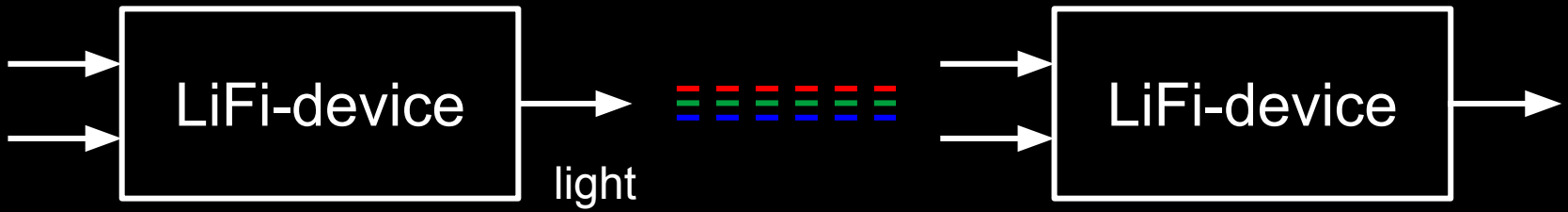


%%problem_solving_input_computation_output%%

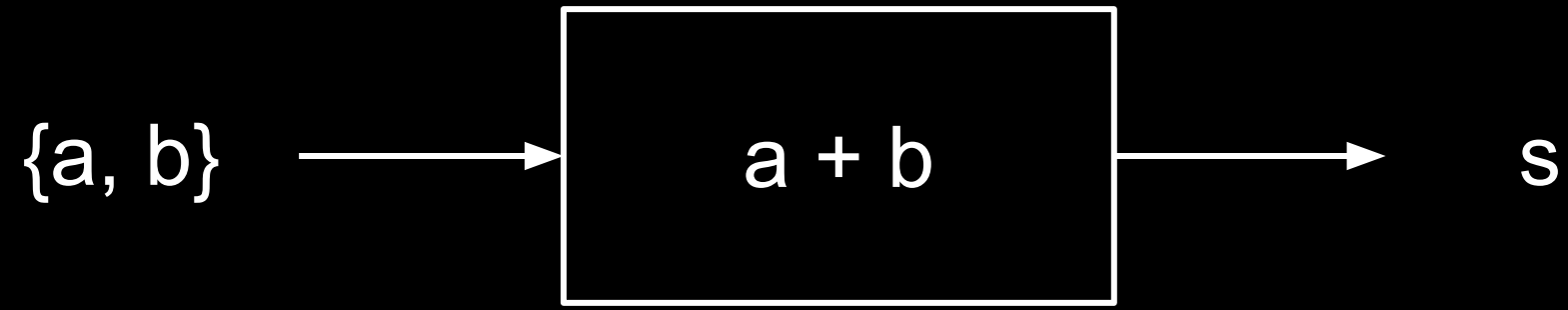
the LiFi-project as an input - processing - output - problem

%%problem_solving_input_computation_output_lifi%%

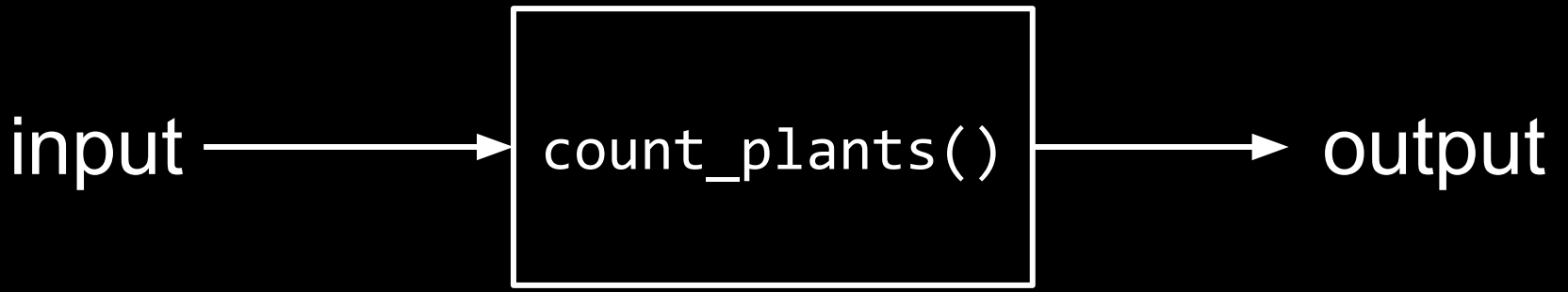
the LiFi-project as a communication problem



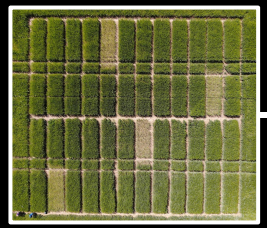
%%problem_solving_input_computation_output_lifi_devices%%



%%problem_solving_example_addition%%



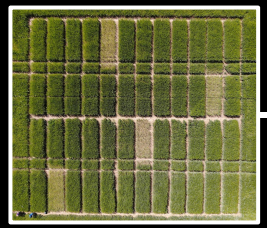
%%problem_solving_example_count_plants_1%%

