

# PROBLEM SOLVING

[BACK](#)

# Polya's approach to problem-solving



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

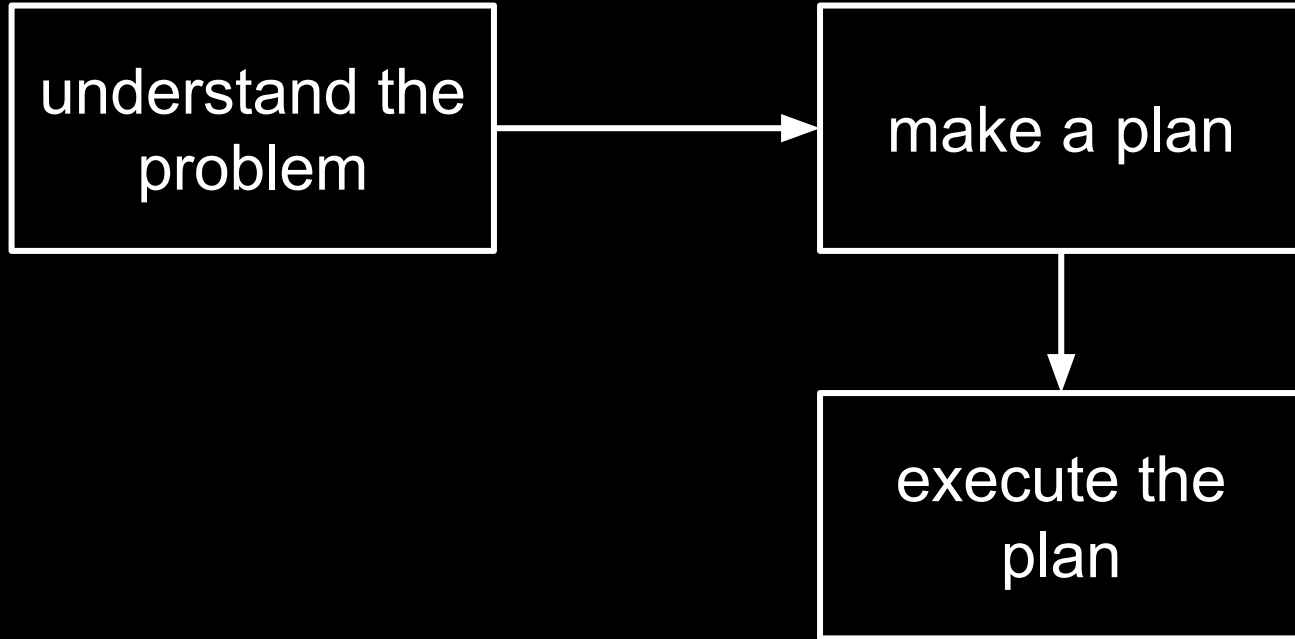
# Polya's approach to problem-solving

understand the  
