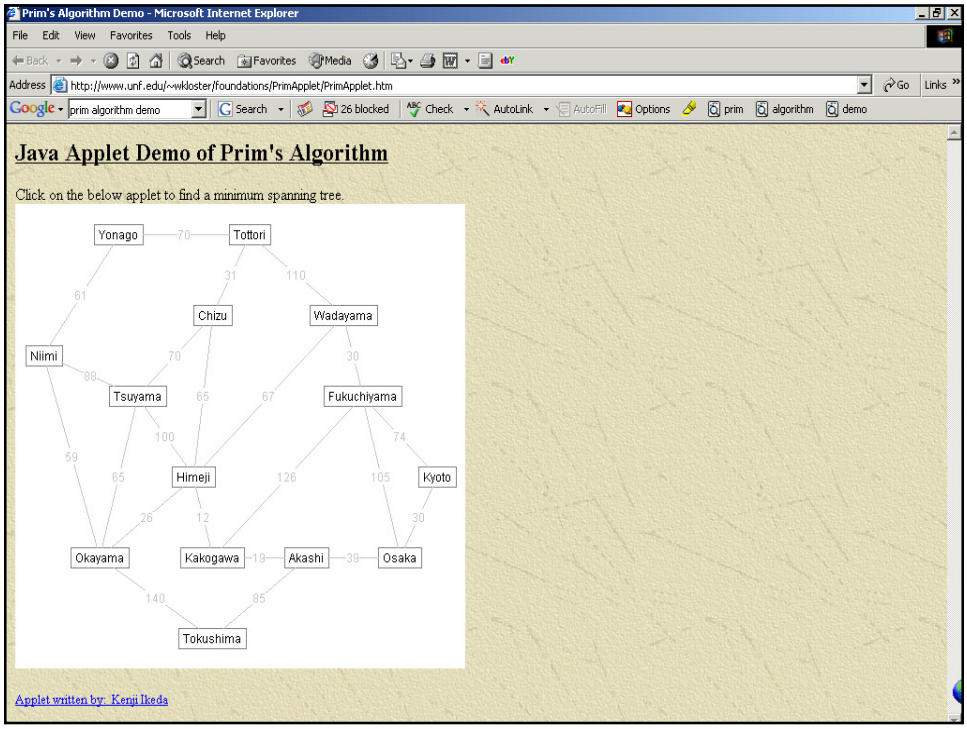
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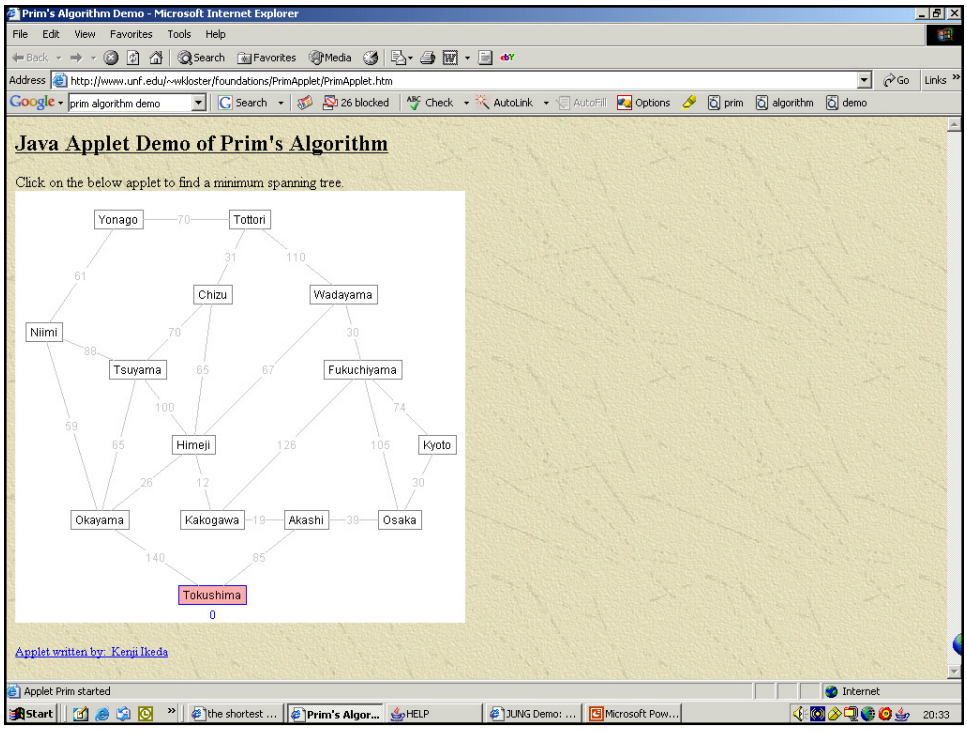
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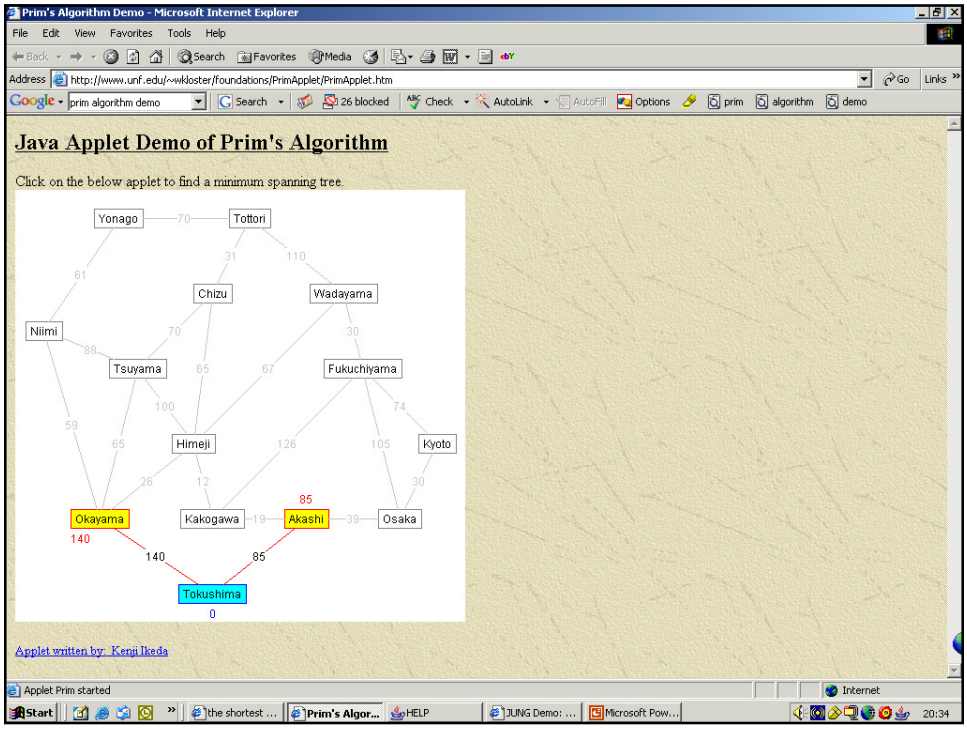
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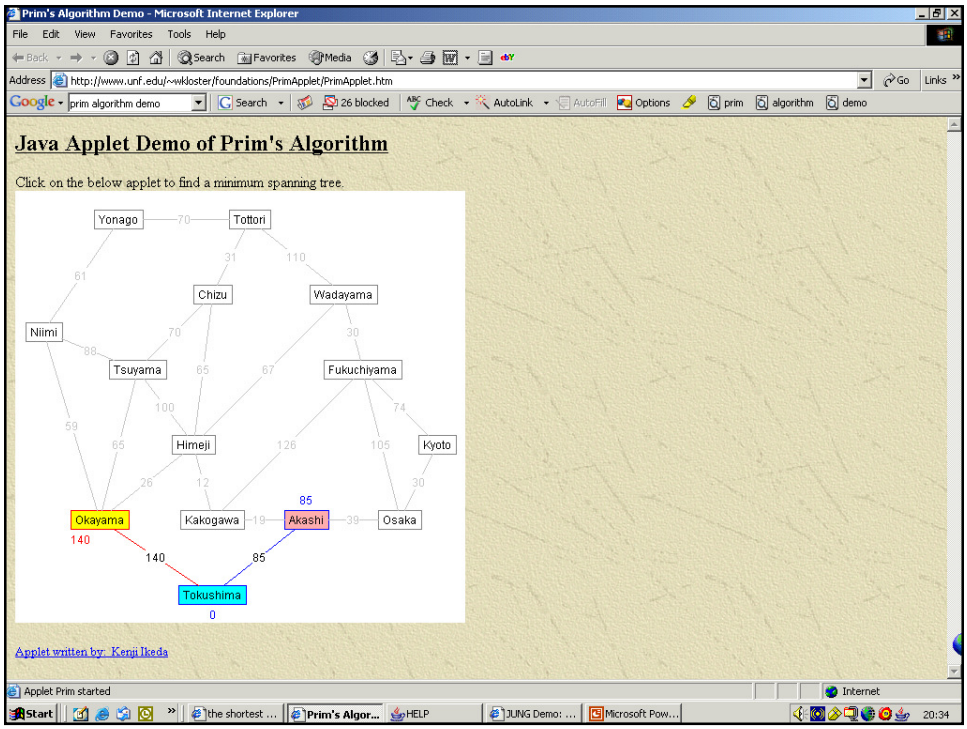
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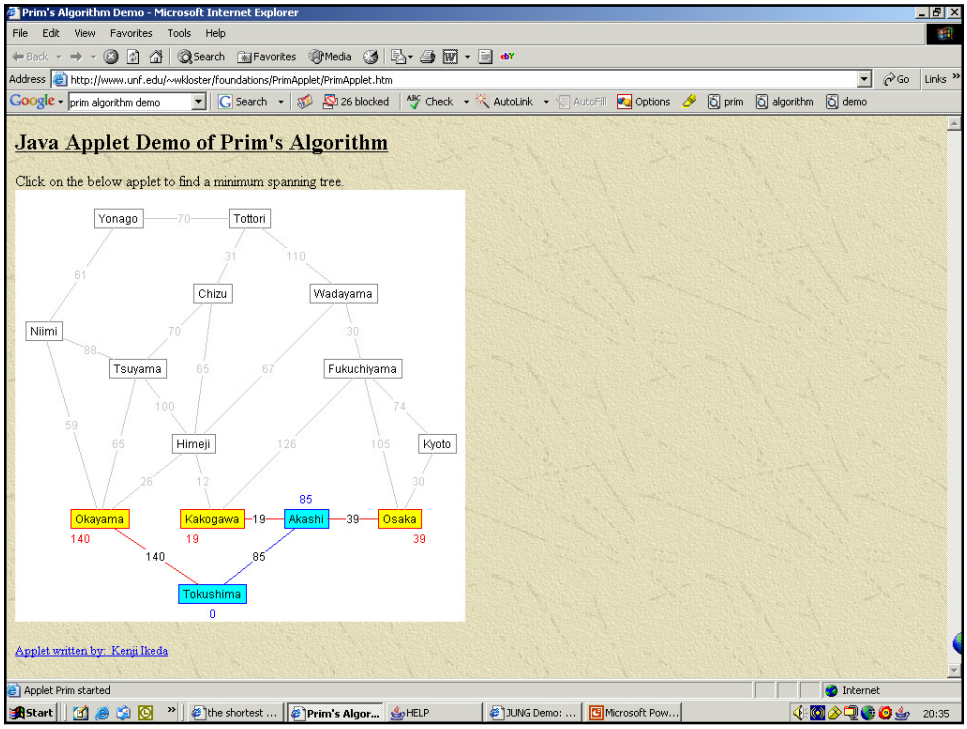
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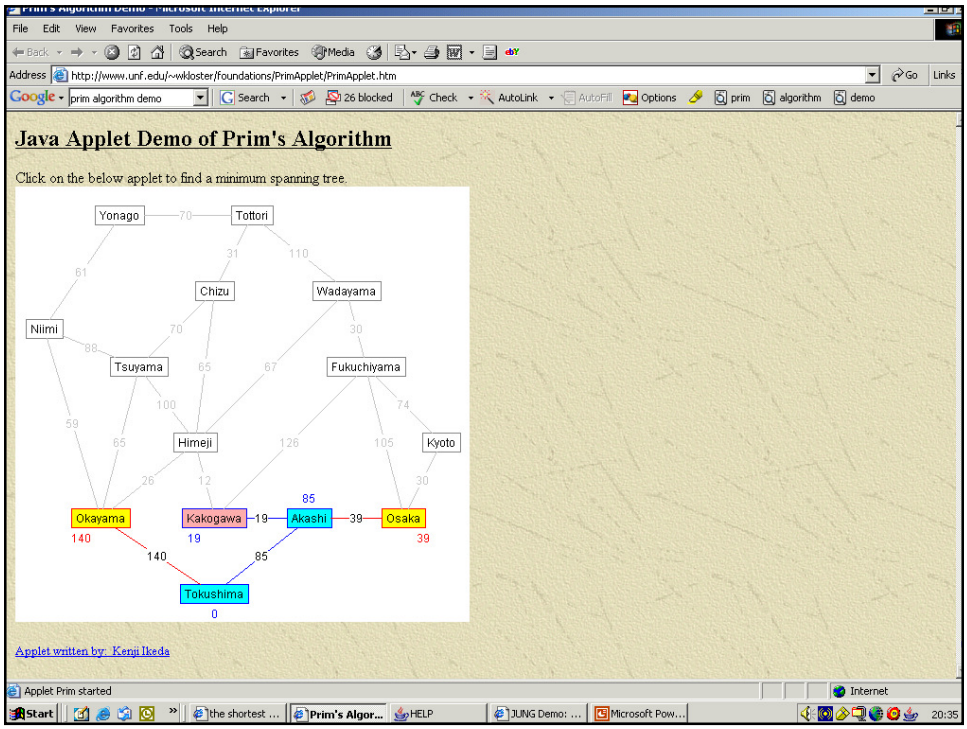
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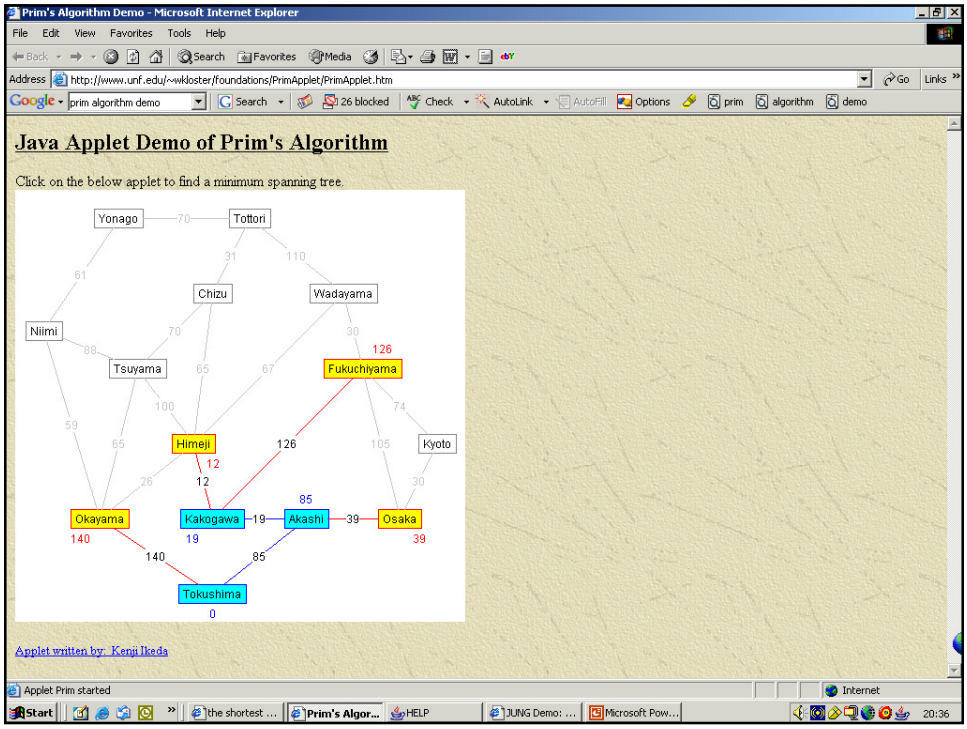
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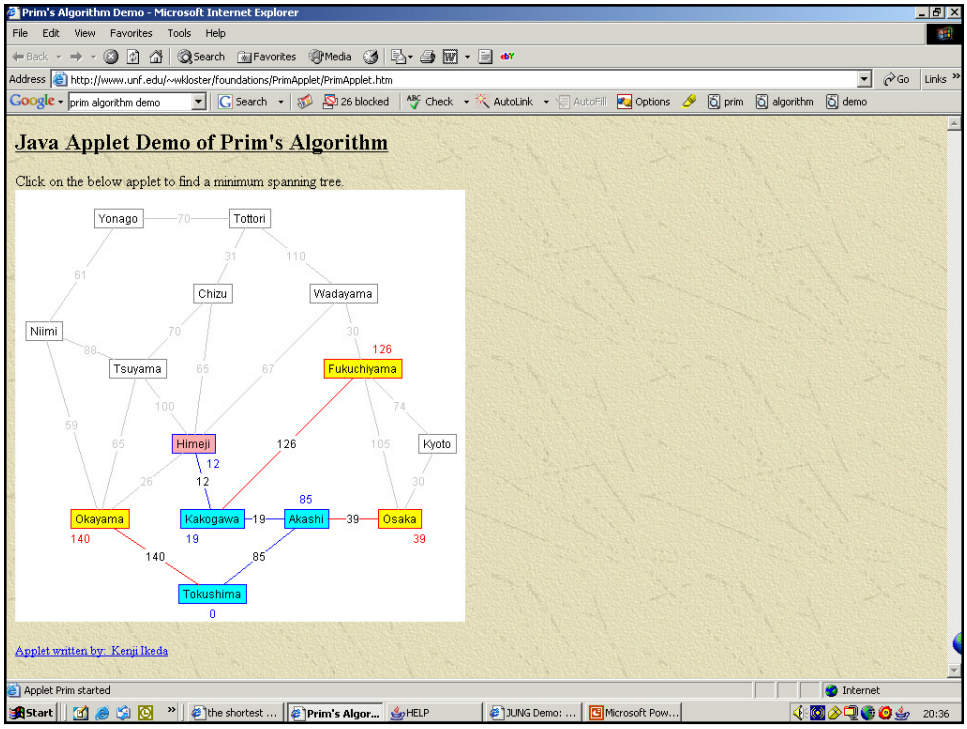