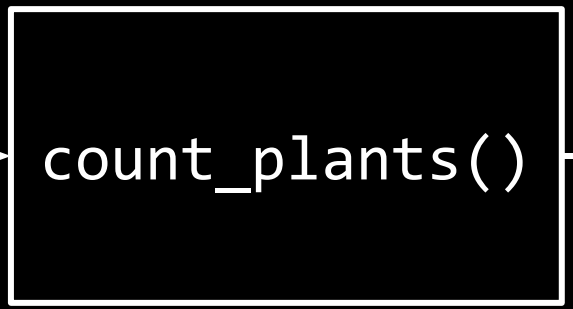


`count_plants()`

output

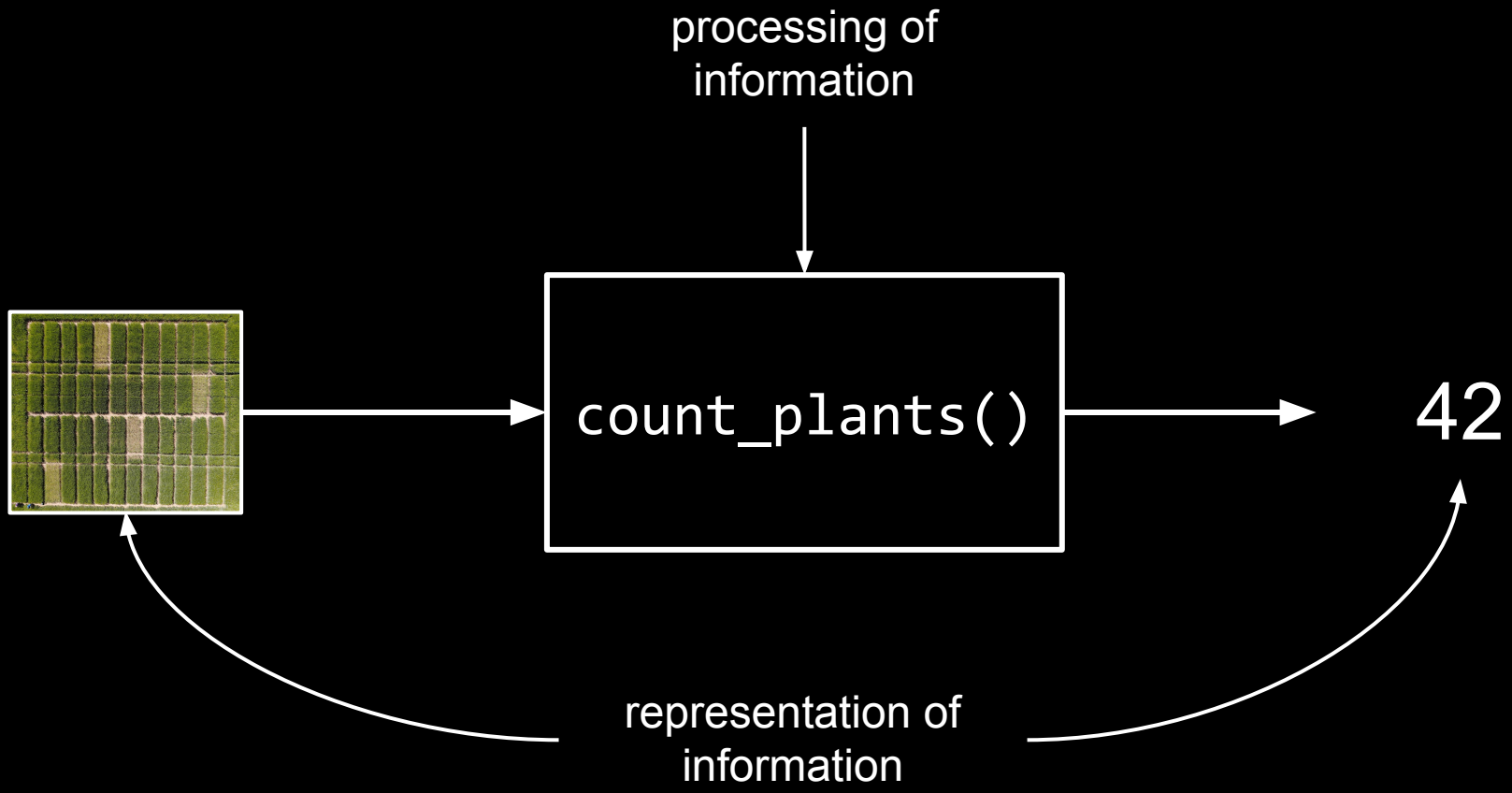
%%problem_solving_example_count_plants_2%%



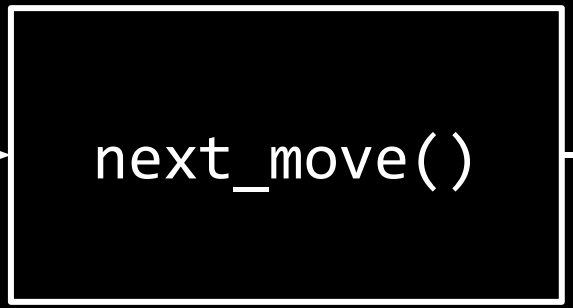


42

%%problem_solving_example_count_plants_3%%



%%problem_solving_example_count_plants_4%%



E2 → E4

%%problem_solving_example_chess%%

```
1: 0R     9: 0P          57: 1R
2: 0N    10: 0P          58: 1N
3: 0B    11: 0P          59: 1B
4: 0K    12: 0P          60: 1K
5: 0Q    13: 0P    ...   61: 1Q
6: 0B    14: 0P          62: 1B
7: 0N    15: 0P          63: 1N
8: 0R    16: 0P          64: 1R
```

