

SECURE CODING GUIDELINES

```
5
6
7 class Unit(object):
8     def __init__(self, **kwargs):
9         self.name = kwargs.get("name")
10        self.damage = kwargs.get("damage")
11        self.armor = kwargs.get("armor")
12        self.hit_points = kwargs.get("hit_points")
13        self.current_hit_points = kwargs.get("current_hit_points")
14        self.level = kwargs.get("level")
15
16    def attack(self, enemy: "Unit") -> int:
17        """
18        Attack enemy unit. Return calculated damage.
19        """
20        damage_top_limit = self.damage * enemy.armor
21        calculated_damage = random.randint(1, damage_top_limit)
22        return calculated_damage
23
24    @staticmethod
25    def fight(unit1: "Unit", unit2: "Unit") -> bool:
26        """
27        Fight between two units. Return True if unit1 wins, False otherwise.
28        """
29        unit1.attack(unit2)
30        unit2.attack(unit1)
31        return unit1.current_hit_points > 0 and unit2.current_hit_points <= 0
```

Input Validation

Guidelines	Compliant
Conduct all data validation on a trusted system (e.g., The server)	
Identify all data sources and classify them into trusted and untrusted. Validate all data from untrusted sources (e.g., Databases, file streams, etc.)	
There should be a centralized input validation routine for the application	
Specify proper character sets, such as UTF-8, for all sources of input	
Encode data to a common character set before validating (Canonicalize)	
All validation failures should result in input rejection	
Determine if the system supports UTF-8 extended character sets and if so, validate after UTF-8 decoding is completed	
Validate all client provided data before processing, including all parameters, URLs and HTTP header content (e.g. Cookie names and values). Be sure to include automated post backs from JavaScript, Flash or other embedded code	
Verify that header values in both requests and responses contain only ASCII characters	
Validate data from redirects (An attacker may submit malicious content directly to the target of the redirect, thus circumventing application logic and any validation performed before the redirect)	
Validate for expected data types	
Validate data range	
Validate data length	
Validate all input against a "white" list of allowed characters, whenever possible	
If any potentially hazardous characters must be allowed as input, be sure that you implement additional controls like output encoding, secure task specific APIs and accounting for the utilization of that data throughout the application . Examples of common hazardous characters include: < > " ' % () & + \ \ ' \ "	
If your standard validation routine cannot address the following inputs, then they should be checked discretely 1. Check for null bytes (%00) 2. Check for new line characters (%0d, %0a, \r, \n) 3. Check for "dot-dot-slash" (../ or ..\) path alterations characters. In cases where UTF-8 extended character set encoding is supported, address alternate representation like: %c0%ae%c0%ae/ (Utilize canonicalization to address double encoding or other forms of obfuscation attacks)	

Output Coding

Guidelines	Compliant
Conduct all encoding on a trusted system (e.g., The server)	
Utilize a standard, tested routine for each type of outbound encoding	

Contextually output encode all data returned to the client that originated outside the application's trust boundary. HTML entity encoding is one example, but does not work in all cases	
Encode all characters unless they are known to be safe for the intended interpreter	
Contextually sanitize all output of un-trusted data to queries for SQL, XML, and LDAP	
Sanitize all output of un-trusted data to operating system commands	