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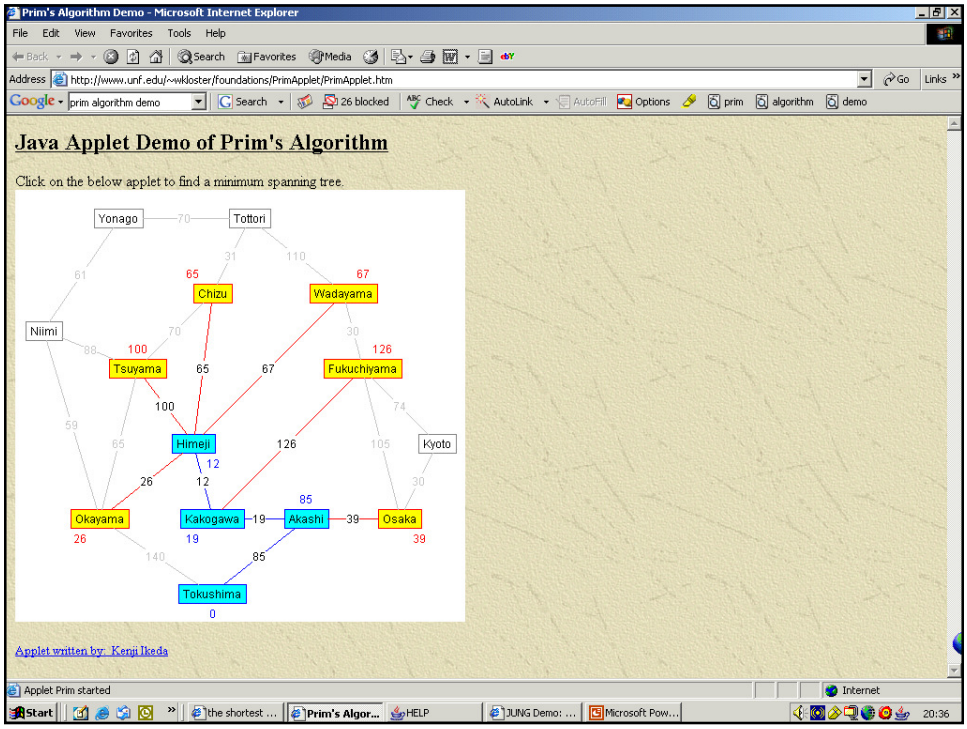
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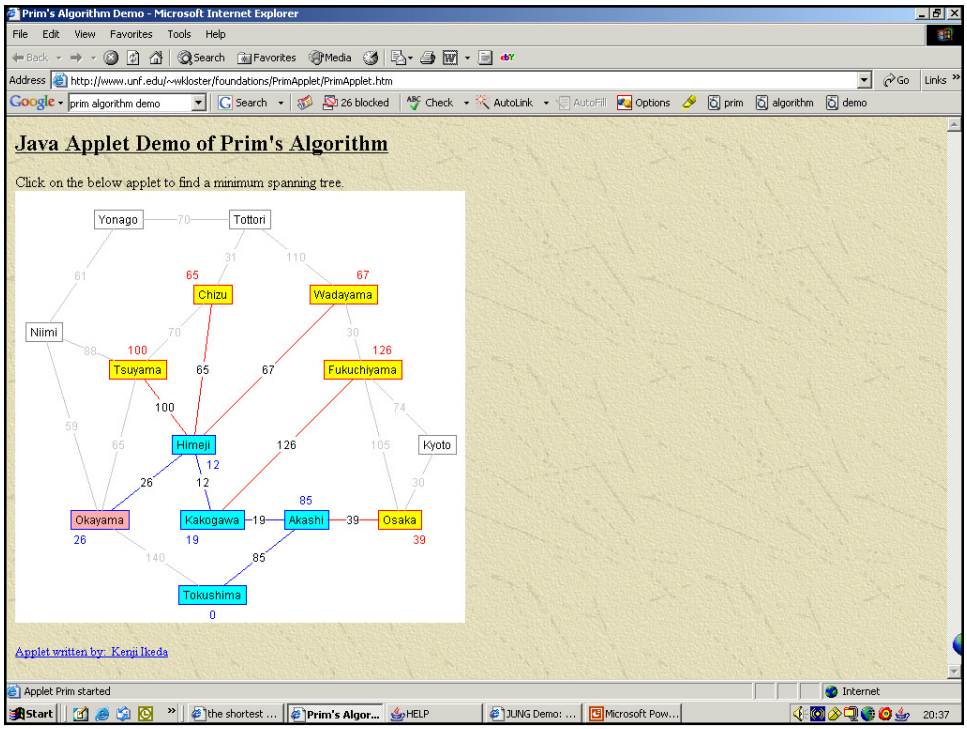
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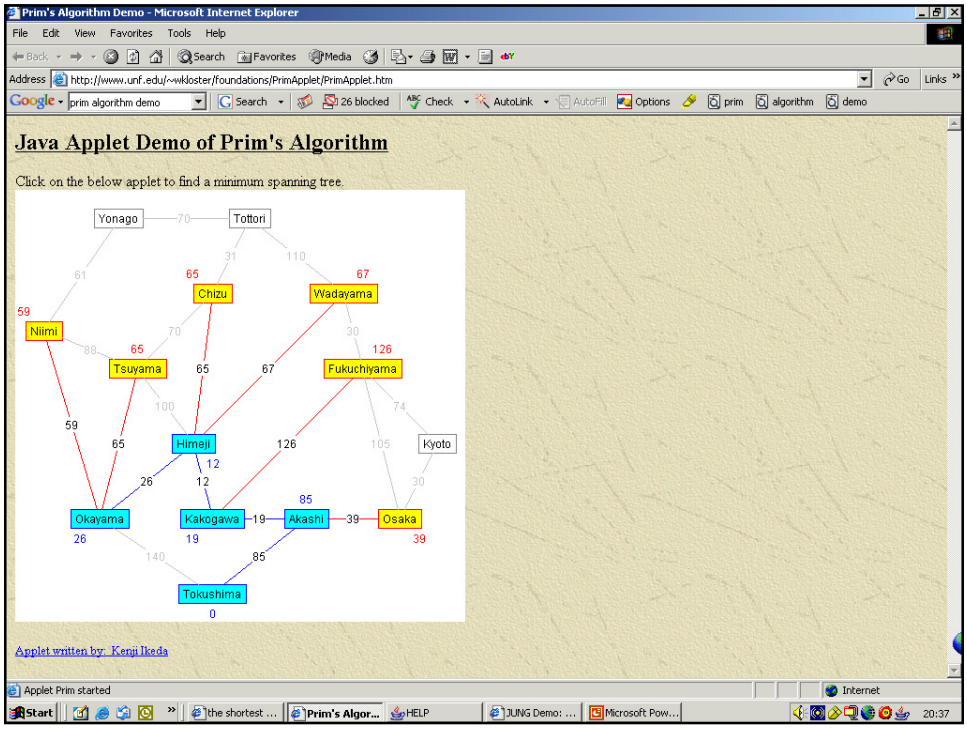
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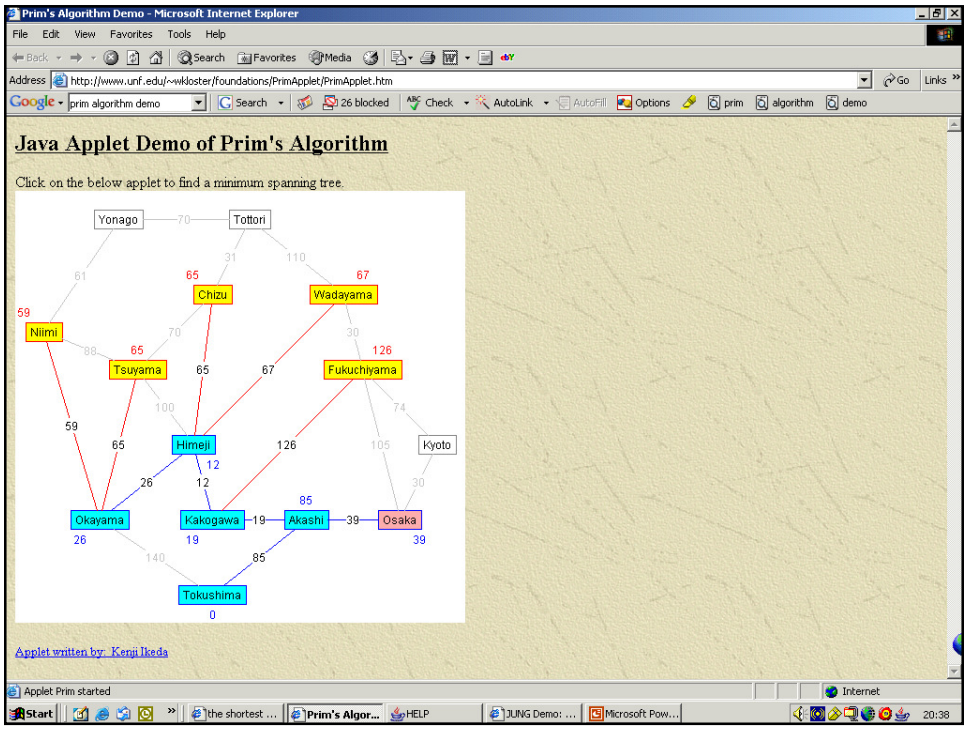
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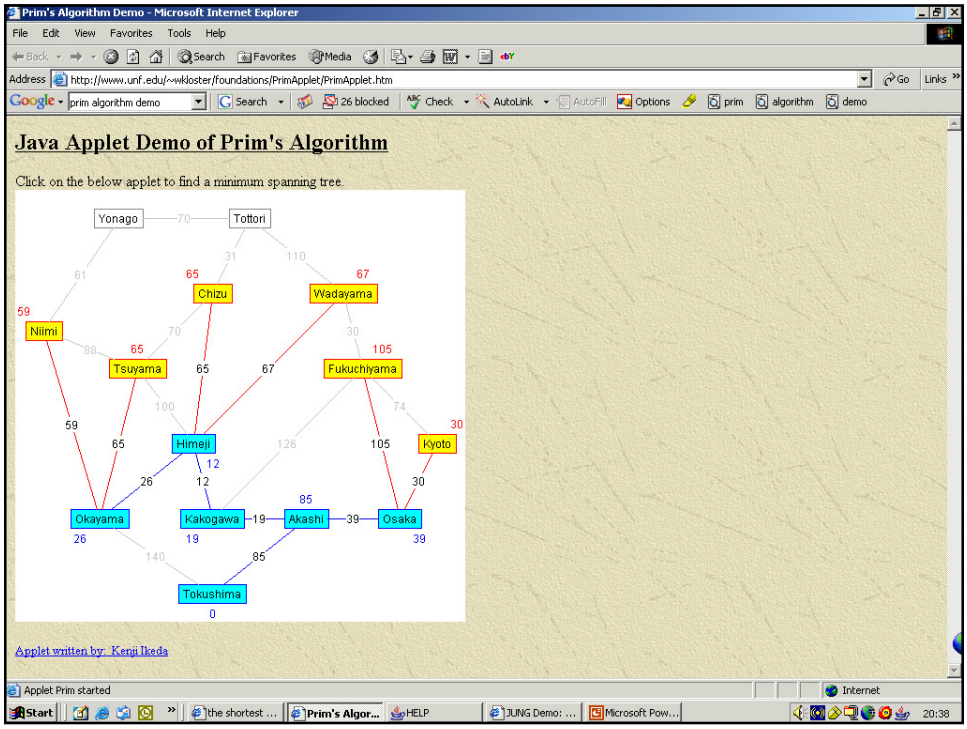
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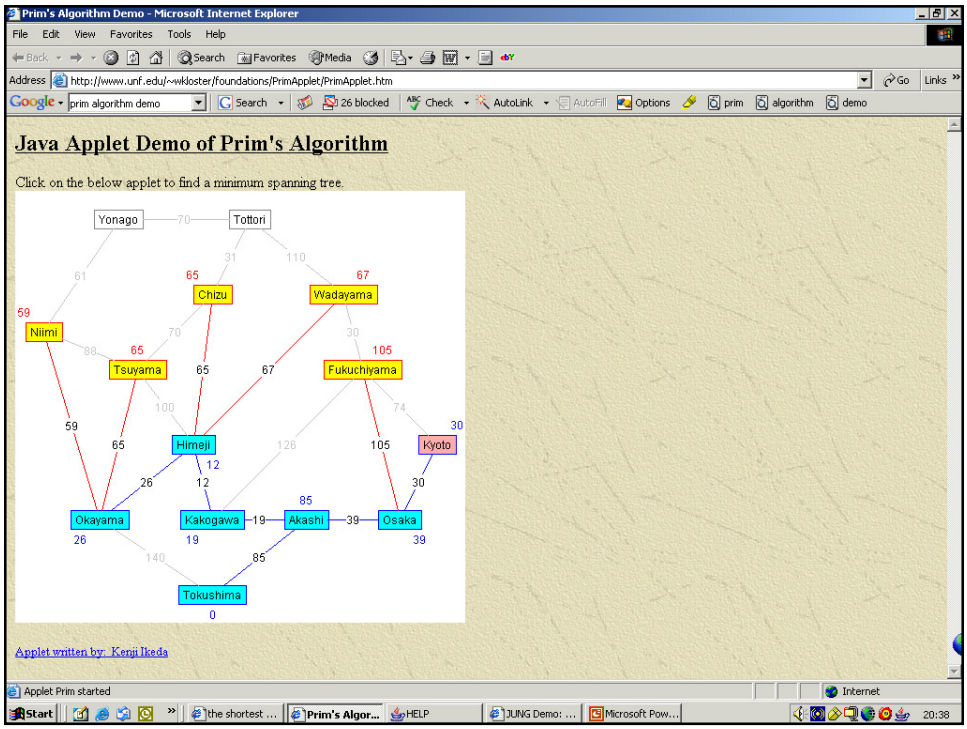
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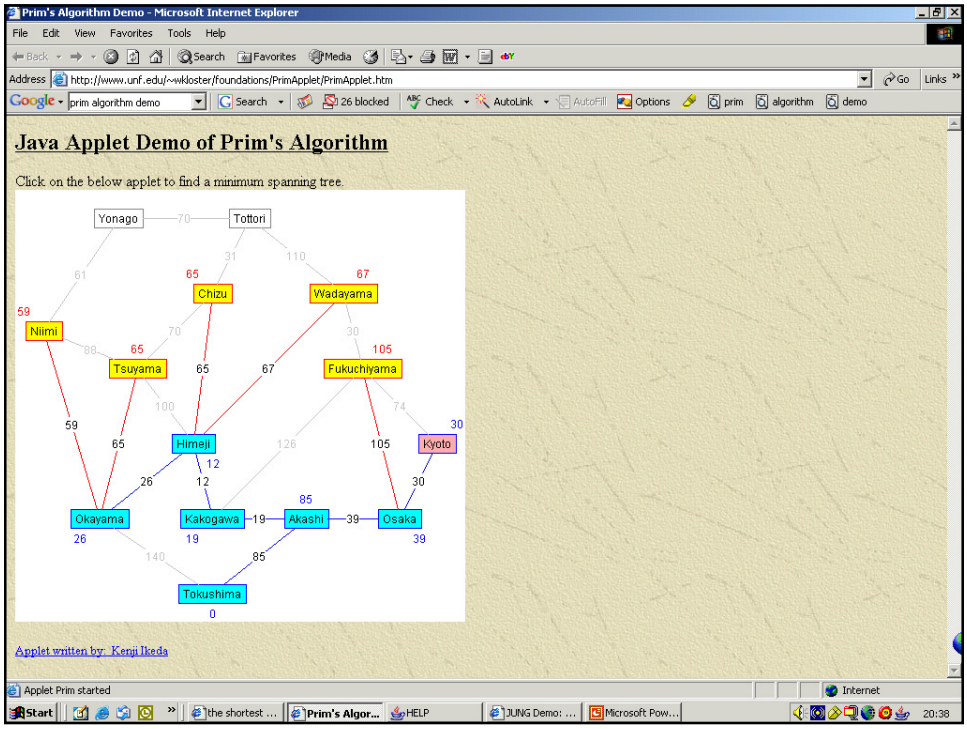