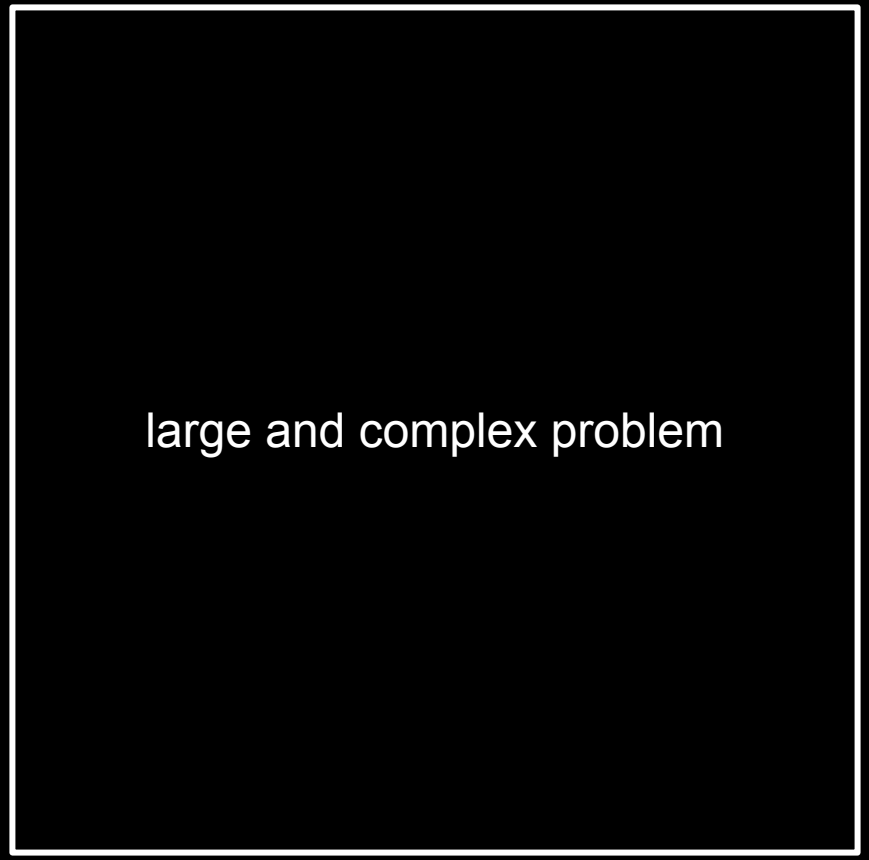
representation of information

%%problem_solving_example_chess_representation%%

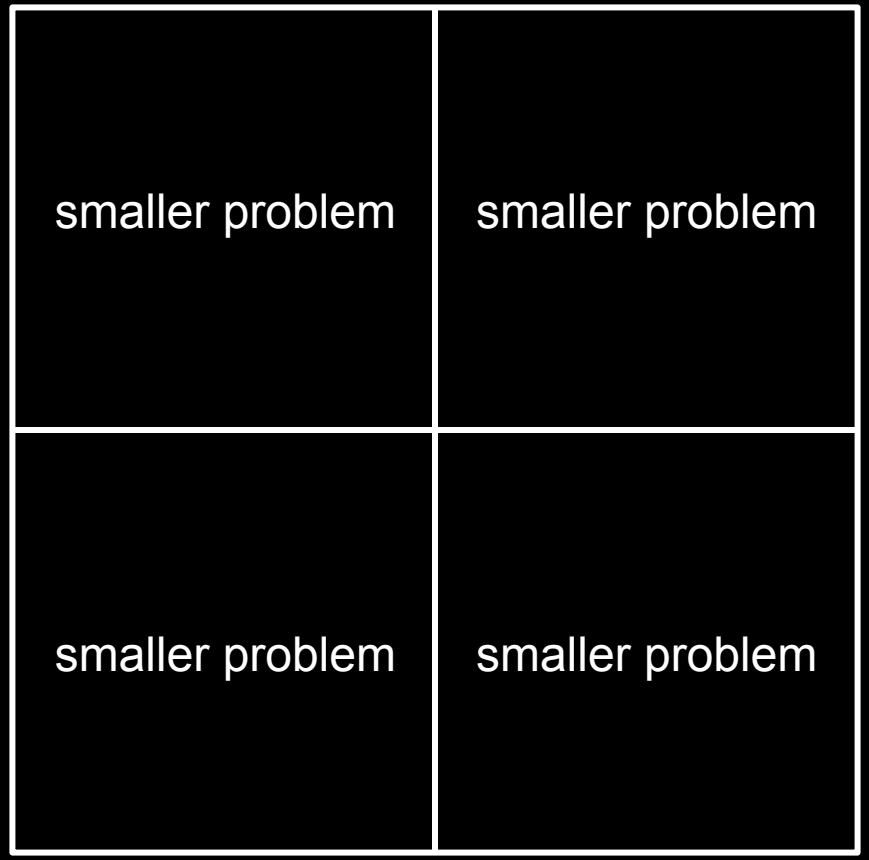
%%problem_solving_example_chatgpt%%

problem solving strategies

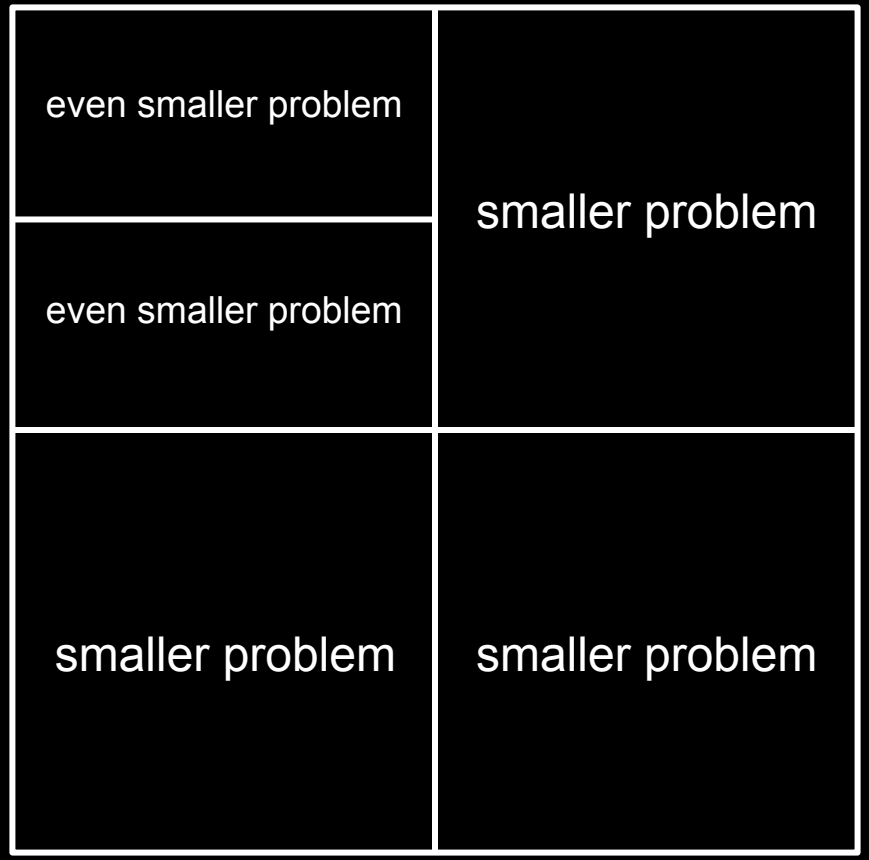
divide and conquer



%%problem_solving_large_complex_problem%%



%%problem_solving_smaller_problems%%



%%problem_solving_even_smaller_problems%%

%%problem_solving_example_search_in_list%%

is 67 a prime number?

```
2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41,
43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97
```

%%problem_solving_67_prime_number%%

linear search

```
2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41,
43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97