Authentication and Password Management

Guidelines	Compliant
Require authentication for all pages and resources, except those specifically intended to be public	
All authentication controls must be enforced on a trusted system (e.g., The server)	
Establish and utilize standard, tested, authentication services whenever possible	
Use a centralized implementation for all authentication controls, including libraries that call external authentication services	
Segregate authentication logic from the resource being requested and use redirection to and from the centralized authentication control	
All authentication controls should fail securely	
All administrative and account management functions must be at least as secure as the primary authentication mechanism	
If your application manages a credential store, it should ensure that only cryptographically strong one-way salted hashes of passwords are stored and that the table/file that stores the passwords and keys is write-able only by the application. (Do not use the MD5 algorithm if it can be avoided)	
Password hashing must be implemented on a trusted system (e.g., The server).	
Validate the authentication data only on completion of all data input, especially for sequential authentication implementations	
Authentication failure responses should not indicate which part of the authentication data was incorrect. For example, instead of "Invalid username" or "Invalid password", just use "Invalid username and/or password" for both. Error responses must be truly identical in both display and source code	
Utilize authentication for connections to external systems that involve sensitive information or functions	
Authentication credentials for accessing services external to the application should be encrypted and stored in a protected location on a trusted system (e.g., The server). The source code is NOT a secure location	
Use only HTTP POST requests to transmit authentication credentials	
Only send non-temporary passwords over an encrypted connection or as encrypted data, such as in an encrypted email. Temporary passwords associated with email resets may be an exception	
Enforce password complexity requirements established by policy or regulation. Authentication credentials should be sufficient to withstand attacks that are typical of the threats in the deployed environment. (e.g., requiring the use of alphabetic as well as numeric and/or special characters)	
Enforce password length requirements established by policy or regulation. Eight characters is commonly used, but 16 is better or consider the use of multi-word pass phrases	
Password entry should be obscured on the user's screen. (e.g., on web forms use the input type "password")	

Enforce account disabling after an established number of invalid login attempts (e.g., five attempts is common). The account must be disabled for a period of time sufficient to discourage brute force guessing of credentials, but not so long as to allow for a denial-of-service attack to be performed	
Password reset and changing operations require the same level of controls as account creation and authentication.	
Password reset questions should support sufficiently random answers. (e.g., “favorite book” is a bad question because “The Bible” is a very common answer)	
If using email based resets, only send email to a pre-registered address with a temporary link/password	
Temporary passwords and links should have a short expiration time	
Enforce the changing of temporary passwords on the next use	
Notify users when a password reset occurs	
Prevent password re-use	
Passwords should be at least one day old before they can be changed, to prevent attacks on password re-use	
Enforce password changes based on requirements established in policy or regulation. Critical systems may require more frequent changes. The time between resets must be administratively controlled	
Disable “remember me” functionality for password fields	
The last use (successful or unsuccessful) of a user account should be reported to the user at their next successful login	
Implement monitoring to identify attacks against multiple user accounts, utilizing the same password. This attack pattern is used to bypass standard lockouts, when user IDs can be harvested or guessed	
Change all vendor-supplied default passwords and user IDs or disable the associated accounts	
Re-authenticate users prior to performing critical operations	
Use Multi-Factor Authentication for highly sensitive or high value transactional accounts	
If using third party code for authentication, inspect the code carefully to ensure it is not affected by any malicious code	

Session Management

Guidelines	Compliant
Use the server or framework’s session management controls. The application should only recognize these session identifiers as valid	
Session identifier creation must always be done on a trusted system (e.g., The server)	
Session management controls should use well vetted algorithms that ensure sufficiently random session identifiers	
Set the domain and path for cookies containing authenticated session identifiers to an appropriately restricted value for the site	
Logout functionality should fully terminate the associated session or connection	
Logout functionality should be available from all pages protected by authorization	
Establish a session inactivity timeout that is as short as possible, based on balancing risk and business functional requirements. In most cases it should be no more than several hours	

Disallow persistent logins and enforce periodic session terminations, even when the session is active. Especially for applications supporting rich network connections or connecting to critical systems. Termination times should support business requirements and the user should receive sufficient notification to mitigate negative impacts	
If a session was established before login, close that session and establish a new session after a successful login	
Generate a new session identifier on any re-authentication	
Do not allow concurrent logins with the same user ID	
Do not expose session identifiers in URLs, error messages or logs. Session identifiers should only be located in the HTTP cookie header. For example, do not pass session identifiers as GET parameters	
Protect server side session data from unauthorized access, by other users of the server, by implementing appropriate access controls on the server	
Generate a new session identifier and deactivate the old one periodically. (This can mitigate certain session hijacking scenarios where the original identifier was compromised)	
Generate a new session identifier if the connection security changes from HTTP to HTTPS, as can occur during authentication. Within an application, it is recommended to consistently utilize HTTPS rather than switching between HTTP to HTTPS.	
Supplement standard session management for sensitive server-side operations, like account management, by utilizing per-session strong random tokens or parameters. This method can be used to prevent Cross Site Request Forgery attacks	
Supplement standard session management for highly sensitive or critical operations by utilizing per-request, as opposed to per-session, strong random tokens or parameters	
Set the "secure" attribute for cookies transmitted over an TLS connection	
Set cookies with the HttpOnly attribute, unless you specifically require client-side scripts within your application to read or set a cookie's value	