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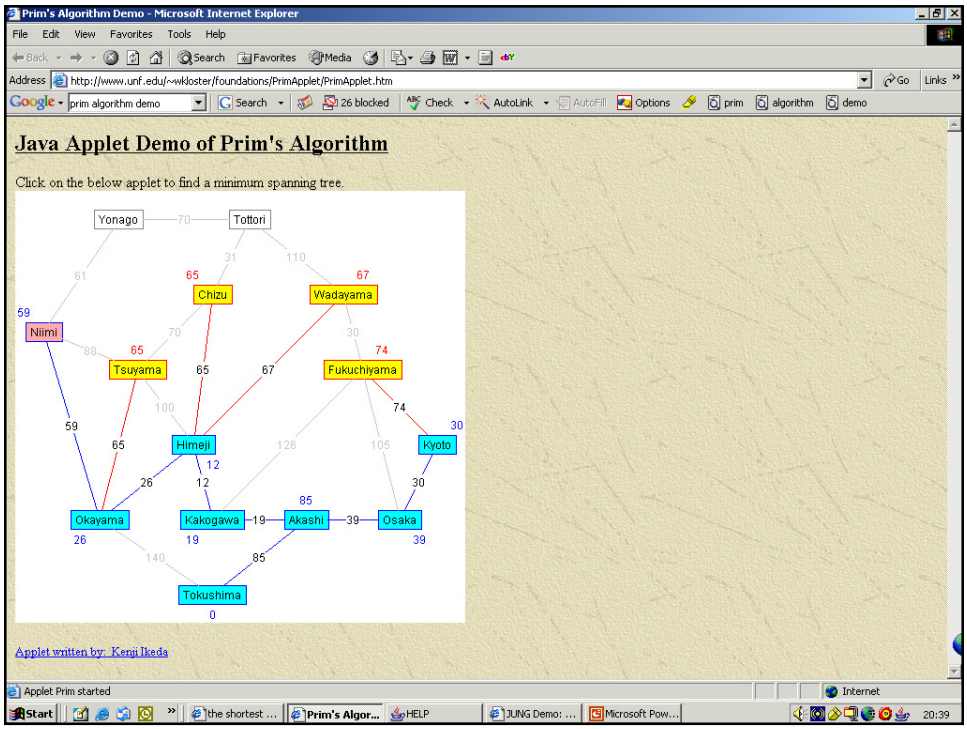
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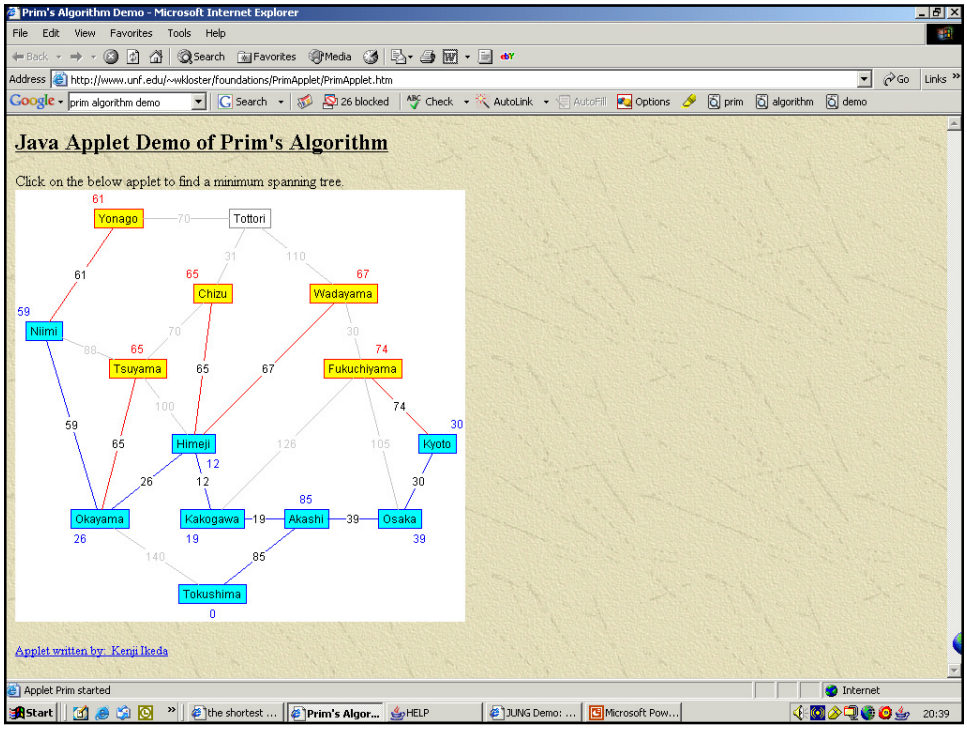
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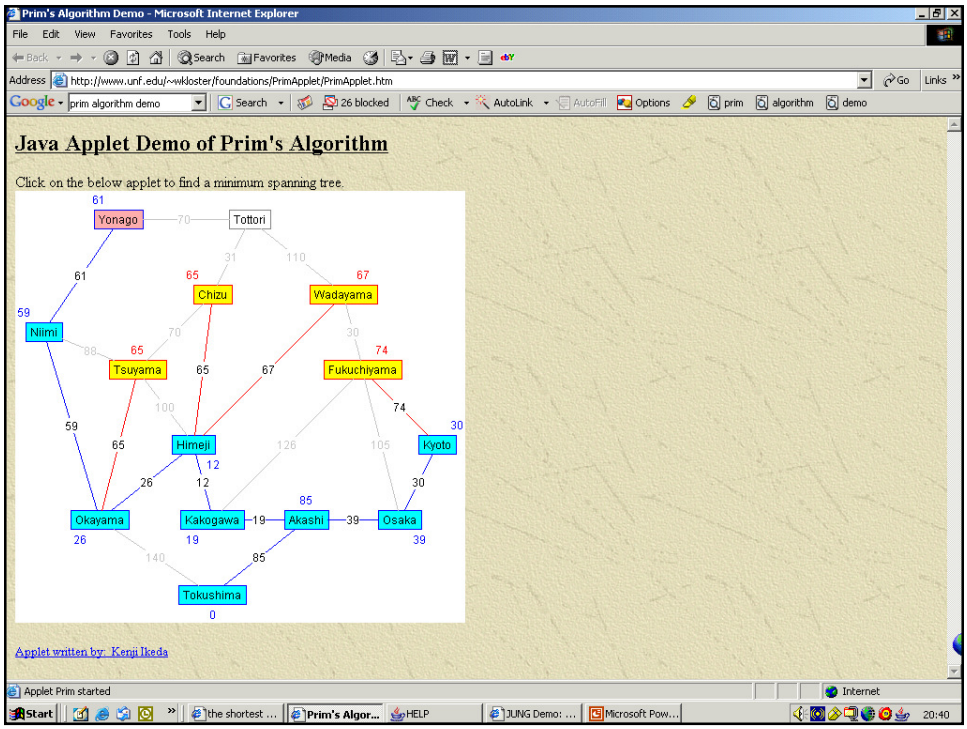
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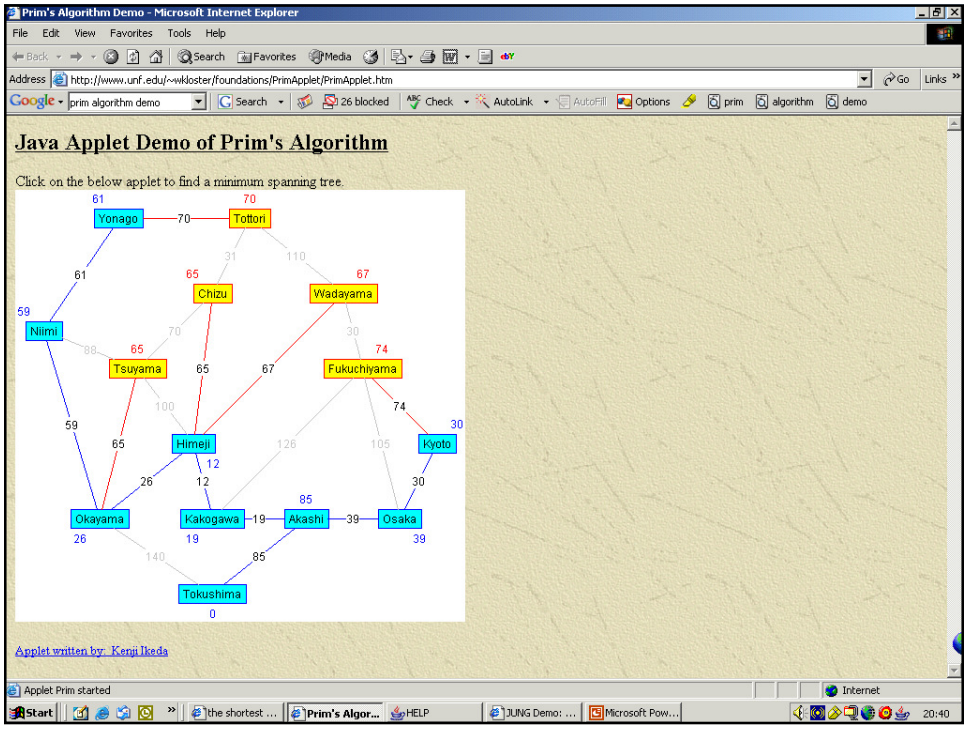
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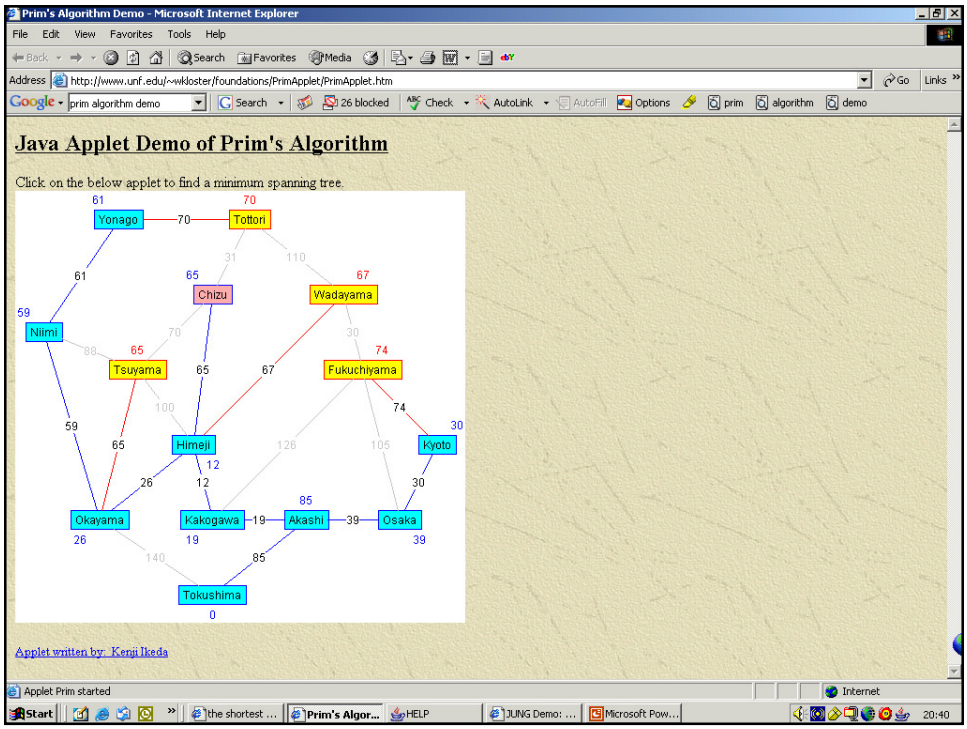
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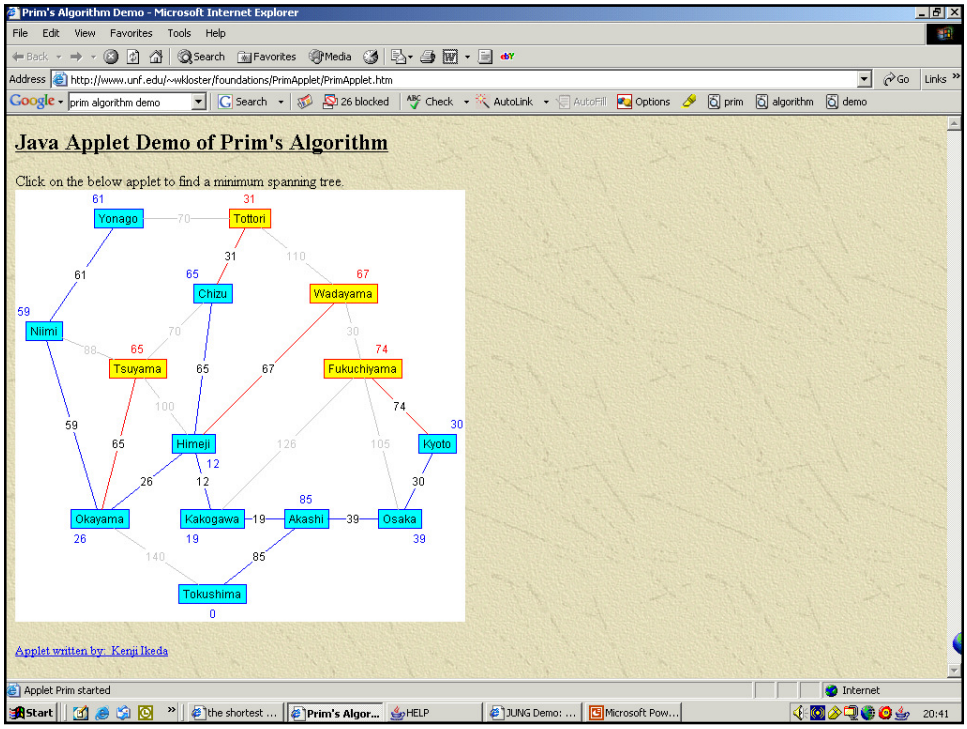
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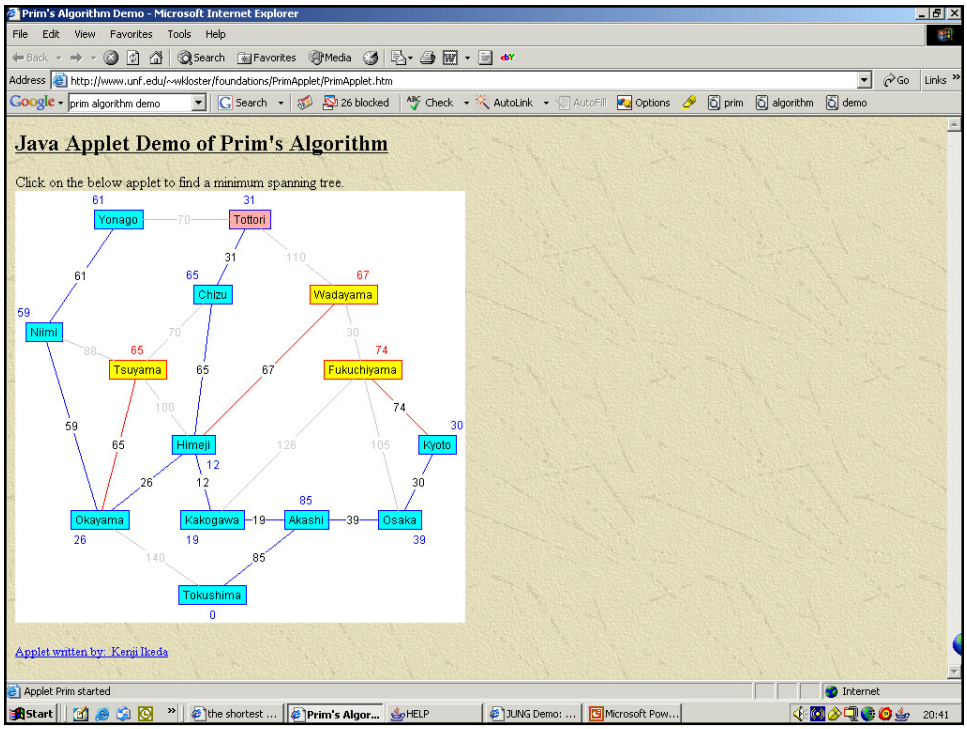
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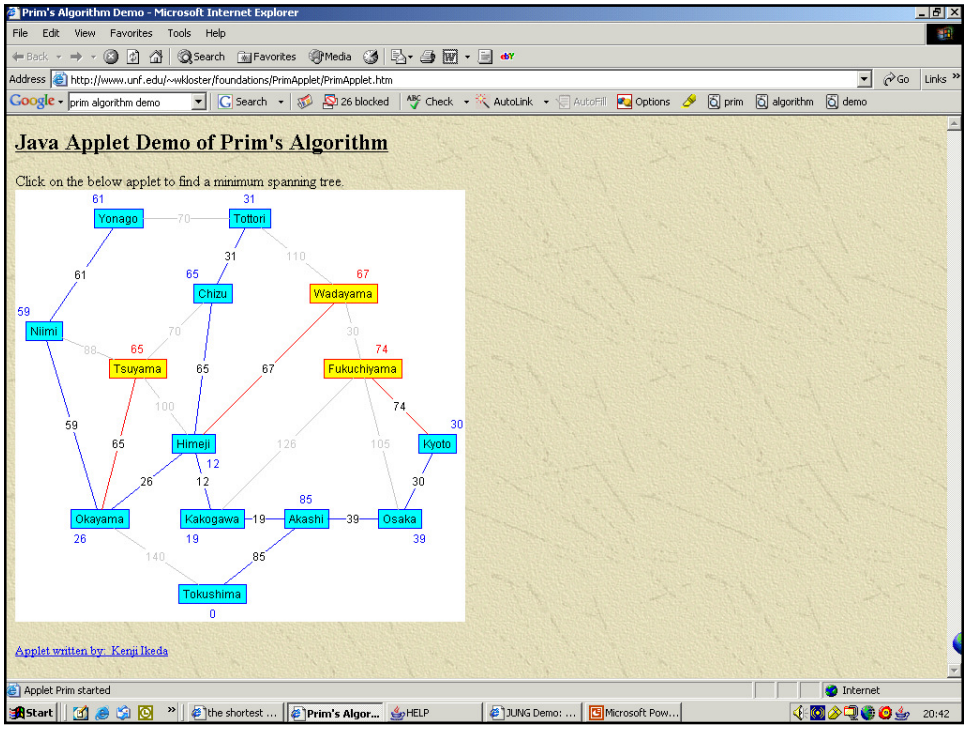
