بسمه تعالی

دانشکده مهندسی برق و کامپیوتر
دانشگاه صنعتی اصفهان
یادگیری ماشین- نیمسال اوّل ۱۴۰۴ - ۱۴۰۳
تکلیف شماره ۳ – تحویل شنبه ۱۴۰۳/۱۱/۱

**سپهر عبادی**

۹۹۳۳۲۴۳

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## ۱)

$$\boldsymbol{a})\ P(A,B,B), P(x,y,z)$$
$$\{x \to A, y \to B, z \to B\}$$

$$\boldsymbol{b})\ Q\big(y, G(A,B)\big), Q(G(x,x), y)$$

در اینجا ابتدا باید y با G(x,x) یکسان سازی بشوند. سپس G(A,B) باید با y که خودش G(x,x) است یکسان شود که این ها میتوان نتیجه گرفت که :

$$A = x, B = x \to A \neq B \text{ تناقض}$$

پس چون به تناقض رسیدیم میتوان گفت یکسان ساز نداریم.

$$\boldsymbol{c})\ Older(Father(y), y), Older(Father(x), Amin)$$
$$\{Father(y) = Father(x), y = Amin \to Father(Amin) = Father(x) \to x = Amin\}$$
$$\{x \to Amin, y \to Amin\}$$

$$\boldsymbol{d})\ Knows(Father(y), y), Knows(x, x)$$
$$\{Father(y) = x, y = x \rightarrow Father(x) = x\}$$
$$\{x \rightarrow Father(x), y \rightarrow x\}$$

## (۲

مرحله اول :

الف) صابر یک مرد بود.

ب) صابر یک شکرستانی بود.

پ) همه شکرستانیها، قندستانی بودند.

ت) ظالم یک حاکم بود.(ظالم نام یک فرد است)

ث) همه قندستانیها به حاکم وفادار نبودند.

ج) هرکسی به کسی وفادار است.

د) مردم تلاش می کنند که حاکمانی که به آنها وفادار نیستند را زندانی کنند.

ذ) صابر تلاش کرد ظالم را زندانی کند.

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$$Man(Saber)$$
$$Shekarestani(Saber)$$
$$\forall x\ Shekarestani(x) \Rightarrow Ghandestani(x)$$
$$Hakem(Zalem)$$
$$\forall x\ [Ghandestani(x) \Longrightarrow \neg Vafadar(x, Hakem)]$$
$$\forall x[\exists y\ Vafadar(x, y)]$$
$$\forall x, y\big[Mardom(x) \wedge Hakem(y) \wedge \neg Vafadar(y, x) \Rightarrow Talash\big(x, Zendani(Y)\big)\big]$$
$$Talash(Saber, Zendani(Zalem))$$

مرحله دوم :

$$Man(Saber)$$
$$Shekarestani(Saber)$$
$$\forall x\ Shekarestani(x) \Rightarrow Ghandestani(x)\text{: } \boldsymbol{\neg Shekarestani(x) \vee Ghandestani(x)}$$
$$Hakem(Zalem)$$

$\forall x\ [Ghandestani(x) \Longrightarrow \neg Vafadar(x, Hakem)]$: $\boldsymbol{\neg Ghandestani(x)}$

$\boldsymbol{\vee \neg Vafadar(x, Hakem)}$

$\forall x[\exists y\ Vafadar(x, y)]$: تابع اسکولم

$$\boldsymbol{Vafadar\big(x, F(x)\big)}$$

$\forall x, y\big[Mardom(x) \wedge Hakem(y) \wedge \neg Vafadar(y, x) \Rightarrow Talash\big(x, Zendani(Y)\big)\big]$:

$\neg\big(Mardom(x) \wedge Hakem(y) \wedge \neg Vafadar(y, x)\big) \vee Talash\big(x, Zendani(Y)\big)$:

$\boldsymbol{\big(\neg Mardom(x) \vee \neg Hakem(y) \vee Vafadar(y, x)\big)}$

$\boldsymbol{\vee Talash\big(x, Zendani(Y)\big)}$

$Talash\big(Saber, Zendani(Zalem)\big)$

**(۳**

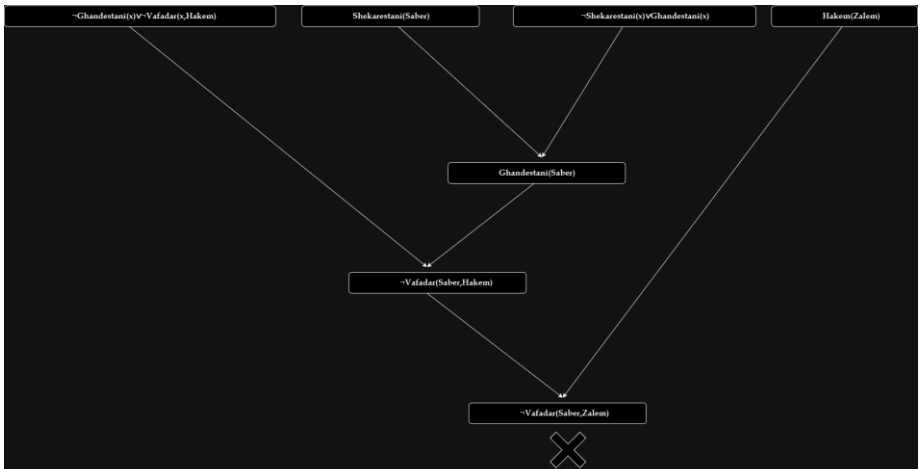
1) $Man(Saber)$
2) $Shekarestani(Saber)$
3) $\boldsymbol{\neg Shekarestani(x) \vee Ghandestani(x)}$
4) $Hakem(Zalem)$
5) $\boldsymbol{\neg Ghandestani(x) \vee \neg Vafadar(x, Hakem)}$
6) $\boldsymbol{Vafadar\big(x, F(x)\big)}$
7) $\boldsymbol{\big(\neg Mardom(x) \vee \neg Hakem(y) \vee Vafadar(y, x)\big) \vee Talash\big(x, Zendani(Y)\big)}$
8) $Talash\big(Saber, Zendani(Zalem)\big)$

$+$ **9**) $\neg Vafadar(Saber, Zalem)$

$A$: $2,3 \rightarrow \{x \rightarrow Saber\}: Ghandestani(Saber)$

$B$: $A, 5 \rightarrow \{x \rightarrow Saber\}: \neg Vafadar(Saber, Hakem)$

$C$: $B, 4 \rightarrow \{Hakem \rightarrow Zalem\}: \neg Vafadar(Saber, Zalem)$



از این نتیجه میگیریم که چون رسیدیم به جمله ای که دقیقا یکسان بند ۹ است که خودمان اضافه کردیم و سوالی بوده که از پایگاه دانش پرسیده ایم : یعنی نتیجه گیری با فرض های پایگاه دانش سازگار است و صابر به ظالم وفادار نبوده است.

## ٤)

در حالتی که با ۴ رنگ می خواهیم رنگ آمیزی انجام دهیم، پرولوگ جواب های زیادی میدهد که اولین این ها به صورت زیر خواهد بود:

```
SWI-Prolog (AMD64, Multi-threaded, version 9.2.8)
File  Edit  Settings  Run  Debug  Help
Welcome to SWI-Prolog (threaded, 64 bits, version 9.2.8)
SWI-Prolog comes with ABSOLUTELY NO WARRANTY. This is free software.
Please run ?- license. for legal details.

For online help and background, visit https://www.swi-prolog.org
For built-in help, use ?- help(Topic). or ?- apropos(Word).

?-
% e:/IUT/Lessons/Semester 9th/AI/HW/HW3/Q4_Prolog.pl compiled 0.00 sec, 19 clauses
?- mapcoloringiran(Solution).
Solution = [hamedan-yellow, markazi-green, kordestan-red, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Solution = [hamedan-green, markazi-yellow, kordestan-red, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Solution = [hamedan-red, markazi-green, kordestan-green, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
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Solution = [hamedan-red, markazi-yellow, kordestan-green, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Solution = [hamedan-red, markazi-green, kordestan-blue, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Solution = [hamedan-yellow, markazi-green, kordestan-blue, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Solution = [hamedan-red, markazi-yellow, kordestan-blue, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
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Solution = [hamedan-red, markazi-green, kordestan-blue, lorestan-blue, chaharmahal-yellow, fars-blue, yazd-green, esfahan-red]
```