Access Control

Guidelines	Compliant
Use only trusted system objects, e.g. server side session objects, for making access authorization decisions	
Use a single site-wide component to check access authorization. This includes libraries that call external authorization services	
Access controls should fail securely	
Deny all access if the application cannot access its security configuration information	
Enforce authorization controls on every request, including those made by server side scripts, "includes" and requests from rich client-side technologies like AJAX and Flash	
Segregate privileged logic from other application code	
Restrict access to files or other resources, including those outside the application's direct control, to only authorized users	
Restrict access to protected URLs to only authorized users	
Restrict access to protected functions to only authorized users	
Restrict direct object references to only authorized users	

Restrict access to services to only authorized users	
Restrict access to application data to only authorized users	
Restrict access to user and data attributes and policy information used by access controls	
Restrict access security-relevant configuration information to only authorized users	
Server side implementation and presentation layer representations of access control rules must match	
If state data must be stored on the client, use encryption and integrity checking on the server side to catch state tampering.	
Enforce application logic flows to comply with business rules	
Limit the number of transactions a single user or device can perform in a given period of time. The transactions/time should be above the actual business requirement, but low enough to deter automated attacks	
Use the "referer" header as a supplemental check only, it should never be the sole authorization check, as it is can be spoofed	
If long authenticated sessions are allowed, periodically re-validate a user's authorization to ensure that their privileges have not changed and if they have, log the user out and force them to re-authenticate	
Implement account auditing and enforce the disabling of unused accounts (e.g., After no more than 30 days from the expiration of an account's password.)	
The application must support disabling of accounts and terminating sessions when authorization ceases (e.g., Changes to role, employment status, business process, etc.)	
Service accounts or accounts supporting connections to or from external systems should have the least privilege possible	
Create an Access Control Policy to document an application's business rules, data types and access authorization criteria and/or processes so that access can be properly provisioned and controlled. This includes identifying access requirements for both the data and system resources	

Cryptographic Practices

Guidelines	Compliant
All cryptographic functions used to protect secrets from the application user must be implemented on a trusted system (e.g., The server)	
Protect master secrets from unauthorized access	
Cryptographic modules should fail securely	
All random numbers, random file names, random GUIDs, and random strings should be generated using the cryptographic module's approved random number generator when these random values are intended to be un-guessable	
Cryptographic modules used by the application should be compliant to FIPS 140-2 or an equivalent standard. (See http://csrc.nist.gov/groups/STM/cmvp/validation.html)	
Establish and utilize a policy and process for how cryptographic keys will be managed	

Error handling and Logging

Guidelines	Compliant
Do not disclose sensitive information in error responses, including system details, session identifiers or account information	
Use error handlers that do not display debugging or stack trace information	
Implement generic error messages and use custom error pages	
The application should handle application errors and not rely on the server configuration	
Properly free allocated memory when error conditions occur	
Error handling logic associated with security controls should deny access by default	
All logging controls should be implemented on a trusted system (e.g., The server)	
Logging controls should support both success and failure of specified security events	
Ensure logs contain important log event data	
Ensure log entries that include un-trusted data will not execute as code in the intended log viewing interface or software	
Restrict access to logs to only authorized individuals	
Utilize a master routine for all logging operations	
Do not store sensitive information in logs, including unnecessary system details, session identifiers or passwords	
Ensure that a mechanism exists to conduct log analysis	
Log all input validation failures	
Log all authentication attempts, especially failures	
Log all access control failures	
Log all apparent tampering events, including unexpected changes to state data	
Log attempts to connect with invalid or expired session tokens	
Log all system exceptions	
Log all administrative functions, including changes to the security configuration settings	
Log all backend TLS connection failures	
Log cryptographic module failures	
Use a cryptographic hash function to validate log entry integrity	

