

Query Optimization

Exercise Session 6

Bernhard Radke

December 12, 2016

Generating Permutations

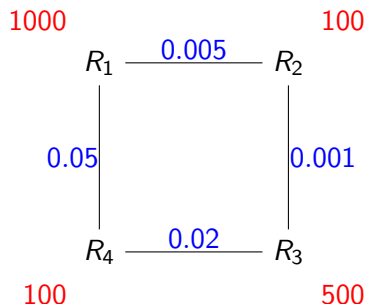
ConstructPermutationsRec(P, R, B)

Input: a prefix P , remaining relations R , best plan B

Output: side effects on B

```
if  $|R| = 0$  {  
  if  $B = \epsilon \vee C(B) > C(P)$  {  
     $B = P$   
  }  
} else {  
  for each  $R_i \in R$  {  
    if  $C(P \circ \langle R_i \rangle) \leq C(P[1 : |P| - 1] \circ \langle R_i, P[|P|] \rangle)$  {  
      ConstructPermutationsRec( $P \circ \langle R_i \rangle, R \setminus \{R_i\}, B$ )  
    }  
  }  
}
```

Generating Permutations



- ▶ Keep current prefix and the rest of relations
- ▶ Extend the prefix only if exchanging the last two relations does not result in a cheaper sequence

Memoization

- ▶ DP: bottom-up construction of the join tree
- ▶ Memoization: top-down construction
- ▶ Memoize already generated join tree to avoid duplicate work
- ▶ Sometimes more efficient

Algorithms: Roadmap

- ▶ Deterministic
 - ▶ Exact (IKKBZ, DP, Permutations, Memoization,...)
 - ▶ Heuristics (GOO, MVP, Query Simplification,...)
- ▶ Probabilistic
- ▶ Hybrid

Random left-deep trees with cross products

- ▶ there are $n!$ trees (every tree - permutation)
- ▶ let's generate a random number in $[0, n![$
- ▶ *unranking* - for a generated number construct a tree
- ▶ *ranking* - for a tree define it's number

Generating random permutations

for each $k \in [0, n[$ **descending**
 $\text{swap}(\pi[k], \pi[\text{random}(k)])$

Array π initialized with elements $[0, n[$.

$\text{random}(k)$ generates a random number in $[0, k[$.

Unranking

Unrank(n, r)

Input: the number n of elements to be permuted
and the rank r of the permutation to be constructed

Output: a permutation π

for each $0 \leq i < n$

$$\pi[i] = i$$

for each $n \geq i > 0$ **descending** {

 swap($\pi[i - 1], \pi[r \bmod i]$)

$$r = \lfloor r/i \rfloor$$

}

return π ;

Random join trees with cross products

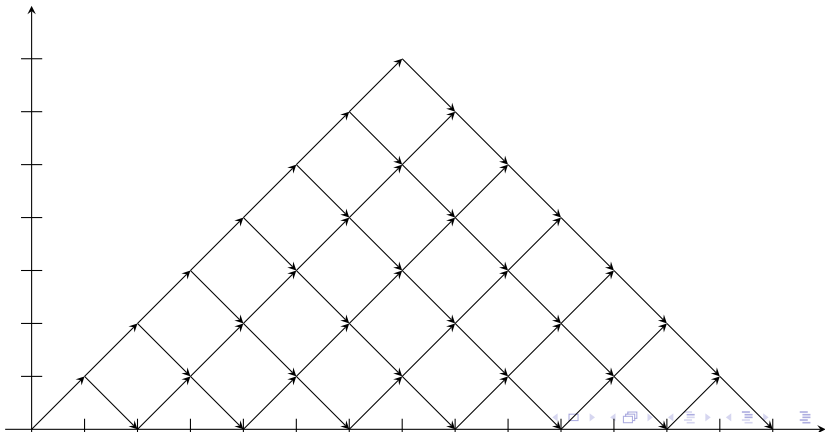
- ▶ Generate a tree, then generate a permutation: $C(n - 1)$ trees, $n!$ permutations
- ▶ Pick a random number $b \in [0, C(n - 1)[$, *unrank* b
- ▶ Pick a random number $p \in [0, n![$, *unrank* p
- ▶ Attach the permutation to the leaves

Unranking

- ▶ every tree is a word in $\{(,)\}$
- ▶ map such words to the grid, every step up is (, down)