```

linear search

~~2,~~ 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41,
43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97

linear search

~~2~~, ~~3~~, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41,
43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97

linear search

~~2~~, ~~3~~, ~~5~~, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41,
43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97

linear search

~~2~~, ~~3~~, ~~5~~, ~~7~~, ~~11~~, ~~13~~, ~~17~~, ~~19~~, ~~23~~, ~~29~~, ~~31~~, ~~37~~, ~~41~~,
~~43~~, ~~47~~, ~~53~~, ~~59~~, ~~61~~, 67, 71, 73, 79, 83, 89, 97

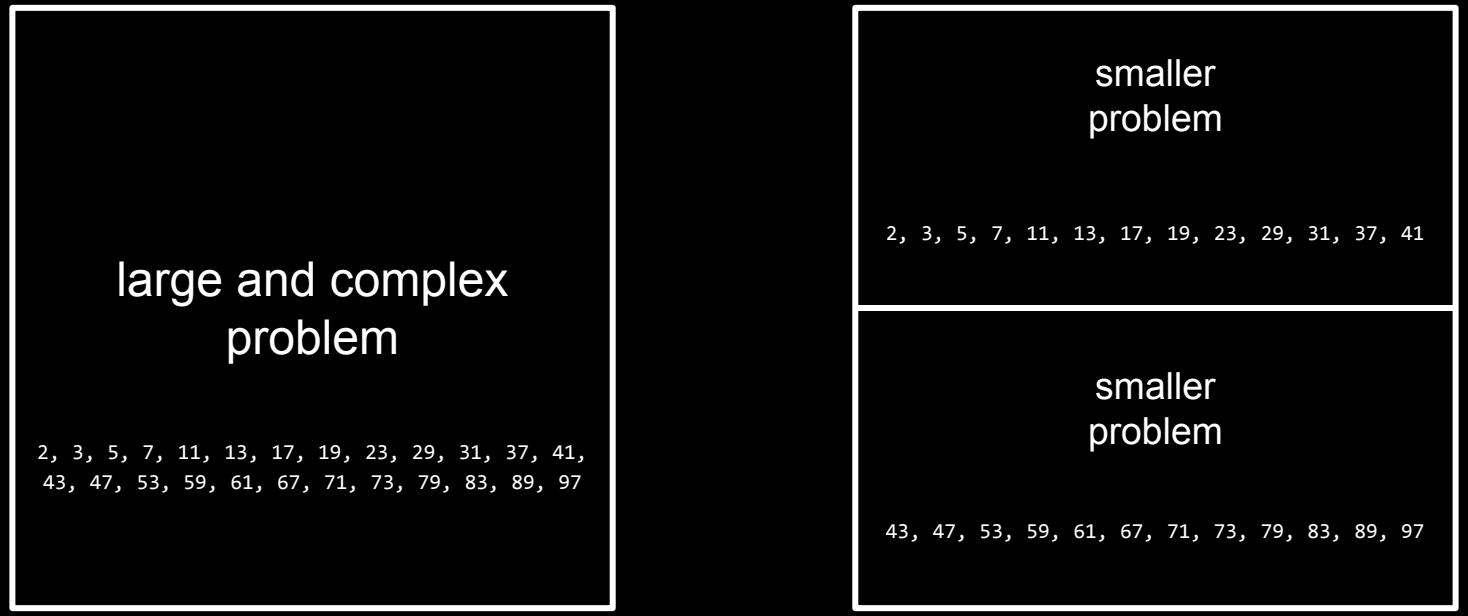
%%problem_solving_67_prime_number_linear%%

19 steps… can’t we do better?

