



# Link Spam Alliances

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# Class List

- Spam 101 — Intro to web spam
- Spam 221 — Spamming PageRank
  - Spam farm model
  - Optimal farm structure
  - Alliances of two farms
  - Larger alliances
- Spam 321 — Link spam detection seminar

# Spam 101

Google Web Images Groups News Froogle Local Scholar more »

Search [Advanced Search](#) [Preferences](#)

Results 1 - 100 of about 175,000 for [kaiser pharmacy online](#). (1.20 seconds)

**Web** Kaiser Health Insurance [www.kaisergrouphealth.com](#) California only. Kaiser Permanente individual, family, and group plans

**Sponsored Links** [Prescriptions Online](#) Are **Online** Prescriptions Safe? Learn the risks of imported drugs. [www.buysafedrugs.info](#)

[Kaiser College Online](#) [ClassesUSA.com](#) Attend College One Class At A Time At Keiser's eCampus. Learn More.

**Sponsored Links** [50% off Online Pharmacies](#) 50% off **Online** Pharmacies 50% off drugs from Canada! [MedCenterCanada.com](#)

**Kaiser online pharmacy**  
Best **online pharmacy**. Information on **Kaiser online pharmacy** and pet **pharmacy online**.  
[www.tak-news.com/online-pharmacy/kaiser-online-pharmacy.html](#) - 40k - [Cached](#) - [Similar pages](#)

**Online pharmacy schools**  
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[www.tak-news.com/online-pharmacy/online-pharmacy-schools.html](#) - 40k - [Cached](#) - [Similar pages](#)  
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**Kaiser Pharmacy >> Online Pharmacy >> BugsBWear.com**  
Home | **Online Pharmacy** | Page 7 | **Kaiser Pharmacy**. Pet Supplies · Beauty Products · Dental · Staying Healthy · **Online Pharmacy**. **Kaiser Pharmacy** ...  
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International **Online** Prescription **Pharmacies** · International **Pharmacies Online** ... **Kaiser Pharmacy** · **Kaiser S** Drugstore · Kaisers Drugstore ...  
[www.bugsbwear.com/pharmacy/Page-7.html](#) - 24k - [Cached](#) - [Similar pages](#)

[PDF](#) [Combating Web Spam with TrustRank](#)  
File Format: PDF/Adobe Acrobat - [View as HTML](#)

**kaiser pharmacy online**. **kaiser pharmacy online**. Stop surfing! Only here. you can get info about. **kaiser pharmacy online**. Click here to read info ...  
[www-db.stanford.edu/~zoltan/presentations/trustrank-vldb-2004-09-02.pdf](#) - [Similar pages](#)

**Kaiser Pharmacy - Uncommonly Classical.com**  
We're offer our **online** customers secure shopping with prices nobody beats! ... Your search for "**Kaiser Pharmacy**" did not match any documents ...  
[www.uncommonlyclassical.com/Category/Pharmacy/Kaiser%20Pharmacy.html](#) - 7k - [Cached](#) - [Similar pages](#)

**Nground >> pharmacy**  
Accutane Accutane - Actonel Actonel - Adderall **online pharmacy** Adderall **online**

kaiser pharmacy online

# Spam 101

The screenshot shows a Google search for "online pharmacy" with several search results. Two callout boxes highlight specific ads:

- Save today on Viagra, Lipitor, Zoloft, ...** (Callout pointing to the "Internet's Pharmacy drug store" result)
- Phentermine 90 Pills/\$119** (Callout pointing to the "Phentermine 90 Pills/\$119" result)

**Search Results:**

- Carisoprodol! Soma Watson 350mg/120tabs \$85**  
Take Advantage of Our Prices without changing Quality! We Continue to provide the Best meds for Your Money! Cod, and Credit Cards Accepted Saturday delivery. Always Lower Prices, Always the Same Quality. U.S. Pharmacy, U.S. Meds. USA Orders Only!  
<http://www.mylifestylemeds.com/> - 49k - Aug 11, 2005 - [Cached](#) - [Similar pages](#)
- Internet's Pharmacy drug store**  
Save today on Viagra, Lipitor, Zoloft and many other pharmaceutical drugs. FDA approved. Fedex overnight on all orders. Live online Help 24/7  
<http://www.bestpharmacydrugs.com> - 49k - Aug 11, 2005 - [Cached](#) - [Similar pages](#)
- Buy View Pharmacy: Your Reliable Online Pharmacy**  
Buy FDA approved medications for pain relief, muscle relaxers and many more - FREE medical consultation. No Prior Prescription required Free Shipping.  
<http://www.buyviewpharmacy.com> - 49k - Aug 11, 2005 - [Cached](#) - [Similar pages](#)
- Phentermine - Blow Out Sale!**  
Best Weight Loss Pill - FDA approved, U.S. Licensed Physicians/ Pharmacist. Free Shipping and Customer Service ready to Help with your order. Orders In By 3:00 EST Shipped Same Day  
<http://www>YourDiscountDrugStore.com> - 49k - Aug 11, 2005 - [Cached](#) - [Similar pages](#)
- Phentermine 90 Pills/\$119**  
Weekly Special: 90 pills (37.5mg). C.O.D., Free Shipping, U.S. Pharmacy, Free Consultation. Phone orders welcome. Orders In By 3:00 EST Shipped Same Day, Saturday Delivery.  
<http://www.yourprescriptionforless.com> - 49k - Aug 11, 2005 - [Cached](#) - [Similar pages](#)
- Online Pharmacy Meds**  
No prior prescription is needed. Fast, one page order form and FedEx overnight delivery of both brand name and generic drugs. Delivery to U.S. customers only.  
<http://www.onlinepharmacymeds.com/?s=tw> - 49k - Aug 11, 2005 - [Cached](#) - [Similar pages](#)
- CostLessMedicine.com - Your Best Source For Meds**  
Cost Less Medicine is your convenient, safe and private source for FDA approved prescription medications. We specialize in delivering quality medications at REALLY LOW PRICES! FREE Shipping by FedEx!  
<http://www.costlessmedicine.com> - 49k - Aug 11, 2005 - [Cached](#) - [Similar pages](#)
- Phentermine Sale! 37.5mg 90 pills \$119.00**  
From A Company You Have Learned to Love and Trust! We are committed in providing