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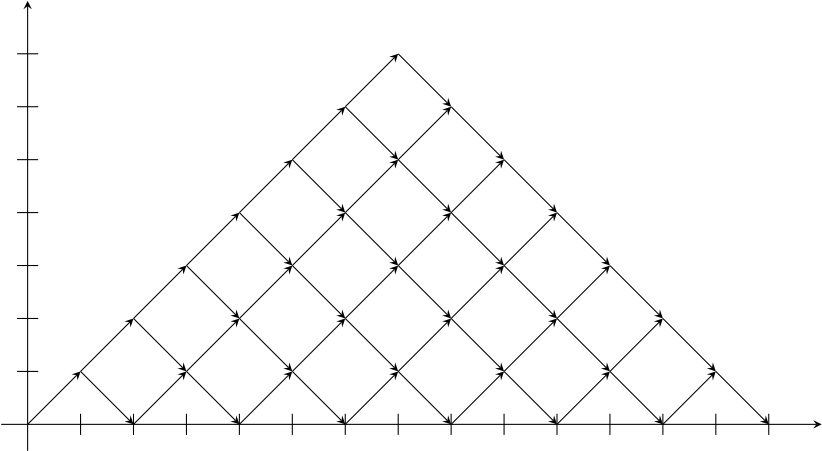
Unranking

- ▶ every tree is a word in $\{(,)\}$
- ▶ map such words to the grid, every step up is (, down)
- ▶ the number of different paths q can be computed (see lectures)
- ▶ Procedure: start in $(0,0)$, walk up as long as rank is smaller than q . When it is bigger, step down, $rank = rank - q$

