Algorithmic How-Possibly Explanation

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Landscape of explanatory concepts

Pluralism

- Causal explanation
- Mechanistic explanation
- Mathematical explanation
- Structural explanation
- How-actually explanation
- How-possibly explanation

Etc.

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Outline

1. Different senses of how-possibly explanation
2. Algorithmic how-possibly explanation
3. Mechanistic explanation, structural explanation
4. Relation between mechanistic, structural, and algorithmic how-possibly explanation

Different senses of explaining how-possibly

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- Dray (1957): HPEs dispel "puzzlement"

" 'It's a long fly ball to centre field, and it's going to hit high up on the fence. The centre fielder's back, he's under it, he's caught it, and the batter is out.' " [Radio] Listeners who knew the fence was twenty feet high couldn't figure out how the fielder caught the ball" (p. 158 Dray, 1957).

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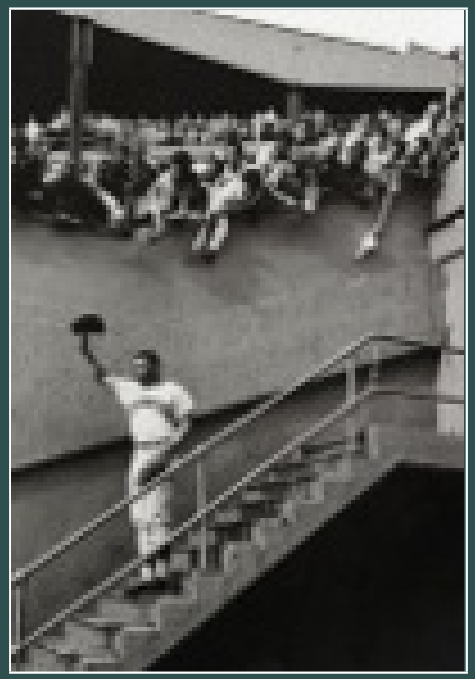

"Spectators could have given the unlikely explanation. At the rear of centre field was a high platform for the scorekeeper. The centre fielder ran up the ladder and caught the ball twenty feet above the ground" (Dray, 1957, p. 158).

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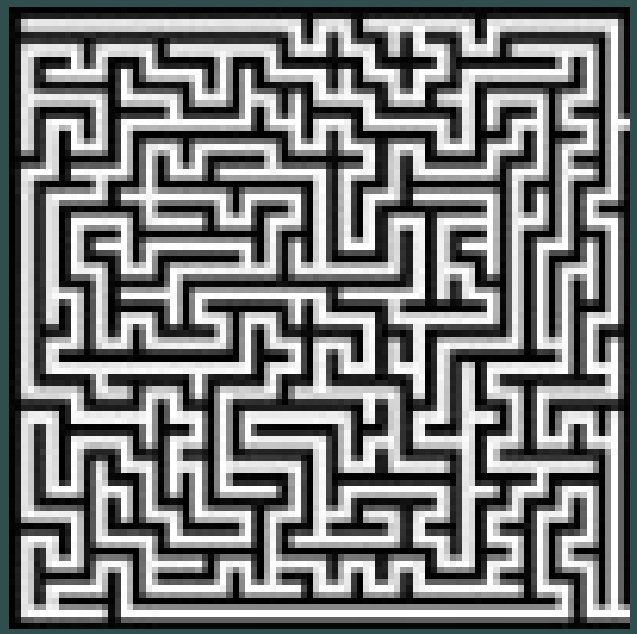

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- Cuffaro (2015): Algorithmic HPEs

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    - E.g., $\approx k^n$ steps in the worst case.
- Finer-grained complexity classes
  - linear: $\approx n$ steps in the worst case
  - quasi-linear: $\approx n \log n$ steps in the worst case
  - etc.

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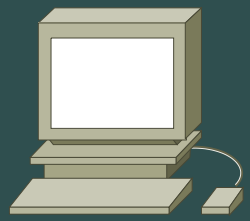
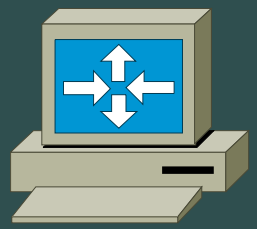


Selection-Sorter Mark I

Introducing the ...