**Sponsored Links:**

- No Prior Script req'd + Free Shipping**  
Low Price Prescriptions on soma, phentermine, floricet, tramadol and much more! Overnight shipping, discreet packaging, and Free online doctors consultation.  
[www.superiorhealthpharmacy.com](http://www.superiorhealthpharmacy.com)
- Best Online Pharmacy + FREE Shipping**  
U.S FDA approved prescription medications. No hidden fees, no consultation fees. Free shipping. Great Prices. Order on line or call us to place your order.  
[www.stronghealthpharmacy.com](http://www.stronghealthpharmacy.com)
- Free Saturday Delivery - 5% Off Reorder**  
FDA approved meds of the highest quality-US licensed Doctors and Pharmacies- Don't be fooled by those foreign imitation meds sold by our competitors-Free Sat Delivery-5% Discount On Reorders.  
[fastfedexmeds.com/index.php?c=7&ck=index](http://fastfedexmeds.com/index.php?c=7&ck=index)

**Advertisement:** ZENEGRA by SILDENAFIL CITRATE 100mg. TREAT ERECTILE DYSFUNCTION CHEAP! ONLY \$2.99! CHEAPEST PILLS ONLINE ORDER NOW! ORDER DISCREETLY ONLINE TODAY!

# Spam 101

Pet shops commonly carry fish for home aquariums, small birds such as parakeets, small mammals such as fancy rats and hamsters...



DON'T BE  
SCARED  
THE ONLY THING  
WE BITE  
IS OUR PRICES.

Pharmacy  
Kaiser Pharmacy  
oooooooooole  
[Puppies For Sale](#)  
Sale/Adoption - Various Breeds - Browse Classifieds  
acoostatimes.com  
[Shepherd](#)  
Share and buy Pets! Simply Fast Savings  
ping.com  
[PuppyPetite.com](#)  
Maltese puppies for sale direct from u.s.d.a. registered breeder!  
www.puppypetite.com  
[Import German Shepherds](#)  
Affordable Import German Shepherd German Shepherd Puppies  
www.Strublek9.com

Shop for:  In:

Pet shops commonly carry fish for home aquariums, small birds such as parakeets, small mammals such as fancy rats and hamsters, and small reptiles such as lizards and snakes. Mice, small goldfish, and other animals that serve to be live food (called feeders) for reptiles and fish are also usually sold.

**Puppies and kittens**  
Less common in pet stores are larger mammals such as dogs and cats. In part, these animals have become less popular in stores because pet stores have received considerable bad press for their inappropriate care of puppies and kittens, which need socialization and are vulnerable to illnesses, and for their purchasing the animals from puppy mills. Most shops that carry puppies and kittens charge inflated prices for them, far above the common rate for the same animal from a breeder. As a result, it is usually easier and cheaper to acquire puppies and kittens from animal shelters, private breeders, or rescue groups than from pet stores.

**Exotic pets**  
Exotic pets like sugar gliders and large parrots are available at some pet shops. Because the care of these types of animals is difficult and expensive, usually only stores that specialize in exotic animals carry them as regular stock.

**Classification of Breeds**

# Spam 101

The screenshot shows a website for 'UNCOMMONLY CLASSIC' with a navigation menu, a 'GO SHOPPING NOW!' button, and several advertisement blocks. Two callout boxes are present: one on the left listing items from the navigation menu, and one on the right containing a definition of pharmacy.

**UNCOMMONLY CLASSIC**  
ONLINE SHOPPING EXTRAVEGANZA!

**NAVIGATE**

- Lawyers
- Loans
- Magazines
- Mortgage
- Nurse
- Pharmacy
- Posters And Crafts
- Ringtones
- Shoes
- Stock Market
- Sunglasses
- Theater
- Viagra
- Video Games

**HOT PRODUCTS**

**ZERO DOWNTIME**  
Host your website on 5 machines!  
**\$7.77 PER MONTH**

**GO SHOPPING NOW!**

**TAKE A LOOK AT SOME OF OUR TOP SELLERS!**

Ads by Goooooogle

**Compounded Medications**  
Quality drugs, nationwide delivery Good prices, great customer service  
[McGuffCompoundingPharmacy.com](http://McGuffCompoundingPharmacy.com)

**Pharmacist-CA**  
We recruit pharmacists for CA jobs. We represent the top CA employers.  
[www.pharmacist-ca.com](http://www.pharmacist-ca.com)

**Pharmacy**  
Safe, Quality, Prescription Drugs Licensed Canadian Pharmacy  
[www.CanPharm.com](http://www.CanPharm.com)

**Online Pharmacy**  
Save on thousands of drugs. Local Pharmacy quality drugs  
[www.usamedsonline.com](http://www.usamedsonline.com)