problem

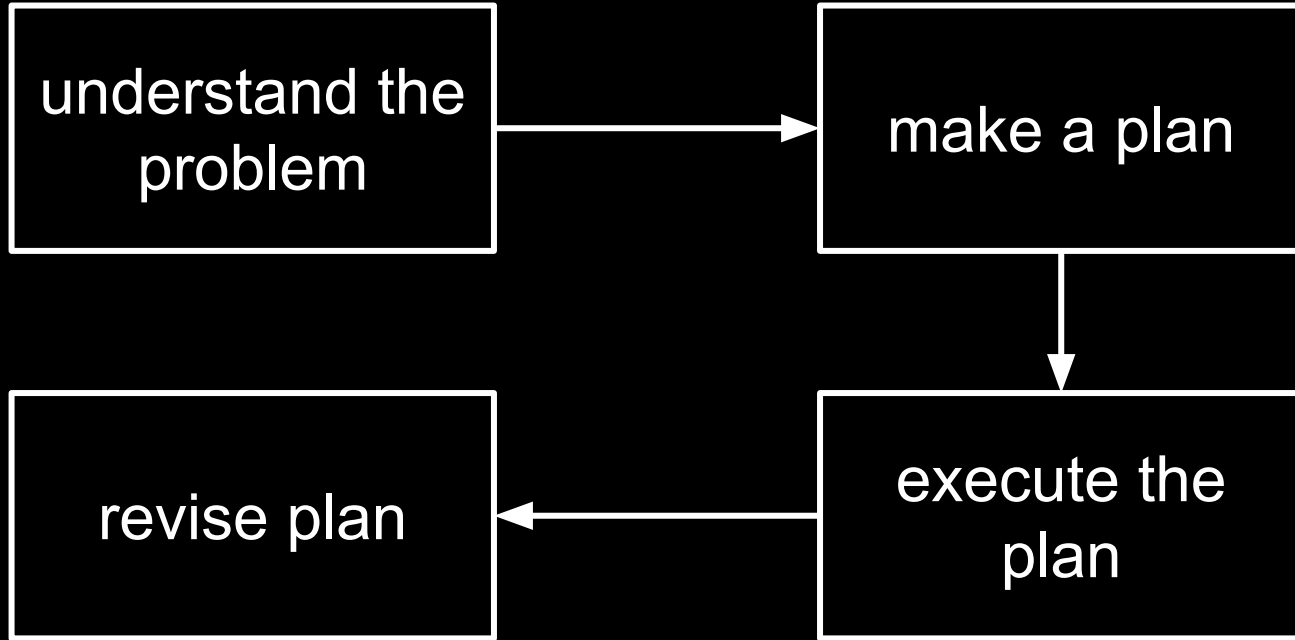
# Polya's approach to problem-solving



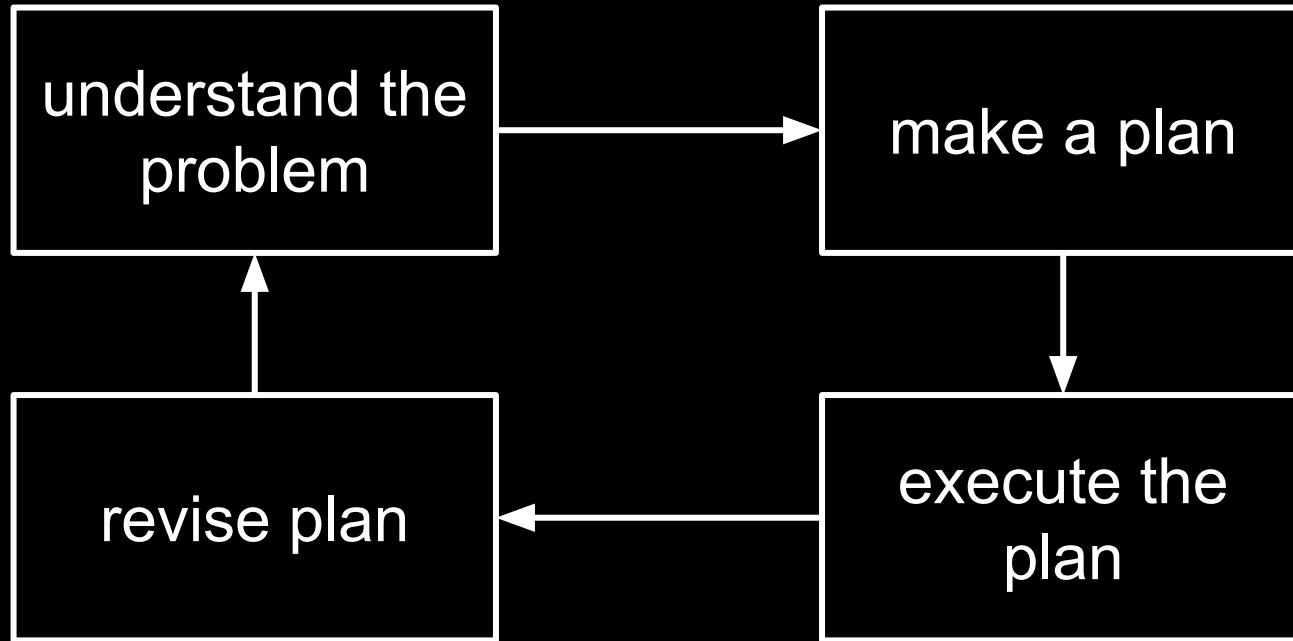
# Polya's approach to problem-solving



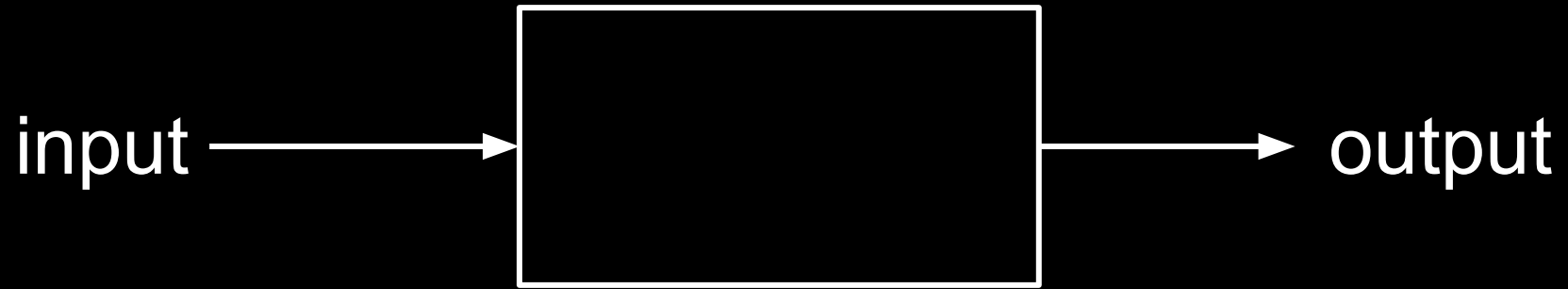