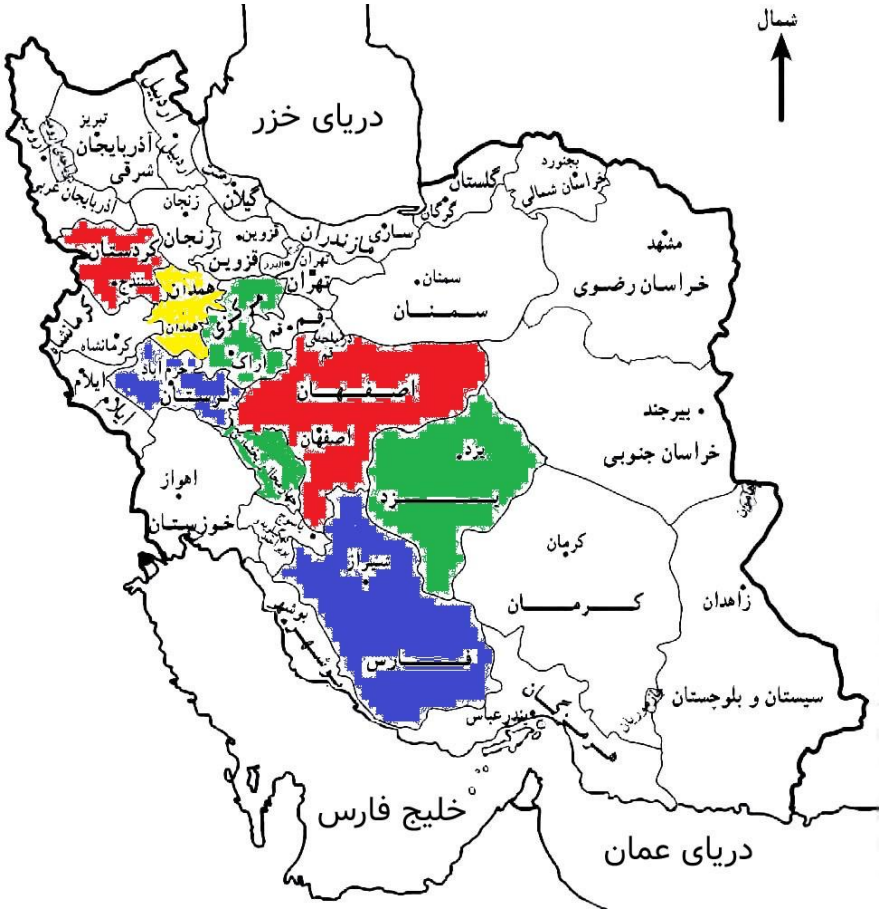


اما برای حالتی که با ۳ رنگ بخواهیم رنگ آمیزی انجام بدهیم تعداد حالات محدود میشود و جواب ها به صورت زیر خواهد بود:

که قابل حل است.

```
% e:/IUT/Lessons/Semester 9th/AI/HW/HW3/Q4_Prolog.pl compiled 0.00 sec, 0 clauses

Unknown action: 0 (h for help)
Action? ,

?- mapcoloringiran(Sol).
Sol = [hamedan-red, markazi-green, kordestan-green, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-red, markazi-green, kordestan-blue, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-red, markazi-blue, kordestan-green, lorestan-green, chaharmahal-blue, fars-blue, yazd-green, esfahan-red] ;
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Sol = [hamedan-red, markazi-green, kordestan-green, lorestan-blue, chaharmahal-green, fars-green, yazd-blue, esfahan-red] ;
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Sol = [hamedan-red, markazi-blue, kordestan-green, lorestan-green, chaharmahal-blue, fars-green, yazd-blue, esfahan-red] ;
Sol = [hamedan-red, markazi-blue, kordestan-blue, lorestan-green, chaharmahal-blue, fars-green, yazd-blue, esfahan-red] ;
Sol = [hamedan-green, markazi-red, kordestan-red, lorestan-blue, chaharmahal-red, fars-blue, yazd-red, esfahan-green] ;
Sol = [hamedan-green, markazi-red, kordestan-blue, lorestan-blue, chaharmahal-red, fars-blue, yazd-red, esfahan-green] ;
Sol = [hamedan-green, markazi-blue, kordestan-red, lorestan-red, chaharmahal-blue, fars-blue, yazd-red, esfahan-green] ;
Sol = [hamedan-green, markazi-blue, kordestan-blue, lorestan-red, chaharmahal-blue, fars-blue, yazd-red, esfahan-green] ;
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Sol = [hamedan-green, markazi-blue, kordestan-blue, lorestan-red, chaharmahal-blue, fars-red, yazd-blue, esfahan-green] ;
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Sol = [hamedan-blue, markazi-red, kordestan-green, lorestan-green, chaharmahal-red, fars-green, yazd-red, esfahan-blue] ;
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Sol = [hamedan-blue, markazi-red, kordestan-green, lorestan-green, chaharmahal-red, fars-red, yazd-green, esfahan-blue] ;
Sol = [hamedan-blue, markazi-green, kordestan-red, lorestan-red, chaharmahal-green, fars-red, yazd-green, esfahan-blue] ;
Sol = [hamedan-blue, markazi-green, kordestan-green, lorestan-red, chaharmahal-green, fars-red, yazd-green, esfahan-blue] ;
false.
```