**ARTICLES**

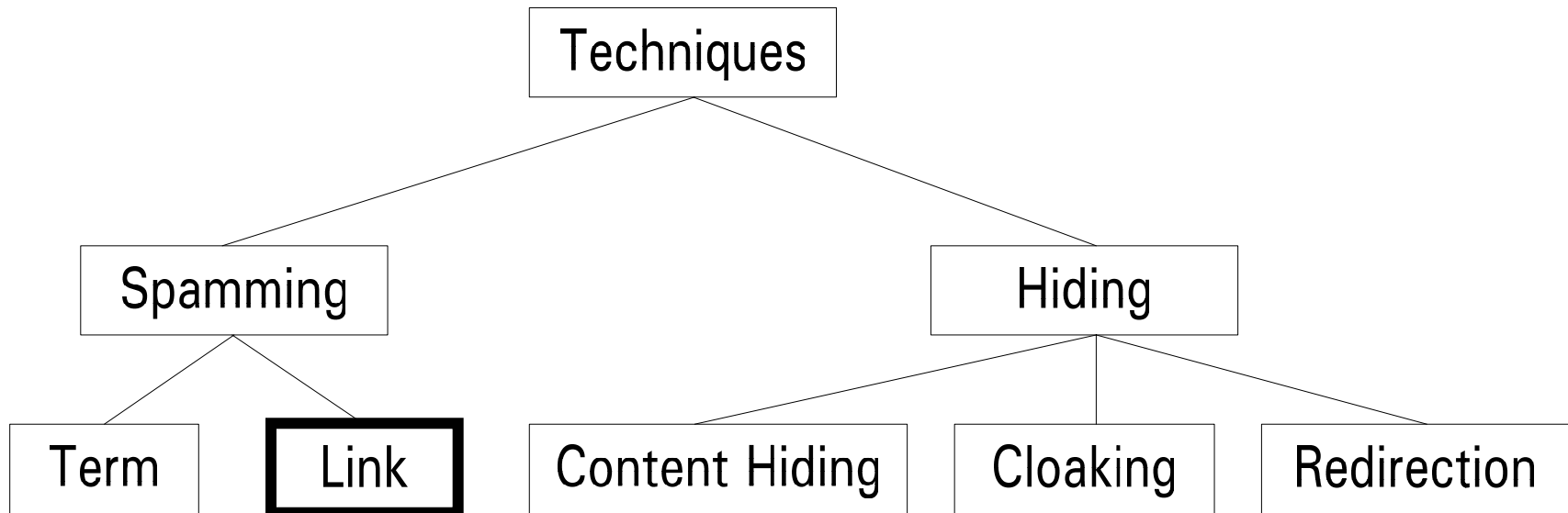
If you're looking for PHARMACY, [Click Here!](#)  
Pharmacy is the profession of compounding and dispensing medication. More recently, the term has come to include other services related to patient care including clinical practice, medication review, drug information, etc. Some of these new roles are now mandated by law in various legislatures. Pharmacists, therefore, are the primary health professionals who optimise

Pharmacy is the profession of compounding and dispensing medication. More recently, the term has come to include other services...

Lawyers  
Loans  
Mortgage  
Ringtones  
Viagra

# Spam 101

**Spamming** = misleading search engines to obtain higher-than-deserved ranking



**Link spamming** = building link structures that boost PageRank score

# Spam 221: PageRank

A page is important if many important pages point to it

$$p_o = c \sum_i p_i / \text{out}(i) + (1 - c)$$

PageRank  
of page  $p_o$

PageRank of page  $p_i$   
that **points to** page  $p_o$



# Spam 221: PageRank

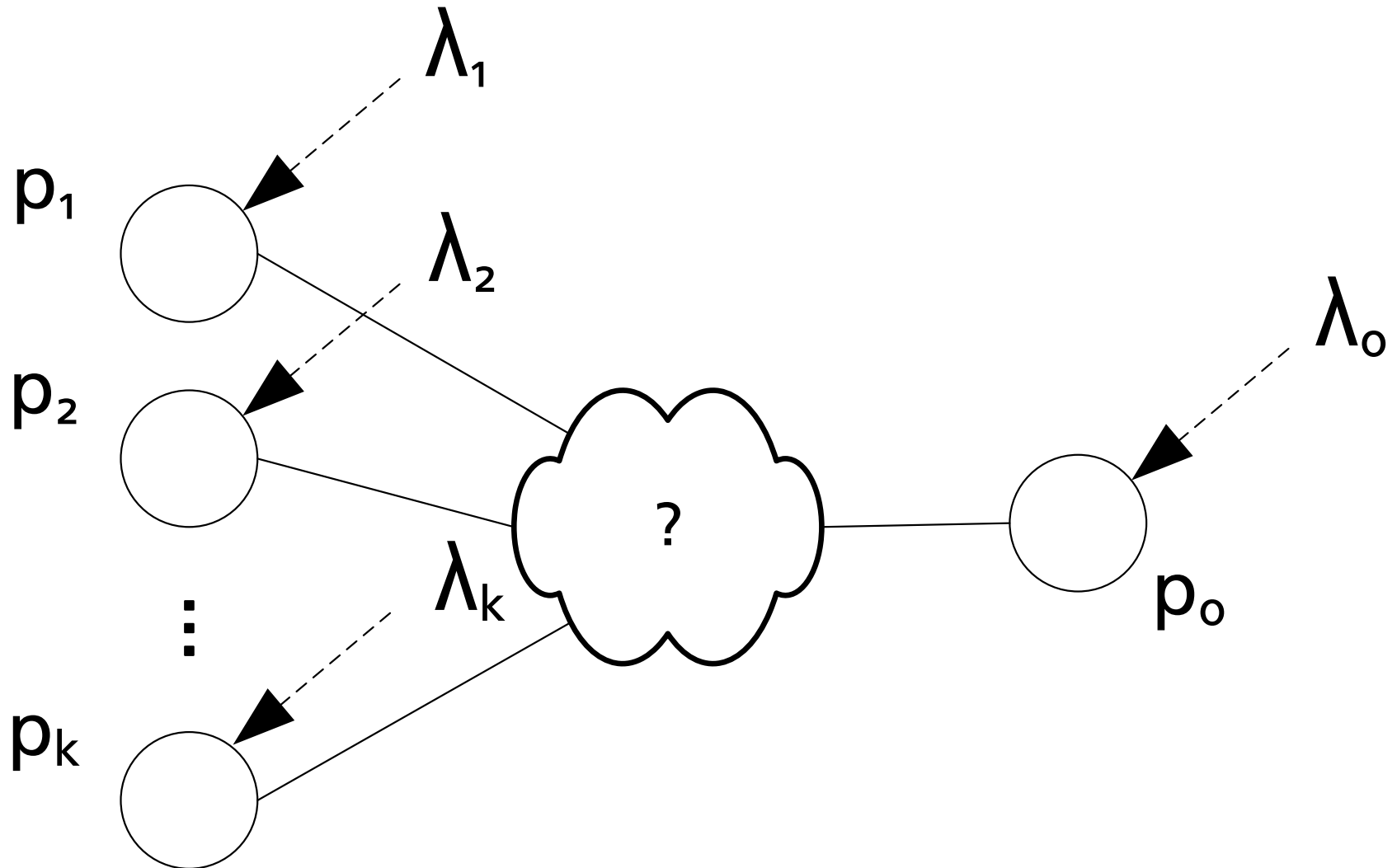
Damping  
factor  $\approx 0.85$

Random jump  
probability  $\approx 0.15$   
(uniform static score)