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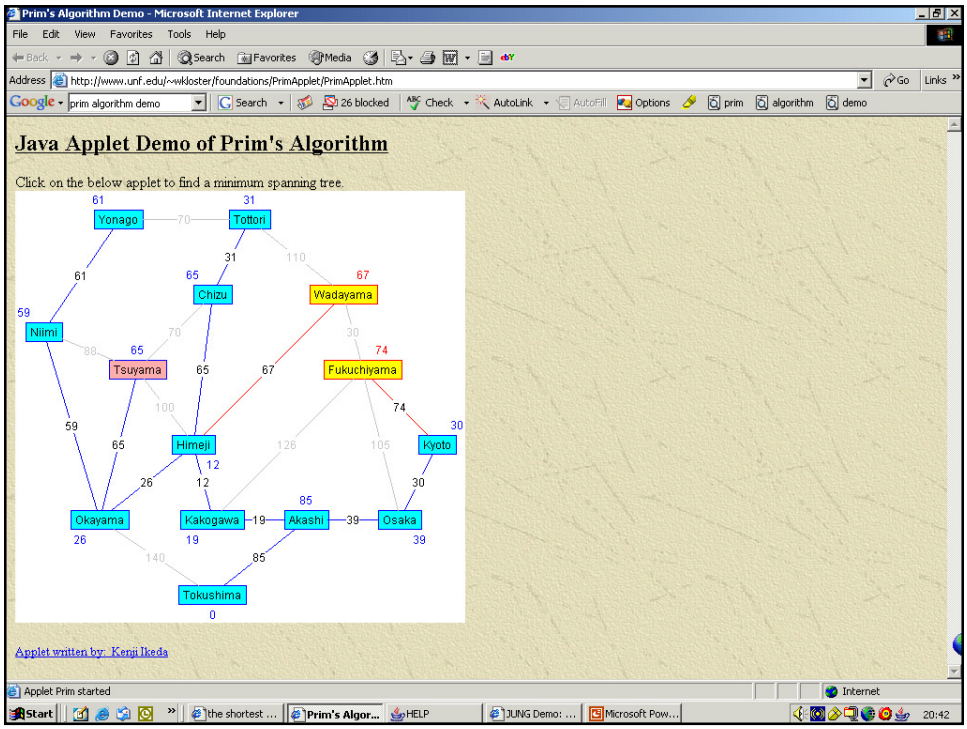
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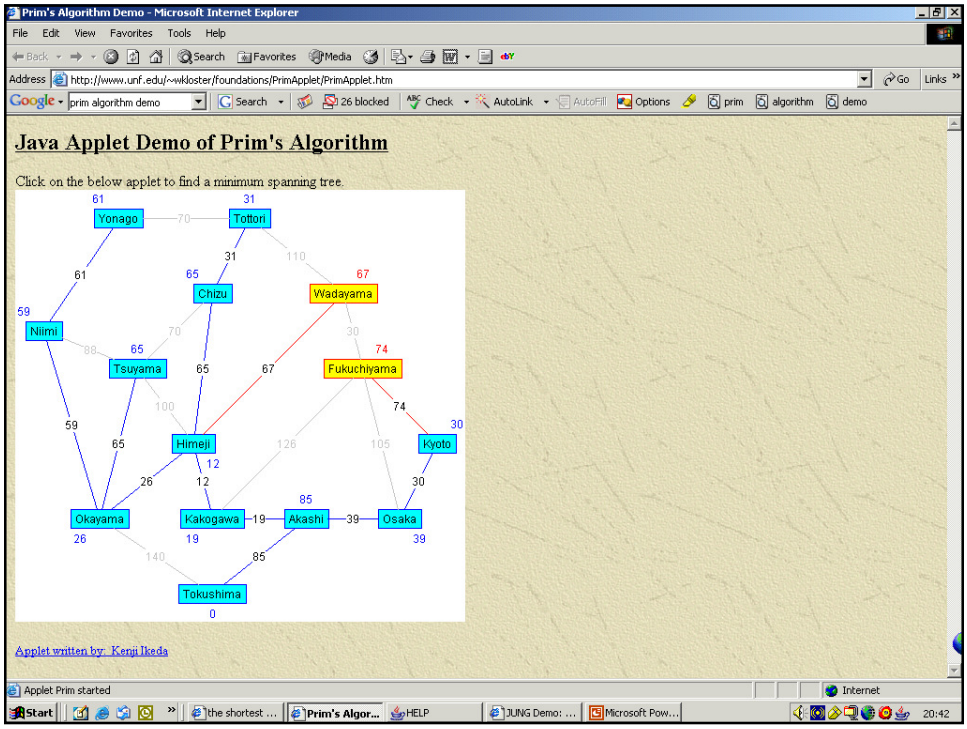
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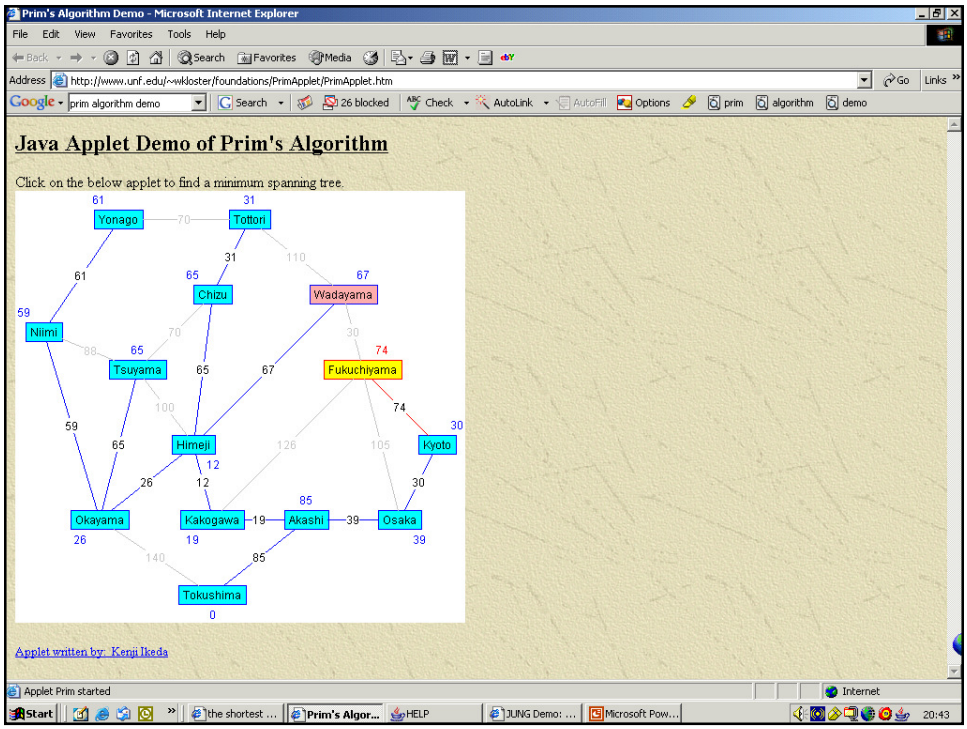
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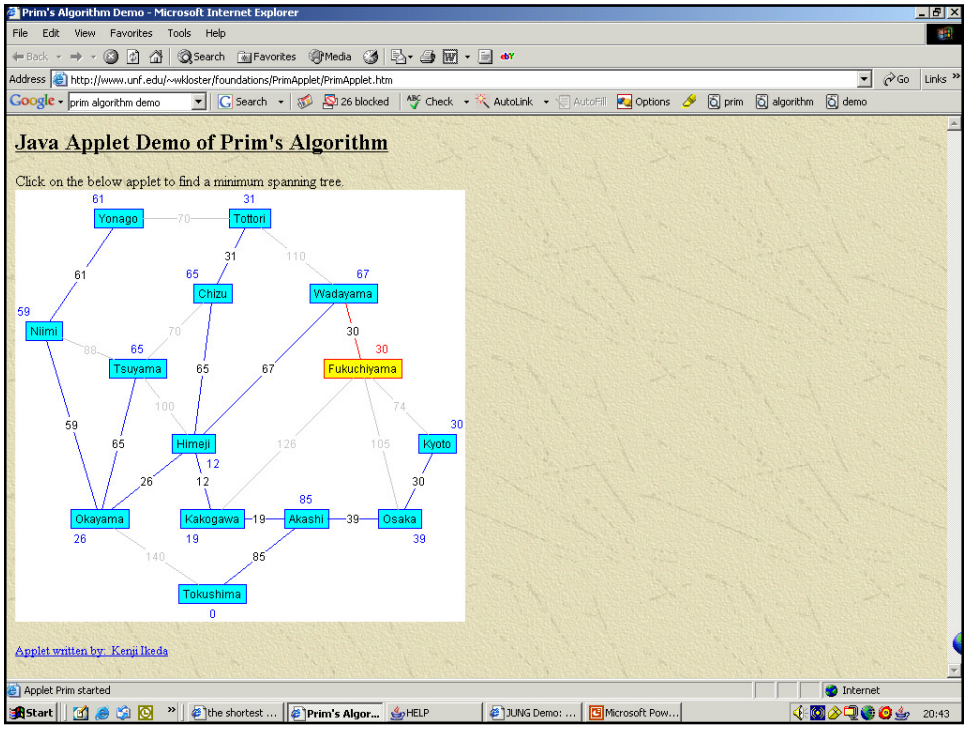
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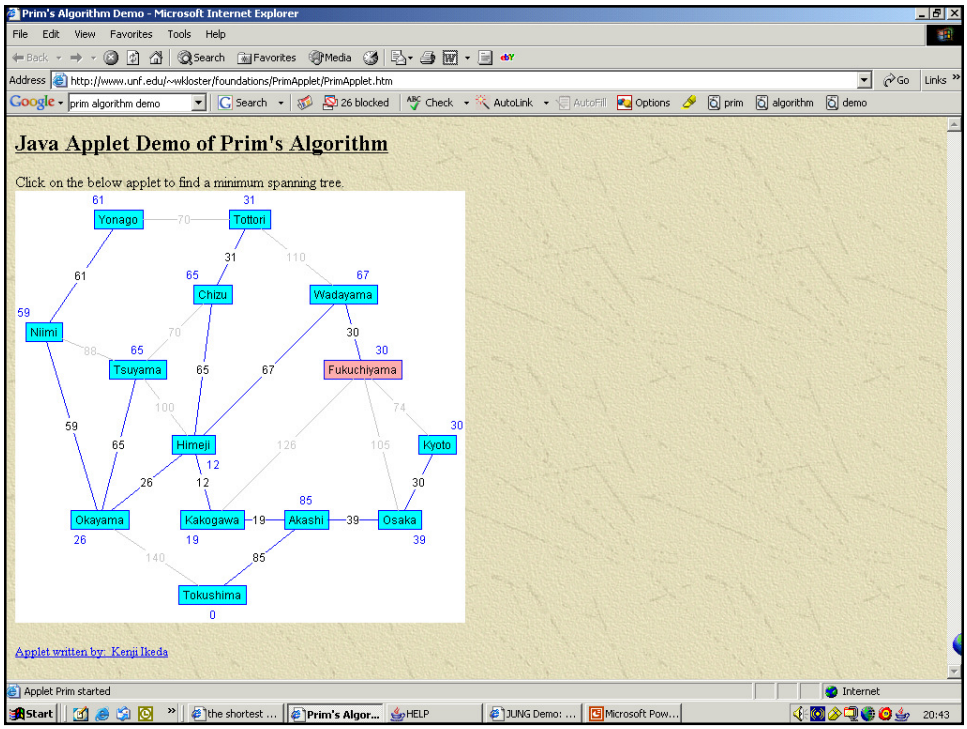
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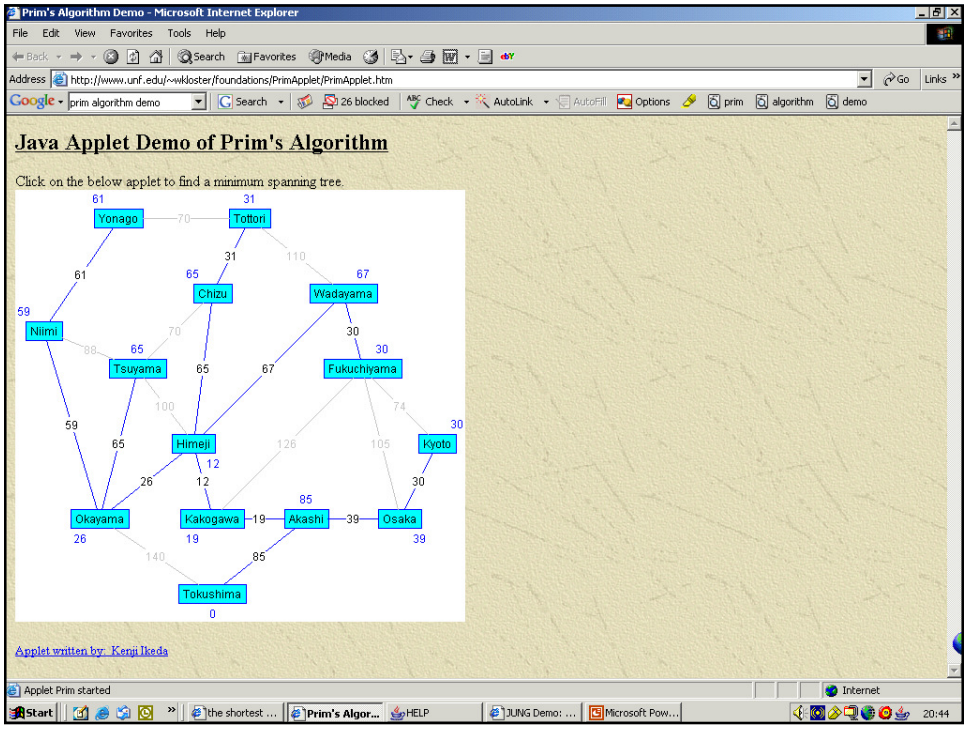
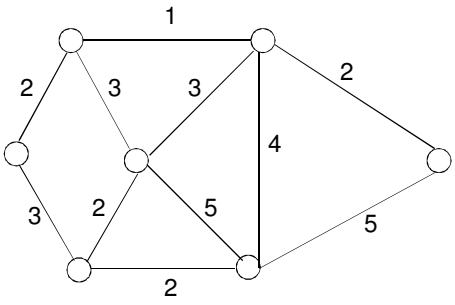
Kakogawa
Akashi
Osaka
Tokushima
Applet written by: Kenji Ikeda
Applet Prim started