~~2~~, ~~3~~, ~~5~~, ~~7~~, ~~11~~, ~~13~~, ~~17~~, ~~19~~, ~~23~~, ~~29~~, ~~31~~, ~~37~~, ~~41~~,
~~43~~, ~~47~~, ~~53~~, ~~59~~, ~~61~~, 67, 71, 73, 79, 83, 89, 97

large and complex problem

2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41,
43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97


large and complex problem
2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97
smaller problem
2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41
smaller problem
43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97

binary search

```
2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41,
43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97
```

%%problem_solving_67_prime_number_binary_search_1%%

binary search

67 != 41

2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, ~~41~~,
43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97

%%problem_solving_67_prime_number_binary_search_2%%

binary search

67 > 41

2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, ~~41~~,
43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97

binary search

67 > 41

~~2~~, ~~3~~, ~~5~~, ~~7~~, ~~11~~, ~~13~~, ~~17~~, ~~19~~, ~~23~~, ~~29~~, ~~31~~, ~~37~~, ~~41~~,
43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97

%%problem_solving_67_prime_number_binary_search_3%%

binary search

~~2~~, ~~3~~, ~~5~~, ~~7~~, ~~11~~, ~~13~~, ~~17~~, ~~19~~, ~~23~~, ~~29~~, ~~31~~, ~~37~~, ~~41~~,
43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97

67 != 71

binary search

~~2~~, ~~3~~, ~~5~~, ~~7~~, ~~11~~, ~~13~~, ~~17~~, ~~19~~, ~~23~~, ~~29~~, ~~31~~, ~~37~~, ~~41~~,
43, 47, 53, 59, 61, 67, ~~71~~, 73, 79, 83, 89, 97

67 != 71

binary search

~~2~~, ~~3~~, ~~5~~, ~~7~~, ~~11~~, ~~13~~, ~~17~~, ~~19~~, ~~23~~, ~~29~~, ~~31~~, ~~37~~, ~~41~~,
43, 47, 53, 59, 61, 67, ~~71~~, ~~73~~, ~~79~~, ~~83~~, ~~89~~, ~~97~~

67 < 71

%%problem_solving_67_prime_number_binary_search_4%%

binary search

~~2~~, ~~3~~, ~~5~~, ~~7~~, ~~11~~, ~~13~~, ~~17~~, ~~19~~, ~~23~~, ~~29~~, ~~31~~, ~~37~~, ~~41~~,
43, 47, 53, ~~59~~, 61, 67, ~~71~~, ~~73~~, ~~79~~, ~~83~~, ~~89~~, ~~97~~

67 != 59

binary search

~~2~~, ~~3~~, ~~5~~, ~~7~~, ~~11~~, ~~13~~, ~~17~~, ~~19~~, ~~23~~, ~~29~~, ~~31~~, ~~37~~, ~~41~~,
~~43~~, ~~47~~, ~~53~~, ~~59~~, 61, 67, ~~71~~, ~~73~~, ~~79~~, ~~83~~, ~~89~~, ~~97~~

67 > 59

%%problem_solving_67_prime_number_binary_search_5%%

binary search

~~2~~, ~~3~~, ~~5~~, ~~7~~, ~~11~~, ~~13~~, ~~17~~, ~~19~~, ~~23~~, ~~29~~, ~~31~~, ~~37~~, ~~41~~,
~~43~~, ~~47~~, ~~53~~, ~~59~~, 61, 67, ~~71~~, ~~73~~, ~~79~~, ~~83~~, ~~89~~, ~~97~~

67 = 67

binary search

~~2~~, ~~3~~, ~~5~~, ~~7~~, ~~11~~, ~~13~~, ~~17~~, ~~19~~, ~~23~~, ~~29~~, ~~31~~, ~~37~~, ~~41~~,
~~43~~, ~~47~~, ~~53~~, ~~59~~, ~~61~~, 67, ~~71~~, ~~73~~, ~~79~~, ~~83~~, ~~89~~, ~~97~~

67 = 67

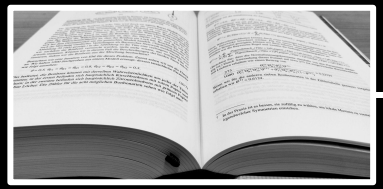
%%problem_solving_67_prime_number_binary_search_6%%

3 splits → much better

~~2~~, ~~3~~, ~~5~~, ~~7~~, ~~11~~, ~~13~~, ~~17~~, ~~19~~, ~~23~~, ~~29~~, ~~31~~, ~~37~~, ~~41~~,
~~43~~, ~~47~~, ~~53~~, ~~59~~, ~~61~~, 67, ~~71~~, ~~73~~, ~~79~~, ~~83~~, ~~89~~, ~~97~~

67 = 67

how efficient are linear and binary search in general?