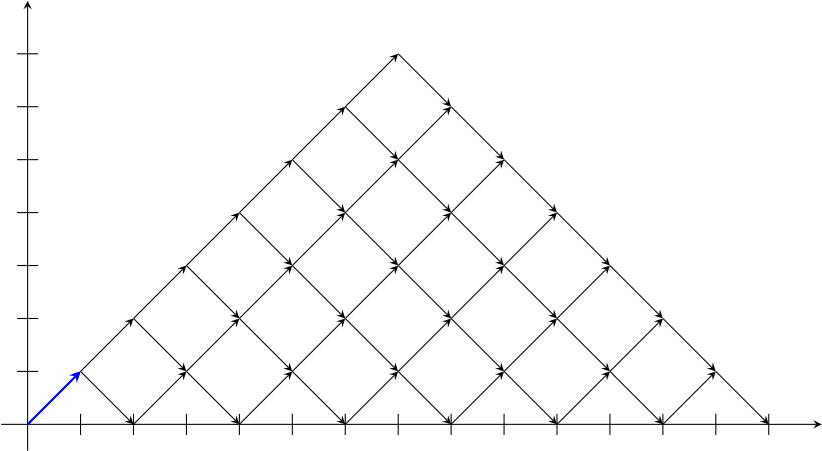
Example

- ▶ Bushy tree number 56, 8 leaves

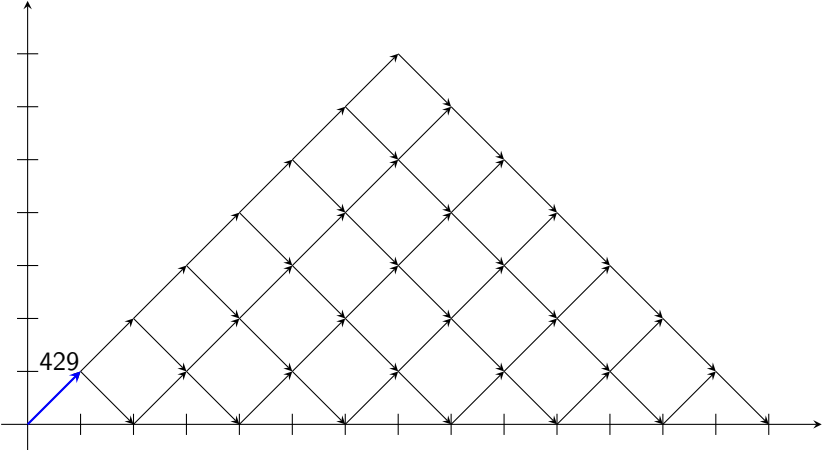
Random Join Tree Selection



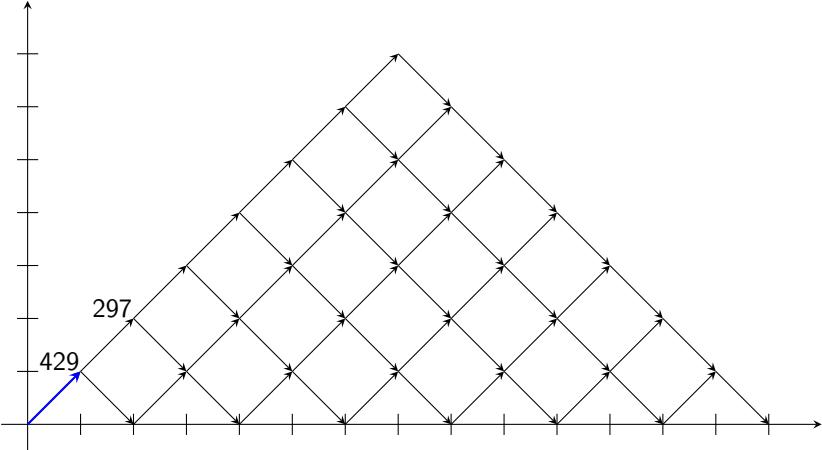
Random Join Tree Selection



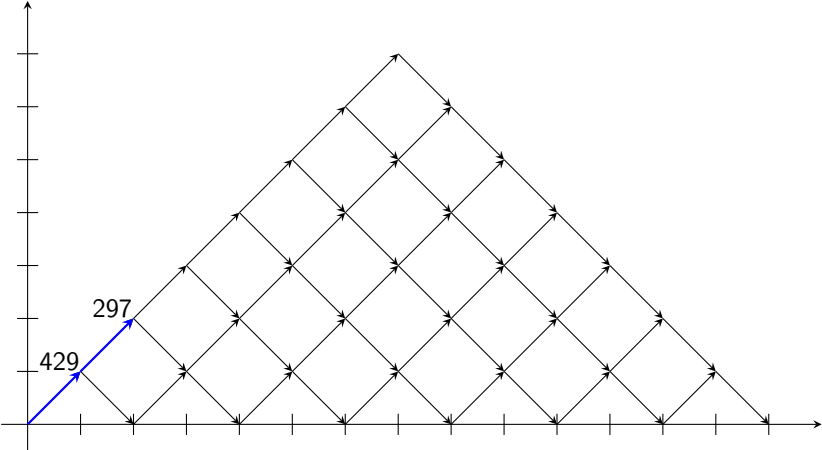
Random Join Tree Selection