Kruskal's Algorithm

- Adım 1: Graftaki en küçük ağırlık değerine sahip kenarı bul (eğer birden fazla varsa rastgele birini seç)
  - Adım 2: En küçük değere sahip bir sonraki kenarı bul ancak kapalı bir döngü oluşturmasın
    - Adım 3: Graftaki her bir düğümü dolaşana kadar adım-2 yi yap

n düğüm için n-1 kenar seçilmelidir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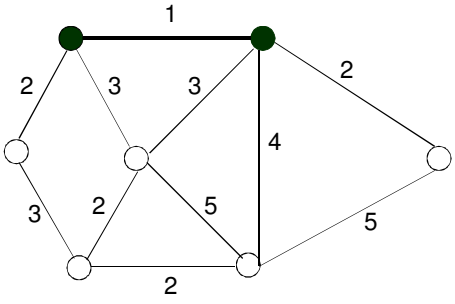
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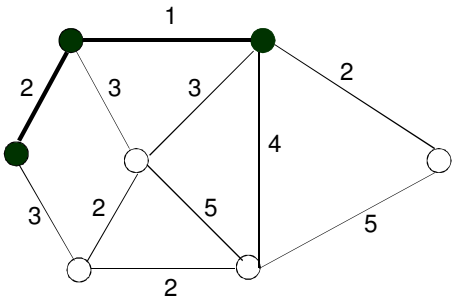
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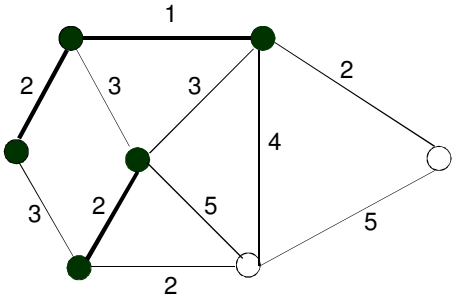
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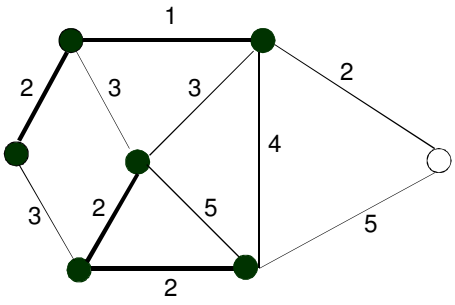
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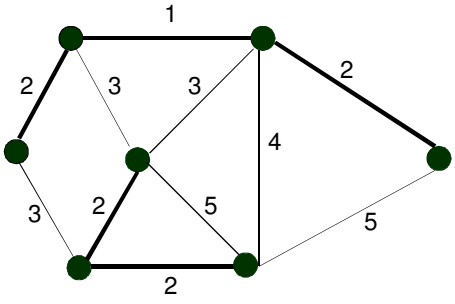
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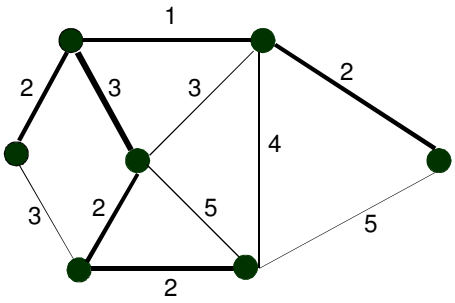
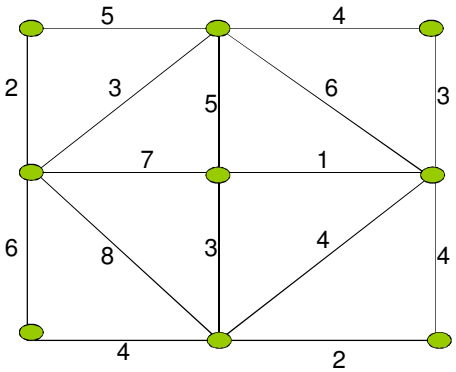
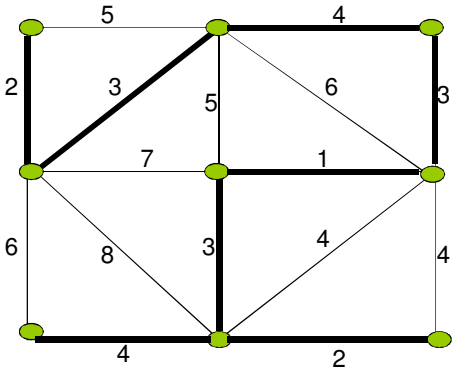


