



程序代写代做 CS编程辅导

Bot



DDoS Deep Dive – Part II

The Business Context for
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Cybersecurity Management
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Semester 2, 2021

- Botnet, DDoS detection

- Feature selection
 - Performance comparison
 - Honeypot-based analysis



- DDoS prevention

- Ingress/egress filtering
 - Router-based filtering

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- DDoS reaction

- Destination-end
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 - Source-end

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- Filter-based methods
 - Information Gain
 - Chi-square Test
 - Fisher's Score
 - Correlation Coefficient
 - Variance Threshold
 - ...

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of all features → Selecting the Best Subset → Learning Algorithm → Performance

- Wrapper-based methods
 - Forward Feature Selection
 - Backward Feature Elimination
- Embedded methods
 - Lasso regression (L1 regularization)
 - Ridge regression (L2 regularization)

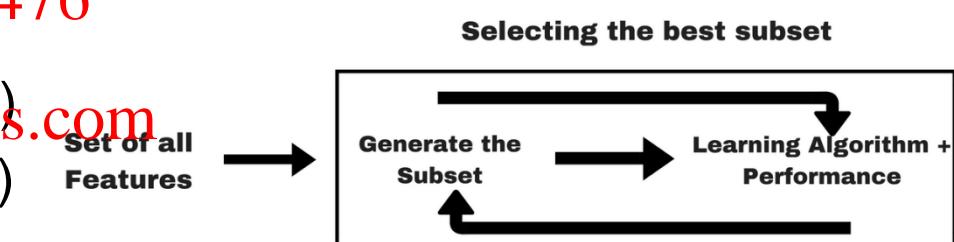
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<https://www.analyticsvidhya.com/blog/2016/12/introduction-to-feature-selection-methods-with-an-example-or-how-to-select-the-right-variables/>

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- Information gain (IG)

- There are k classes, let $S, S = \{S_1, S_2, \dots, S_k\}$
- Entropy for dataset

$$H(S) = - \sum_{i=1}^k p_i \log p_i = - \sum_{i=1}^k \frac{|S_i|}{|S|} \log \frac{|S_i|}{|S|}$$

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- Feature F has m values: v_1, v_2, \dots, v_m
- Subset with feature F being $v_j, S_{F=v_j}$
- The conditional entropy of S given feature F ,

$$H(S|F) = \sum_{j=1}^m \frac{|S_{F=v_j}|}{|S|} \cdot H(S_{F=v_j})$$

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- $IG(S, F) = H(S) - H(S|F)$

Feature Selection – KDD Cup 99

- Results of feature selection on KDD Cup 99 using information gain [1]

Table 3. Most relevant features for each class label and information gain

Class Label	Info. Gain	Feature #	Feature Name
smurf	0.9859	5	source bytes
neptune	0.7429	30	diff srv rate
normal	0.6439	5	source bytes
back	0.0411	6	destination bytes
satan	0.0257	27	error rate
ipsweep	0.0222	37	dst host srv diff host rate
teardrop	0.0206	5	source bytes
warezclient	0.0176	5	source bytes
portsweep	0.0163	4	status Flag
pod	0.0065	5	source bytes
nmap	0.0024	4	flag
guess_passwd	0.0015	5	source bytes
buffer_overflow	0.0007	6	destination bytes
land	0.0007	7	land
warezmaster	0.0006	6	destination bytes
imap	0.0003	3	service
loadmodule	0.0002	6	destination bytes
rootkit	0.0002	5	source bytes
perl	0.0001	16	# root
ftp_write	0.0001	5	source bytes
phf	0.0001	6	destination bytes
multihop	0.0001	6	destination bytes
spy	0.0001	39	dst host srv error rate

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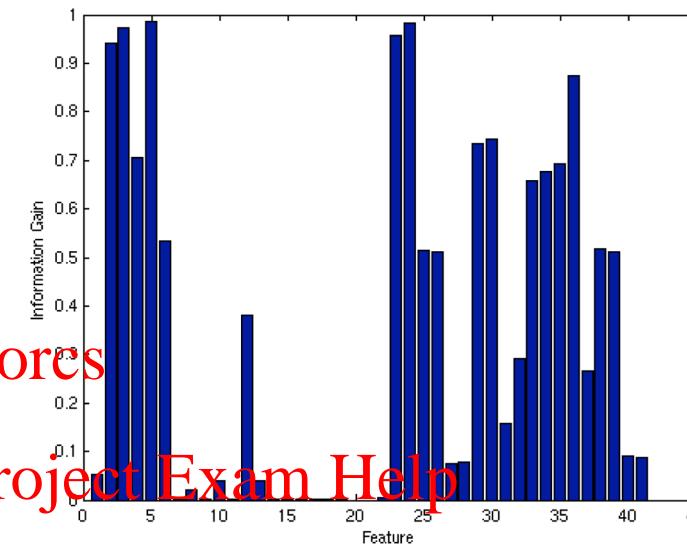