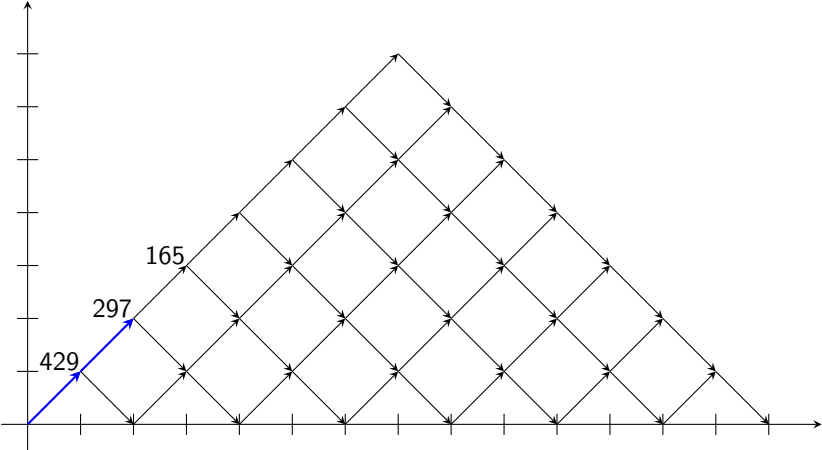
Random Join Tree Selection



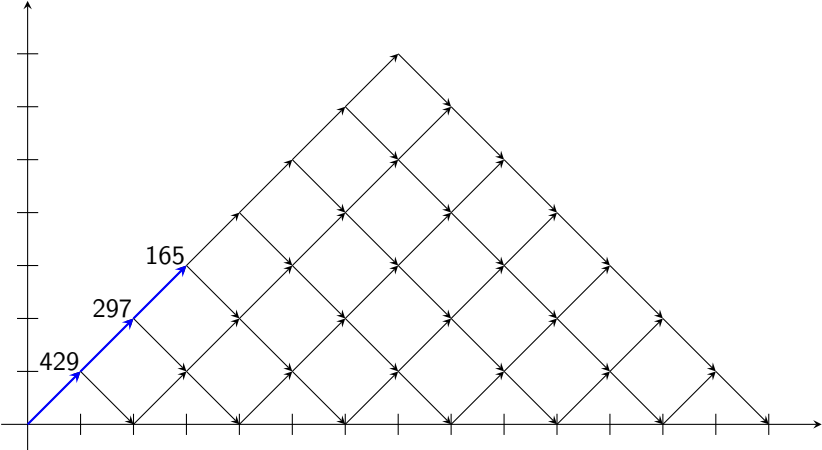
Random Join Tree Selection



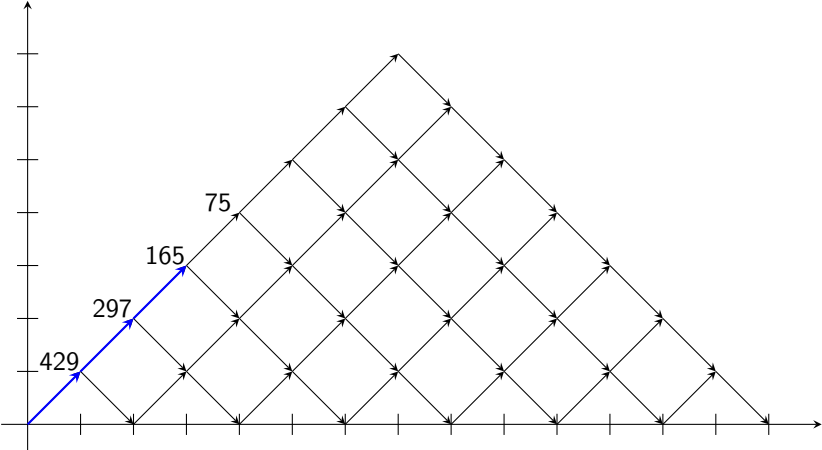
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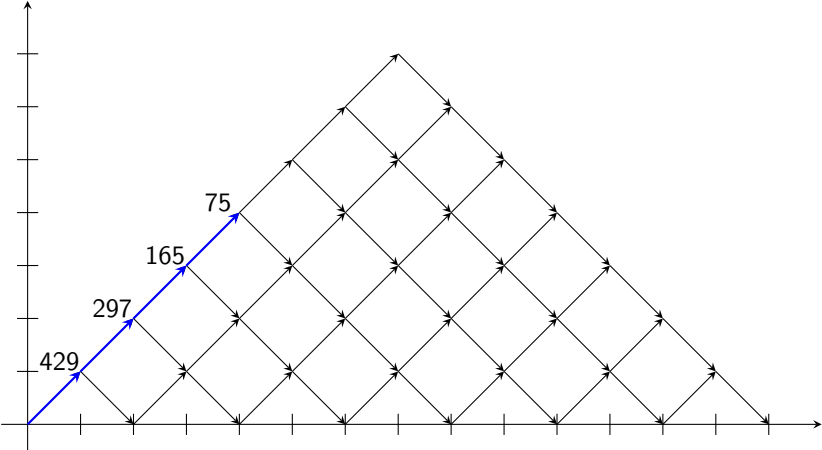
Random Join Tree Selection