Örnek



çözüm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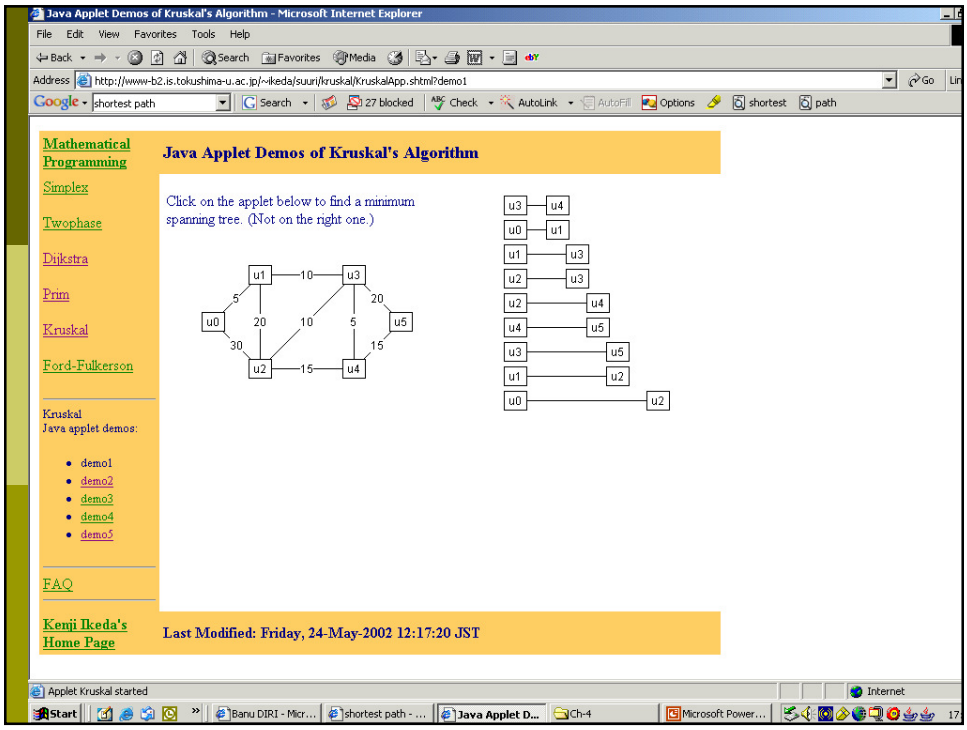
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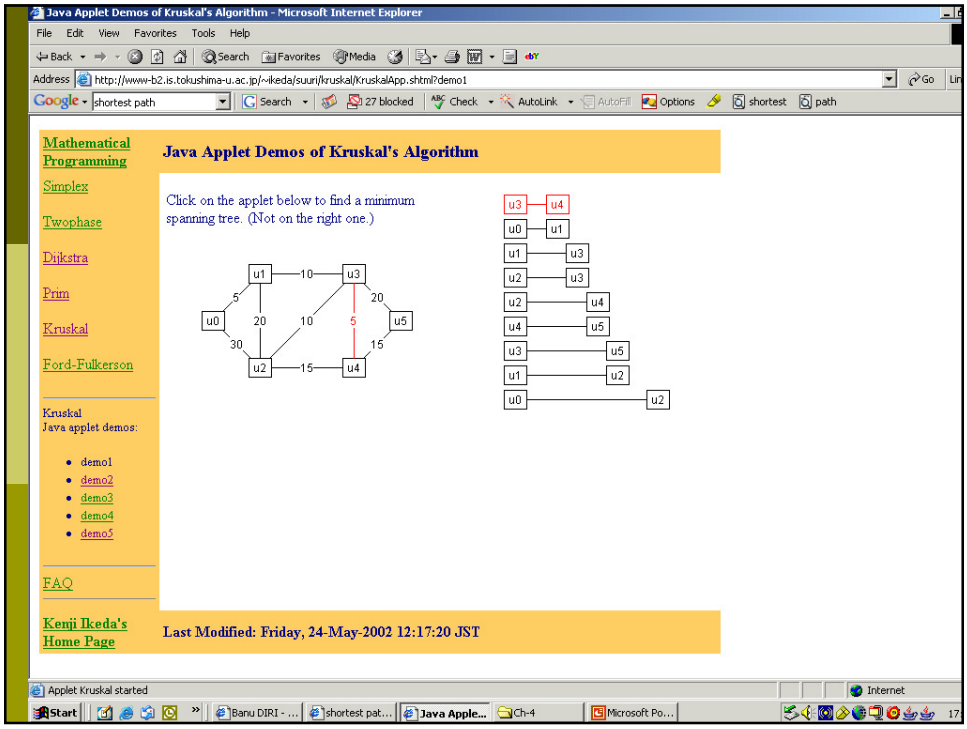
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u0 u1 u2 u3 u4 u5
10 5 20 20 10 5 30 15 15
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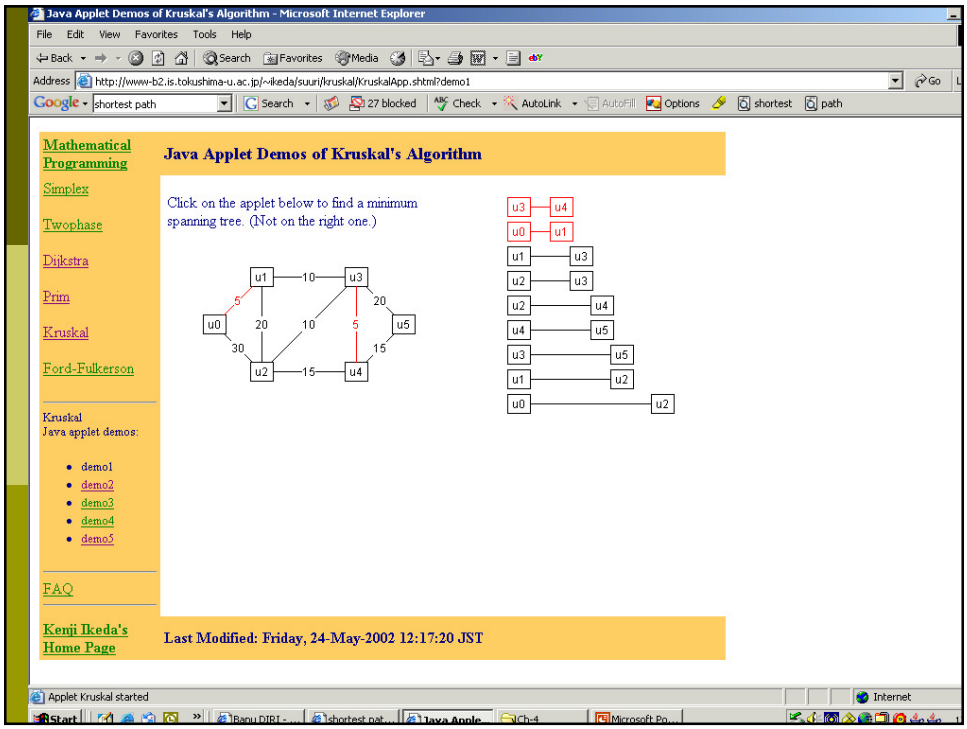
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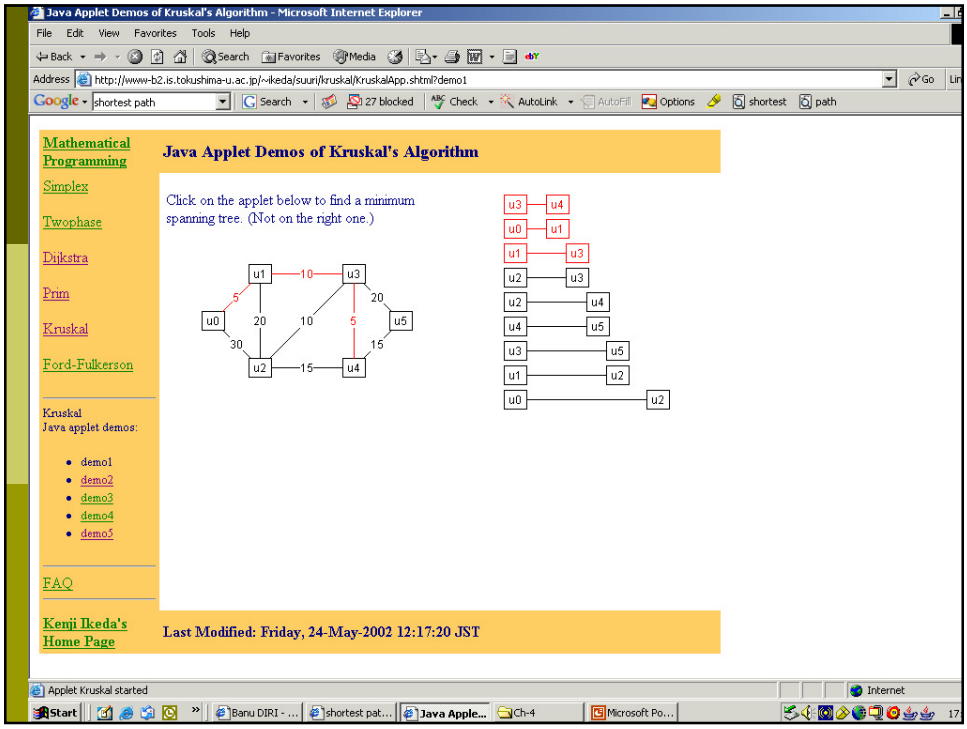
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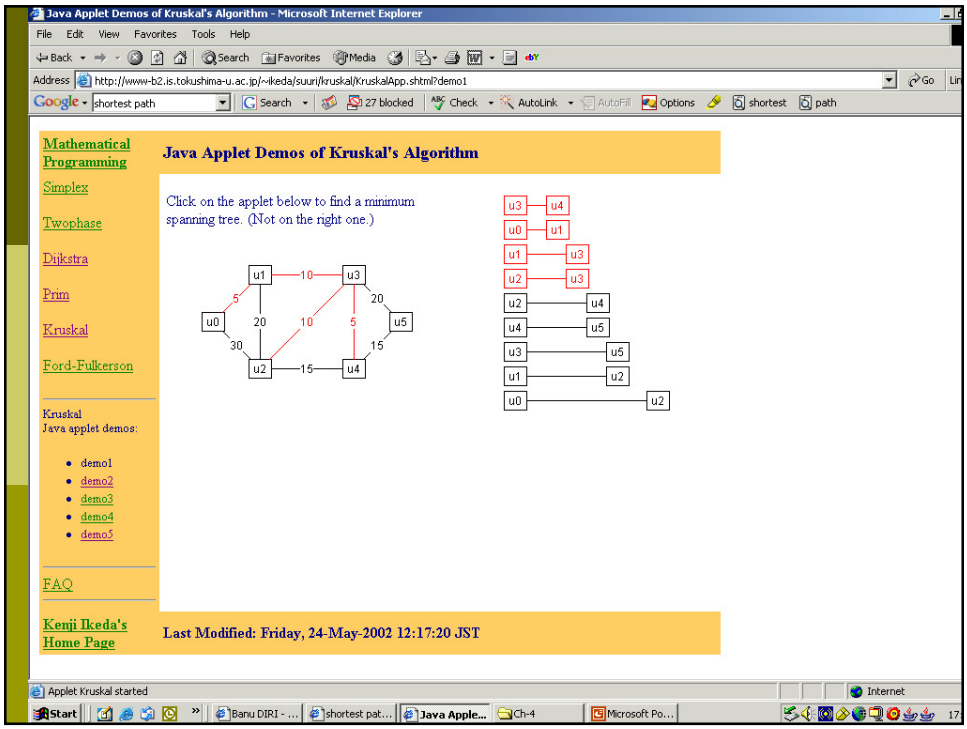
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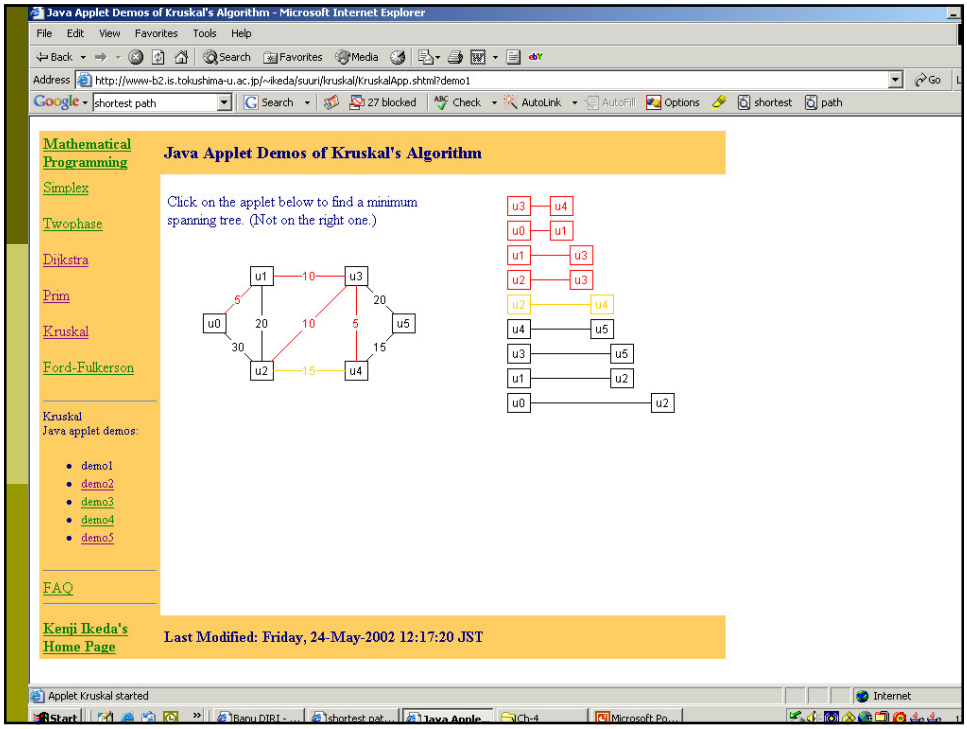
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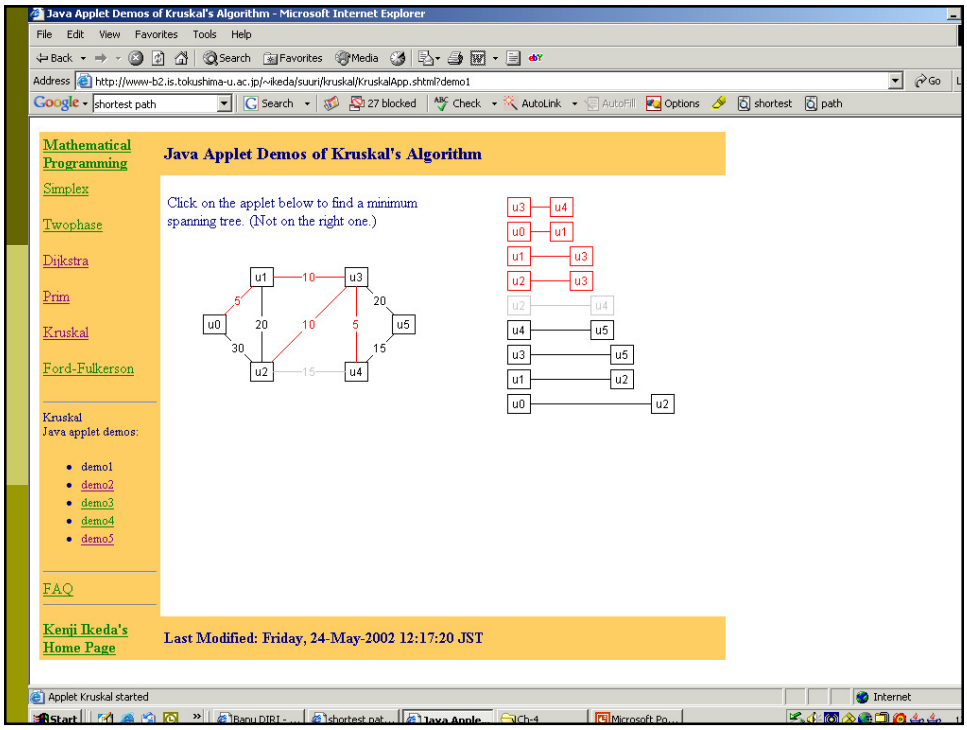
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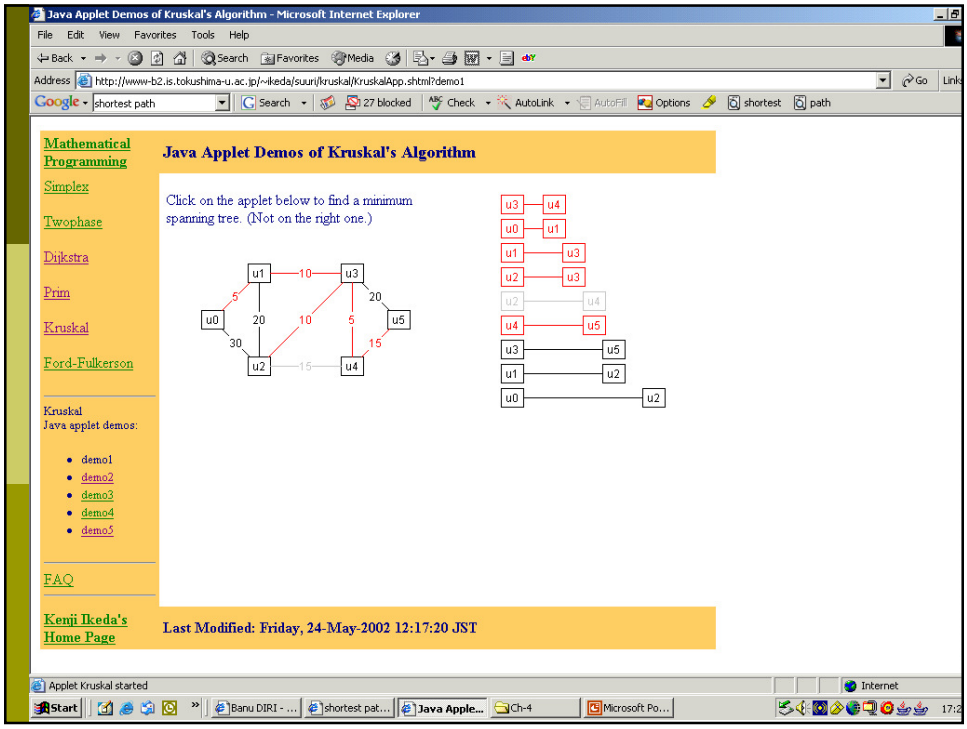
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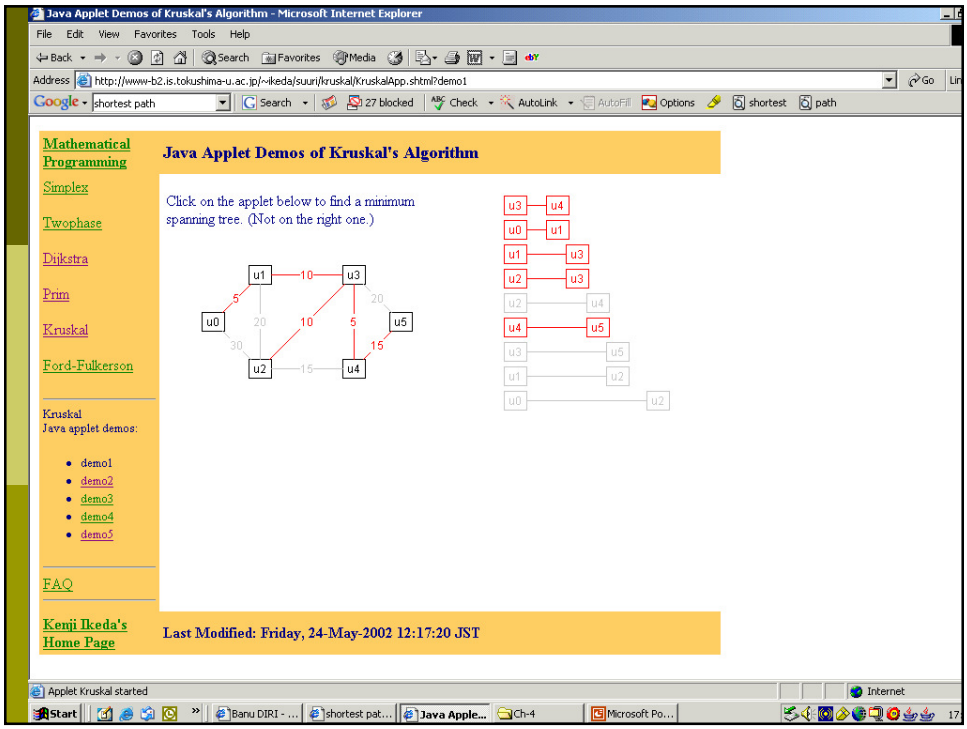
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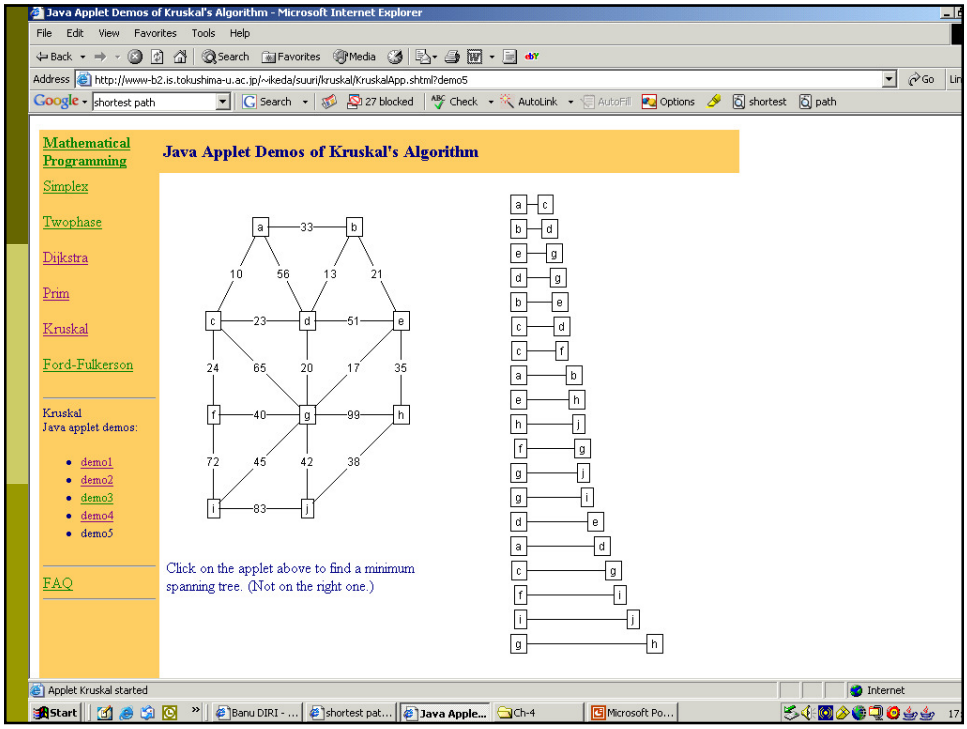
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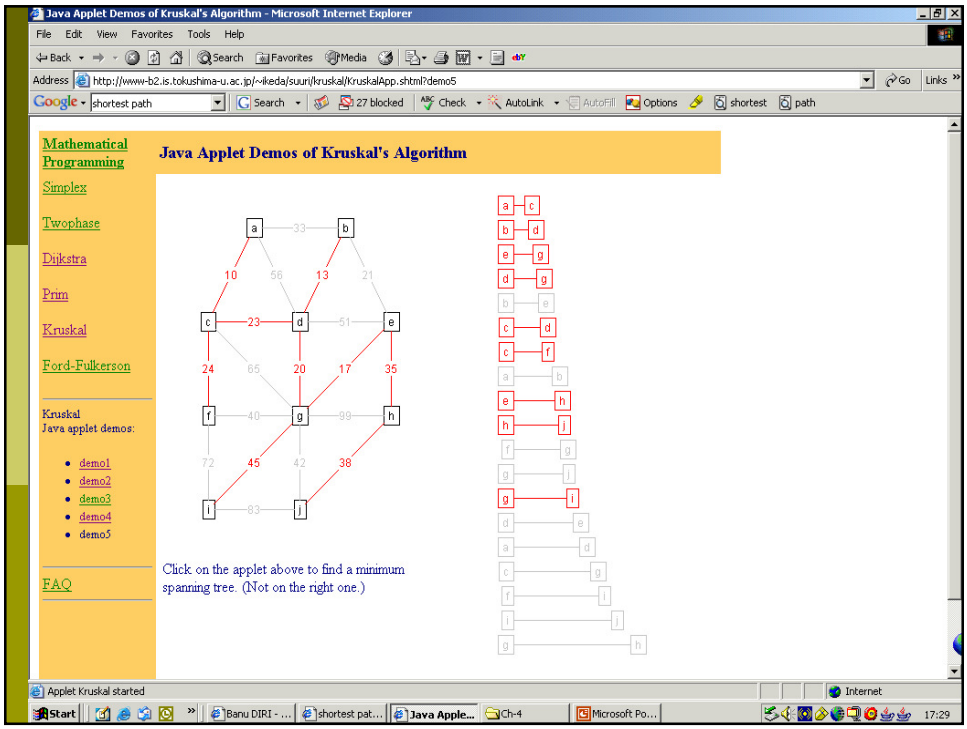
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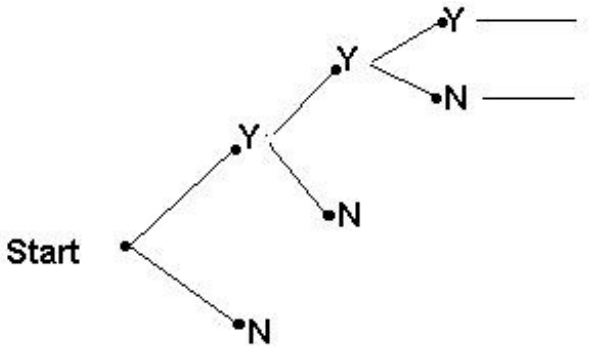
Karar Ağaçları (Decision trees)