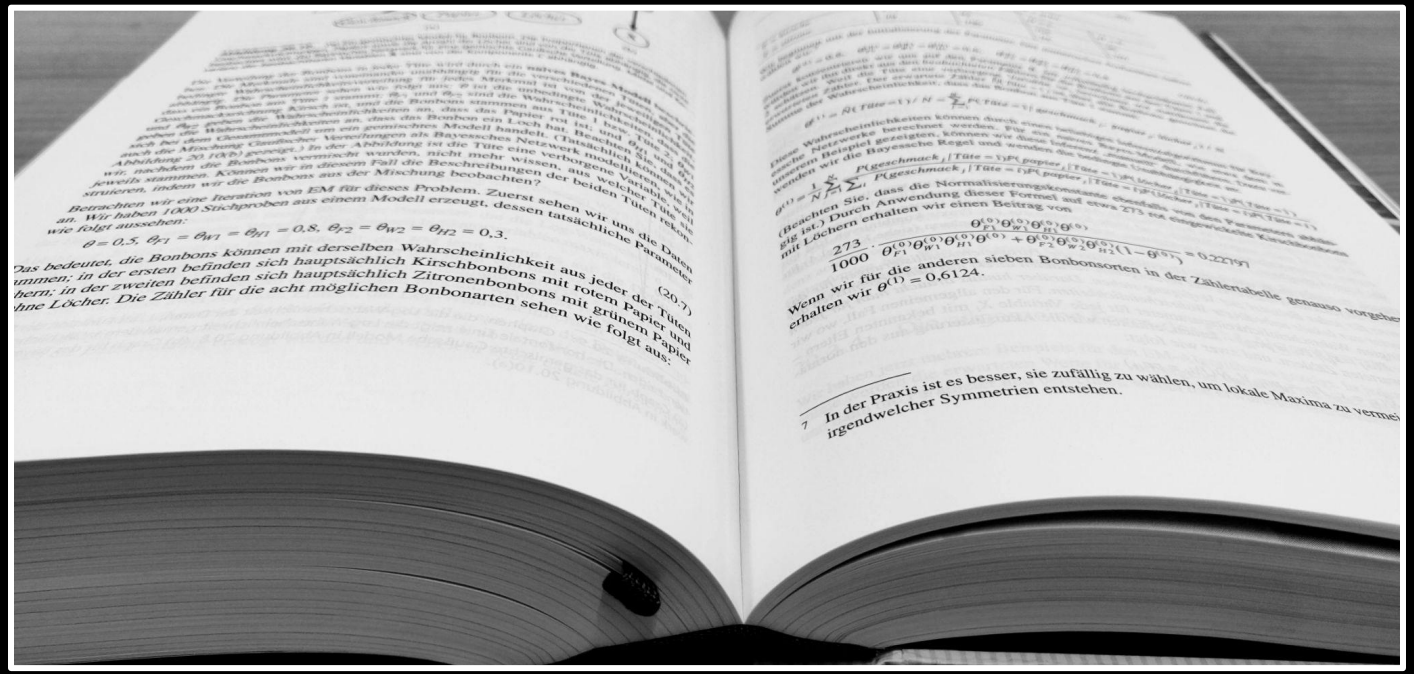


`count_words()`

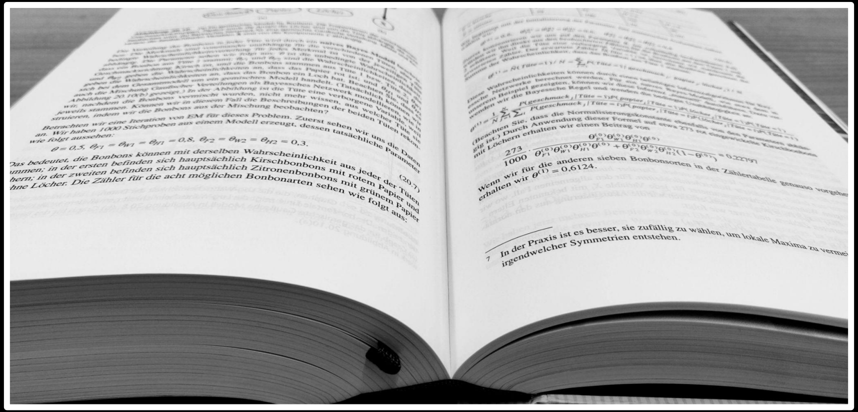
word count

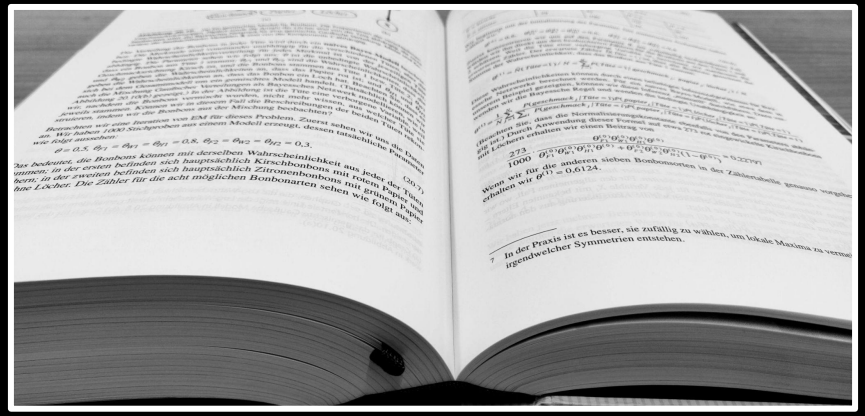
%%problem_solving_example_word_count%%

how many words are in the book?

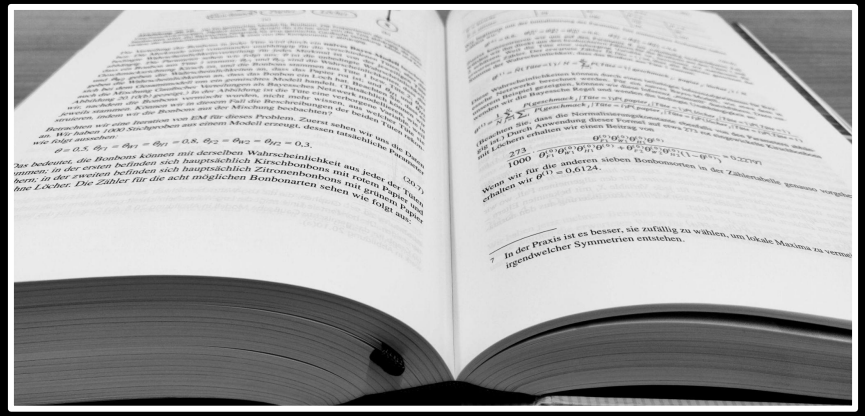


strategies, anyone?


Betrachten wir eine Iteration von EM für dieses Problem. Zuerst sehen wir uns die Daten
Wenn wir für die anderen sieben Bonbonsorten in der Zählertabelle genauso
In der Praxis ist es besser, sie zufällig zu wählen, um lokale Maxima zu
irgendwelcher Symmetrien entstehen.