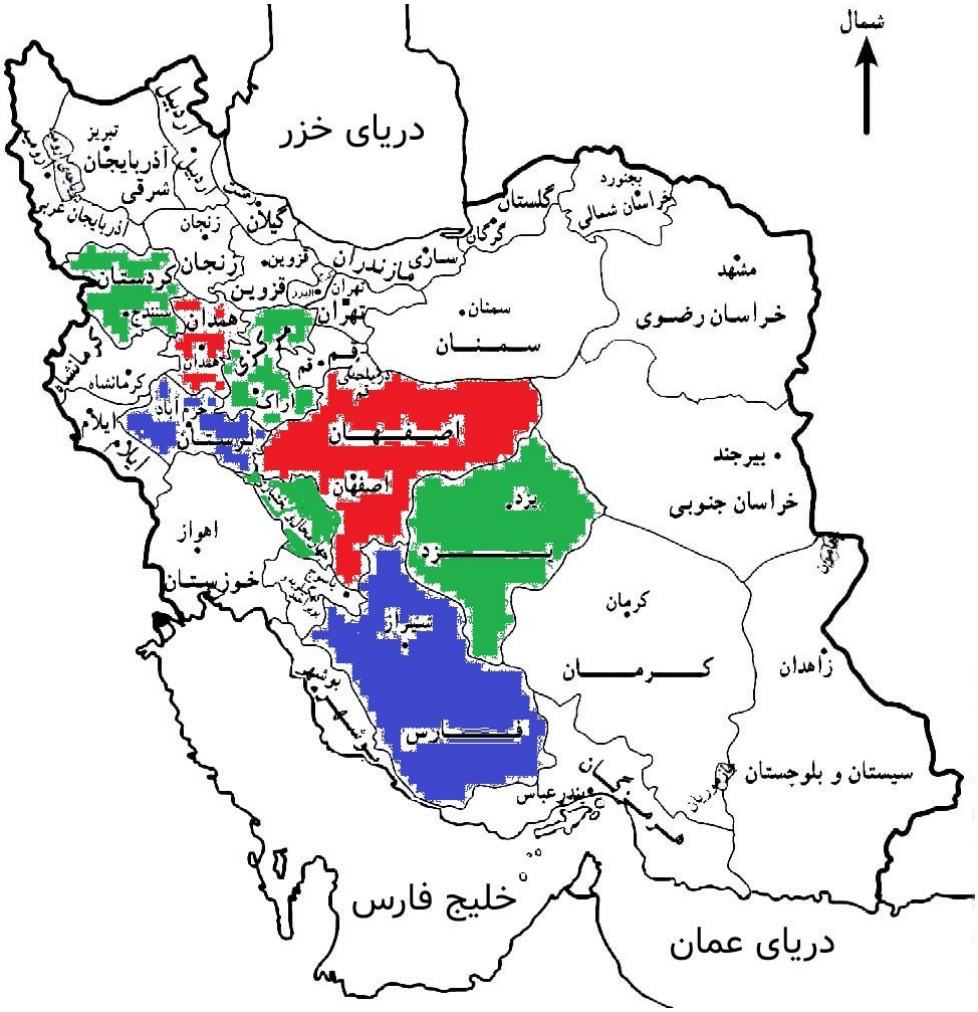


برای حالتی که با ۶ رنگ بخواهیم رنگ آمیزی کنیم به صورت زیر خواهد بود:

```
% e:/IUT/Lessons/Semester 9th/AI/HW/HW3/Q4_Prolog.pl compiled 0.00 sec, 3 clauses
?- mapcoloringiran(Sol).
Sol = [hamedan-yellow, markazi-green, kordestan-red, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-black, markazi-green, kordestan-red, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-pink, markazi-green, kordestan-red, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-green, markazi-yellow, kordestan-red, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-black, markazi-yellow, kordestan-red, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-pink, markazi-yellow, kordestan-red, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-green, markazi-black, kordestan-red, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-yellow, markazi-black, kordestan-red, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-pink, markazi-black, kordestan-red, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-green, markazi-pink, kordestan-red, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-yellow, markazi-pink, kordestan-red, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-black, markazi-pink, kordestan-red, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-red, markazi-green, kordestan-green, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-yellow, markazi-green, kordestan-green, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-black, markazi-green, kordestan-green, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-pink, markazi-green, kordestan-green, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-red, markazi-yellow, kordestan-green, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-black, markazi-yellow, kordestan-green, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-pink, markazi-yellow, kordestan-green, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-red, markazi-black, kordestan-green, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-yellow, markazi-black, kordestan-green, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
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Sol = [hamedan-black, markazi-pink, kordestan-green, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-red, markazi-green, kordestan-blue, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
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Sol = [hamedan-black, markazi-pink, kordestan-yellow, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-red, markazi-green, kordestan-black, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-yellow, markazi-green, kordestan-black, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-pink, markazi-green, kordestan-black, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-red, markazi-yellow, kordestan-black, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-green, markazi-yellow, kordestan-black, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-pink, markazi-yellow, kordestan-black, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-red, markazi-black, kordestan-black, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-green, markazi-black, kordestan-black, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-yellow, markazi-black, kordestan-black, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-pink, markazi-black, kordestan-black, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-red, markazi-pink, kordestan-black, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-green, markazi-pink, kordestan-black, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-yellow, markazi-pink, kordestan-black, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-red, markazi-green, kordestan-pink, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
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Sol = [hamedan-green, markazi-yellow, kordestan-pink, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red] ;
Sol = [hamedan-black, markazi-yellow, kordestan-pink, lorestan-blue, chaharmahal-green, fars-blue, yazd-green, esfahan-red]
```