# Polya's approach to problem-solving



# Polya's approach to problem-solving



a model to represent problems

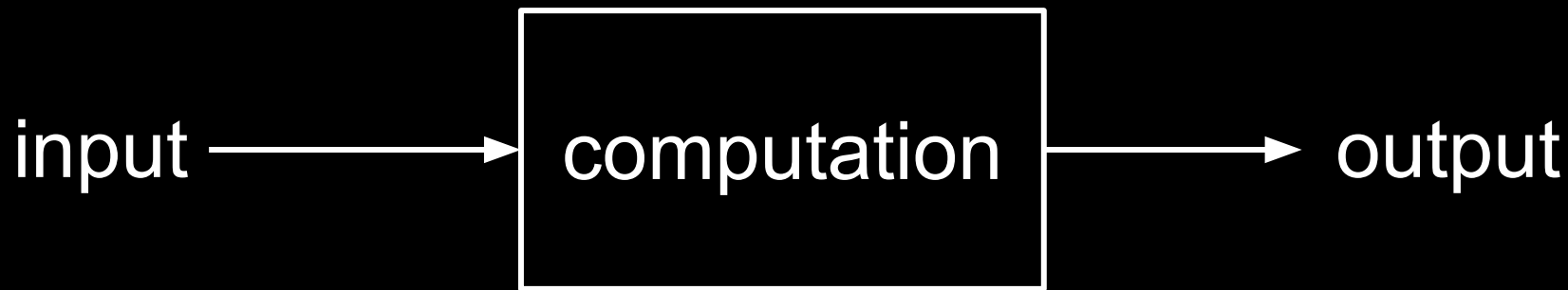




a model to represent problems