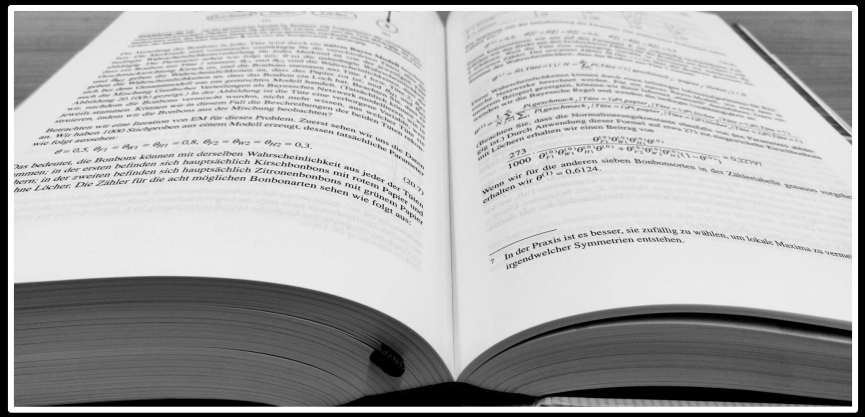


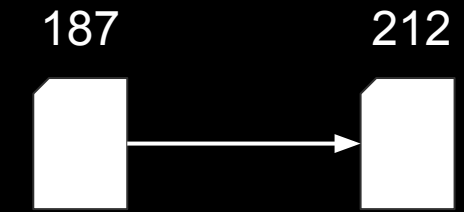
page 1

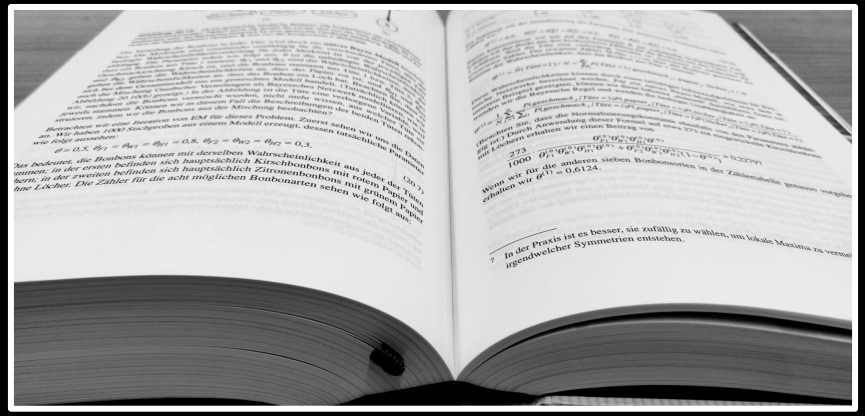


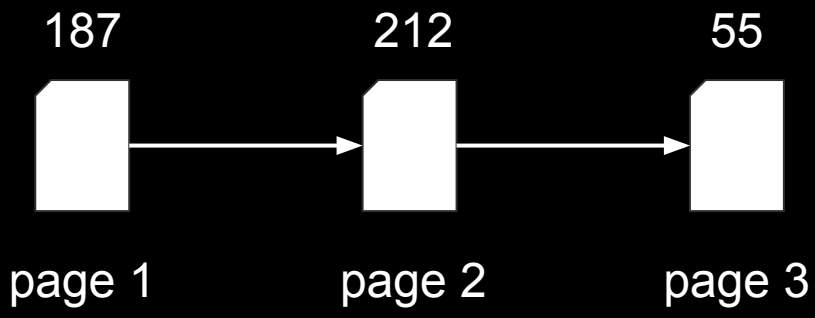
187

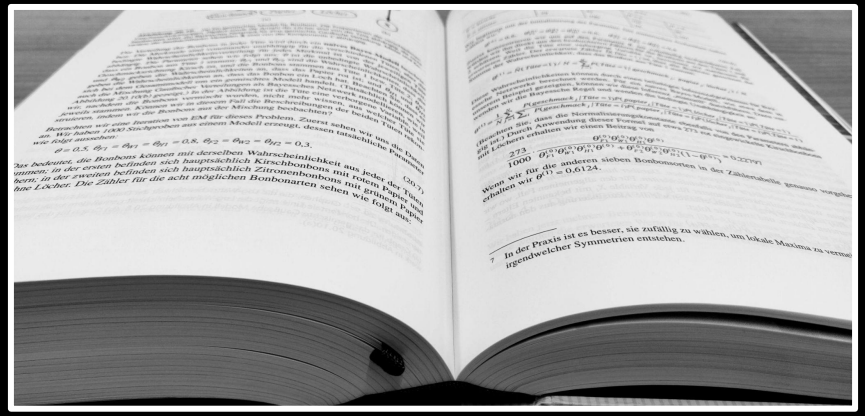
page 1

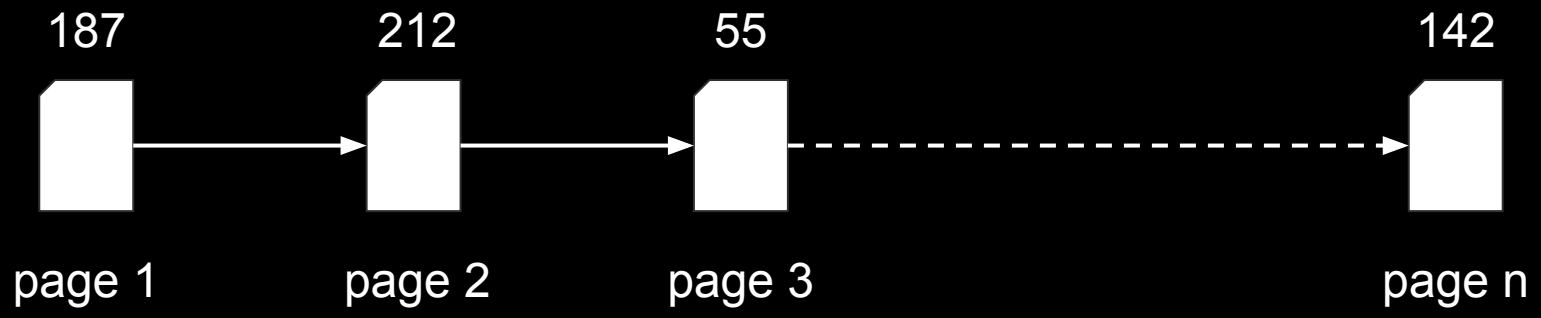



187
212
page 1
page 2

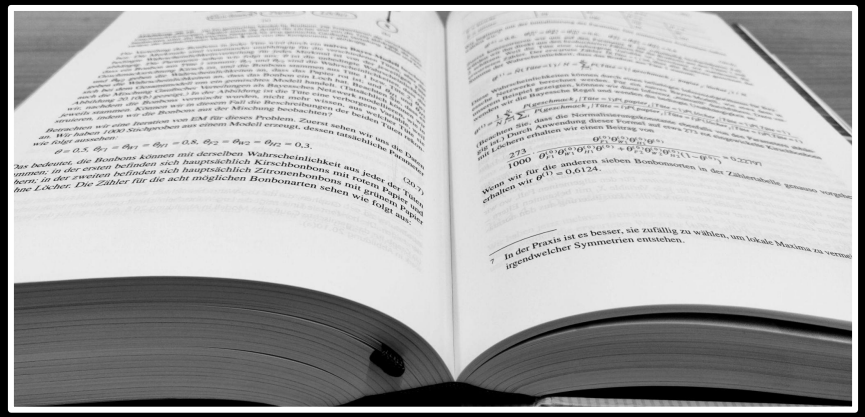



187
212
55
page 1
page 2
page 3





%%problem_solving_example_word_count_sequentially%%



n = 1327 pages

Ø 2:23 minutes per page

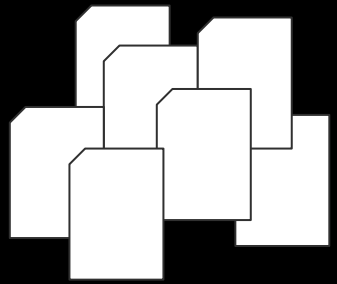
~ 52.34 hours

divide and conquer

+

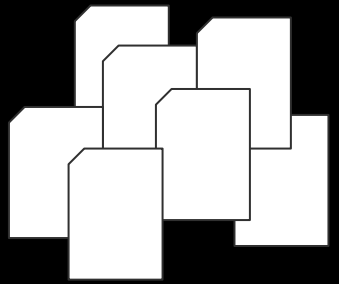
?