Data Protection

Guidelines	Compliant
Implement least privilege, restrict users to only the functionality, data and system information that is required to perform their tasks	
Protect all cached or temporary copies of sensitive data stored on the server from unauthorized access and purge those temporary working files as soon as they are no longer required.	
Encrypt highly sensitive stored information, like authentication verification data, even on the server side. Always use well vetted algorithms, see "Cryptographic Practices" for additional guidance	
Protect server-side source-code from being downloaded by a user	

Do not store passwords, connection strings or other sensitive information in clear text or in any non-cryptographically secure manner on the client side. This includes embedding in insecure formats like: MS viewstate, Adobe flash or compiled code	
Remove comments in user accessible production code that may reveal backend system or other sensitive information	
Remove unnecessary application and system documentation as this can reveal useful information to attackers	
Do not include sensitive information in HTTP GET request parameters	
Disable auto complete features on forms expected to contain sensitive information, including authentication	
Disable client side caching on pages containing sensitive information. Cache-Control: no-store, may be used in conjunction with the HTTP header control "Pragma: no-cache", which is less effective, but is HTTP/1.0 backward compatible	
The application should support the removal of sensitive data when that data is no longer required. (e.g. personal information or certain financial data)	
Implement appropriate access controls for sensitive data stored on the server. This includes cached data, temporary files and data that should be accessible only by specific system users	

Communication Security

Guidelines	Compliant
Implement encryption for the transmission of all sensitive information. This should include TLS for protecting the connection and may be supplemented by discrete encryption of sensitive files or non-HTTP based connections	
TLS certificates should be valid and have the correct domain name, not be expired, and be installed with intermediate certificates when required	
Failed TLS connections should not fall back to an insecure connection	
Utilize TLS connections for all content requiring authenticated access and for all other sensitive information	
Utilize TLS for connections to external systems that involve sensitive information or functions	
Utilize a single standard TLS implementation that is configured appropriately	
Specify character encodings for all connections	
Filter parameters containing sensitive information from the HTTP referer, when linking to external sites	

System Configuration

Guidelines	Compliant
Ensure servers, frameworks and system components are running the latest approved version	
Ensure servers, frameworks and system components have all patches issued for the version in use	
Turn off directory listings	
Restrict the web server, process and service accounts to the least privileges possible	
When exceptions occur, fail securely	
Remove all unnecessary functionality and files	

Remove test code or any functionality not intended for production, prior to deployment	
Prevent disclosure of your directory structure in the robots.txt file by placing directories not intended for public indexing into an isolated parent directory. Then "Disallow" that entire parent directory in the robots.txt file rather than Disallowing each individual directory	
Define which HTTP methods, Get or Post, the application will support and whether it will be handled differently in different pages in the application	
Disable unnecessary HTTP methods, such as WebDAV extensions. If an extended HTTP method that supports file handling is required, utilize a well-vetted authentication mechanism	
If the web server handles both HTTP 1.0 and 1.1, ensure that both are configured in a similar manor or insure that you understand any difference that may exist (e.g. handling of extended HTTP methods)	
Remove unnecessary information from HTTP response headers related to the OS, web-server version and application frameworks	
The security configuration store for the application should be able to be output in human readable form to support auditing	
Implement an asset management system and register system components and software in it	
Isolate development environments from the production network and provide access only to authorized development and test groups. Development environments are often configured less securely than production environments and attackers may use this difference to discover shared weaknesses or as an avenue for exploitation	
Implement a software change control system to manage and record changes to the code both in development and production	