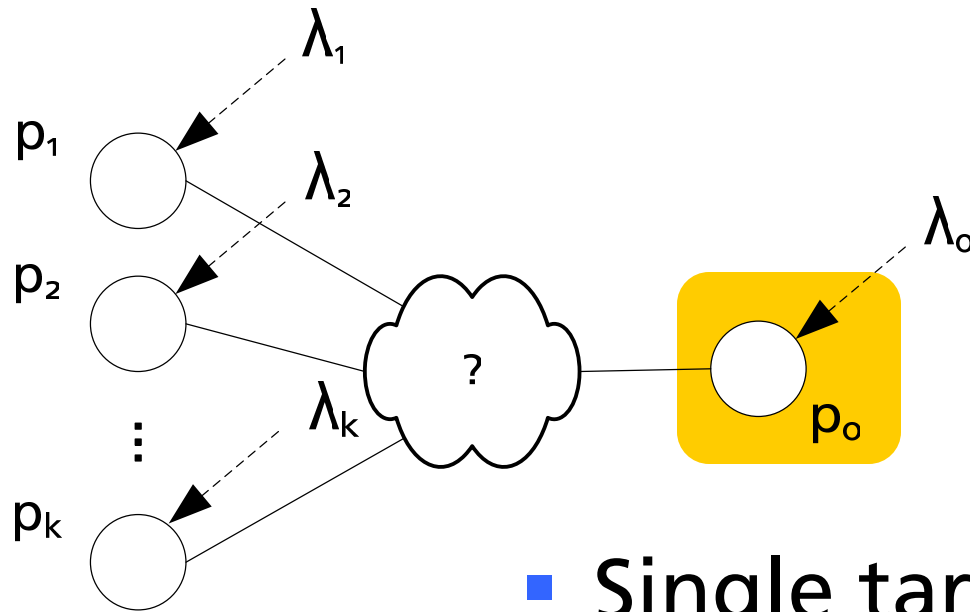
$$p_o = c \sum_i p_i / \text{out}(i) + (1 - c)$$

Outdegree  
of page  $p_i$

# Spam 221: Spam Farm Model

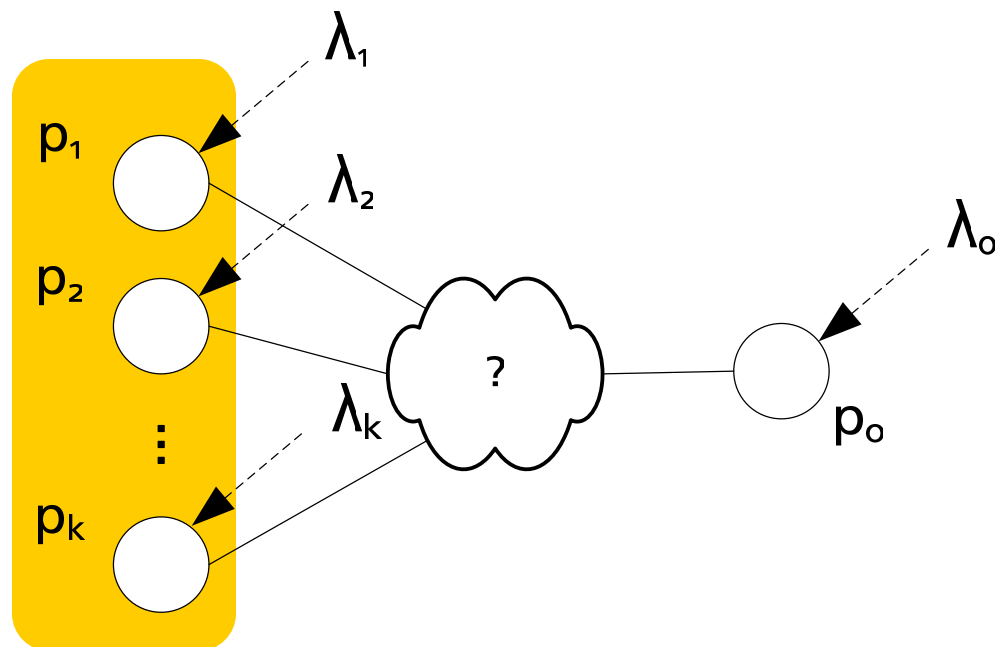
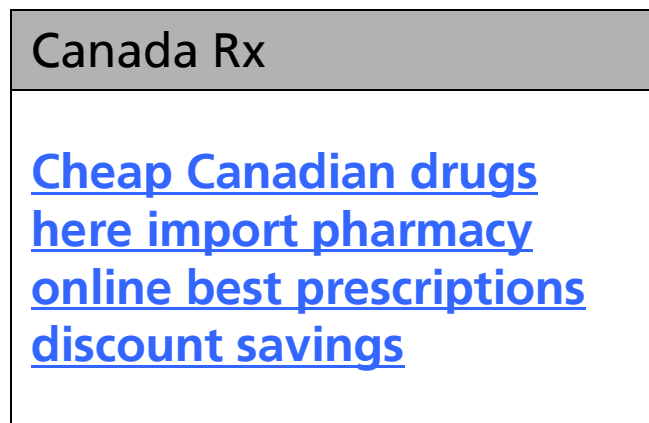


# Spam 221: Spam Farm Model



- Single target page  $p_0$ 
  - Increase exposure
  - In particular, increase PageRank