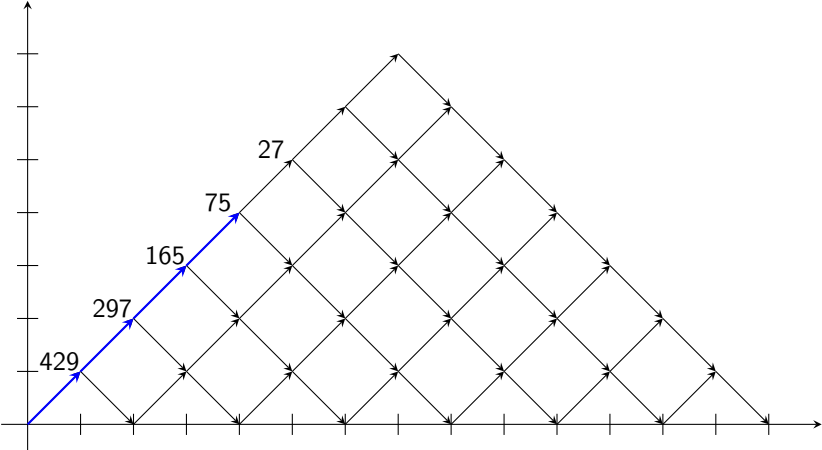
Random Join Tree Selection



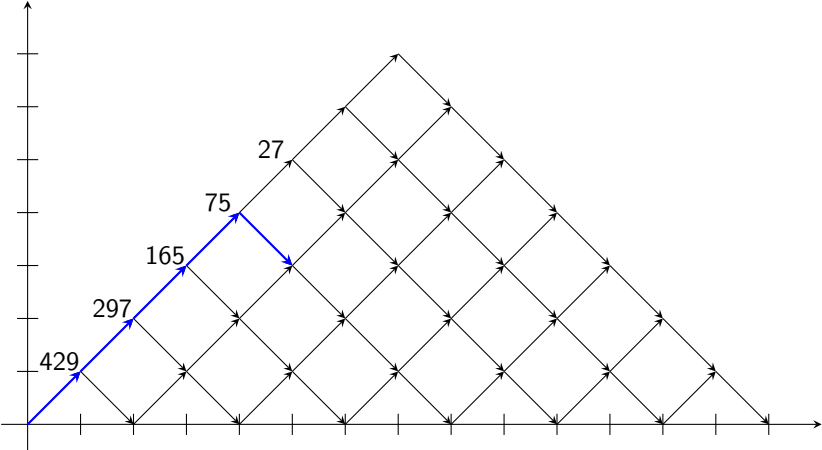
Random Join Tree Selection



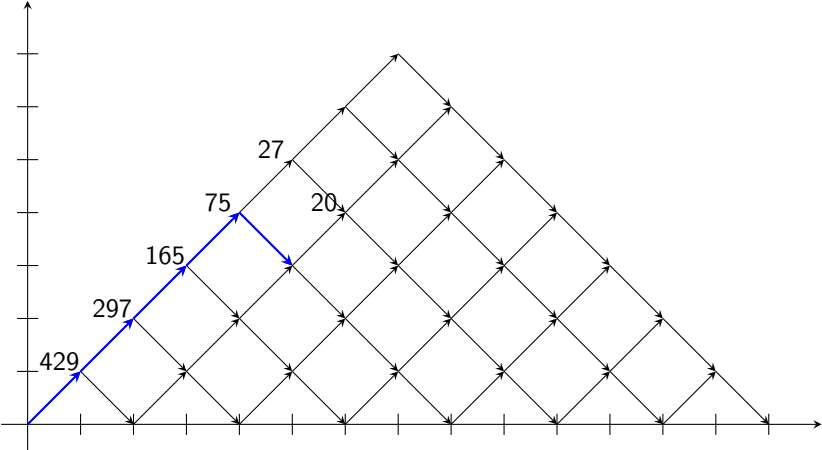
Random Join Tree Selection



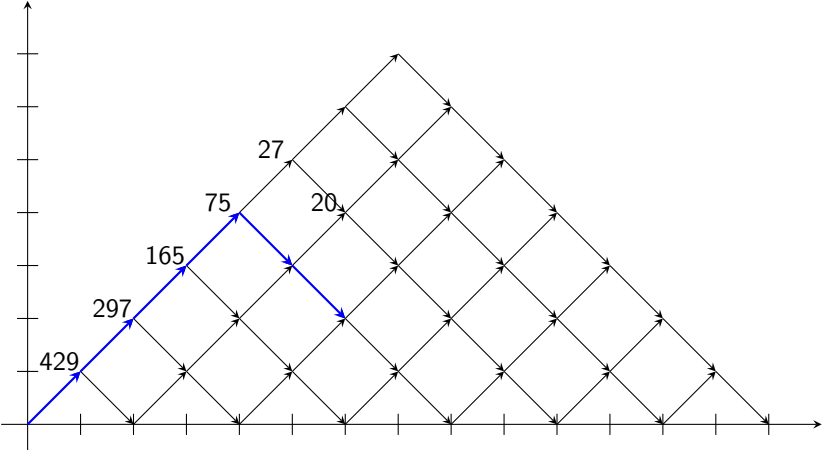