Table 4. List of features for which the class is selected most relevant

Class Label	Relevant Features
normal	1, 6, 12, 15, 16, 17, 18, 19, 31, 32, 37
smurf	2, 3, 5, 23, 24, 27, 28, 36, 40, 41
neptune	4, 25, 26, 29, 30, 33, 34, 35, 38, 39
land	7
teardrop	8
ftp_write	9
back	10, 13
guess_pwd	11
buffer_overflow	14
warezclient	22

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- Correlation-based Feature Selector [2]

- Heuristic “merit” of



$$\text{subset } S: M_S = \frac{k \cdot \bar{r}_{cf}}{\sqrt{k+k(k-1)\bar{r}_{ff}}}$$

- k : the number of
 - \bar{r}_{cf} : the average feature-class correlation ($f \in S$)
 - \bar{r}_{ff} : the average feature-feature intercorrelation

- Objectives:

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- Increase feature-to-class correlation (\bar{r}_{cf})
 - Reduce feature-to-feature correlation (\bar{r}_{ff})

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- Results of feature selection on NSL KDD [3]
 - Wrapper-based: 4,  26, 30
 - Filter-based: the global performance were achieved with the top 10 features (5, 3, 6, 4,  13, 34, 35, 38)

Table 4. Feature selection/reduction using the wrapper method (CfsSubsetEval + BestFirst) and the filter method (InfoGainAttributeEval + Ranker) on the full NSL-KDD training dataset in the second phase of this study.

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Attribute Evaluator, Search Method, and Ranker	Email: tutors@163.com Features Selected	Method Used
CfsSubsetEval + BestFirst	QQ: 749389476 4, 5, 6, 12, 26, 30 5, 3, 6, 4, 30, 29, 33, 34, 35, 38, 12, 3, 9, 25, 23,	Wrapper method
InfoGainAttributeEval + Ranker	https://tutorscs.com 26, 37, 32, 36, 31, 24, 41, 2, 27, 40, 28, 1, 10, 8, 13, 16, 19, 22, 17, 15, 14, 18, 11, 7, 21, 20, 9	Filter method

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- DDoS reaction

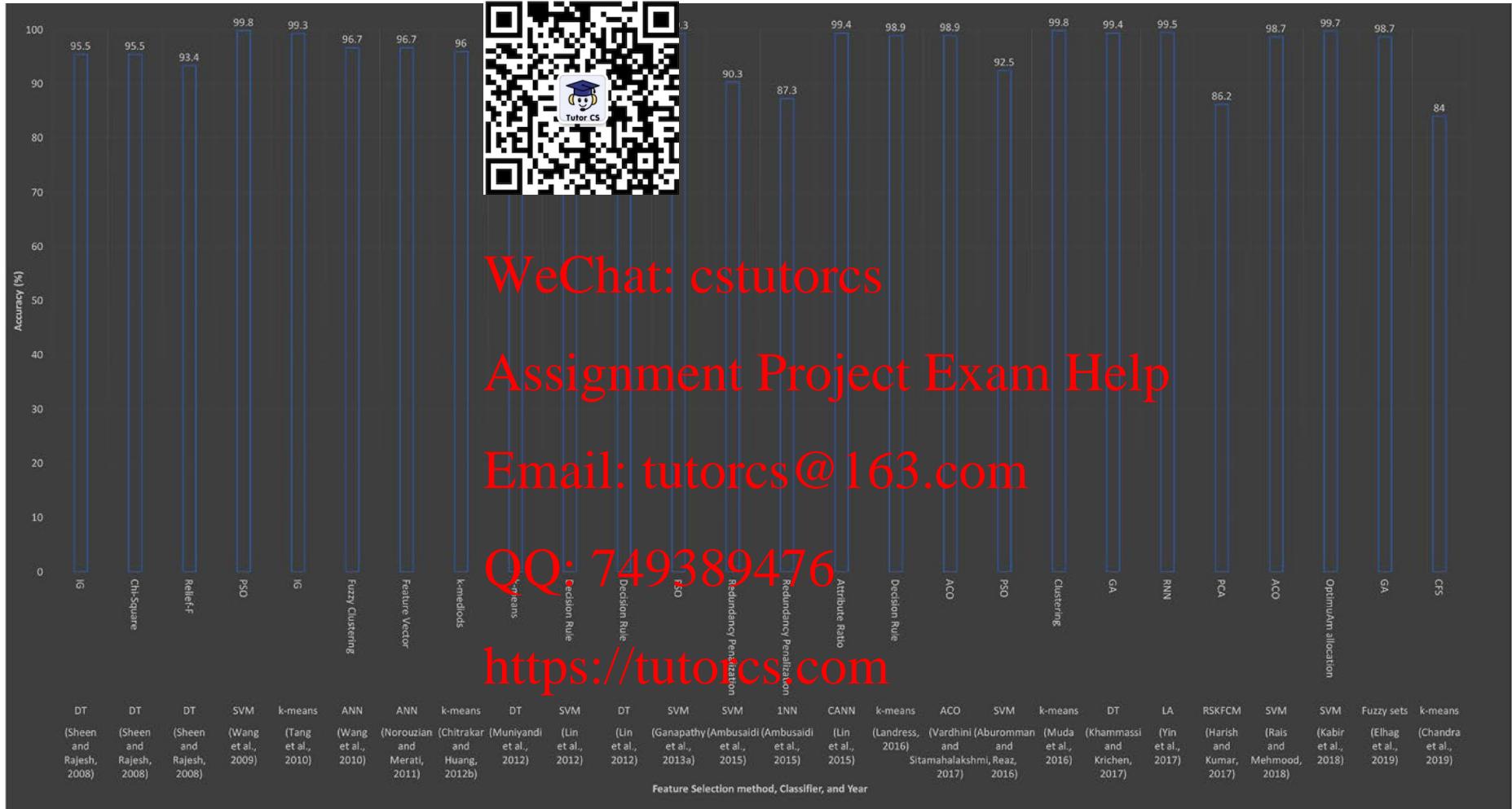
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Botnet Detection – KDD Cup 99