pages 1 - 700



student 1

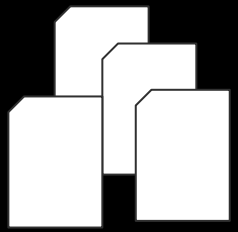
pages 701 - 1327



student 2

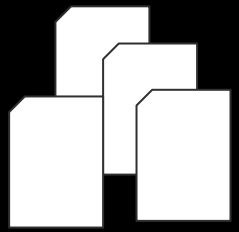
%%problem_solving_example_word_count_distribute%%

pages 1 - 350



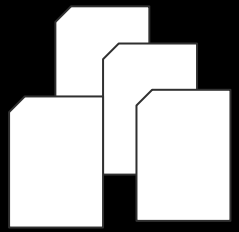
student 1

pages 351 - 700



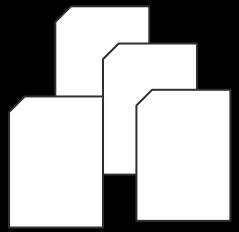
student 2

pages 701 - 1050



student 3

pages 1051- 1327



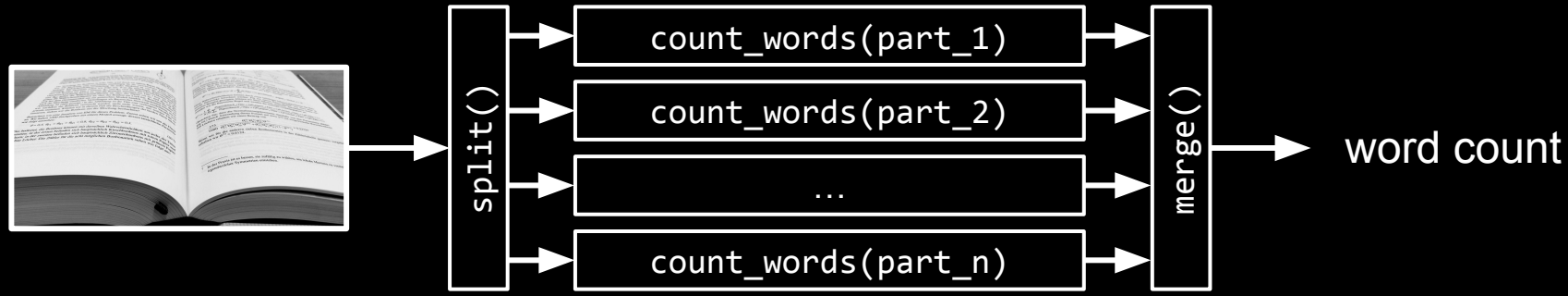
student 4

%%problem_solving_example_word_count_distribute_further%%

divide and conquer

+

distribution and parallelization



%%problem_solving_example_word_count_distribute_parallelize%%