Random Join Tree Selection



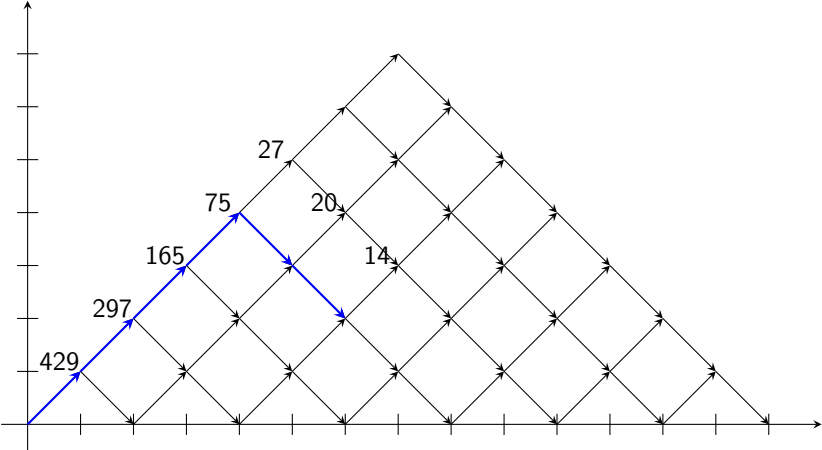
Random Join Tree Selection



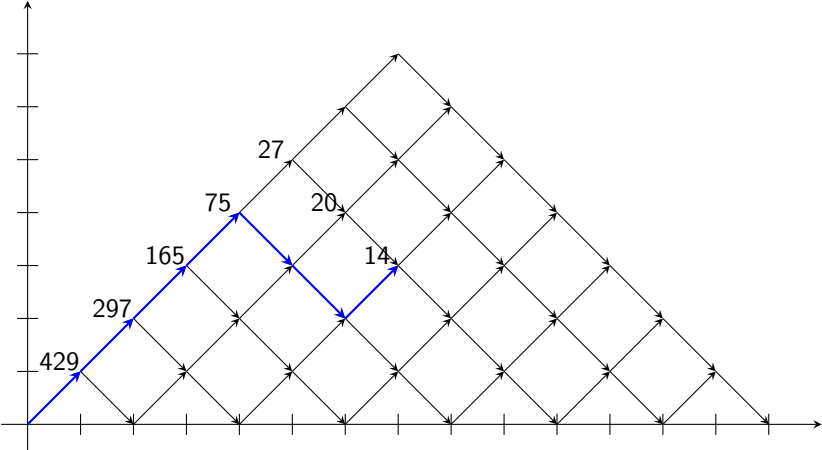
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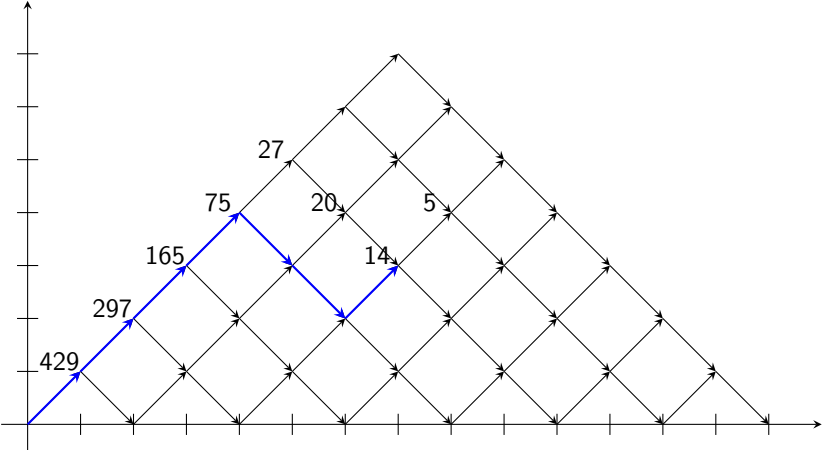
Random Join Tree Selection