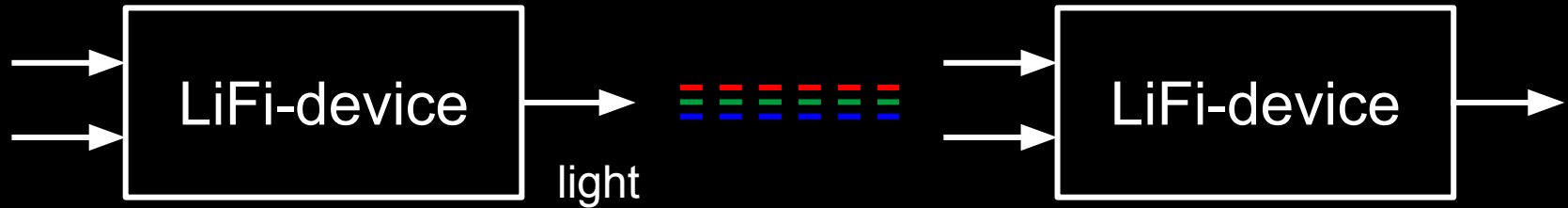
a model to represent problems

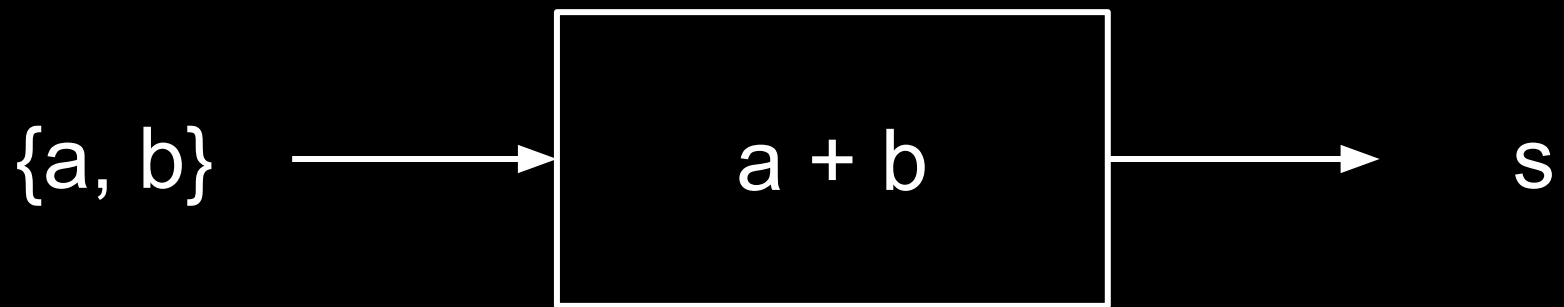


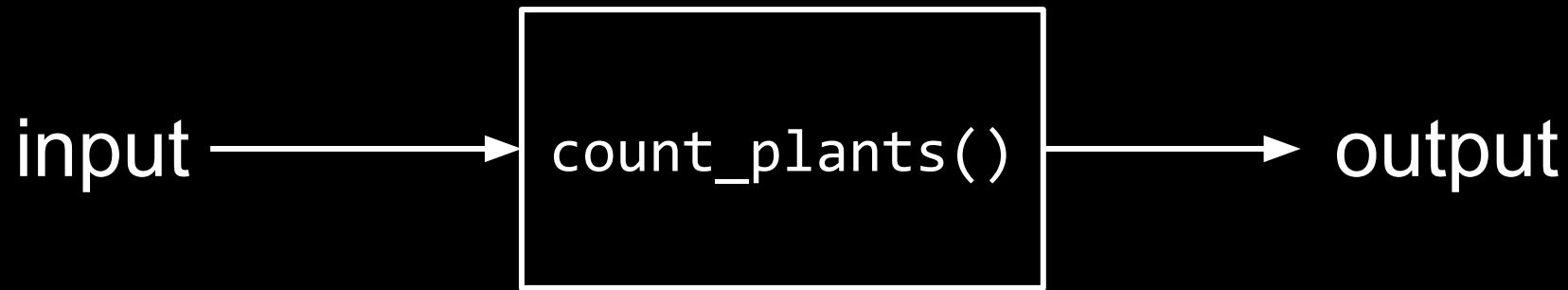
the LiFi-project as an  
input - processing - output - problem