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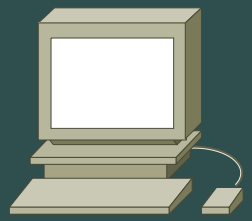

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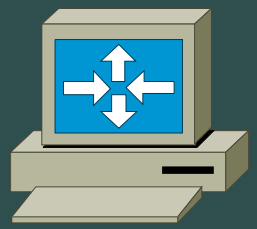

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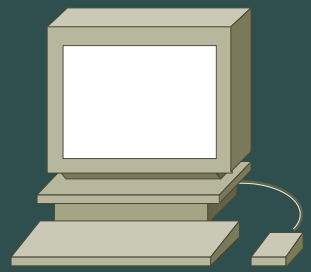
How-actually explanation

"My account has the somewhat counterintuitive consequence that one can move from a rather well-confirmed how-actually explanation ... at a high level of abstraction ... to a how-possibly model explanation as one tries to fill in some of the further details of that mechanism" (Bokulich, 2014, p. 335).

Coarse-grained description:



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Detailed description?

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Detailed description?

- Look at the code

```
void SelectionSort(int intsToSort[], int lengthOfList) {
   // Declare list indices:
   int i, j, indexOfLowestNum;
   // For each position in the list,
   for (i = 0; i < lengthOfList - 1; i++) {
      // provisionally assert that it points to the lowest number,
      indexOfLowestNum = i;
      // and then for each of the other list positions,
      for (j = lengthOfList - 1; j > i; j--) {
         // if the number pointed to by it is less than the number
         // pointed to by indexOfLowestNum,
         if (intsToSort[j] < intsToSort[indexOfLowestNum]) {
            // then make this the new provisional minimum index.
            indexOfLowestNum = j;
         }
      }
      // At the end of the ith iteration, put the number that is in the
      // indexOfLowestNum position into the ith position (and vice versa).
      Swap(&intsToSort[i], &intsToSort[indexOfLowestNum]);
   }
}
```

```
// on the first call, low = 0, high = n - 1
void Partition(int arr[], int low, int high) {
  // divide the list in two
  int mid;
  if (low < high){
    mid = (low + high) / 2;
    // recursively call partition function on
    // both halves of the list
    Partition(arr, low, mid);
    Partition(arr, mid + 1, high);
    // once the list is partitioned, call the
    // main merge sort procedure
    MergeSort(arr, low, mid, high);
  }
}

void MergeSort(int arr[], int low,
                    int mid,int high) {
  int i, m, k, l, temp[MAX];

  l = low;
  i = low;
  m = mid+1;

  while ((l <= mid) && (m <= high)){
    if (arr[l] <= arr[m]){
      temp[i] = arr[l];
      l++;
    }
    else{