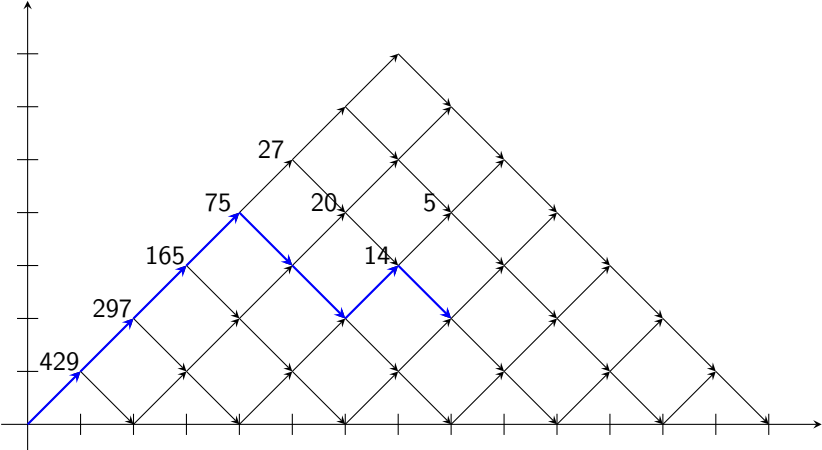
Random Join Tree Selection



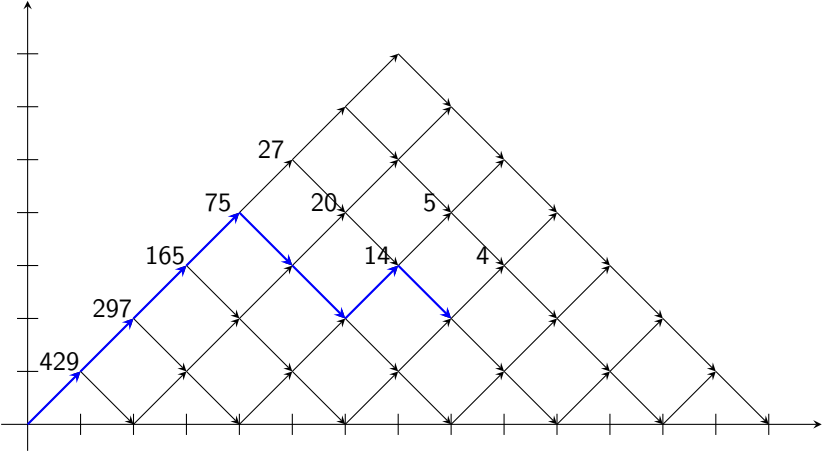
Random Join Tree Selection



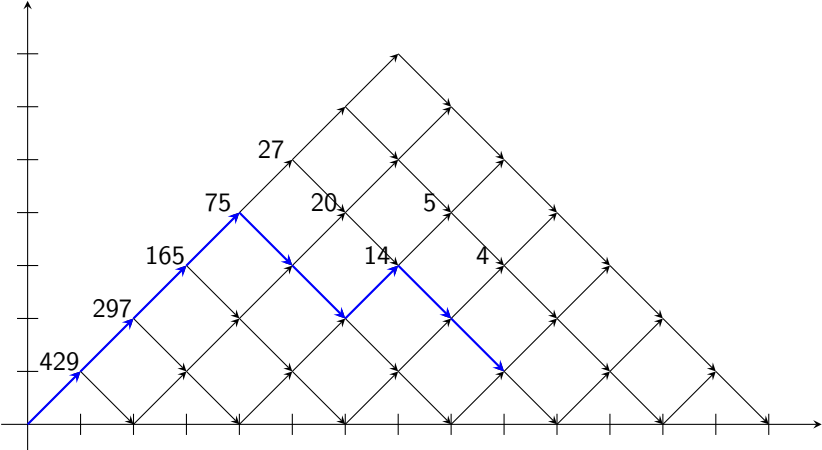
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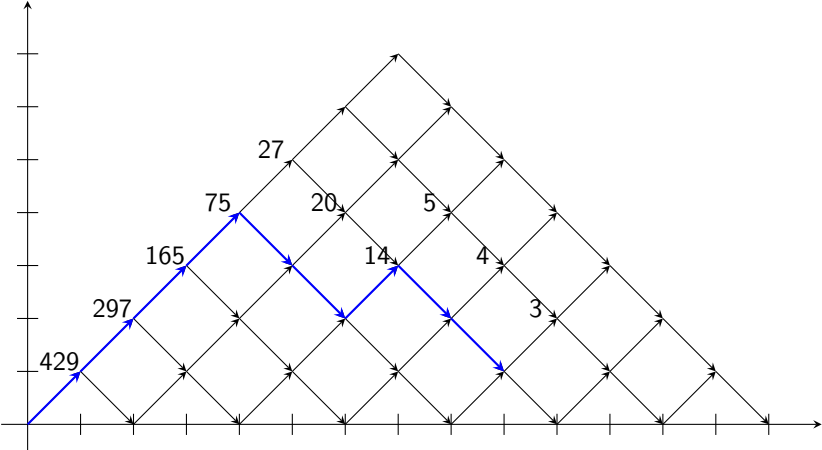
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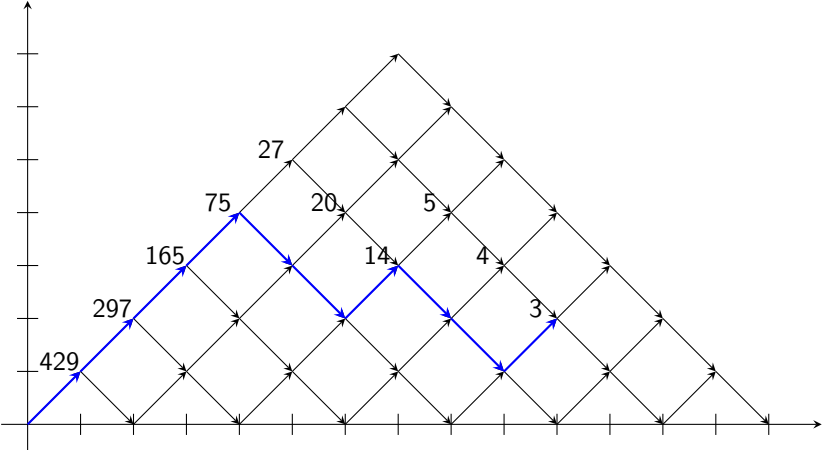
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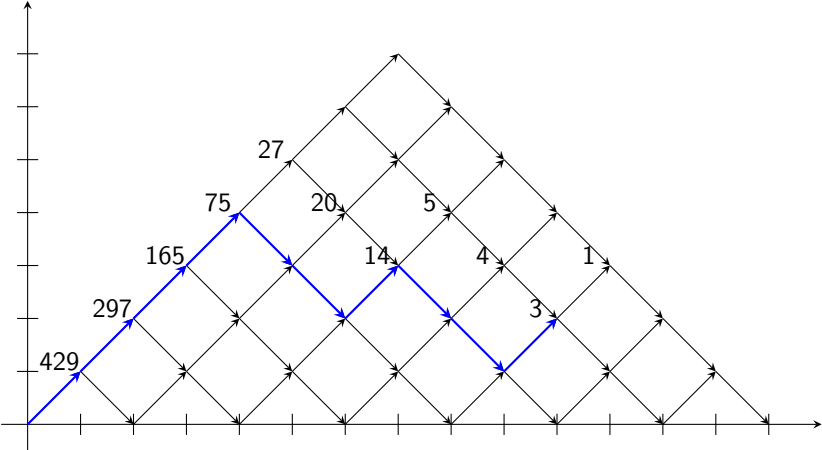
Random Join Tree Selection