Karar Ağaçları, bir Binary Tree olup bir olayın sonuçlandırılmasında sorunun cevabına göre hareket ederler. Binary Search, Hileli paranın bulunması örnek olarak verilebilir

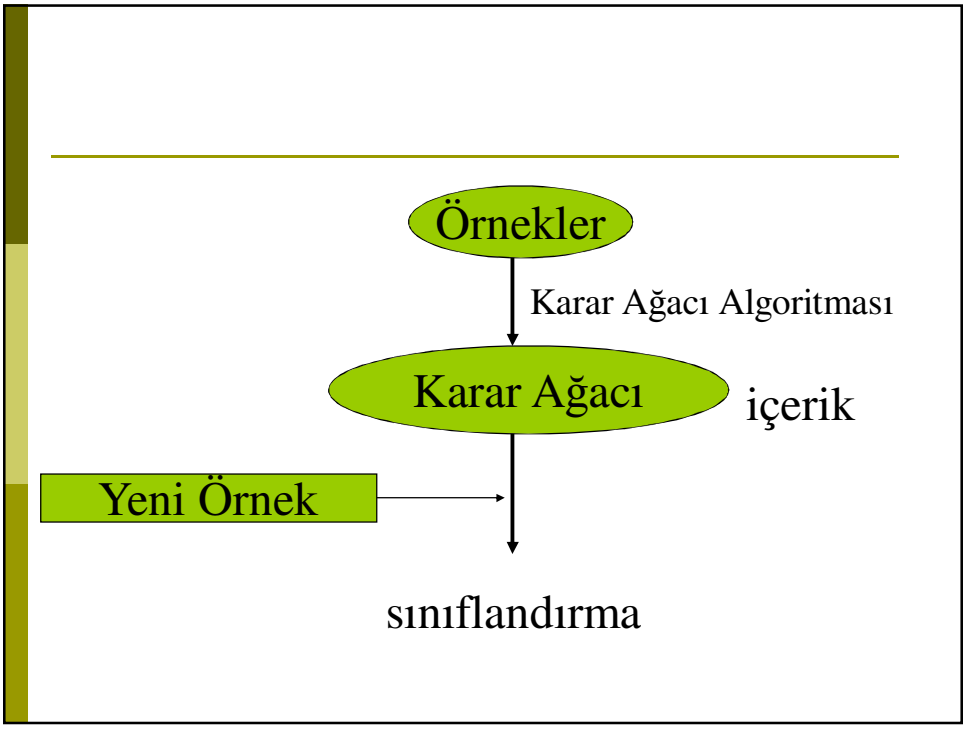


Tümevarımsal Sonuç Çıkarım

(inductive inference) için kullanılan

en popüler yöntemlerden birisi

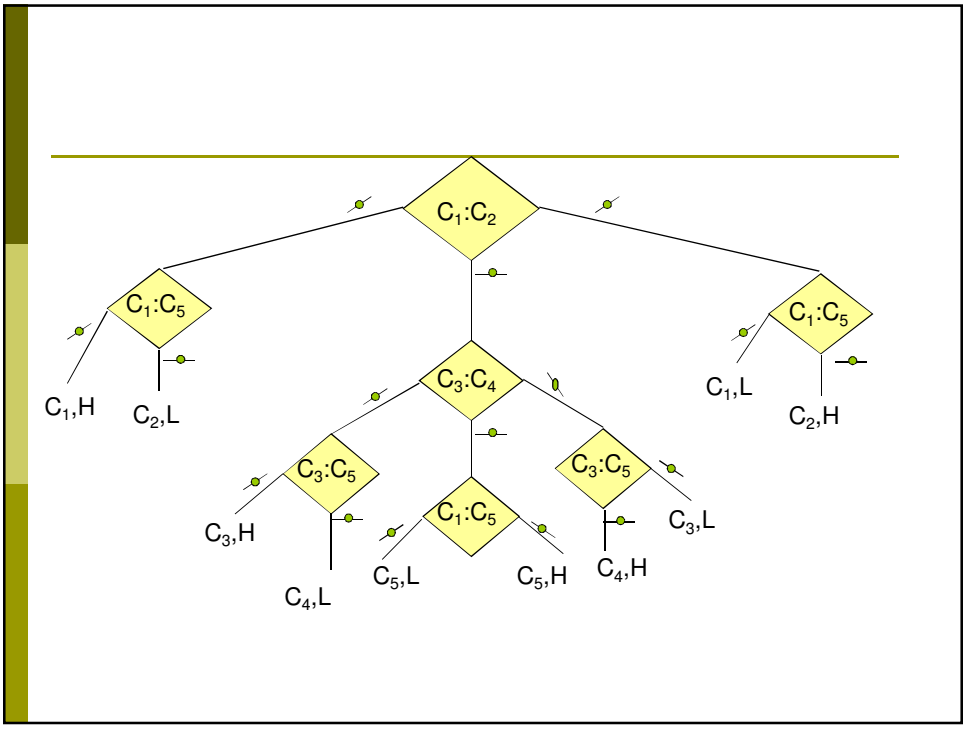
Karar Ağaç'larıdır (Decision Tree)



FIVE-COINS PUZZLE

- Görünüşleri birbirinin aynı olan 5 paradan biri sahtedir.
- Sahte olan para diğerlerinden daha ağır veya daha hafif olabilir.
- Karar ağacını kullanarak hangi paranın sahte olduğuna karar veriniz
- Sahte olan para diğerlerine göre hafif midir yoksa ağır mıdır?

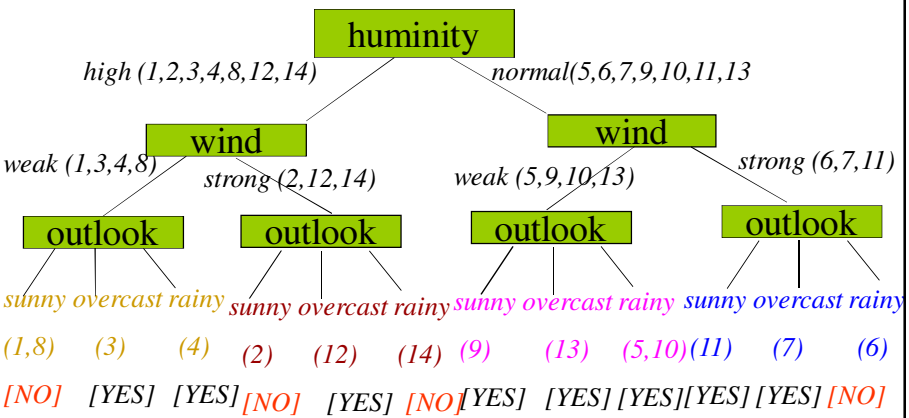
K A R A R ????