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- Accuracy comparison on KDD Cup 99 [4]



Botnet Detection – NSL KDD

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- Accuracy comparison on NSL KDD [4]



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- Performance comparison of six classifiers [3]

Table 2. Performance comparison of six classifiers using 10-fold cross-validation.



Parameters \ Classifier	PTree	NBTree	RBF	LogitBoost	BayesNet
Correctly Classified Instances	122,704 97.40%	125,766 99.83%	125,819 99.87%	123,394 97.95%	122,329 97.10%
Incorrectly Classified Instances	3269 2.595%	207 0.164%	154 0.122%	2579 2.0473%	3644 2.892%
TP Rate	0.974	0.998	0.999	0.980	0.971
FP Rate	0.028	0.002	0.001	0.022	0.030
Precision	0.74	0.99	0.99	0.980	0.971
F-measure	0.974	0.998	0.999	0.980	0.971
ROC Area	0.973	0.999	1.000	0.987	0.996
Specificity (%)	96.0	99.8	99.81	96.8	96.2
Sensitivity (%)	98.5	99.8	99.9	98.9	97.8
Model Building Time (second)	1137.71 s	3.59 s	213.18 s	81.01 s	18.3 s

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- Impact of feature selection on the performance [3]



Table 11. Performance of the NBTrainer on the NSL-KDD training dataset using different feature selection/reduction methods.

Parameters \ Methods	General Method	Discretize Filter Classifier	Wrapper Method	Wrapper Method + Discretize Filter	Filter Method	Filter Method + Discretize Filter
Correctly Classified Instances	125,819	125,787	125,300	125,414	125,764	125,634
	99.87%	99.85%	99.46%	99.55%	99.83%	99.73%
Incorrectly Classified Instances	154	186	673	559	209	339
	0.122%	0.147%	0.534%	0.443%	0.165%	0.269%
TP Rate	0.999	0.999	0.995	0.996	0.998	0.997
FP Rate	0.001	0.002	0.006	0.005	0.002	0.003
Precision	0.999	0.999	0.995	0.996	0.998	0.997
F-measure	0.999	0.999	0.995	0.996	0.998	0.997
ROC Area	1.000	1.000	0.999	1.000	1.000	1.000
Specificity (%)	99.8	99.8	99.0	99.3	99.7	99.6
Sensitivity (%)	99.9	99.9	99.7	99.7	99.9	99.7
Model Building Time(second)	213.18 s	70.95 s	14.23 s	8.7 s	23.94 s	13.6 s

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- DDoS reaction

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- Honeypot-based analysis
 - Mimic the actual service to trap the attacker
 - Deliberately expose vulnerabilities/materials
 - Educational purposes vs. security purposes
 - Limitations
 - Encrypted traffic
 - Unknown attacks
 - Attacker may move laterally to infiltrate the real production network

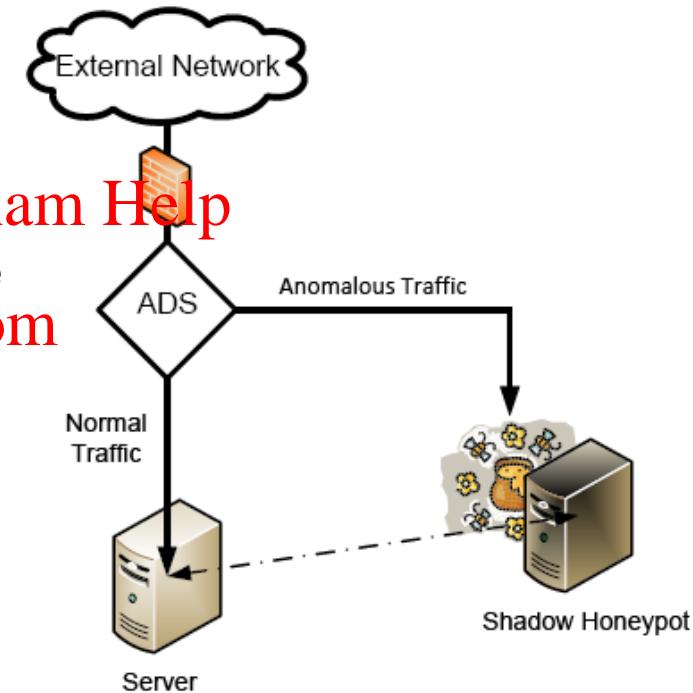
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<https://www.cse.wustl.edu/~jain/cse571-09/ftp/honey/>