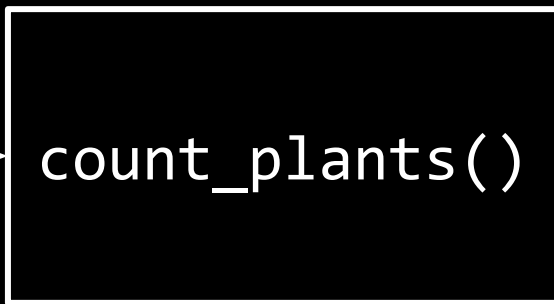


# the LiFi-project as a communication problem









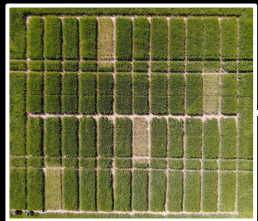
output



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processing of  
information



`count_plants()`

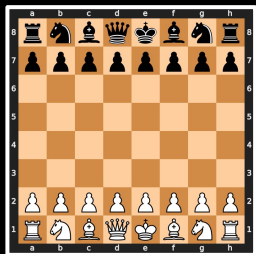
42

representation of  
information



next\_move()

E2 → E4



1: 0R

2: 0N

3: 0B

4: 0K

5: 0Q

6: 0B

7: 0N

8: 0R

9: 0P

10: 0P

11: 0P

12: 0P

13: 0P

14: 0P

15: 0P

16: 0P

57: 1R

58: 1N

59: 1B

60: 1K

61: 1Q

62: 1B

63: 1N

64: 1R

...

representation of information



problem solving strategies

divide and conquer

large and complex problem

smaller problem

smaller problem

smaller problem

smaller problem



even smaller problem	smaller problem
even smaller problem	
smaller problem	smaller problem

sorted list +  
element



search()



yes / no

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

## 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

↑



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

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

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

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



$67 < 71$

## 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

## 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

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

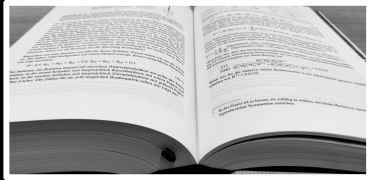


67 = 67



how efficient are linear and  
binary search in general?





`count_words()`

word count

$\theta = 0.5$ ,  $\theta_{T1} = \theta_{W1} = \theta_{H1} = 0.8$ ,  $\theta_{T2} = \theta_{W2} = \theta_{H2} = 0.3$ .

Dies bedeutet, die ersten befinden sich hauptsächlich Zitronenbonbons mit rotem Papier und umher; in der zweiten befinden sich hauptsächlich Zitronenbonbons mit grünem Papier ohne Löcher. Die Zähler für die acht möglichen Bonbonarten sehen wie folgt aus:

(20.7)

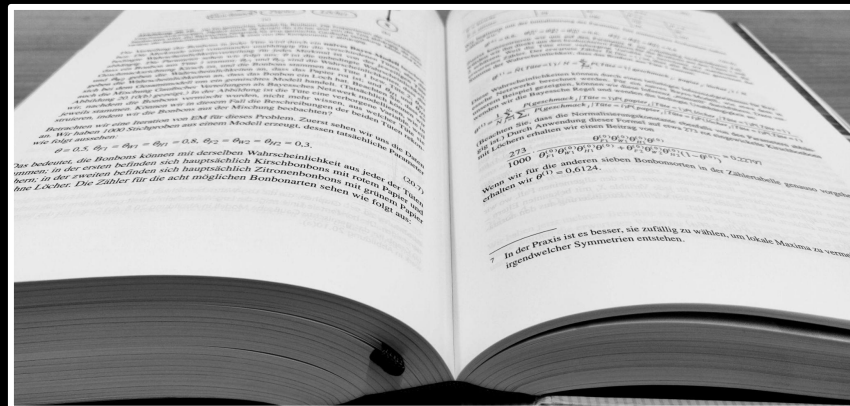
Wir haben 1000 Stichproben aus einem Modell erzeugt, dessen tatsächliche Parameter wie folgt aussahen:

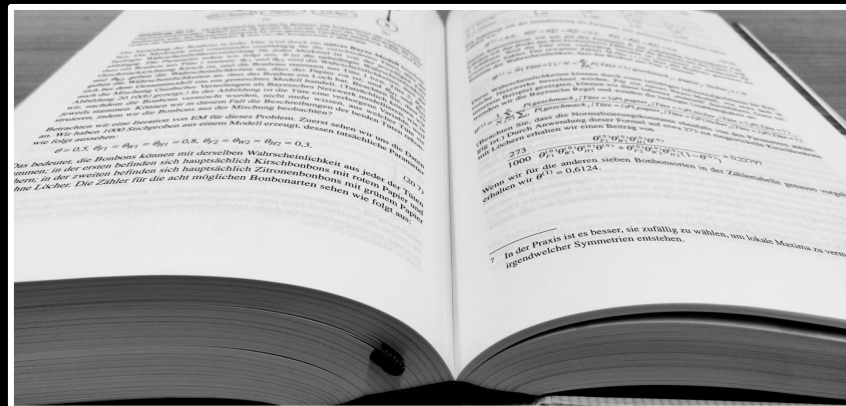
Wenn wir für die anderen sieben Bonbonsorten in der Zählertabelle genauso vorgehen erhalten wir  $\theta(1) = 0.6124$ .

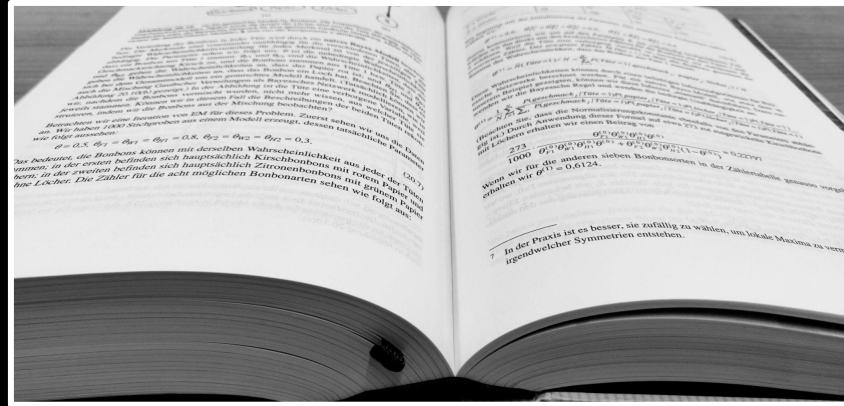
In der Praxis ist es besser, sie zufällig zu wählen, um lokale Maxima zu vermeiden.

7 In der Praxis ist es besser, sie zufällig zu wählen, um lokale Maxima zu vermeiden, irgendwelcher Symmetrien entstehen.

strategies, anyone?



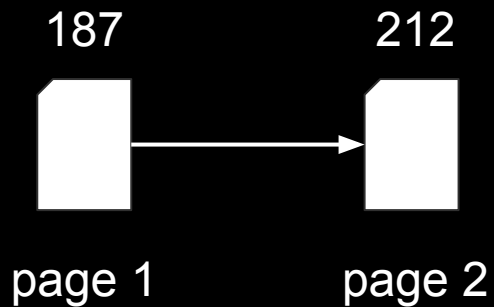
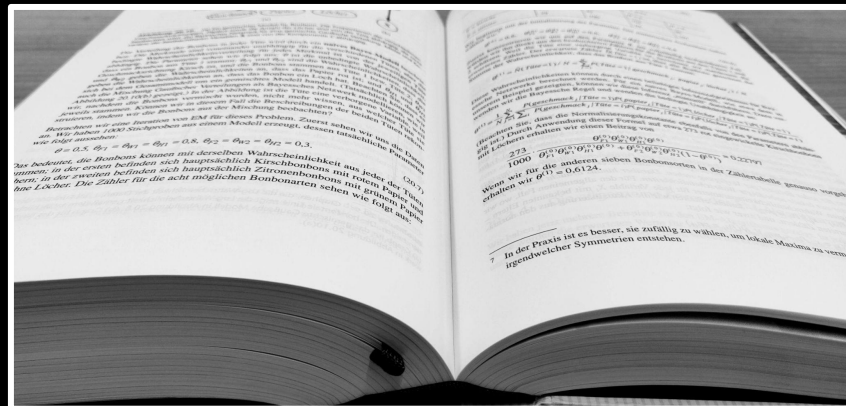