# Spam 221: Spam Farm Model

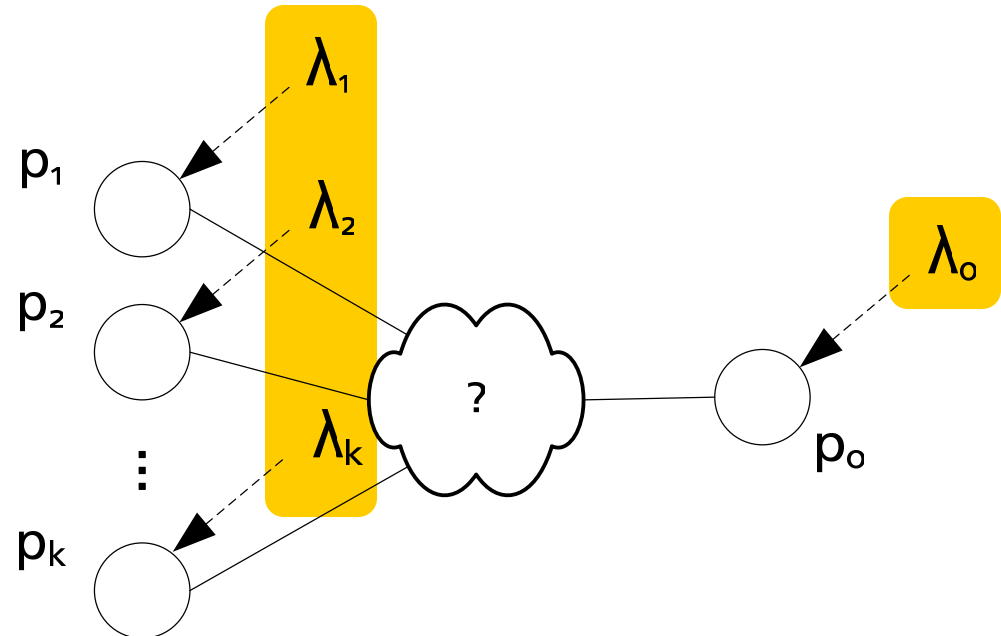


- Boosting pages  $p_1, \dots, p_k$ 
  - Owned/controlled by spammer

# Spam 221: Spam Farm Model

- Leakages  $\lambda_0, \dots, \lambda_k$ 
  - Fractions of PageRank
  - Through hijacked links
    - Spammer has limited access to source page
  - $\lambda = \lambda_0 + \dots + \lambda_k$

Joe's Blog
Posted on 04/28/05
...
<b>Comments</b>
Great thoughts! I also wrote about this issue in <a href="#">my blog</a> . (by <a href="#">as7869</a> )

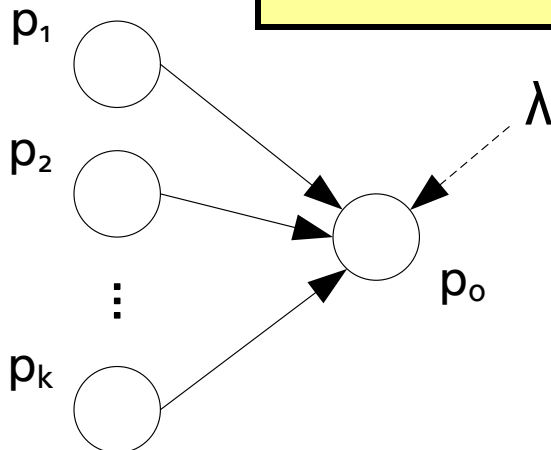


# Spam 221: Optimal Farm

## ■ Simple

$$p_o = \lambda + (1 - c)(ck + 1)$$

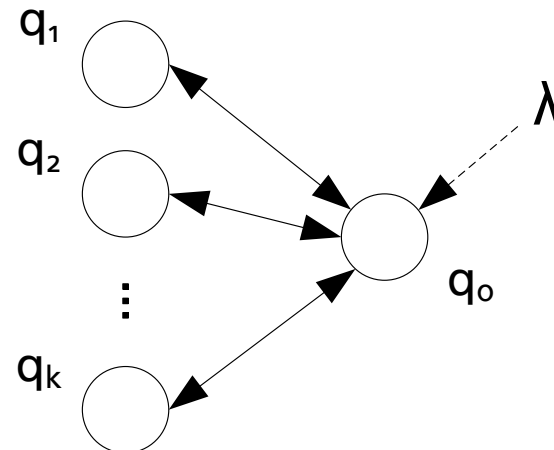
- Every link points to  $p_o$



## ■ Optimal

$$q_o = p_o / (1 - c^2)$$

- Links to boosting pages
- 3.6x increase in target PageRank

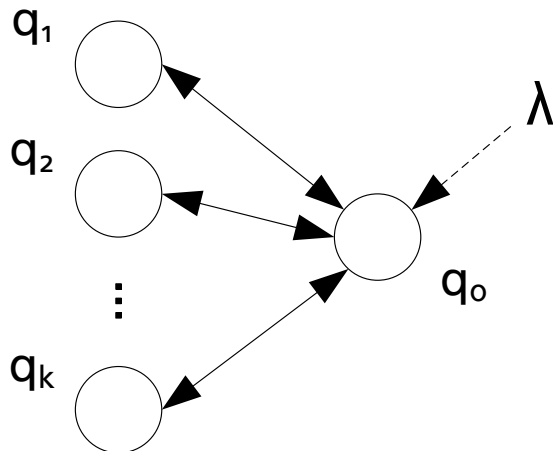


# Spam 221: Optimal Farm

## ■ Optimal

$$q_o = p_o / (1 - c^2)$$

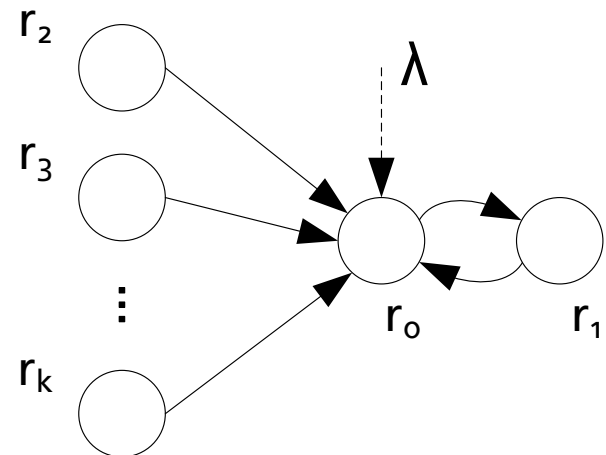
- Links to boosting pages
- 3.6x increase in target PageRank