- Botnet, DDoS detection

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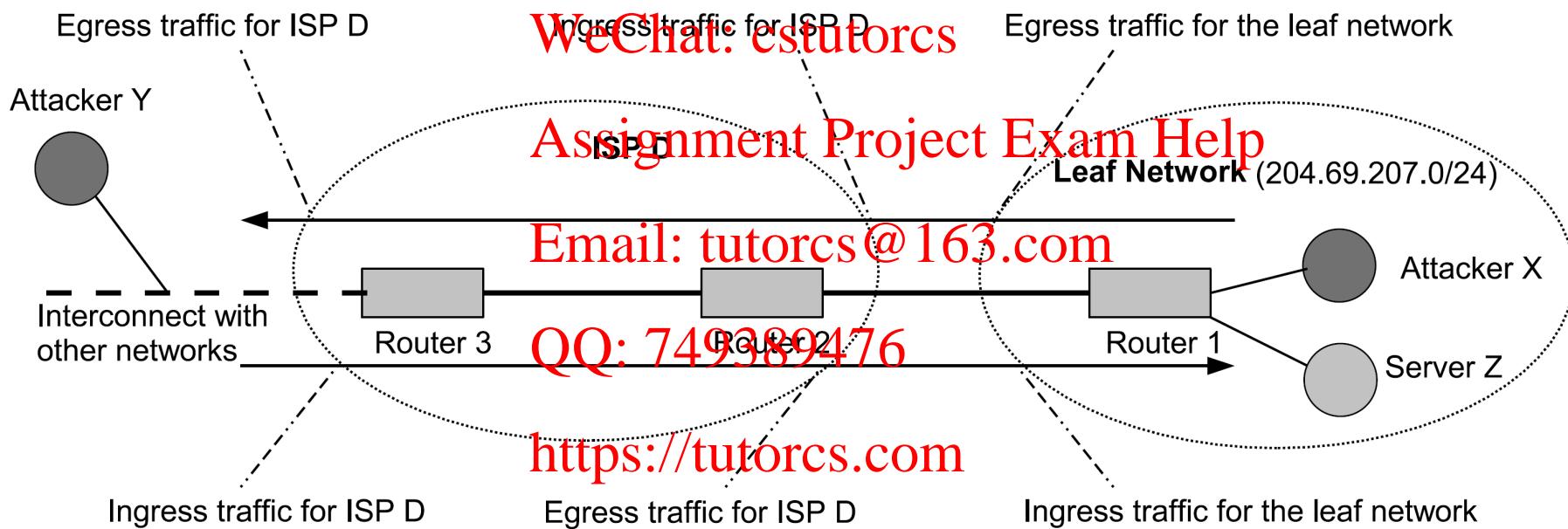
- DDoS reaction

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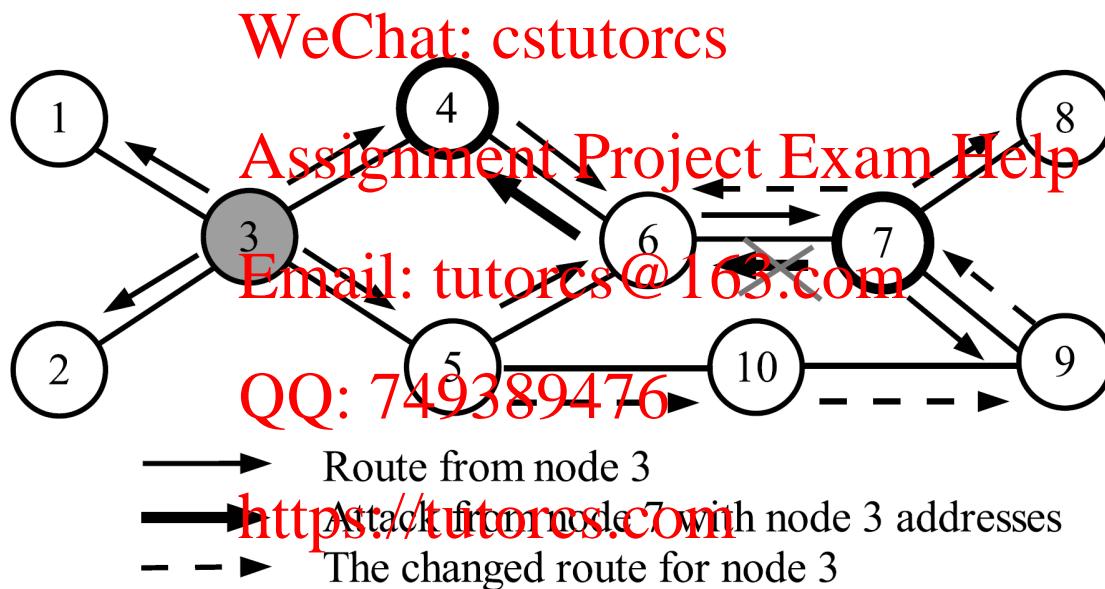
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- Ingress/egress filtering [2]: only allow traffic to enter/leave the network if its source addresses are in the expected IP address range
 - E.g., Router 1 only forwards packets having a source IP address with the 204.69.207.0/24 prefix to leave the network