Play Tennis ?????

Day	Outlook	Temperature	Humidity	Wind	PlayTennis
1	sunny	hot	high	weak	no
2	sunny	hot	high	strong	no
3	overcast	hot	high	weak	yes
4	rain	mild	high	weak	yes
5	rain	cool	normal	weak	yes
6	rain	cool	normal	strong	no
7	overcast	cool	normal	strong	yes
8	sunny	mild	high	weak	no
9	sunny	cool	normal	weak	yes
10	rain	mild	normal	weak	yes
11	sunny	mild	normal	strong	yes
12	overcast	mild	high	strong	yes
13	overcast	hot	normal	weak	yes
14	rain	mild	high	strong	no

Özelliklerden biri kök seçilir
(outlook, temp, huminity, wind)



Karar Ağacı iyi bir çözümdür

ancak

optimum değildir

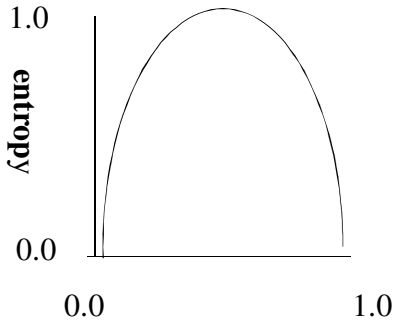
optimum bir karar ağacının oluşturulması için bir kuralın olması gerekir

Information Gain (maksimum kazanç)

$$Entropy(S) \equiv -p_{\oplus} \log_2 p_{\oplus} - p_{\ominus} \log_2 p_{\ominus}$$

Bütün örnekler aynı sınıfa ait ise E(S)=0 (homojen)

Bütün örnekler sınıflara eşit dağılmış ise E(S)=1 (heterojen)



Entropy([9+,5-] = 0.940

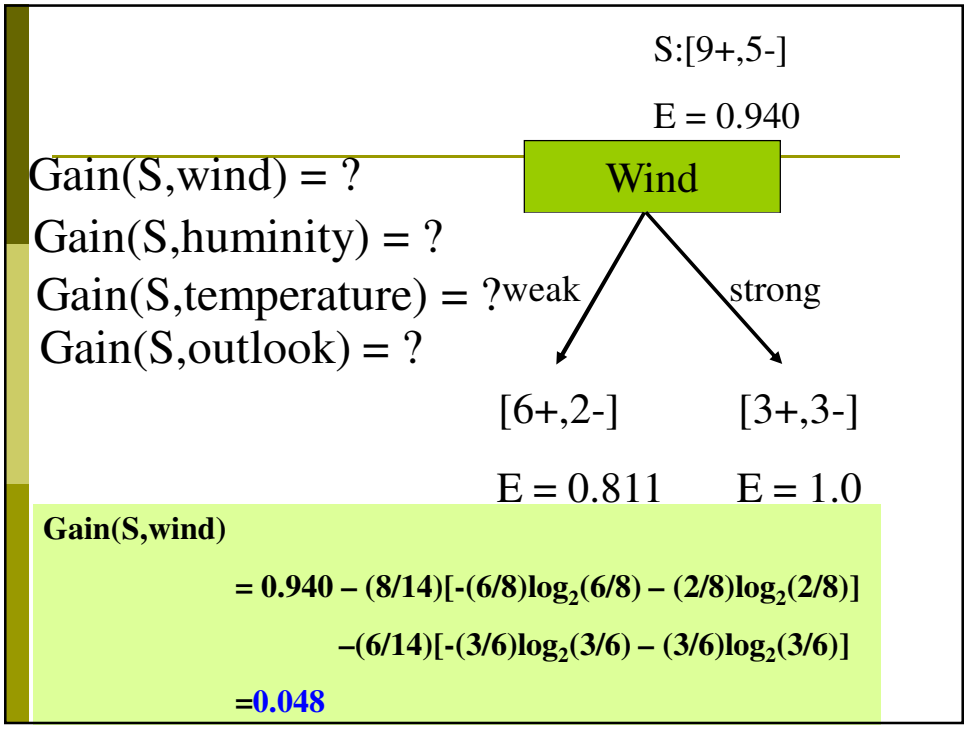
Entropy([7+,7-] = 1

A özelliğinin, S örneği için kazancı (information gain)

$$Gain(S,A) \equiv Entropy(S) - \Sigma\, P(v)\, Entropy(S(v))$$

v: Values of A

$P(v) \equiv |S(v)| / |S|$



Gain(S,wind)

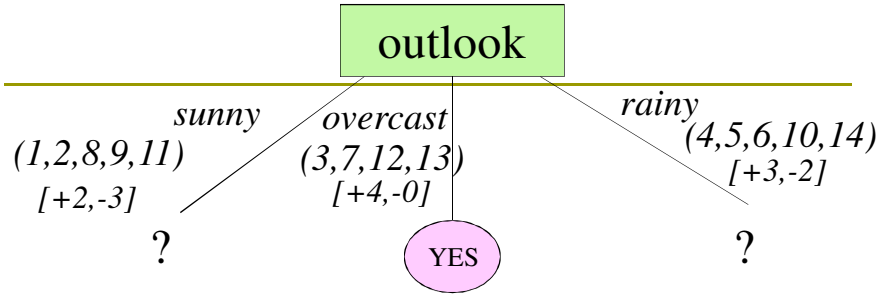
$$= 0.940 - (8/14)[-(6/8)\log_2(6/8) - (2/8)\log_2(2/8)]$$
$$-(6/14)[-(3/6)\log_2(3/6) - (3/6)\log_2(3/6)]$$
$$=0.048$$

Gain(S,wind) = 0.048

Gain(S,huminity) = 0.15

Gain(S,temperature) = 0.029

Gain(S,outlook) = 0.246



S_{sunny}=[+2,-3]

E(sunny)=-(2/5)$\log_2$(2/5)-(3/5)$\log_2$(3/5)=0.97

Gain($S_{sunny,huminity}$) = ?

Gain($S_{sunny,temp}$) = ?

Gain($S_{sunny,wind}$) = ?

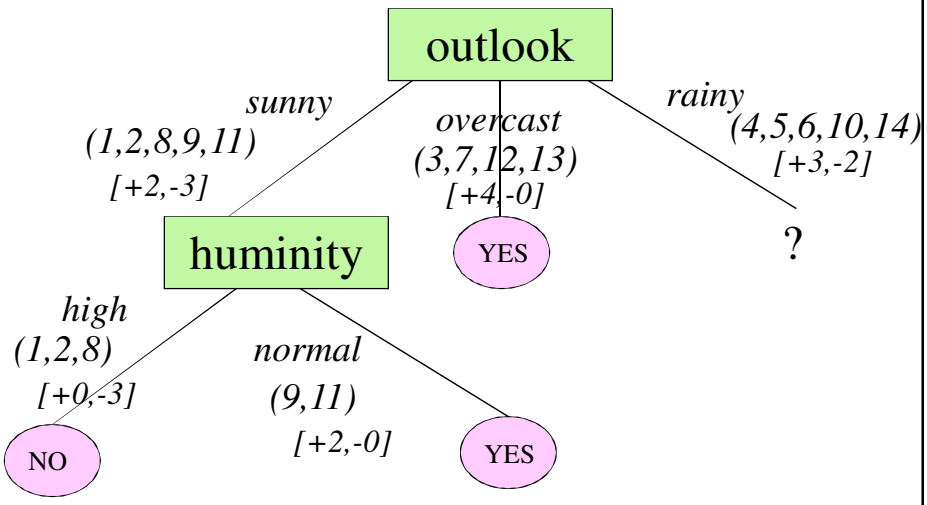
Gain($S_{sunny,huminity}$) = 0.97-(2/5)[-(2/2)$\log_2$(2/2)-(0/2)$\log_2$(0/2)]

-(3/5)[-(3/3)$\log_2$(3/3)-(0/3)$\log_2$(0/3)]

= 0.97

Gain($S_{sunny,wind}$) = 0.019

Gain($S_{sunny,temp}$) = 0.57



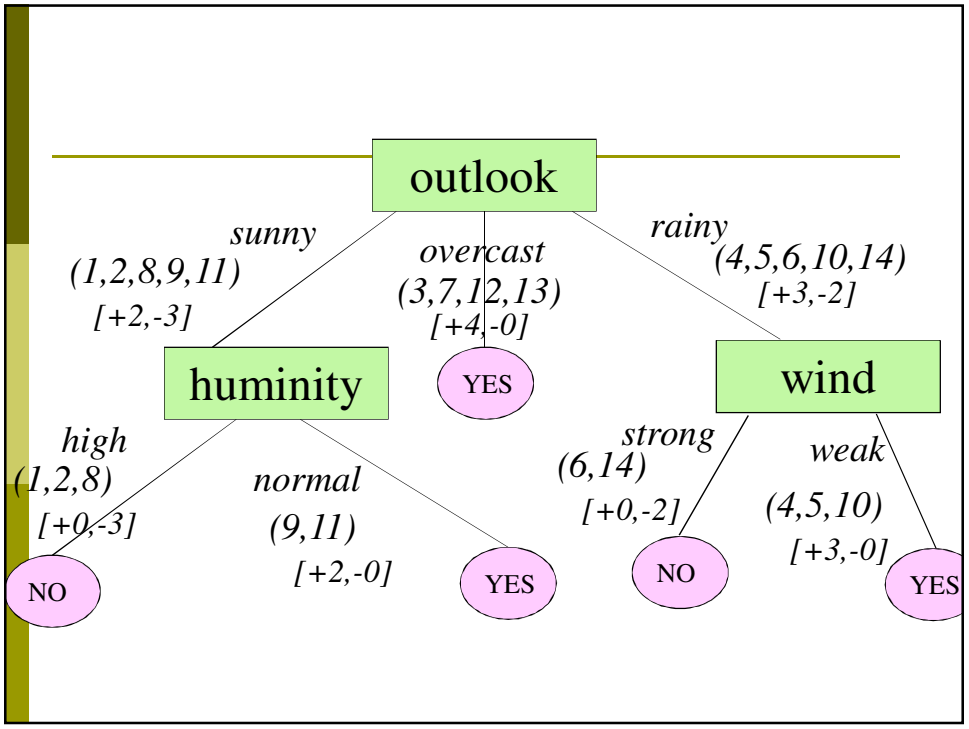
Aynı işlem

$Gain(S_{rainy,huminity}) = ?$

$Gain(S_{rainy,temp}) = ?$

$Gain(S_{rainy,wind}) = ?$

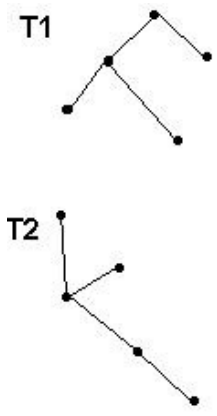
bulmak için yapılır.



Ağaçlarda Isomorphism

Verilen iki ağaç T_1 ve T_2 olsun

- T_1 ve T_2 *isomorphic* dir
- Bire-Bir ve örten fonksiyon özelliklerini görmemiz gerekir
  $f : T_1 \rightarrow T_2$
- T_1 ve T_2 birbirlerine çok yakındır



Köklü Ağaçlarda Isomorphism

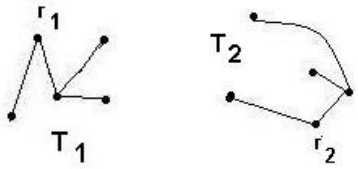
T_1 ve T_2 , r_1 ve r_2 kök değerine sahip köklü iki ağaç olsun. Eğer

- Bire-Bir fonksiyon özelliği mevcut ise

  f: $V(T_1) \rightarrow V(T_2)$

  Örnek:

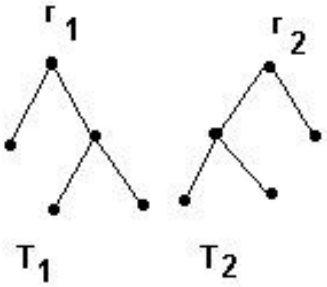
  - T_1 ve T_2, köklü bir ağaç olarak isomorphic



Devam...

Örnek: aşağıdaki iki ağaç

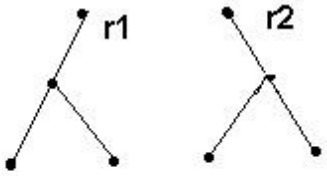
- isomorphic köklü bir ağaç olarak
- not isomorphic binary tree olarak



Özet...

Ağaçlarda 3 çeşit isomorphism vardır

- Ağaçlarda Isomorphism
- Köklü ağaçlarda Isomorphism
- Binary Tree'de Isomorphism



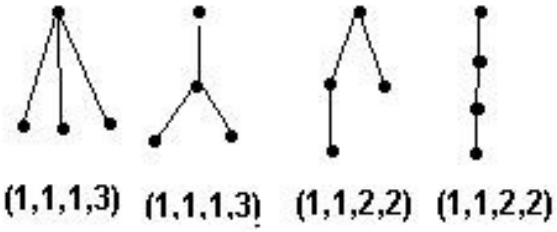
Two binary trees
isomorphic as rooted trees,
not as binary trees

Ağaçlarda Non-isomorphism

- Çoğu zaman iki ağaçda **not isomorphism** olduğunu göstermek ağaçlarda **isomorphism** olduğunu göstermekten daha kolaydır
- İki ağaç arasında isomorphism aramak için aşağıdaki şartların oluşması beklenir
  - Düğüm sayıları aynı olmalı
  - Kenar sayıları aynı olmalı
  - Karşılıklı düğümlerin dereceleri aynı olmalı
  - Kökten köke eşleme yapılmalı (rooted tree)
  - Çocukların(child-leave) pozisyonları aynı olmalı (binary tree)

Köklü Ağaçlarda Non-isomorphism

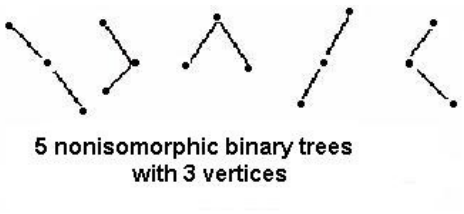
- En tepedeki düğümü kök olarak kabul edersek düğüm ve kenar sayıları eşit olsa bile bu köklü ağaçlar non-isomorphism dir
- Köklü ağaç özelliği verilmeseydi, 1 ve 2. ağaç, 3 ve 4.ağaç kendi aralarında isomorphism olacaktı



Binary Tree'lerde Non-isomorphic

Theorem

- n düğümlü, C(2n,n) / (n+1) adet non-isomorphic ikili ağaç(binary tree) vardır, n $\geq$ 0



5 nonisomorphic binary trees with 3 vertices