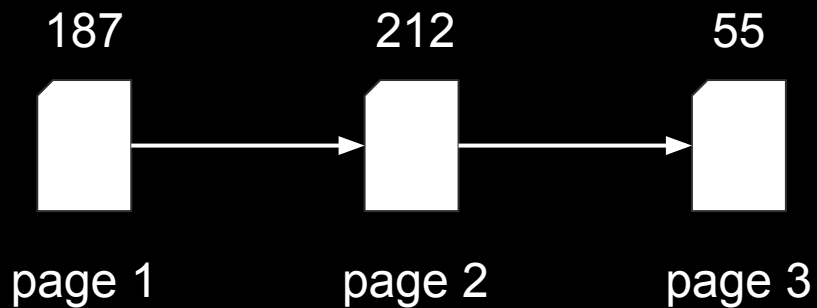
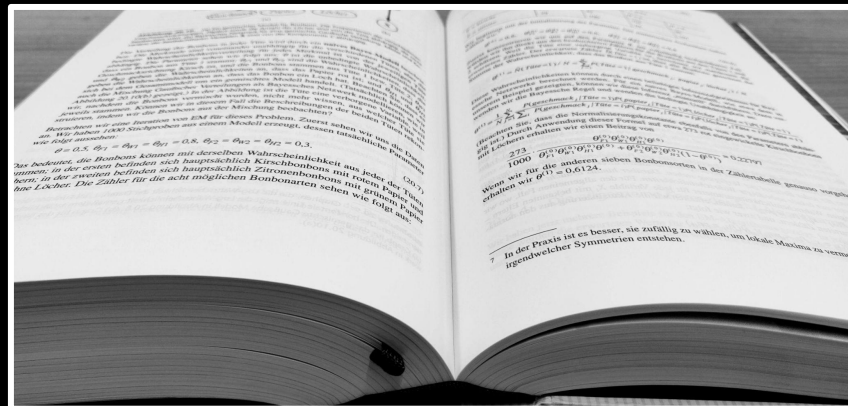


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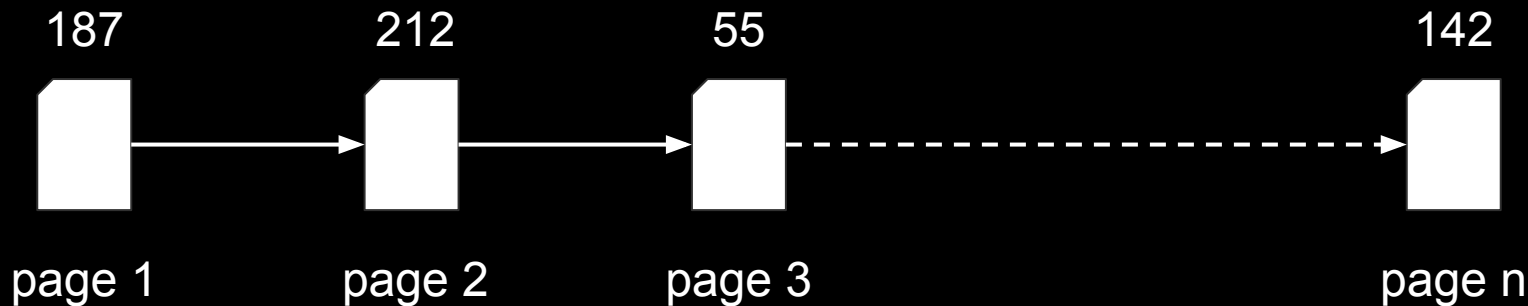
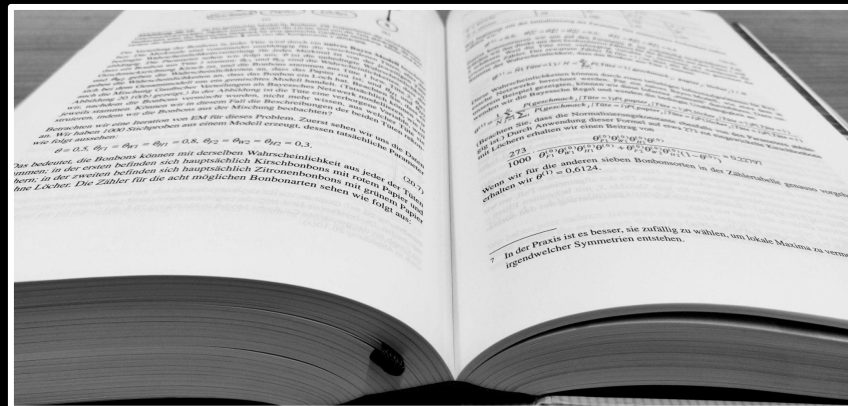