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- Router-based filtering: use information about the BGP routing topology to filter traffic with spoofed addresses
 - E.g., attack traffic from AS3 (spoofed as AS3) to AS4; router-based filtering deployed at AS6 can filter attack traffic from AS7 can be filtered if AS6 knows the BGP routing topology



- Botnet, DDoS detection

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 - Honeypot-based analysis



- DDoS prevention

- Ingress/egress filtering
 - Router-based filtering

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- DDoS reaction

- Destination-end
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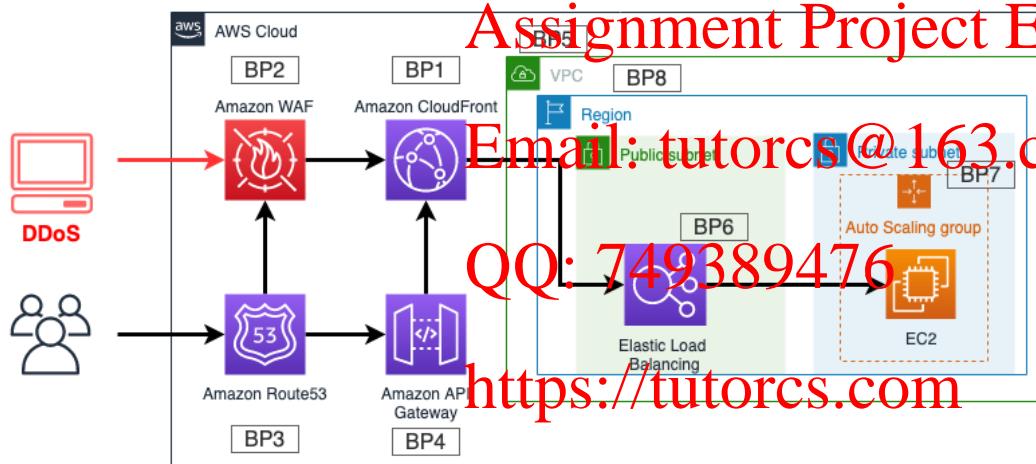
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- Mitigation Techniques at AWS

- Infrastructure Layer

- Amazon EC2 Scaling
 - Choice of Region
 - Elastic Load Balancing

- Application Layer Defence



<https://docs.aws.amazon.com/whitepapers/latest/aws-best-practices-ddos-resiliency/mitigation-techniques.html>

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- Examples of Botnet/DDoS detection on KDD Cup, NSL KDD
 - Feature selection
 - Example 1: information gain applied on KDD Cup
 - Example 2: CF on NSL KDD
 - Performance comparison
 - Feature selection can reduce model building time without impacting the performance
- DDoS prevention
 - Ingress/egress filtering at leaf networks
 - Router-based filtering
- DDoS reaction
 - Destination-end, intermediate network, source-end

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Reference

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- [2] M. A. Hall (1998). Correlation-based Feature Subset Selection for Machine Learning. Hamilton, New Zealand.
- [3] Alabdulwahab, Saleh & Moon, Bong-Kyo. (2020). Feature Selection Methods Simultaneously Improve the Detection Accuracy and Model Building Time of Machine Learning Classifiers. *Symmetry*. 12. 1424. 10.3390/sym12091424.
- [4] Thakkar, A., Lohiya, R. A survey on intrusion detection system: feature selection, model, performance measures, application perspective, challenges, and future research directions. *Artif Intell Rev* (2021). <https://doi.org/10.1007/s10462-021-10037-9>



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Reference

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- [5] Eric Chou and Rich Groves, 2016, *Distributed Denial of Service*, O'Reilly Media, Inc.
- [6] Tao Peng, Chris Leckie, Katagiri Ramamohanrao, *Survey of Network-Based Defense Mechanisms Countering the DoS and DDoS Problems*, ACM Computing Surveys



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The Business Context for Cybersecurity Management

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Outline

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- Security and Risk Management Practice



- Information Security Management Governance

- Organizational Behaviour

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- Ethics

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Security and Risk Management Practice

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- Security management ensures

– Risks are identified



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Interrelationships among

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- Assessing risk

• Implementing policies and controls in response to the risks

• Promoting awareness of the expectations

• Monitoring the effectiveness of the controls



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- According to IT Governance Institute (ITGI)



The Board of Directors' Role

- Be informed about information security
- Set direction to drive policy and strategy
- Provide resources to security efforts
- Assign management responsibilities
- Set priorities Email: tutorcs@163.com
- Support changes required QQ: 749389476
- Define cultural values related to risk assessment
- Obtain assurance from internal or external auditors <https://tutorcs.com>
- Insist that security investments are made measurable and reported on for program effectiveness