      temp[i] = arr[m];
      m++;
    }
    i++;
  }
  if (l > mid){
    for(k = m; k <= high; k++){
      temp[i] = arr[k];
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What does this code represent?

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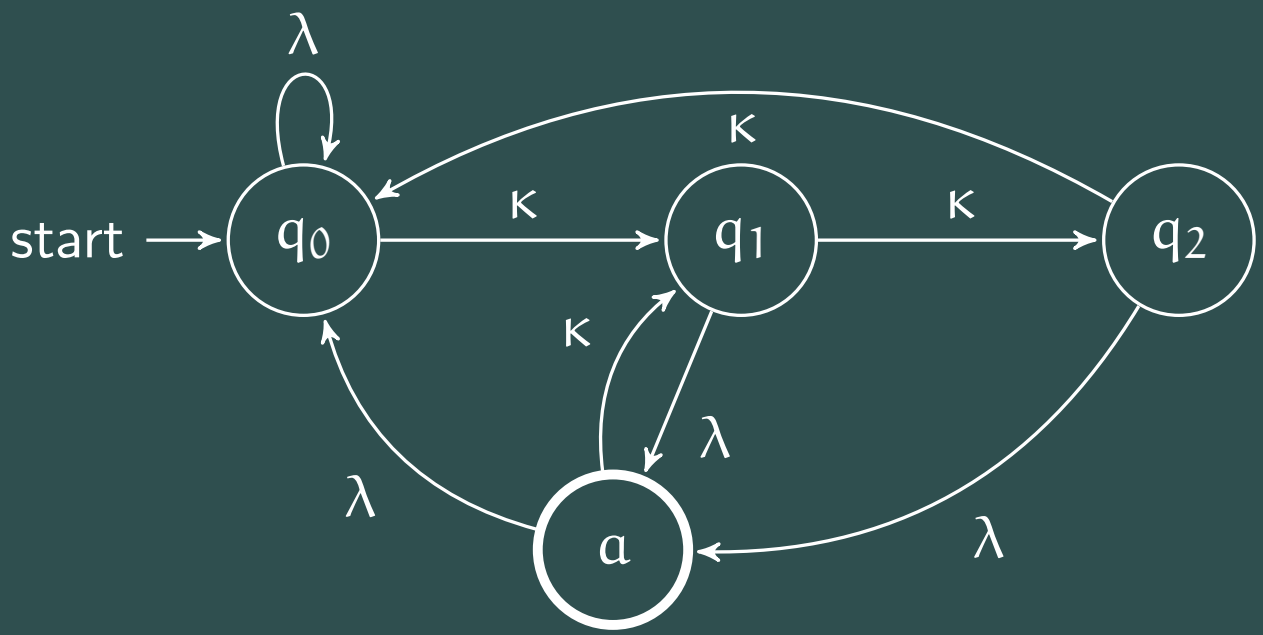
λ
κ
start
q_0
κ
q_1
κ
q_2
κ
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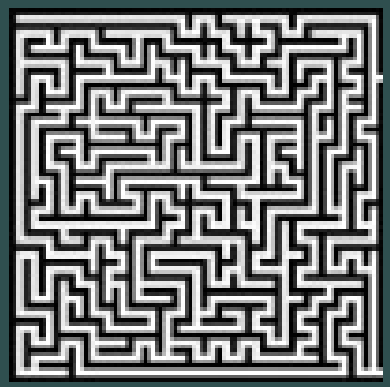
λ
a
λ

Space of possibilities

- The pathways available to `MergeSort` allow for quicker running times than the pathways available to `SelectionSort`.



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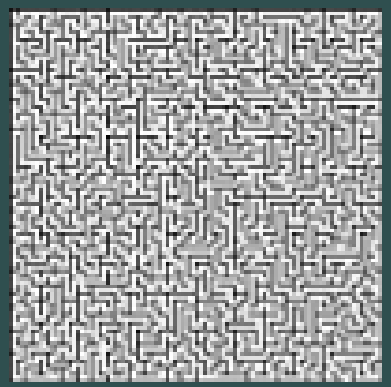

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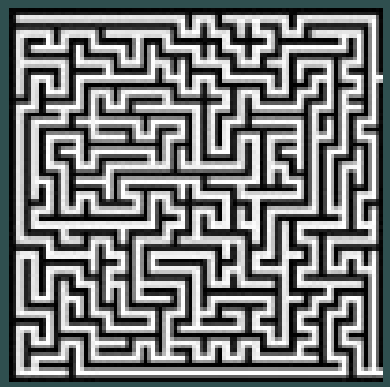

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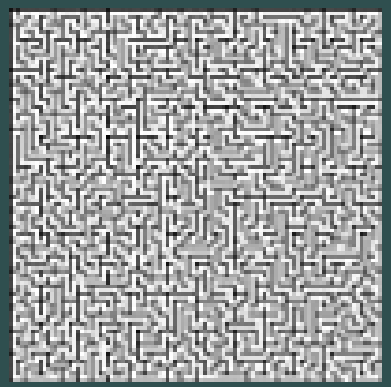

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- They explain how-possibly.

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- Probably not
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Characteristic examples

- Comparisons between (not necessarily abstract) algorithmic processes
  - Why is $\mathbb{A}$ more ____ than $\mathbb{B}$?

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  - What is a mechanism?

"The goal of understanding the world is a theoretical goal, and if the world is a machine—a vast arrangement of nomic connections—then our theory ought to give us some insight into the structure and workings of the mechanism, above and beyond the capability of predicting and controlling its outcomes" (Railton, 1978, p. 208).

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Mechanistic explanation

- Railton's DNP model
  - What is a mechanism?
    - Describable in terms of lawlike statements / D-N style argument.
    - Deliberately vague

"Calling for an account of the mechanism leaves open the nature of that account, and as far as I can see, the model explanations offered in scientific texts are D-N when complete, D-N sketches when not" (Railton, 1978, p. 208).

Mechanistic explanation

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  - Aim: to describe the “causal nexus”
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    - Mark transmission (Salmon, 1984); invariant quantity (Salmon, 1994); conserved quantity (Salmon, 1997).

Complex systems approach ("New Mechanism"):