## ■ Optimal #2

$$r_o = p_o / (1 - c^2)$$

- Same PageRank
- Fewer links



# Spam 221: Optimal Farm

## ■ Optimal

$$q_o = p_o / (1 - c^2)$$

- Links to boosting pages
- 2.6x increase in target

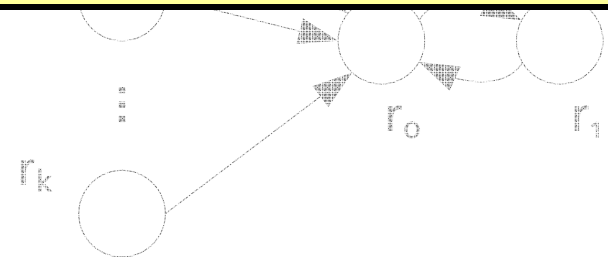
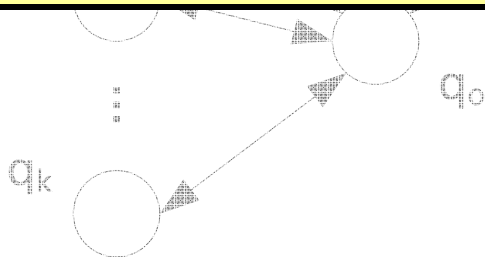
## ■ Optimal #2

$$r_o = p_o / (1 - c^2)$$

- Same PageRank
- Fewer links

### Lesson #1:

Short loop(s) increase target PageRank





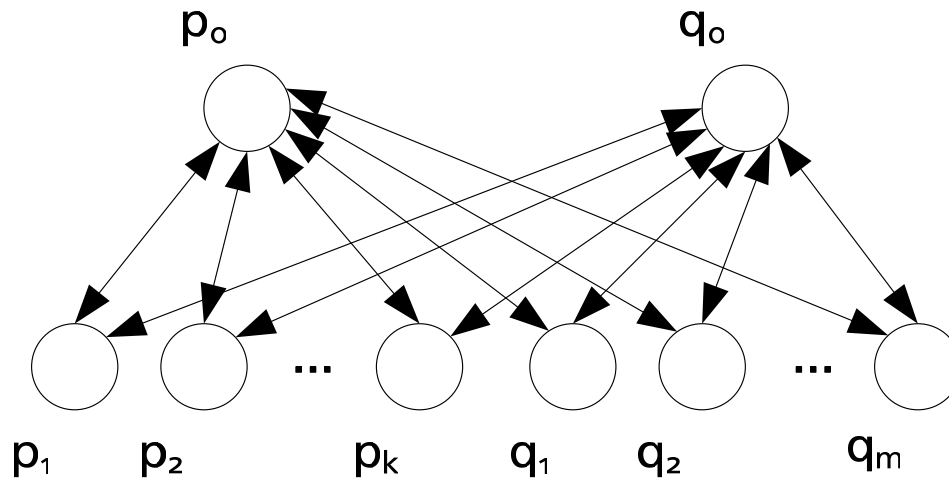
# Spam 221: Two Farms

- **Alliances** = interconnected farms
  - Single spammer, several target pages/farms
  - Multiple spammers

What happens if you and I  
team up?

# Spam 221: Two Farms

- We can do this...



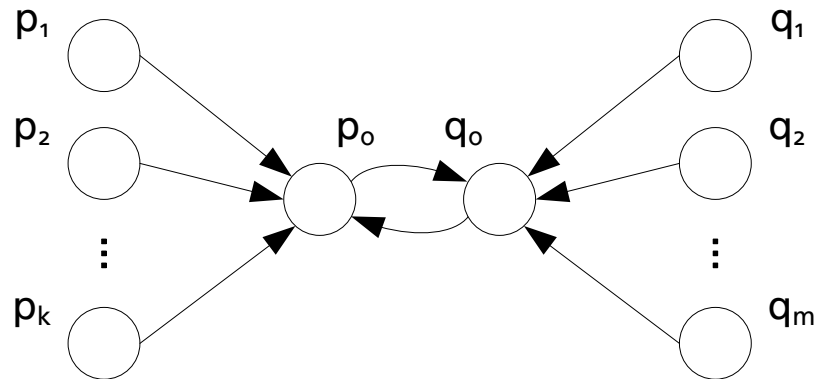
- ... but it won't help:  
target scores **balance out**

$$p_o = q_o = d (k + m) / 2$$

$$d = c / (1 + c)$$

# Spam 221: Two Farms

- However, we can also do this...
  - Remove the links to boosting pages



- ... and both target scores increase
  - For  $k = m$ , we have a 6.7x increase

$$p_o = dk + cdm + 1$$

$$q_o = dm + cdk + 1$$

# Spam 221: Two Farms

- However, we can also do this...

## Lesson #2:

Target pages should only link to other targets



## Lesson #3:

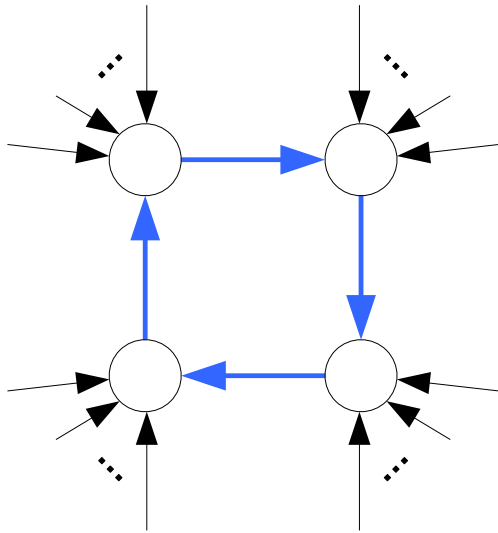
In an alliance of two, both participants win

$$q_0 = dm + cdk + 1$$

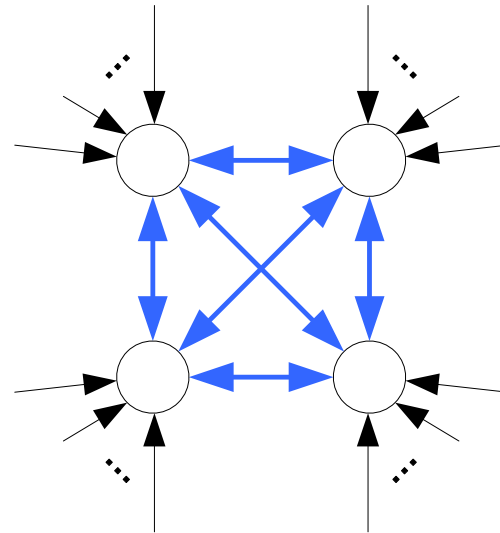
# Spam 221: Larger Alliances

- "Extremes"