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The Management should

- Write security policies based on business input
- Ensure that roles and responsibilities are defined and clearly understood
- Identify threats and vulnerabilities
- Implement security infrastructure and control frameworks (standards, guidelines, baselines, and procedures)
- Ensure that policy is approved by the governing body
- Establish priorities and implement security projects in a timely manner
- Monitor breaches
- Conduct periodic reviews and tests
- Reinforce awareness education as critical
- Build security into the systems development life cycle



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- Security Policies, Procedures, Standards, Guidelines, and Baselines



- What's Risk Management

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- Risk Management Principles

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- Risk Assessment

Security Policies, Procedures, Standards, Guidelines, and Baselines

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Laws, Regulations, Requirements,
Organizational Goals, Objectives



Organizational Policy

Management's
Security Statement

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Functional Implementing Policies
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Management's
Security
Directives

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Standards

Procedures

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Baselines

Guidelines

Specific
Hardware and
Software

Step by Step
Instructions

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Consistent
Level of
Security

Recommendations

Relationships among policies, standards, procedures, baselines, and guidelines (Source: [1])

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- “A discipline for living with the possibility that future events may cause harm, it reduces risks by identifying and controlling threats and vulnerabilities”



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- by (ISC)² (The International Information System Security Certification Consortium)

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- **Risk avoidance**

The practice of coming up with alternatives so that the risk in question is not realized

e.g., Parents won't allow their teenage child to drive the family car to avoid the risks of poor driving performance or the cost of insurance for the child

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- **Risk transfer**

The practice of passing on the risk in question to another entity, such as an insurance company

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- **Risk mitigation**

The practice of the elimination of, or the significant decrease in the level of risk presented



e.g., Organizations put measures in place such as firewalls, IDSs/IPSs, and other mechanisms to deter malicious outsiders from accessing personal and financial information to lessen the risk of exposing this highly sensitive and confidential information

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- **Risk acceptance**

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The practice of accepting certain risk(s), typically based on a business decision that may also weigh the cost versus the benefit of dealing with the risk in another way

- Identify vulnerabilities
- Identify threats
- Qualitative assessment
- Quantitative assessment
- Reporting findings
- Countermeasure selection
- Information valuation

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- Identify Vulnerabilities

- Vulnerability: “*a flaw or weakness in system security procedures, design, implementation, or in the way it is being used that could be exercised (accidentally triggered or intentionally exploited) and result in a security breach or a violation of the system security policy*” – by NIST (National Institute of Standards and Technology)

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- Examples of vulnerabilities

- Absence of a receptionist, mantrap, or other physical security mechanism upon entrance to a facility
- Inadequate integrity checking in financial transaction software
- Neglecting to require users to sign an acknowledgment of their responsibilities with regard to security, as well as an acknowledgment that they have read, understand, and agree to abide by the organization’s security policies
- Patching and configuration of an organization’s information systems are done on an ad hoc basis, and, therefore, are neither documented nor up to date

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- Identify Threats



- Threats: “*the potential for a particular threat-source to successfully exert a particular vulnerability*” – by NIST
- Threat source: “*either (1) intent and method targeted at the intentional exploitation of a vulnerability or (2) a situation and method that may accidentally trigger a vulnerability*” – by NIST

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- Threat source category



- **Human:** Malicious insider, (bio)terrorist, saboteur, spy, political or competitive, loss of key personnel, errors made by human intervention issues
- **Natural:** Fire, flood, tornado, hurricane, snow storm, earthquake
- **Technical:** Hardware failure, software failure, malicious code, unauthorized use of emerging services such as wireless, new technologies
- **Physical:** Closed-circuit TV failure, perimeter defence failure
- **Environmental:** Hazardous waste, biological agent, utility failure
- **Operational:** A process (manual or automated) that affects confidentiality, integrity, or availability

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Qualitative Assessment

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- Determination of likelihood and impact

- Likelihood and Consequences rating

Likelihood			
Rare (very low)	E	Insignificant (business is not disrupted)	1
Unlikely (low)	D	Minor (low – business is disrupted, some loss of confidence)	2
Moderate (medium)	C	Moderate (Medium – business is interrupted, less of confidence)	3
Likely (high)	B	Major (High – business is disrupted, major loss of confidence)	4
Almost Certain (very high)	A	Catastrophic (High – business cannot continue)	5



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- Likelihood Qualification—how to arrive at a Likelihood rating

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How to Qualify Likelihood	Rating
Skill (High skill level required → low or no skill required)	1 = high skill required → 5 = No skill required
Ease of Access (very difficult to do → very simple to do)	1 = very difficult → 5 = simple
Incentive (high incentive → Low incentive)	1 = low or no incentive → 5 = high incentive
Resource (requires expensive or rare equipment → no resources required)	1 = Rare/expensive → 5 = No resource required
Total (add rating and divide by 4)	1 = E, 2 = D, 3 = C, 4 = B, 5 = A

Qualitative Assessment

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- Determination of risk - the product of likelihood and impact

		Consequence		
	Insignificant	Moderate	Major	Catastrophic
Likelihood	1	3	4	5
A (<i>almost certain</i>)	H	H	E	E
B (<i>likely</i>)	M	H	H	E
C (<i>possible</i>)	L	M	H	H
D (<i>unlikely</i>)	L	L	M	H
E (<i>rare</i>)	L	L	M	H
E	Extreme Risk: Immediate action required to mitigate the risk or decide to not proceed QQ: 749389476			
H	High Risk: Action should be taken to compensate for the risk https://tutorcs.com			
M	Moderate Risk: Action should be taken to monitor the risk			
L	Low Risk: Routine acceptance of the risk			

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- Example



- An exploit has a likelihood of 4 (high) and an impact of 3 (moderate), what is the risk level?