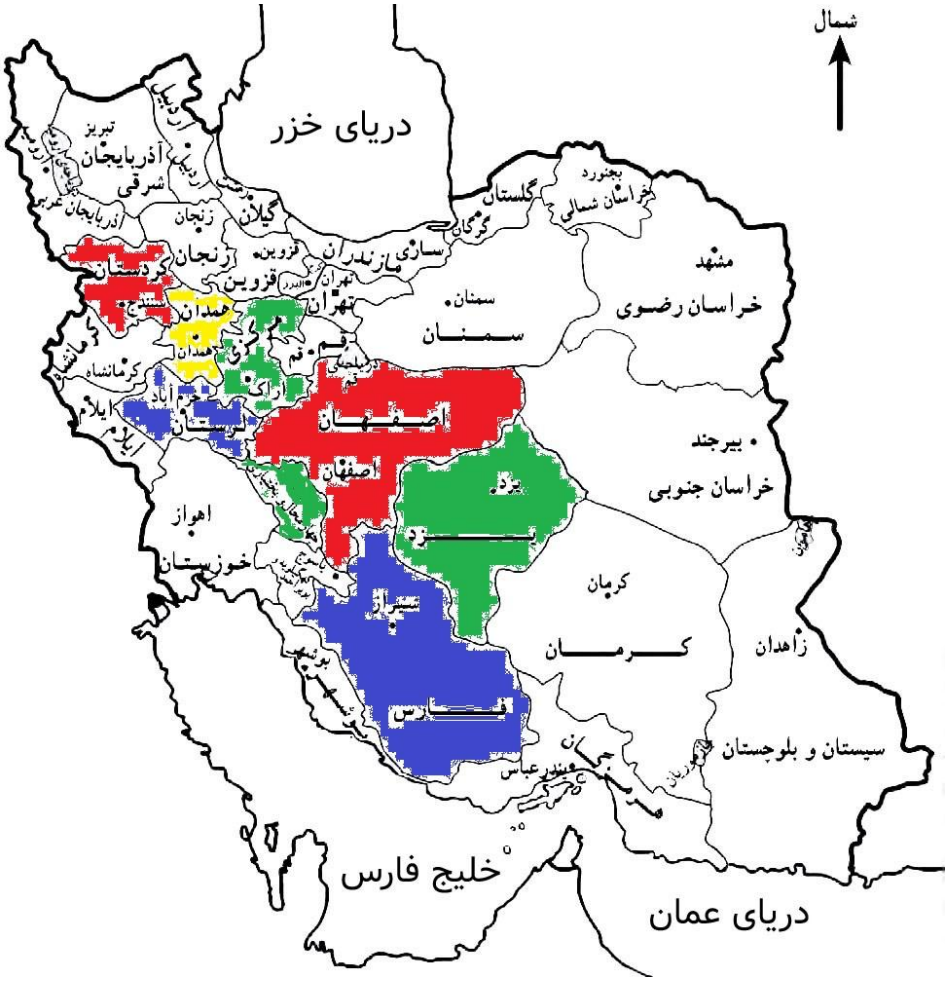


همانطور که میبینیم درحالتی که با ۶ رنگ است شبیه به حالتی می شود که ۴ رنگ داشتیم و علاوه بر جواب هایی که برای ۴ رنگ داشتیم در اینجا جواب ها بیشتر است.

## ۵)

با ۴ رنگ همانطور که میبینیم قابل حل است و تعداد حالت های زیادی دارد:

```
% e:/IUT/Lessons/Semester 9th/AI/HW/HW3/CS_Prolog.pl compiled 0.02 sec, 151 clauses
?- mapcoloringiran(Sol).
Sol = [qom-blue,west_azerbaijan-yellow,east_azerbaijan-blue,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-blue,razavi_khorasan-red,semnan-yellow,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,
ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gree
n,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-blue,west_azerbaijan-yellow,east_azerbaijan-blue,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-blue,razavi_khorasan-red,semnan-yellow,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,
ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gree
n,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-blue,west_azerbaijan-yellow,east_azerbaijan-blue,zanjan-green,gilan-yellow,ardabil-red,north_khorasan-green,south_khorasan-blue,razavi_khorasan-red,semnan-yellow,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-re
d,ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gr
een,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-blue,west_azerbaijan-blue,east_azerbaijan-yellow,zanjan-green,gilan-yellow,ardabil-red,north_khorasan-green,south_khorasan-blue,razavi_khorasan-red,semnan-yellow,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-re
d,ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gr
een,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-blue,west_azerbaijan-yellow,east_azerbaijan-green,zanjan-blue,gilan-yellow,ardabil-red,north_khorasan-green,south_khorasan-blue,razavi_khorasan-red,semnan-yellow,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-re
d,ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gr
een,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-blue,west_azerbaijan-green,east_azerbaijan-yellow,zanjan-blue,gilan-yellow,ardabil-red,north_khorasan-green,south_khorasan-blue,razavi_khorasan-red,semnan-yellow,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-re
d,ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gr
een,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-blue,west_azerbaijan-green,east_azerbaijan-yellow,zanjan-blue,gilan-yellow,ardabil-green,north_khorasan-blue,south_khorasan-blue,razavi_khorasan-red,semnan-yellow,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-re
d,ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gr
een,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-blue,west_azerbaijan-yellow,east_azerbaijan-red,zanjan-blue,gilan-yellow,ardabil-green,north_khorasan-green,south_khorasan-blue,razavi_khorasan-red,semnan-yellow,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red
,ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gre
en,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-blue,west_azerbaijan-green,east_azerbaijan-red,zanjan-blue,gilan-yellow,ardabil-green,north_khorasan-green,south_khorasan-blue,razavi_khorasan-red,semnan-yellow,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-r
ed,ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-g
reen,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-blue,west_azerbaijan-blue,east_azerbaijan-red,zanjan-green,gilan-blue,ardabil-yellow,north_khorasan-green,south_khorasan-blue,razavi_khorasan-red,semnan-yellow,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,
ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gree
n,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-blue,west_azerbaijan-yellow,east_azerbaijan-red,zanjan-green,gilan-blue,ardabil-yellow,north_khorasan-green,south_khorasan-blue,razavi_khorasan-red,semnan-yellow,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-re
d,ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gr
een,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-blue,west_azerbaijan-yellow,east_azerbaijan-blue,zanjan-green,gilan-blue,ardabil-yellow,north_khorasan-green,south_khorasan-blue,razavi_khorasan-red,semnan-yellow,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-r
ed,ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-g
reen,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-blue,west_azerbaijan-yellow,east_azerbaijan-blue,zanjan-green,gilan-blue,ardabil-red,north_khorasan-blue,south_khorasan-blue,razavi_khorasan-red,semnan-yellow,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,i
lan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-green
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lan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-green
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ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gree
n,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-blue,west_azerbaijan-yellow,east_azerbaijan-red,zanjan-blue,gilan-yellow,ardabil-green,north_khorasan-blue,south_khorasan-blue,razavi_khorasan-red,semnan-yellow,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red
,ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-red
,ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-g
reen,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-blue,west_azerbaijan-green,east_azerbaijan-yellow,zanjan-blue,gilan-yellow,ardabil-green,north_khorasan-blue,south_khorasan-blue,razavi_khorasan-red,semnan-yellow,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-r
ed,ilan-yellow,kohgiluyeh_and_boyer_ahad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-g
reen,fars-blue,yazd-green,isfahan-red] ▮
```