- Ring core

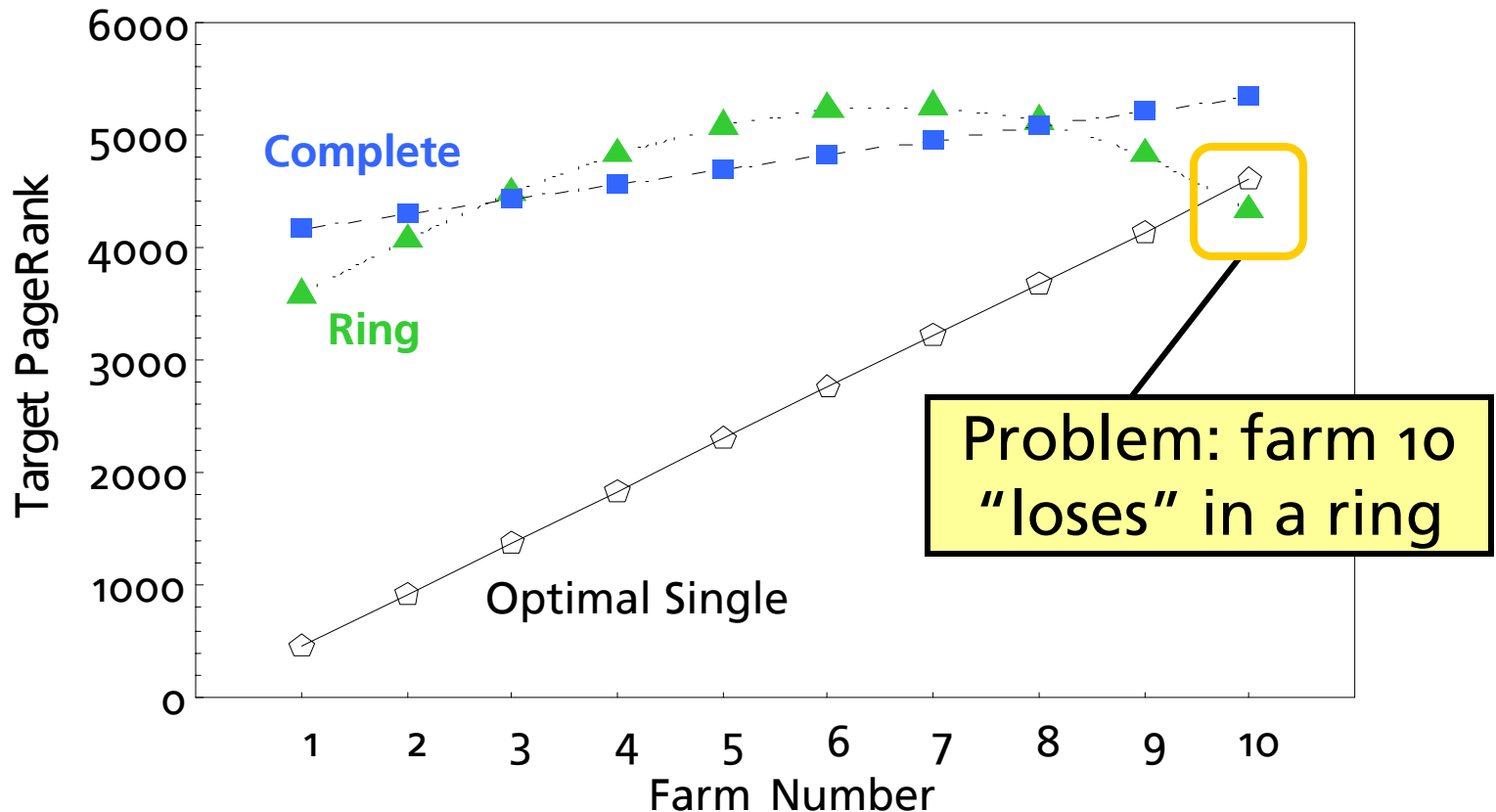


- Completely connected core



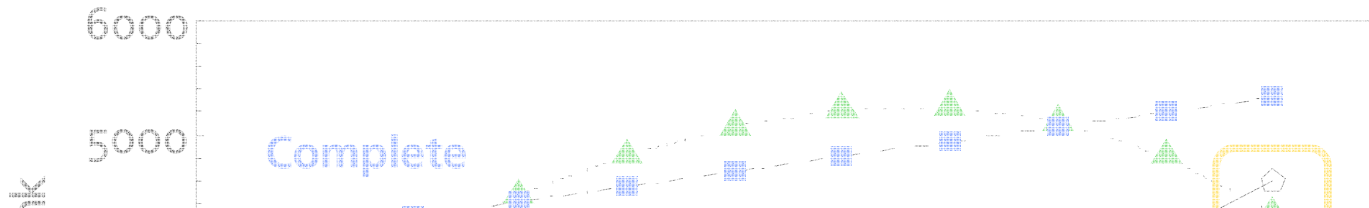
# Spam 221: Larger Alliances

- Target scores for ring/complete cores
  - 10 farms of sizes 1000, 2000, ..., 10000



# Spam 221: Larger Alliances

- Target scores for ring/complete cores
  - 10 farms of sizes 1000, 2000, ..., 10000