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Answer: High risk Assignment Project Exam Help

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- **Single loss expectancy (SLE)**: the difference between the original value and the remaining value of an asset after a single exploit

$$\text{SLE} = \text{asset value (in \$)} \times \text{exploit rate} \times \text{loss in successful threat exploit, as \%}$$



- **Annualized rate of occurrence (ARO)**: an estimate of how often a threat will be successful in exploiting a vulnerability over the period of a year

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- **Annualized loss expectancy (ALE)**: a product of the yearly estimate for the exploit (ARO) and the loss in value of an asset after a single exploitation (SLE)

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$$\text{ALE} = \text{ARO} \times \text{SLE}$$

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- Example



- Company A's intellectual property on racing car design is worth \$600,000, the exposure factor is 80%, and the annualized rate of occurrence is 5%. What's the annualized loss expectancy?

Answer:

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$$\text{SLE} = \$600,000 \times 80\% = \$480,000$$

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$$\text{ALE} = \text{ARO} \times \text{SLE} = 5\% \times \$480,000 = \$24,000$$

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- Reporting findings

- Once the findings from the assessment have been consolidated and the calculations have been completed, it is time to present a finalized report to senior management



- Countermeasure selection

- Considerations for countermeasures

- Accountability (can be held responsible)
 - Auditability (can it be tested?)
 - Publicly available, simple design (the construction and the nature of the countermeasure are not secret)
 - Trusted source (source is known)
 - Independence (self-determining)
 - Consistently applied
 - Cost-effective
 - Reliable
 - Distinct from other countermeasures (no overlap)

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- Ease of use
- Minimum manual intervention
- Sustainable
- Secure
- Protects confidentiality, integrity, and availability of assets
- Can be “backed out” in event of issue
- Creates no additional issues during operation
- Leaves no residual data from its function



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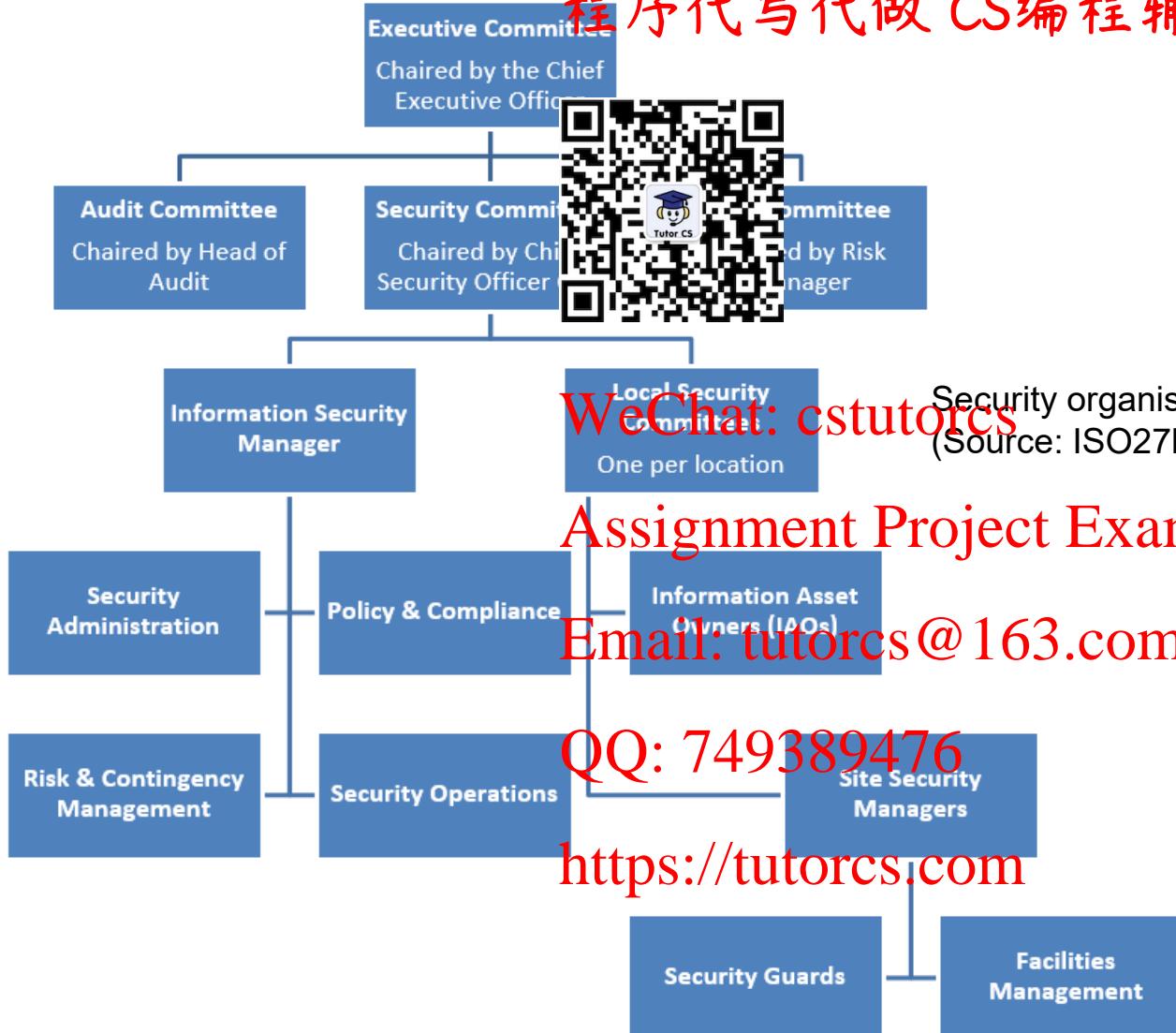
- Information valuation
 - Periodically attempt to properly value information assets, as information may lose its value
 - Over time
 - If it is modified, improperly disclosed
 - Not had its proper value calculated