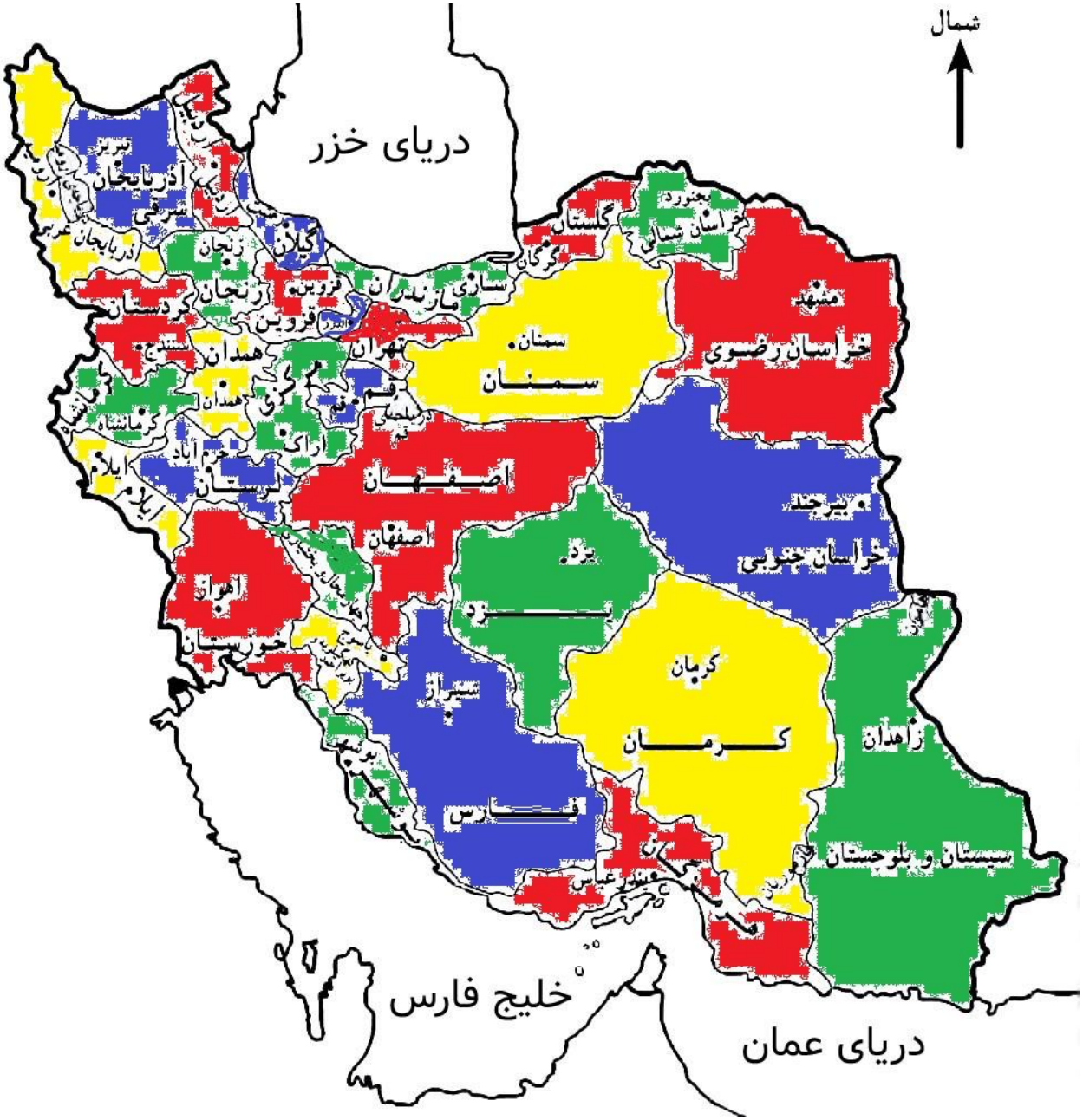


اما همانطور که میبینیم برای ۳ رنگ پاسخی ندارد :

```
?- mapcoloringiran(Sol).
false.
```

اگر تعداد رنگ ها بیشتر از ۳ باشد هم تعداد حالت ها برابر است با همان حالت هایی که با ۴ رنگ داشتیم به علاوه تعدادی زیادی حالت های دیگر.

```
Unknown action: 8 (h for help)
Action? .

?- wapcoloringiran(Sol)
Sol = [qom-yellow,west_azerbaijan-yellow,east_azerbaijan-blue,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red
,ilam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gre
en,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-black,west_azerbaijan-yellow,east_azerbaijan-blue,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,
ilam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gree
n,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-pink,west_azerbaijan-yellow,east_azerbaijan-blue,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,i
lam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-green
,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-yellow,west_azerbaijan-black,east_azerbaijan-blue,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,
ilam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gree
n,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-black,west_azerbaijan-black,east_azerbaijan-blue,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,i
lam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-green
,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-pink,west_azerbaijan-black,east_azerbaijan-blue,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,il
am-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-green,
fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-yellow,west_azerbaijan-pink,east_azerbaijan-blue,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,il
am-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-green,
fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-black,west_azerbaijan-pink,east_azerbaijan-blue,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,il
am-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-green,f
ars-blue,yazd-green,isfahan-red] ;
Sol = [qom-pink,west_azerbaijan-pink,east_azerbaijan-blue,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,ila
m-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gre
en,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-yellow,west_azerbaijan-blue,east_azerbaijan-yellow,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red
,ilam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gre
en,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-black,west_azerbaijan-blue,east_azerbaijan-yellow,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,
ilam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gree