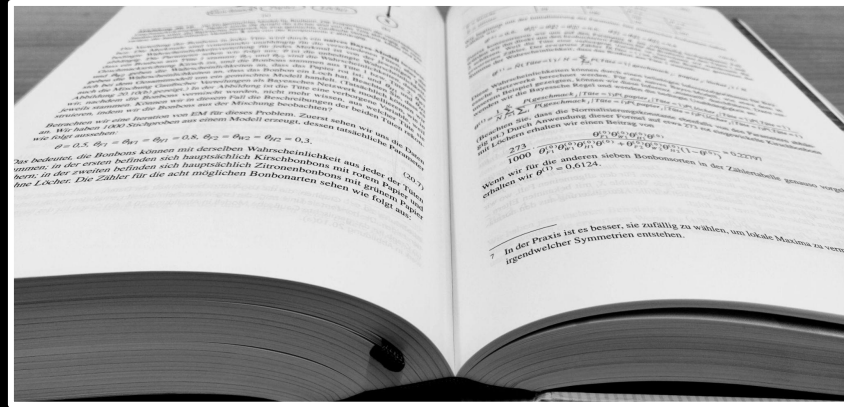
page 1











n = 1327 pages

Ø 2:23 minutes per page

~ 52.34 hours

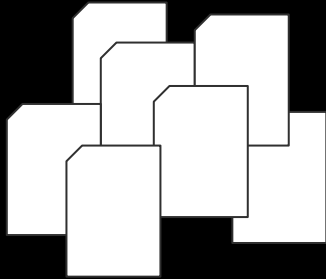


divide and conquer

+

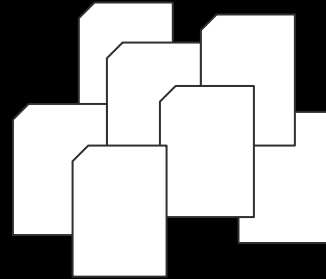
?

pages 1 - 700



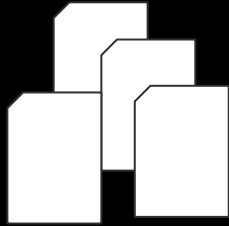
student 1

pages 701 - 1327



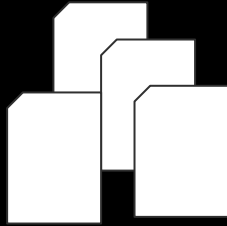
student 2

pages 1 - 350



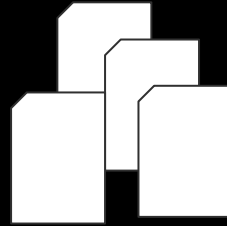
student 1

pages 351 - 700



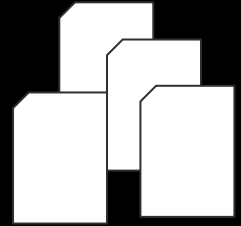
student 2

pages 701 - 1050



student 3

pages 1051- 1327



student 4

divide and conquer

+

distribution and parallelization