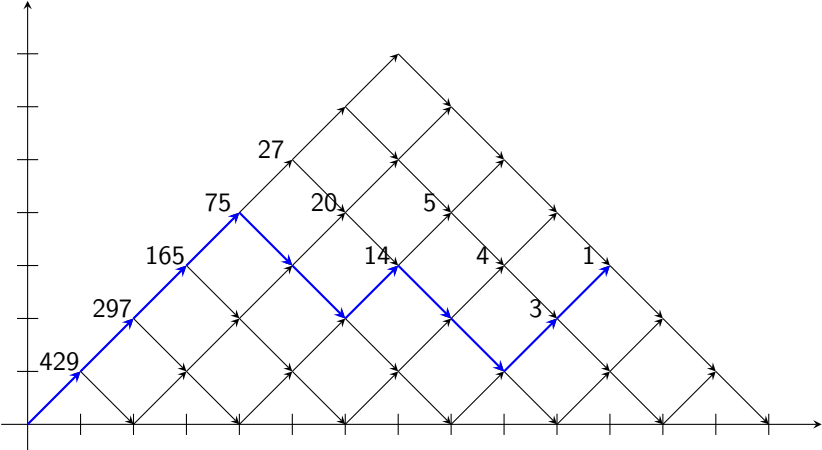
Random Join Tree Selection



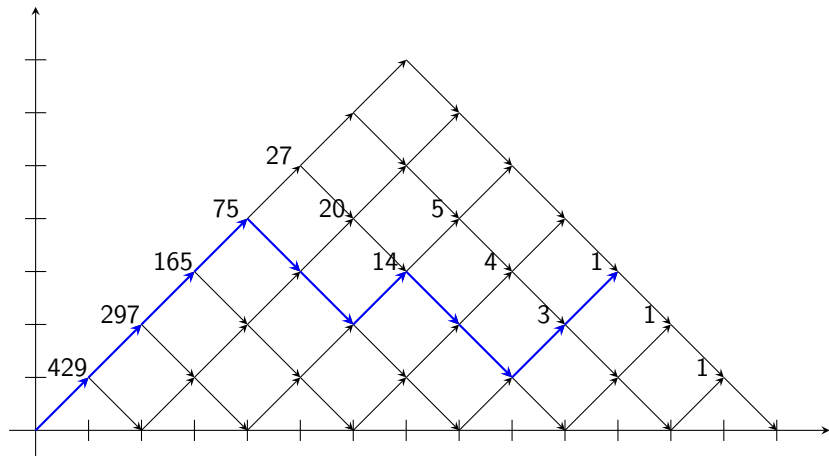
Random Join Tree Selection



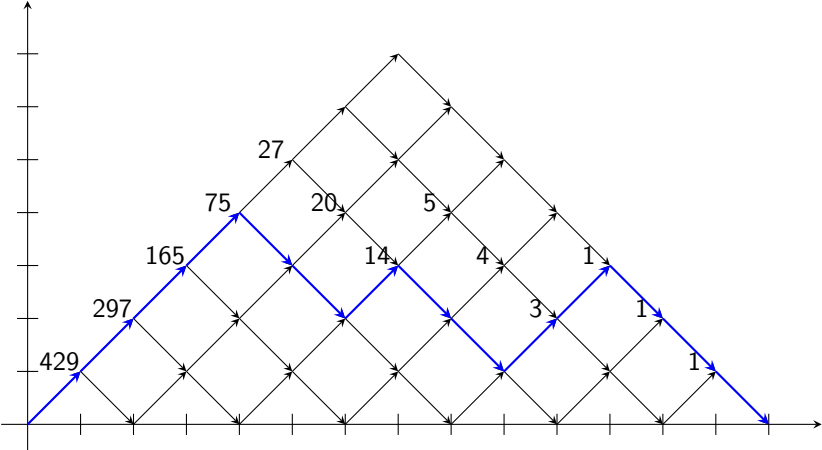
Random Join Tree Selection



Random Join Tree Selection



Random Join Tree Selection



Info

- ▶ Exercises due: 9 AM, December 19, 2016