n,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-pink,west_azerbaijan-blue,east_azerbaijan-yellow,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,i
lam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-green
,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-yellow,west_azerbaijan-black,east_azerbaijan-yellow,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red
,ilam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gre
en,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-black,west_azerbaijan-black,east_azerbaijan-yellow,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red
,ilam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gre
en,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-pink,west_azerbaijan-black,east_azerbaijan-yellow,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,
ilam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gree
n,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-yellow,west_azerbaijan-pink,east_azerbaijan-yellow,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,
ilam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gree
n,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-pink,west_azerbaijan-pink,east_azerbaijan-yellow,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,i
lam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-green
,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-yellow,west_azerbaijan-blue,east_azerbaijan-black,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,
ilam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gree
n,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-black,west_azerbaijan-blue,east_azerbaijan-black,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,i
lam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-green
,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-pink,west_azerbaijan-black,east_azerbaijan-blue,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red,il
am-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-green,
fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-yellow,west_azerbaijan-yellow,east_azerbaijan-black,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-re
d,ilam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gr
een,fars-blue,yazd-green,isfahan-red] ;
Sol = [qom-black,west_azerbaijan-yellow,east_azerbaijan-black,zanjan-green,gilan-blue,ardabil-red,north_khorasan-green,south_khorasan-black,razavi_khorasan-red,semnan-blue,golestan-red,mazandaran-green,tehran-red,alborz-blue,qazvin-red
,ilam-yellow,kohgiluyeh_and_boyer_ahmad-yellow,bushehr-green,kerman-yellow,sistan_and_baluchestan-green,hormozgan-red,kermanshah-green,khuzestan-red,hamadan-yellow,markazi-green,kurdistan-red,lorestan-blue,chaharmahal_and_bakhtiari-gre
en,fars-blue,yazd-green,isfahan-red]
```