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- Job rotation
- Separation of duties
- Least privilege
- Mandatory vacations
- Job position sensitivity
- Budget for Information Security Activities
- Policies, Procedures, Baselines, Standards, and Guidelines
- Security Awareness Program
- Understand Business Objectives



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- Maintain Awareness of Emerging Threats and Vulnerabilities
- Evaluate Security Incidents and Response
- Develop Security Compliance Program
- Establish Security Metrics
- Participate in Management Meetings
- Ensure Compliance with Government and Industry Regulations
- Assist Internal and External Auditors
- Stay Abreast of Emerging Technologies

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- Common computer ethics fallacies

- Computer game fallacy

- Computer users think that computers will generally prevent them from cheating



- Law-abiding citizen fallacy

- Sometimes users confuse what is legal with regard to computer use with what is reasonable behaviour for using computers. Laws basically define the minimum standard about which actions can be reasonably judged, but such laws also call for individual judgment

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- Shatterproof fallacy

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- Computer users believe that they can do little harm accidentally with a computer beyond perhaps erasing or messing up a file

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- Candy-from-a-baby fallacy

- Illegal and unethical acts, such as software piracy and plagiarism, are very easy to do with a computer. However, just because it is easy does not mean that it is right



- Hacker fallacy

- Numerous reports and publications of the commonly accepted hacker belief is that it is acceptable to do anything with a computer as long as the motivation is to learn and not to gain or make a profit from such activities

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- Free information fallacy

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- The notion that information “wants to be free” ignores the fact the copying and distribution of data are completely under the control of the author who allow it to happen

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- Sample code of conduct - (ISC)²

- Code of Ethics Pre

- Safety of the computer system, duty to our principals, and to each other requires that we must be seen to adhere, to the highest ethical standards of behaviour

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- Code of Ethics Canons

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- Protect society, the commonwealth, and the infrastructure
 - Promote and preserve public trust and confidence in information and systems
 - Promote the understanding and acceptance of prudent information security measures
 - Preserve and strengthen the integrity of the public infrastructure
 - Discourage unsafe practice

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- Act honourably, honestly, justly, responsibly, and legally
 - Tell the truth to stakeholders aware of your actions on a timely basis
 - Observe all laws and agreements, express or implied
 - Treat all constituents fairly. In resolving conflicts, consider public safety and duties to principals, individuals, and the profession in that order
 - Give prudent advice; avoid raising unnecessary alarm or giving unwarranted comfort. Take care to be truthful, objective, cautious, and within your competence
 - When resolving differing laws in different jurisdictions, give preference to the laws of the jurisdiction in which you render your service

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- Provide diligent and competent service to principals
 - Preserve the integrity of their systems, applications, and information
 - Respect the boundaries of the privileges that they grant you
 - Avoid conflicts of interest or the appearance thereof
 - Render only services for which you are fully competent and qualified

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- Advance and protect the profession
 - Sponsor for professional advancement those best qualified. All other things equal, prefer those who are certified and who adhere to these canons. Avoid professional association with those whose practices or reputation might diminish the profession
 - Take care not to injure the reputation of other professionals through malice or indifference
 - Maintain your competence to keep your skills and knowledge current. Give generously of your time and knowledge in training others



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- Security and Risk Management Practice
 - Explain relationships between security and risk management
- Information Security Management Governance
 - Describe risk management process and four risk management principles
 - Explain risk assessment process
 - Determine qualitative risks
 - Calculate quantitative risks
- Organizational Behaviour
 - Understand best practices
- Ethics
 - Explain common computer ethics fallacies

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- [1] Harold F. Tipton, 2010, *Official (ISC)2 guide to the CISSP CBK, Second Edition*, SciTec



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