## Lesson #4:

Larger alliances need to be *stable* to keep all participants happy



# Spam 221: Larger Alliances

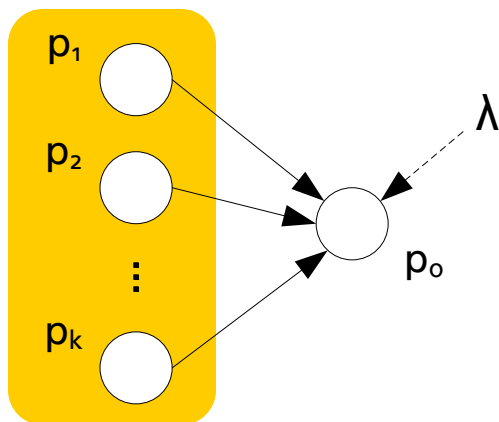
- **Stable alliance** = no farm has incentive to split off
  - Alliances of two are always stable
  - Larger alliances are not necessarily stable
- **Dynamics** ⇒ see paper
  - Should a new farm be added?
  - What about adding more boosting pages?
  - When/with whom should a farm split off?
  - Should a “loser” be compensated?





# Spam 321: Spam Detection

- Identifying regular structures
  - Inlink/outlink/PageRank distribution “unnatural”
  - Fetterly *et al.*, 2004
  - Benczúr *et al.*, 2005

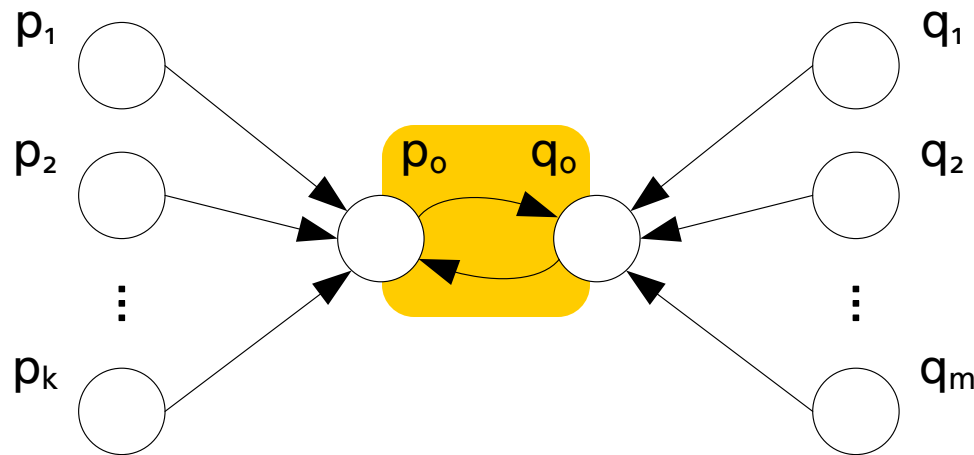


$$p_1 = p_2 = \dots = p_k$$

# Spam 321: Spam Detection

- Detecting collusion

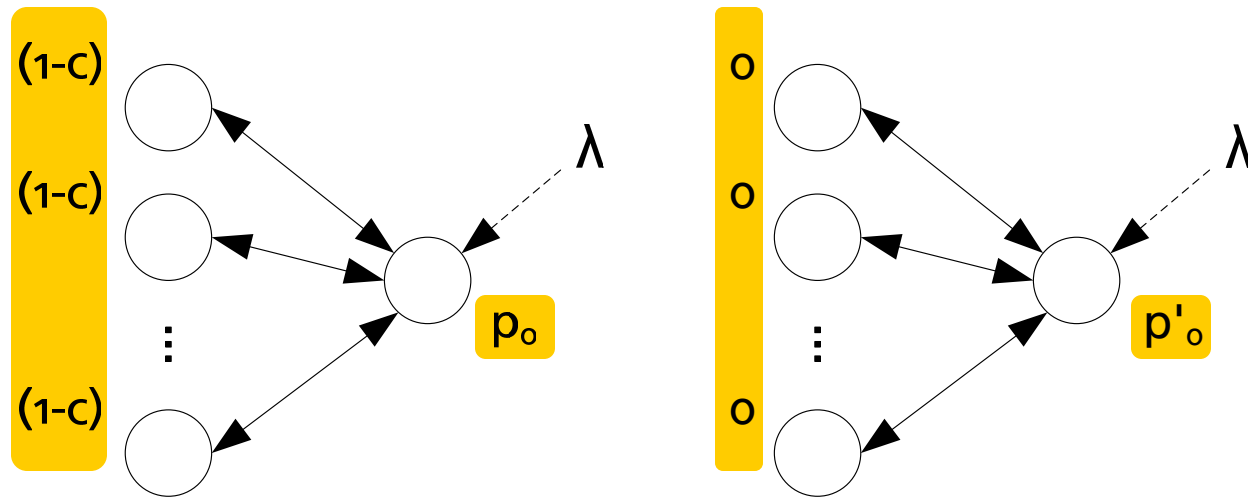
- Alliance cores preserve (capture) PageRank
- Zhang *et al.*, 2004



$$(p_o + q_o) / (\sum_i p_i + \sum_j q_j) \approx c / (1 - c)$$

# Spam 321: Spam Detection

- Estimating spam mass
  - Target PageRank depends on boosting
  - Work in progress



$$(p_o - p'_o) / p_o \text{ large}$$

# Review Session

- Link spammers target PageRank
- Spam farm model
  - Single target page
  - Boosting pages + leakage
- Alliances of two
  - Always better than alone
- Larger alliances
  - Different core structures
  - Not necessarily stable
    - Conditions on joining and leaving

# Review Session

- Related work
  - Bianchini *et al.*, 2005. Inside PageRank
  - Langville and Meyer, 2004. Deeper Inside PageRank
  - Baeza-Yates *et al.*, 2005. PageRank Increase under Different Collusion Topologies
- Future work
  - Spam detection
  - Cost model extension

# Spam 221: Larger Alliances

- Various core structures
  - 4 farms of size 50
  - One target probed (others symmetrical)