"A mechanism for a behavior is a complex system that produces that behavior by the interaction of a number of parts, where the interactions between parts can be characterised by direct, invariant, change-relating generalisations" (Glennan, 2002, p. S344).

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  - description of a mechanism's behaviour
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Cf. Anderson (2014a,b), Piccinini (2007), Craver (2007), etc.

"New Mechanism"

- Anti-reductionist
- Metaphysically agnostic

"It is not explicitly anti-metaphysical but rather metaphysically agnostic. The anti-reductive character of Mechanism_1 allows us to make methodological recommendations about investigating the world ... without thereby committing ourselves to a single account of what that world is like" (Anderson, 2014a, p. 276).

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- Anti-metaphysical
    - No presuppositions regarding underlying entities and dynamical processes

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Hughes (1989b)

- SE, unlike ME, is anti-metaphysical
  - No presuppositions regarding the character of underlying entities and dynamical processes (and no account of them either)

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Felline (2015)

- SE, unlike ME, is non-mechanistic
  - No account of underlying entities and dynamical processes
  - SE not necessarily non-metaphysical?

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Algorithmic How-Possibly Explanation

- Structural explanation?

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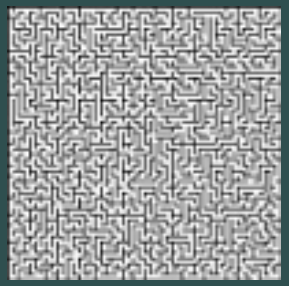
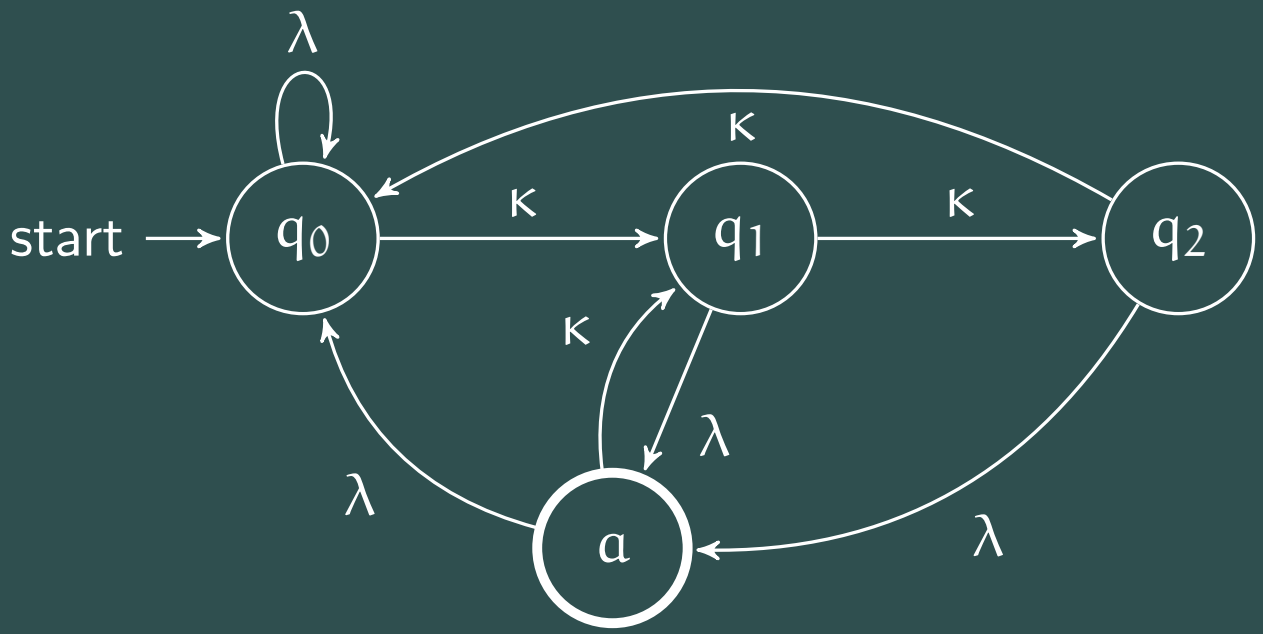


`SelectionSort`

Algorithmic How-Possibly Explanation

- Structural explanation?



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    partition(arr, mid + 1, high);
    // once the list is partitioned, call the
    // main merge sort procedure
    mergeSort(arr, low, mid, high);
  }
}

void MergeSort(int arr[], int low,
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  int i, m, k, l, temp[MAX];

  l = low;
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  while ((l <= mid) && (m <= high)){
    if (arr[l] <= arr[m]){
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Distinct type (appears to be):

- Shares features with both types of explanation
- But differs from each

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Thanks!