Database Security

Guidelines	Compliant
Use strongly typed parameterized queries	
Utilize input validation and output encoding and be sure to address meta characters. If these fail, do not run the database command	
Ensure that variables are strongly typed	
The application should use the lowest possible level of privilege when accessing the database	
Use secure credentials for database access	
Connection strings should not be hard coded within the application. Connection strings should be stored in a separate configuration file on a trusted system and they should be encrypted.	
Use stored procedures to abstract data access and allow for the removal of permissions to the base tables in the database	
Close the connection as soon as possible	
Remove or change all default database administrative passwords. Utilize strong passwords/phrases or implement multi-factor authentication	
Turn off all unnecessary database functionality (e.g., unnecessary stored procedures or services, utility packages, install only the minimum set of features and options required (surface area reduction))	
Remove unnecessary default vendor content (e.g., sample schemas)	
Disable any default accounts that are not required to support business requirements	

The application should connect to the database with different credentials for every trust distinction (e.g., user, read-only user, guest, administrators)	
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File Management

Guidelines	Compliant
Do not pass user supplied data directly to any dynamic include function	
Require authentication before allowing a file to be uploaded	
Limit the type of files that can be uploaded to only those types that are needed for business purposes	
Validate uploaded files are the expected type by checking file headers. Checking for file type by extension alone is not sufficient	
Do not save files in the same web context as the application. Files should either go to the content server or in the database.	
Prevent or restrict the uploading of any file that may be interpreted by the web server.	
Turn off execution privileges on file upload directories	
Implement safe uploading in UNIX by mounting the targeted file directory as a logical drive using the associated path or the chrooted environment	
When referencing existing files, use a whitelist of allowed file names and types. Validate the value of the parameter being passed and if it does not match one of the expected values, either reject it or use a hard coded default file value for the content instead	
Do not pass user supplied data into a dynamic redirect. If this must be allowed, then the redirect should accept only validated, relative path URLs	
Do not pass directory or file paths, use index values mapped to pre-defined list of paths	
Never send the absolute file path to the client	
Ensure application files and resources are read-only	
Scan user uploaded files for viruses and malware	

Memory Management

Guidelines	Compliant
Utilize input and output control for un-trusted data	
Double check that the buffer is as large as specified	
When using functions that accept a number of bytes to copy, such as strncpy(), be aware that if the destination buffer size is equal to the source buffer size, it may not NULL-terminate the string	
Check buffer boundaries if calling the function in a loop and make sure there is no danger of writing past the allocated space	
Truncate all input strings to a reasonable length before passing them to the copy and concatenation functions	
Specifically close resources don't rely on garbage collection. (e.g., connection objects, file handles, etc.)	
Use non-executable stacks when available	
Avoid the use of known vulnerable functions (e.g., printf, strcat, strcpy etc.)	
Properly free allocated memory upon the completion of functions and at all exit points	

General Coding Practices

Guidelines	Compliant
Use tested and approved managed code rather than creating new unmanaged code for common tasks	
Utilize task specific built-in APIs to conduct operating system tasks. Do not allow the application to issue commands directly to the Operating System, especially through the use of application initiated command shells	
Use checksums or hashes to verify the integrity of interpreted code, libraries, executables, and configuration files	
Utilize locking to prevent multiple simultaneous requests or use a synchronization mechanism to prevent race conditions	
Protect shared variables and resources from inappropriate concurrent access	
Explicitly initialize all your variables and other data stores, either during declaration or just before the first usage	
In cases where the application must run with elevated privileges, raise privileges as late as possible, and drop them as soon as possible	
Avoid calculation errors by understanding your programming language's underlying representation and how it interacts with numeric calculation. Pay close attention to byte size discrepancies, precision, signed/unsigned distinctions, truncation, conversion and casting between types, "not-a-number" calculations, and how your language handles numbers that are too large or too small for its underlying representation	
Do not pass user supplied data to any dynamic execution function	
Restrict users from generating new code or altering existing code	
Review all secondary applications, third party code and libraries to determine business necessity and validate safe functionality, as these can introduce new vulnerabilities	
Implement safe updating. If the application will utilize automatic updates, then use cryptographic signatures for your code and ensure your download clients verify those signatures. Use encrypted channels to transfer the code from the host server	

Source: OWASP SCP



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